EFFECTS OF PROSODY AND CONTEXT ON THE COMPREHENSION OF SYNTACTIC AMBIGUITY IN ENGLISH AND KOREAN

DISSERTATION

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ABSTRACT

This study investigates how prosodic and contextual information affects the way syntactically ambiguous sentences in English and Korean are understood in spoken language comprehension. English materials used include rarely studied present participial constructions. Korean materials include a type of relative clause that contains empty pronouns as one of arguments, a structure that was never examined before. When these sentence materials were presented without biasing contexts, results showed that prosodic phrasing largely determined meaning assignment. These results extended previous research that demonstrated prosodic effects on syntactically ambiguous structures. Results from experiments that manipulated both prosodic and contextual information showed that prosodic information was still effective even in the presence of biasing contextual information. Taken together, these results demonstrate the robust effect of prosodic information and necessitate the inclusion of prosodic component in any model of spoken language processing.
To my family.
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CHAPTER 1

INTRODUCTION

1.1 Ambiguity, context, and prosody

This dissertation investigates the role of prosody in the parsing of syntactically ambiguous sentences, both in and out of the context. An example of syntactically ambiguous sentences in English is provided in (1).

(1) Mary saw the cop with binoculars.
    a. Mary used binoculars to see the cop.
    b. Mary saw the cop that was holding binoculars.

As seen in (1a) and (1b), the same string of words can be interpreted in two different ways and thus used to describe two distinct events that may not be compatible with each other. Furthermore, that possibility of multiple interpretations comes from the fact that a certain string of words in the sentence (with binoculars in the above example) can be grouped differently with respect to the other words in the same sentence. In (1a), with binoculars is more associated with the verb saw whereas in (1b), the same phrase is grouped more closely with the immediately preceding noun cop (see more discussion in English materials section in this chapter). In technical terms, we call the first instance a high attachment and the second one a low attachment. This kind of multiple analyses and interpretations of the same string of words arising from the possibility of multiple structural grouping of some words is referred to as syntactic or structural ambiguity. This kind of ambiguity is different from the ambiguity originating from homophony – i.e., when a word form such as bank can have more than one meaning as shown in (2).
I’m going to the bank.
   a. I’m going to the financial institution where I keep my money.
   b. I’m going to the riverside.

Given that the listener detects two different meanings, the next thing to do is to decide which of the two the sentence means. In the decision process, various considerations are relevant, such as whether the event described by each analysis is more plausible, whether the type of the ambiguous phrase with binoculars is more often used to describe one or the other event, and whether one or the other analysis is simpler or more complicated in terms of grammatical structure. Then, based on whatever seems more important, either (1a) or (1b) may be chosen, but not both since the sentence cannot describe both events simultaneously. However, what if our sentence above has a follow-up as seen in (3)?

(3) Mary saw the cop with binoculars.
   However, she was not sure whether she identified the cop because the binoculars were not good enough.

The second sentence makes it clear that the first sentence should mean (1a). In this case, the syntactic ambiguity is resolved by the subsequent context. In fact, most of the time, we language users do not feel at a loss about which meaning to select, even when encountering ambiguous sentences such as (1). That’s because it is rare that we encounter an isolated sentence either in every day conversation or in a written context. The context where each possibly ambiguous sentence occurs provides information rich enough for us to narrow down our analyses to the most likely interpretation as seen in (3).

Suppose now that instead of reading the binoculars sentence, you are listening to a conversation of which the above sentence is part. Is there something else that we can and/or must consider in the selection of the ultimate meaning of an ambiguous sentence? The answer is yes, as will be detailed soon, and often times, that information can play a critical role (that is what this study will argue). What is, then, that additional information we need to consider in spoken language? Without going into the technical details, which will be provided later, I can suggest the following. When you speak, your utterance is not a monotoneous sequence of consonant and vowel sounds. Rather,
it has a certain rhythmic structure, characterized by different rhythmic grouping of words and pitch prominence on some words. This rhythmic structure will be called the intonation of the utterance or more technically the prosodic structure. There can be multiple possible prosodic patterns for the same sentence depending on many factors. Our binoculars sentence above can be uttered in many different ways. For example, the sentence in (1) may be produced to have a prosodic grouping as in (4a) or (4b).  

(4) a. [Mary saw the cop] [with binoculars].  
    b. [Mary saw] [the cop with binoculars].

The questions that this dissertation addresses are: Will the way we utter this sentence have anything to do with the way we interpret it in spoken language? Furthermore, if so, will that still be effective in the presence of a disambiguating context within which the ambiguous sentence is embedded?

The first question has been answered positively as proven by the last 30 years of research demonstrating the effects of prosodic information on resolving syntactic ambiguity. In fact, the results of this research have been robust enough to be attested with different experimental measures, including auditory comprehension measures (Lehiste 1973; Schafer, Speer, Warren, and White 2000; Schafer, Speer, and Warren 2005; Warren, Schafer, Speer, and White 2000; Price, Ostendorf, Shattuck-Huffnagel, and Fong 1991; Warren, Grabe, and Nolan 1995), cross-modal naming times (Marslen-Wilson, Tyler, Warren, Grenier, and Lee 1992; Kjelgaard and Speer 1999), Event-Related Potentials (ERP) (Steinhaur, Alter, and Friederici 1999), and eye-movement monitoring analyses (Snedeker and Trueswell 2003). The results using ERP or eye-movements as the experimental measure lend more credibility to prosodic effects as they allow implicit measurements of processing, and use uninterrupted materials without a secondary task.

However, most of the studies so far have presented the target ambiguous sentences with differing prosody in isolation. What if those ambiguous sentences were presented along with a prior context? Given that it is rare to encounter sentences without any contexts, it will be interesting to see how prosodic information interacts with a disambiguating context in exerting its influence on resolving syntactic ambiguity. As seen in example (3), context can prove very effective in resolving any

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1A square bracket is used to indicate the prosodic grouping.
type of ambiguity. In fact, analysis of the Buckeye Speech Corpus (available at http://vic.psy.ohio-state.edu) shows that many words were pronounced with deletion of sounds and syllables, but we can assume that these conversations flowed with little difficulty in understanding. This demonstrates the power of context in conversation. In other words, even in these cases with incomplete articulation of words, the reason that conversational partners experience little difficulty is that from the context, they can infer information that was needed for understanding but was not adequately provided.

If this is the case, what is the relationship between contextual information and prosodic information? For our binoculars sentence, instead of being read, if it is spoken out loud with a specific intonation pattern as in (4), will it be predominantly interpreted in one way or the other? Or due to a bias present in the context, will the information from the intonation pattern be ignored? We could assume one of two extreme positions and say either that prosodic information is not utilized whenever other contextual cues are available or that prosodic information dominates in determining meanings for otherwise ambiguous strings even in the presence of other sources of information. Of course, it is possible that the two sources interact with each other and both are used by the comprehension system.

The purposes of this study are, first, to build on the previous studies in showing prosodic effects in the resolution of syntactic ambiguity, and second, to test the robustness of prosodic information in resolving syntactic ambiguity in the presence of previously presented contexts. In doing so, this study will test not only English but also Korean, which is a completely different language typologically, most relevantly regarding their syntactic and prosodic properties (see sections in this chapter for English and Korean prosodic structures and for syntactic properties of relevant constructions for English and Korean). Most of previous studies on this topic center around English, and there are only a few studies that examine Korean (Jun and Oh 1996; Schafer and Jun 2002; Kang and Speer 2002, 2004, 2005; Kim 2004). A cross-linguistic examination will allow us to evaluate the hypothesis to be tested in a more general way.

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2 This corpus contains 40 hours of free conversations between interviewers and 40 speakers from Columbus, Ohio.
In addition, demonstrating that prosodic information is still effective in resolving syntactic ambiguity when there is other contextual information will add strong evidence to the existing work that demonstrated the importance of prosody in spoken language processing.

There are several reasons why this study is worth doing. For one thing, much debate in sentence processing has been devoted to whether discourse and/or semantic factors as well as syntactic information have any impact on initial parsing. Some studies show that referential constraints in a prior discourse (Crain and Steedman 1985; Altmann and Steedman 1988), previous biasing contexts (Britt, Perfetti, Garrod, and Rayner 1992), or thematic role expectations within the same sentence (Taraban and McClelland 1988) can be immediately used to guide initial parsing of ambiguous prepositional phrases. Others, on the other hand, failed to find evidence for the immediate use of discourse factors, and thus claimed that the use of contextual information was delayed (Ferreira and Clifton 1986; Clifton and Ferreira 1989; Rayner, Garrod, and Perfetti 1992). These prior studies are mostly reading studies in English and so the current study will provide an interesting comparison from spoken language.

An additional motivation for the current study comes from the fact that most of the studies on prosodic disambiguation on syntactic ambiguity are limited to one of three types of syntactic ambiguity. Ambiguous prepositional phrases have been studied by Lehiste (1973), Schafer, Speer, and Warren (2005), Warren, Schafer, Speer, and White (2000), Warren (1985), and by Price, Ostendorf, Shattuck-Huffnagel, and Fong (1991). Early/late closure ambiguity has been studied by Warren (1985), Kjelgaard and Speer (1999), Slowiaczek (1991), Speer, Kjelgaard, and Dobroth (1996), Blodgett (2004), and finally NP/S ambiguity in English has been investigated by Warren (1985), Beach (1991), Stirling and Wales (1996), Marslen-Wilson, Tyler, Warren, Grenier, and Lee (1992), Watt and Murray (1996), and by Nagel, Shapiro, Tuller, and Nayy (1996). An example of ambiguous prepositional phrases is already given in our binoculars sentence. Examples of early/late closure ambiguity and NP/S ambiguity are provided in (5) and (6).

(5) When Roger leaves the house . . . .
   a. When Roger leaves the house, it’s dark. (late closure)
   b. When Roger leaves, the house is dark. (early closure)
(6) Jay believed the gossip . . .
   a. Jay believed the gossip about the neighbours right away. (NP object of the main verb)
   b. Jay believed the gossip about the neighbours wasn’t true. (S of the embedded clause)

In this dissertation, a different type of constructions will be examined—namely, participial constructions in English like those in (7) and relative clauses that contain an empty pronoun, pro, in Korean such as (8).

(7) Aaron followed a poor guy drinking his soda.

(8) Yenghun-ika ipwonjungi-n pyoungwon-ul pangmwunha-ysse.
     Yenghun-NOM hospitalized-REL hospital-ACC visit-PAST
     a. Yenghun visited the hospital where (pro) was hospitalized. (embedded pro interpretation)
     b. (pro) visited the hospital where Yenghun was hospitalized. (main pro interpretation)

By examining constructions that have received only limited attention (for English) and a novel type of ambiguous structure (for Korean), this study will corroborate existing evidence for, and thus lend more generality to, prosodic effects on syntactic disambiguation.

Finally, looking at both English and Korean will allow us to look for a more general principle to be applicable cross-linguistically. The results of this study will provide a valuable opportunity to examine availability of information from contexts and prosodic structures as well as syntactic structures in parsing. In a more general context, this will provide more detailed evidence for the process by which information other than syntactic structure is used during sentence comprehension.

The remaining chapters will discuss the following. Chapter 2 discusses a written pre-test and an auditory listening comprehension experiment for English participial constructions presented in isolation. Chapter 3 discusses the same participial constructions with a slight modification to make the constructions temporarily ambiguous. Since these constructions were presented along with a prior context in one of the experiments, another written pre-test was conducted first to ensure the intended bias of each context. This is followed by a discussion of a cross-modal naming experiment and an auditory listening comprehension experiment conducted with the presentation of contexts. Chapter 4 discusses a written pre-test and an auditory listening comprehension study that
tested Korean ambiguous sentences in isolation. In Chapter 5, results from a written pre-test and an auditory listening comprehension study that include contextual manipulation are discussed. Finally, Chapter 6 concludes the dissertation.

In the remainder of this chapter, first, intonation models for American English (section 1.2) and Seoul Korean (section 1.3) to be assumed in this dissertation will be discussed. This discussion is followed by previous studies that examined prosodic effects in both production and comprehension (section 1.4), three processing accounts that investigated prosodic effect on the comprehension of ambiguous sentences (section 1.5), and finally English (section 1.6) and Korean materials (section 1.7) to be used in this dissertation.

1.2 Prosodic structures of American English

In a model of English intonation developed by Pierrehumbert and her colleagues (Pierrehumbert 1980; Pierrehumbert and Beckman 1988; Beckman and Pierrehumbert 1986), an intonation contour of each utterance consists of the sequence of two tonal targets, Low and High. This is a phonological model in that different combinations of these tones and the types of tones along with prosodic junctures used give rise to meaning differences and that there can be different surface phonetic realizations of these tone targets.

The tones that comprise an intonation contour can be categorized into three distinct types; pitch accents, phrase accents and boundary tones, each of which has a different type of association to the syllables of a sentence. Each multi-syllabic English word has strong and weak syllables, which group together in pairs to comprise a foot. When there is more than one foot within a word, one of them bears the primary stress in citation forms (Beckman 1996). These stressed syllables contribute to tonal patterns of an intonation contour of an utterance. In other words, stressed syllables are the ones that bear pitch prominence of a certain word although not every stressed syllable gets prominence in an utterance. This pitch prominence of stressed syllables in an utterance is called a pitch accent. Pitrelli, Beckman, and Hirschberg (1994) listed five different types of tones (H*, L*, L+H*, L*+H, H+!H*) that can be anchored to stressed syllables of prominent words.
Unlike pitch accents linked to specific syllables of words, phrase accents notated as H- or L- are loosely associated with some point after the last pitch-accented syllable (called the nuclear pitch accent) and control pitch contours between boundary tones and the last pitch accents. Finally, boundary tones (H% or L%) are aligned with the last syllable of the biggest prosodic unit to be discussed below.

In addition to pitch prominence described above, a juncture or break in an utterance is another component of an utterance to be addressed in an intonation model. The intonation model being discussed here assumes that an utterance is organized in a hierarchical way with the assumption of Strict Layer Hypothesis (Selkirk 1984; Nespor and Vogel 1986; Hayes 1984), which states that a prosodic constituent at one level in a hierarchy is exhaustively parsed into the next lower level of a constituent. In this intonation model, each utterance consists of one or more Intonation Phrases (IP henceforth). The edge of this boundary is marked by one of boundary tones (transcribed as H% or L%) associated with the final syllable of a word that comes at the edge and the syllable that comes at this edge is typically lengthened (Warren 1985; Wightman, Shattuck-Hufnagel, Ostendorf, and Price 1992, among others) and optionally followed by a pause. An IP can consist of one or more prosodic units of a lower level in the hierarchy. This unit, an intermediate phrase (ip, henceforth), can have more than one prosodic word but should have at least one pitch accent. The edge of this ip is demarcated by one of phrase accents (H- or L-).

The existence of these prosodic units was supported by phonetic and perceptual evidence. For example, Keating, Cho, Fougeron, and Hsu (2004) found the strengthening of initial consonants at the initial positions of prosodic constituents. In addition, Price, Ostendorf, Shattuck-Hufnagel, and Fong (1991) found that the duration of certain syllables at prosodic boundaries increased, as the level of prosodic break indices got bigger. A corpus study on glotalization of vowels provided another piece of phonetic evidence for the different levels of prosodic units. Dilley, Shattuck-Hufnagel, and Ostendorf (1996) found that there was a significant difference in the degree of vowel glottalization among the vowels at non-phrase initial positions, the beginning of intermediate phrases and the beginning of Intonation Phrases.

Mary Beckman, however, pointed out that there are syllables that are not included in any foot in Pierrehumbert and Beckman (1988)’s model.
1.3 Prosodic structures of Seoul Korean

Jun (1993) developed a phonological model based on the model of intonation developed by Pierrehumbert and her colleagues (Pierrehumbert 1980; Pierrehumbert and Beckman 1988; Beckman and Pierrehumbert 1986, among others). In the discussion of English prosodic structure in the previous section, we assumed the hierarchical nature of English intonation structure. Likewise, according to Jun’s model, the intonational structure of Korean is also organized hierarchically. Each utterance consists of one or more Intonation Phrases (IP hereafter), which in turn is composed of one or more Accentual Phrases (AP henceforth). Each AP can have one or more phonological words (lexical items followed by case markers or postpositions). In addition, Korean intonation structure also follows the Strict Layer Hypothesis (Selkirk 1984; Nespor and Vogel 1986; Hayes 1984); each IP is exhaustively parsed into a sequence of APs and the boundary of an IP coincides with the boundary of an AP, which in turn coincides with a word boundary.

Each AP has a tonal pattern demarcating the beginning and the end of the phrase. Jun posited that the underlying tonal pattern of an AP in Seoul Korean is Low High Low High (LHLH). However, the initial L tones are subject to segmental effects and so when the phrase-initial segment is either aspirated or tense, this L is replaced by an H. Thus, the two underlying tonal patterns of an AP in Seoul Korean are LHLH or HHLH (let’s represent this as THLH covering both) depending on the feature of the initial segment. These four tones are all realized when there are enough syllables to associate the four tones with but some of the tones are undershot when the number of syllables is less than four. When these tones are undershot, there are various surface tonal patterns for an AP. Depending on which of the medial tones (HL in THLH) are undershot, Jun (2005) summarized that there can be five different tonal patterns; LH (or HH for the HHLH), LLH (or HLH), LHH (or HHH, the same as HH). To make things more complicated, the AP final H tone is sometimes, although not very often, realized as an L tone, which means that there can be 14 tonal patterns. According to Jun (2005), the exact conditioning of different tonal realizations is not clear and besides, there does not seem to be a contrast in meaning.

An IP, the biggest prosodic unit in Korean intonation hierarchy, can consist of one or more APs as pointed out above. An IP final tone is realized on the final syllable in the IP. It has been
suggested that there are at least 9 boundary tones (L%, H%, LH%, HL%, LHL%, HLH%, HLHL%, LHLH%, LHLHL%) (Jun 2005). One of these boundary tones replaces the AP final tone when that AP final tone coincides with the end of an IP. The use of different boundary tones can carry information on various pragmatic meanings as well as the sentence type. Again, there is no one-to-one mapping between each boundary tone and the meaning.

One of the most important factors that affects prosodic phrasings is the focusing of certain words. Unlike English, where pitch accent placement typically marks focus, Korean prosodic phrasings are obligatorily affected by focus (Jun 1993). According to Jun, focus sets off a word from a preceding phrase, creates a phrase boundary between the focused word and the preceding word, and dephrases the words following it until a new focused word is reached.

1.4 Previous studies on the use of prosodic and contextual information in production and comprehension

1.4.1 Studies that found that prosodic information is redundant

The claim that prosodic information is not utilized, or that its use is reduced, when other sources of information are available will be best summarized by Straub (1997)’s ‘Contingent (Prosodic) Cue-ing’ Hypothesis. According to this hypothesis, in production, prosodic cues to syntactic structure are produced by speakers only when there is no contextual information available that can be used to restrict the possible interpretations into the correct one. On the comprehension side, the hypothesis predicts that in the presence of contextual information that can be used for resolving ambiguity, listeners do not make use of prosodic information for facilitated comprehension.

Indeed, the production study of Cooper and Paccia-Cooper (1980) showed that disambiguating contexts could reduce prosodic cues in producing ambiguous sentences. In an analysis of duration of segments in a constituent-final position, Cooper and Paccia-Cooper found that a reduction in durational contrasts was observed when the same sentences such as (9) that contains an ambiguous prepositional phrase with a handicap were presented in disambiguating contexts compared to when they were read in isolation. These results were also replicated by Straub (1997).
(9) Lieutenant Baker instructed the troop with a handicap.

As another factor that can modulate prosodic cues produced by speakers, Allbritton, McKoon, and Ratcliff (1996) claimed that the awareness of ambiguity could affect the extent to which naive speakers provide prosodic cues to ambiguous sentences. In their production study, various types of ambiguous target sentences were embedded in disambiguating contexts and speakers were either informed or uninformed of the ambiguity. It was found that only in the informed setting, where the ambiguity was pointed out, did speakers produce pronounced prosodic cues.

Similar findings were reported by Fox Tree and Meijer (2000). Just like uninformed speakers of Allbritton et al. (1996), speakers of Fox Tree and Meijer were not told of the ambiguity of target sentences embedded in disambiguating contexts. Examples are provided in (10) and (11) 4.

(10) Toni went deep sea diving in the Pacific Ocean. She saw a man-eating fish. It scared her.

(11) Jenny went to the Seafood restaurant. She saw a man eating fish. He seemed to like it.

Productions from these speakers were presented to listeners, who identified which of the two passages each prosodic version of the target sentence came from. In the first perception experiment, the overall average response that correctly guessed the contexts from which the target spoken utterances came reached only 51%. In the second perception experiment, each prosodic version was spliced into appropriate and inappropriate contexts and listeners were asked a comprehension question about the entire context. Their results showed that when prosodic and contextual information did not match with each other, listeners relied more on contextual information, thus ignoring prosodic cues. Hence, their results seemed to show that both speakers and listeners do not always utilize prosodic information when other cues are available.

Results from Snedeker and Trueswell (2003) were consistent with Allbritton et al. (1996) and Fox Tree and Meijer (2000). The awareness of ambiguity resulted in differences in the extent of prosodic cues produced by speakers for ambiguous prepositional sentences such as (12).

4As will be explained later in section (1.6), items such as the one in these examples are in fact more ambiguous than given here, which may cause a problem in producing matched syntactic and prosodic structure.
12 Tap the frog with a flower.
   a. Use a flower to tap the frog. (high-attached)
   b. Tap the frog that was holding a flower. (low-attached)

As before, the prepositional phrase *with a flower* can be used as an instrument to perform the tapping or as a modifier of the immediately previous noun *frog* to indicate which frog among multiple ones was tapped. For this type of ambiguous sentence, two “referential” contexts were created by different arrangements of toy objects. The first referential context supported both meanings of the prepositional phrase. That is, in the set of objects speakers saw, there was a frog that was holding a miniature flower, an unmarked frog that was not holding anything, a full scale flower (the target instrument), and some distracter objects. In this context, the target instrument *the flower* can be used instrumentally to tap *the frog*, supporting the high-attached reading. On the other hand, since there were two frogs in the display of objects, the definite noun phrase *the frog* needs the following modifier to be able to uniquely identify one single frog among the two, which makes the low-attached reading felicitous. In this setup, which supported both interpretations, it was highly likely that speakers noticed the ambiguity of the sentence, as was confirmed by a post-experiment questionnaire.

In the second referential context, each speaker saw only one of two displays; in one such display, the most critical difference from the first context was that there was only one frog, which was not holding anything. In this case, it is easy to interpret the prepositional phrase as an instrument, because the definite noun phrase could uniquely identify the referent, and thus it is less likely for the prepositional phrase to be used as a modifier to pick out one single referent. Hence, this display was highly biased toward the high-attached reading. On the other hand, in the other display, there were two frogs, one of which was not holding anything, and the other was holding a small flower. In addition, there was no full scale flower intended as a target instrument. This time, since there were two possible referents for the definite noun phrase, the definite noun phrase itself could not uniquely identify one single referent. Thus, in this case, it is more likely for the prepositional phrase to be used as a modifier, biasing toward the low-attached interpretation.
In creating the environment for producing utterances, Snedeker and Trueswell differentiated themselves from other studies mentioned in this section. Instead of having their speakers read target sentences in a laboratory setting without any interactions with listeners, Snedeker and Trueswell came up with the following procedure. First, the experimenter demonstrated an action to the speaker. Next, the speaker produced the target sentence to the listener to describe the action demonstrated by the experimenter. To limit the possible number of sentences to be produced, each target sentence was written on a card, from which speakers read those sentences. Finally, the listener performed the action of the target sentence produced by the speaker.

The analysis of prosodic cues produced by speakers from these two different contexts showed that speakers from the first context, who had noticed the ambiguity of target sentences since the context supported both interpretations, provided clearer prosodic cues than speakers from the second context, which was highly biased toward one or the other reading. In the second, highly biased context, since the referential context made only one interpretation highly likely, and thus disambiguated the target sentence, prosodic cues were made “unnecessary” in Snedeker and Trueswell’s term. This led Snedeker and Trueswell to conclude that production of reliable prosodic cues for syntactic disambiguation depend, at least partly, on speakers’ awareness of ambiguity. However, this conclusion may not be without controversy. Kraljic and Brennen (2005), to be discussed in the next section, used a similar experimental design but failed to replicate the results of Snedeker and Trueswell. Kraljic and Brennen attributed this difference to the fact that in the second context of Snedeker and Trueswell, speakers had to produce target sentences for only one meaning repeatedly and this repetition may have reduced the extent of prosodic cues. Other authors (Schafer, Speer, and Warren 2005) note that Snedeker and Trueswell’s sentences were very short so that substantial prosodic breaks would be less likely, and that the production task involved reading, which prompts speech that is quite different from that produced spontaneously.

In summary, all of these studies mentioned in this section claimed that prosodic marking for syntactic disambiguation is not consistent; such cues are either reduced or rendered unnecessary when there is contextual information that can resolve syntactic ambiguity or when speakers are unaware of the ambiguity. The results of these studies contrast sharply with the ones from work

There may be several possible reasons for this discrepancy but one of the most probable reason might be the environment and method to gather the production data. In most studies mentioned in this section except possibly Snedeker and Trueswell, speakers read target sentences in a laboratory setting without any interaction with possible listeners. Furthermore, even if Snedeker and Trueswell’s speakers were not in a laboratory setting and did partner with listeners, these speakers still read target sentences from scripted cards, and their interactions with listeners were limited because two parties were separated by a screen and there was no feedback from the listeners. This may not be a natural conversational setting, which might have affected the way in which and the extent to which speakers produced prosodic cues. Indeed, production studies (Ayers 1994) showed some of the differences between read and spontaneous speech in terms of prosodic structures: there were fewer and shorter pauses and fewer prosodic phrases in read speech. As will be discussed in the next section, unlike the studies mentioned in this section, Schafer and her colleagues designed a more natural, quasi-spontaneous environment for speakers while controlling the possible kinds of sentences to be produced.

Furthermore, one study (Fox Tree and Meijer 2000) did not even provide analyses of the produced materials. This made it impossible to compare the prosodic structure for one interpretation to the one for another interpretation. Another problem with Fox Tree and Meijer worth mentioning is their selection of test materials. It had been found in previous studies that some types of ambiguous sentences are not prosodically resolved. This is true especially of those with ambiguity in deep structure (Lieberman 1967; Lehiste 1973; Wales and Toner 1979). According to the previous findings, when structures differ only in terms of labels on brackets (i.e., NP, VP) in syntactic phrase structures but not in the bracketing itself, prosodic disambiguation is not possible. The example in (13) is one of the most commonly cited examples to illustrate this point.
Flying planes can be dangerous.

In this example, *Flying planes* can refer to either the act of flying planes or planes that are flying. In the former, the label would be some kind of gerundival verb phrase whereas the latter would be labeled as an noun phrase. Still, in both cases, the whole phrase functions as the subject of the sentence and has two immediate daughters.

In the Fox Tree and Meijer study, three out of twelve types belong to this category and the example in (13) is precisely one of those used in their experiment. In addition, some of the sentences used in this study seem to be those for which prosodic effects were not attested in the literature (for example, (10) and (11) mentioned before). In fact, the string *She saw a man eating fish* can be analyzed in too many different ways. For one thing, as the authors in Fox Tree and Meijer were using, as long as there is a dash between *man* and *eating*, the phrase *man eating* can be a compound that functions as a modifier of the following noun *fish* (Compound reading). When there is no such dash, this sentence still has three-way ambiguity (Noncompound reading) (for the details, see section 1.6 in this chapter). The paraphrases for the three are provided below.

(14) *She saw a man eating fish.*
   a. She saw a man who was eating fish.
   b. She saw an event of a man eating fish.
   c. While she was eating fish, she saw a man.

Although there is little semantic difference between (14a) and (14b), there are some tests to show that these two belong to two different syntactic structures (see the discussion in section 1.6). However, (14c) is clearly distinct from the other two meanings. The problem of uncertainty between these two sets aside, the more problematic is the following scenario. Previous studies (see Price et al. 1991) showed that prosodic marking of sentence (14c) is quite distinct from (14a) and/or (14b). When the sentence in (14) was intended for (14c), a relatively larger prosodic break tended to occur immediately before *eating*. On the other hand, the prosodic break tended to occur somewhere else when (14a) or (14b) was intended. The author suspects that the compound reading should be more similar to (14a) or (14b) than to (14c). Since Fox Tree and Meijer compared the compound meaning in (10) and (14a) and/or (14b), if the prosodic structure for the compound reading is more
similar to (14a) or (14b) than to (14c), it is not surprising that speakers of their study did not provide contrastive prosodic cues in their production. Unfortunately, two out of twelve sentences in Fox Tree and Meijer’s study belong to this type. It is an interesting question as to whether the compound reading in (10) and readings in (14a) or (14b) should differ in terms of prosody, but at the least, care needs to be taken in selecting test materials.

1.4.2 Studies that showed consistent use of prosodic cues

In contrast to studies mentioned previously, studies to be discussed in this section showed that speakers and listeners utilized prosodic cues regardless of the availability of other sources of information.

In Lehiste (1973), speakers produced various types of ambiguous sentences in two occasions. The first recording was made without speakers’ being told about ambiguity and after the production of each sentence speakers were asked what meaning they had in mind. Then, additional two recordings were made after they were told about the ambiguity and allowed to make conscious efforts to disambiguate. The perception study in Lehiste showed that 10 out of 15 sentences were disambiguated at above chance level (overall 62.19%). Interestingly, there was not much difference in correct identification between utterances without conscious efforts to disambiguate and utterances produced with explicit instructions for prosodic disambiguation.

Price, Ostendorf, Shattuck-Huffnagel, and Fong (1991) showed similar results. Speakers from this study were not told of the ambiguity of target sentences embedded in a biasing context, which would be comparable to the second referential context of Snedeker and Trueswell, where the display was highly biased toward one meaning and most speakers were not aware of the ambiguity. We already saw that this context produced less prosodic cues by speakers in Snedeker and Trueswell.

To examine how their speakers produced these materials, Price et al. first conducted a perception experiment. In their perception experiment, participants listened to the spoken target sentences presented in isolation and then were asked to choose one of the two disambiguating contexts, which were written out for each target sentence. Two measurements were taken in this perception study; accuracy (the percentage of correct responses) and confidence (the percentage of the time
that participants said that they were confident of the response choices. Overall, the results showed that listeners were able to identify two separate meanings based on prosody. The average for all sentence types and all speakers showed that the overall accuracy reached 84% while confidence got a little lower score, 52%. This, in turn, implies that speakers were able to encode prosodic cues to the correct interpretations of those ambiguous sentences, even when the context provided cues for the disambiguation and even when they were not told of the ambiguity.

In addition, Price et al. conducted analyses of prosodic breaks and pitch prominences (see the discussion in 1.2). Overall, prosodic breaks assumed a more important role, and often, they were the only cue available to resolve syntactic ambiguity. Pitch prominence seemed to play a supporting role. Sometimes, when one version of the pair was produced with a prosodic pattern that would be more compatible with the alternative reading, listeners opted to choose prosodic cues rather than context in order to assign the ultimate meaning. This demonstrated a very convincing role for prosody, and is exactly opposite of the findings of Fox Tree and Meijer (2000).

The difficulty with a production study lies in the fact that it is hard to create an ideal situation. This ideal situation means that the utterances produced are spontaneous and typical of everyday conversations, but at the same time carefully controlled for the sentence types used so that various renditions of the otherwise same syntactic structures can be contrasted. Typically, many of previous production studies elicited utterances from read speech which was often produced by professional speakers (such as trained phoneticians or professional radio announcers used in Price et al. 1991). Allbritton et al. (1996) argued that read speech from the lab setting is different from spontaneous speech, and so that the results cannot generalize to naive speakers who are not aware of ambiguity. The work by Schafer and her colleagues (Schafer, Speer, Warren, and White 2000; Warren, Schafer, Speer, and White 2000; Schafer, Speer, and Warren 2005), however, is designed to avoid many of the problems inherent in previous studies.

Recognizing that there is a difference between the prosody of read speech and that of spontaneous speech, Schafer and her colleagues designed a cooperative board game task in an effort to mimic a normal everyday conversational setting as much as possible. In addition, to control the sentence types to be used by the speakers, they invented the following procedures. Each game was
played by two players, the “Driver” and the “Slider”. They were only able to use expressions from the written list. The list contained ambiguous sentences although the speakers were not told of the ambiguity. These expressions were used to negotiate and confirm the movements of the game pieces. Although the sentences they produced were based on written sentence ‘frames’, as players became familiar with the game, they were able to produce sentences fluently without looking at the text. Therefore, although their speech was not totally spontaneous, their utterances can be said to be comparable to productions from normal conversations in terms of communicative purpose.

Like Price et al., Schafer and her colleagues were also interested in whether speakers would mark ambiguous sentences with distinct prosodic structures when there was other information available to resolve the ambiguity. In contrast to Price et al., instead of manipulating linguistic contexts, Schafer and her colleagues created two different types of situational contexts using game board pieces and game board configuration. The first kind, involving the contrast of game pieces, is discussed below and sentences were of the form in (15) and (16).

(15) I want to change the position of the square with the triangle.

(16) I want to change the position of the square with the cylinder.

Just like the sentence introduced in the beginning of this chapter, both of these sentences contain ambiguous prepositional phrases (with the triangle and with the cylinder). Both prepositional phrases can potentially be attached to the verb phrase headed by change (high-attached), in which case the prepositional phrases are used as an instrument to change the position of the square. Alternatively, the prepositional phrases can be attached to the noun phrase headed by the noun square (low-attached), in which case the square with the triangle or the square with the cylinder would refer to one piece.

However, the set of game pieces that the players used allowed ambiguity only in (15). In other words, in addition to two separate objects called the square and the triangle, there was a third object that had a shape of a house that could be called the square with the triangle. Thus, for sentence (15), both high-attached and low-attached meanings were possible; the separate object the triangle could be used instrumentally to change the position of another separate object the
square (high-attached) or the position of the house-shaped object the square of the triangle could be changed (low-attached). On the other hand, sentence (16) has only the high-attached meaning because there was no one piece that could be called the square with the cylinder.

The second type of situational ambiguity had to do with how the game board was configured. That is, during the course of the game, depending on the availability of certain movements of game pieces, three different levels of ambiguity were created; truly ambiguous contexts where both interpretations are equally likely, contexts biased toward one or the other interpretation where the prepositional phrase the triangle was more likely to be used instrumentally to move the square because of a prior move in the game, and unambiguous contexts where a rule of the game allowed only one legal move, resulting in only one meaning.

Like Price et al., Schafer and her colleagues performed phonetic and phonological analyses of the utterances and also checked listeners’ interpretation in the perception experiment. The results from the analyses from the production part showed clear prosodic differences for distinct meanings regardless of the levels of situational ambiguity and whether there was ambiguity or not. For the high-attached reading, longer durations of square, pause, and combined duration of square and pause were observed and this reading tended to have the strongest prosodic boundary before the ambiguous prepositional phrases in ambiguous, biased and unambiguous contexts. Moreover, the situational ambiguity resulting from the game piece contrast did not affect the prosodic disambiguation; the duration of square, of pause and of the combined duration of square plus pause in (15) and (16) did not differ.

In summary, the analyses of the production data confirmed the idea that speakers mark syntactic difference in terms of prosodic structure and that this is not affected by whether they gather disambiguating information from the context or by whether there is ambiguity. Based on these results, Schafer and her colleagues argued “production of sentence prosody is primarily controlled by grammatical factors, such as phonosyntactic constraints relating prosodic form to syntactic form, phonological constraints governing the length or weight of prosodic units, and semantic/pragmatic constraints relating information/discourse structure and prosody.”
The comprehension study using productions by the Driver also found that listeners were correctly able to identify with the syntactic structures regardless of where the utterances came from; from ambiguous, unambiguous or biased situations. Using a quasi-spontaneous setting, this study effectively demonstrated that naive speakers do produce prosodic cues in all situations that can be used effectively by listeners.

Work by Kraljic and Brennen (2005) replicated the results of Schafer and her colleagues just mentioned. Kraljic and Brennen also created a similar, quasi-spontaneous situation where speakers instructed listeners to move certain objects in the display. Just as the players in the work of Schafer and her colleagues did, participants in this study freely interacted with each other. This study differs from work by Snedeker and Trueswell (2003) or by Schafer and her colleagues in the way utterances were elicited from speakers. We saw before that because it is difficult to gather naturally produced sentences that are also controlled to study ambiguity, Snedeker and Trueswell and Schafer and her colleagues had to have speakers produce sentences from a written script. Unlike these studies, the study by Kraljic and Brennen used pictorial guides to make speakers produce similar, syntactically ambiguous sentences such as (17). Again, this sentence contains an ambiguous prepositional phrase *in the basket* that can be high-attached as the goal of the verb or low-attached as a modifier of the previous noun. The only constraint was that speakers had to start with their sentences either *put* or *place*. Hence, this study seems to be closer to an actual conversational setting in terms of communicative purposes and the extent of naturally produced utterances.

(17) Put the dog *in the basket* on the star.
   a. Put the dog in the basket that’s on the star. (high-attached)
   b. Put the dog that’s in the basket on the star. (low-attached)

Kraljic and Brennen also tested whether prosodic cues for these ambiguous sentences are modulated by referential situation or speakers’ awareness of ambiguity. That is, similar to the differing situational ambiguity in the work by Schafer and her colleagues, the arrangements of objects displayed supported one or both interpretations.

In addition, by having switching the role of the speaker and the listener, Kraljic and Brennen examined whether the awareness of ambiguity affected the way speakers produced prosodic cues.
The results of their production data showed that speakers provide disambiguating prosodic cues regardless of situational ambiguity or the awareness of ambiguity, replicating the results of Schafer and her colleagues.

In summary, these studies showed that speakers do produce prosodic cues regardless of whether they were aware of the ambiguity or regardless of the availability of other sources of information. In the next section, three recent processing accounts that examined prosodic effects on the comprehension of ambiguous sentences are introduced.

1.5 Processing accounts of prosodic effects on comprehension

In this section, three recent processing accounts that examined prosodic effects in comprehension will be introduced. Since the ambiguity of prepositional phrases has been extensively studied, most of the discussion will revolve around this type of ambiguity. However, it is possible to apply these accounts to other types, too.

1.5.1 Schafer (1997)

In a spoken language comprehension, there is a large body of work that has demonstrated prosodic effects on the interpretation of ambiguous prepositional phrases (Lehiste 1973; Price et al. 1991; Schafer 1997; Warren et al. 2000; Schafer et al. 2005; Kraljic and Brennen 2005; Snedeker and Trueswell 2003). All of these studies agree that the presence of the biggest prosodic break before the ambiguous prepositional phrase as in (18a) seems to inhibit the attachment of the prepositional phrase to the preceding noun phrase, resulting in more high attachment readings.  

(18)  a. \[[The bus driver angered the rider]\_ip [with a mean look]\_ip.  
   b. \[[The bus driver angered]\_ip [the rider with a mean look]\_ip

\(^5\)Although Schafer used the term ‘Phonological Phrase’ in her description, this prosodic unit is comparable to an intermediate phrase in the model of Pierrehumbert and her colleagues. Hence, intermediate phrases, notated as ‘ip’, are used throughout this study.
On the other hand, if the biggest prosodic break occurs somewhere except before the ambiguous prepositional phrase as in (18b), the low attached reading is enhanced. Schafer (1997) proposed the following Prosodic Visibility Hypothesis to account for this pattern.

(19) Prosodic Visibility:
   a. The phonological phrasing of an utterance determines the visibility of syntactic nodes.
   b. Nodes within the phonological phrase currently being processed are more visible than nodes outside of that phonological phrase; visibility is gradient across multiple phonological phrases.
   c. In first analysis and reanalysis, attachment to a node with high visibility is less costly in terms of processing/attentional resources than attachment to a node with low visibility.

This hypothesis predicts the preference for the low-attached reading in (18b) in the following way. There are two attachment sites, *angered* (high-attached) or *the rider* (low-attached), for the ambiguous prepositional phrase *with a mean look*. With the prosodic phrasing in (18b), the prepositional phrase is within the same phonological phrase (ip in the example) as one of the two target attachment nodes, *the rider*. Since this node is more visible to the prepositional phrase than the other attachment node, *angered*, attachment to the noun phrase is less costly than to the verb, resulting in the preference for the low-attached reading.

On the other hand, the following prediction follows from the hypothesis for the prosodic phrasing in (18a). Because the ambiguous prepositional phrase *with a mean look* is separated by a phonological phrase from both *angered* and *the rider*, both attachment sites now get less visible to the prepositional phrase. Thus, according to the hypothesis, attachment of the prepositional phrase to either site should be equally costly and so the hypothesis itself does not predict a preference to either site.

However, both intuition and experimental results including Schafer’s indicated the presence of a preference to the high-attached reading with the prosodic phrasing in (18a). To account for this effect, Schafer had to rely on the ‘default’ reading, claimed to be found in the realm of written language comprehension, because previous studies found the overall preference for the high-attached reading for ambiguous prepositional phrases in written language (Frazier 1987; Rayner, Carlson,
and Frazier 1983; Ferreira and Clifton 1986, among others). Therefore, the preference for attachment of ambiguous prepositional phrases with the prosodic phrasing such as in (18a) in Schafer’s system is decided by what would be the default reading and does not fall directly from the hypothesis.

Overall, Schafer’s model emphasizes the importance of global prosodic structures rather than local prosodic cues such as the ones before ambiguous phrases. Although this emphasis nicely captures the low-attached case, the model critically has to rely on the presence of ‘default’ reading. Later, we will see how this reliance on the default reading makes a wrong prediction regarding the materials to be examined in this dissertation.

1.5.2 Watson and Gibson (2005)

If Schafer’s hypothesis provided a better account of an easier integration of an ambiguous phrase within the same prosodic phrase, Watson and Gibson (2005)’s Anti Attachment Hypothesis, stated below, suggests that the break-up of a phrase that does not form a constituent should make processing easier.

(20) Anti-Attachment Hypothesis (AAH):

Listeners prefer not to attach an incoming word to a lexical head that is immediately followed by an intonational boundary.

Thus, according to this hypothesis, for sentence (18a), because of the presence of the prosodic boundary, listeners prefer not to attach the following prepositional phrase to the preceding noun phrase. Although this hypothesis predicts the non-local attachment of the prepositional phrase, it does not directly predict the high-attached reading. The hypothesis works only when there are only two attachment sites, the low and high attachment. If the ambiguous phrase is not attached locally into the immediately preceding constituent, then it is automatically attached to the other remaining site. However, Blodgett (2004) showed that listeners still attached the post-Intonation Phrase materials into the constituent containing the immediately preceding lexical head. In addition, in chapters discussing English materials, we will see why the AAH hypothesis cannot handle the case when there are two possible attachment sites other than the local one.
Recently, Blodgett proposed a spoken language processing model that incorporates prosodic effects in the tradition of constraint-based models (Altmann and Steedman 1988; Taraban and McClelland 1988; Britt 1994; Boland 1997; Sedivy and Spivey-Knowlton 1994; MacDonald, Pearlmuter, and Seidenberg 1994, among others). In constraint-based models, multiple syntactic analyses are generated at the point of ambiguity. The selection of one analysis is guided not only by syntactic information but also by other non-syntactic type of information including frequency, semantic/pragmatic plausibility, among others.

Blodgett (2004) assumes Boland (1997)’s model among variants of these constraint-based models. In this model, among multiple syntactic alternatives generated for ambiguous points, one analysis is selected by the syntactic processor although other alternatives will be reactivated when information compatible with those alternatives arrives. Following an assumption in a constraint-based model, the selection process is governed by various factors including syntactic and semantic ones. Blodgett adds to this model a phonological processor, which will generate an abstract prosodic structure. When selecting one analysis to pursue, the parser looks at how good the match between the prosodic structure and possible syntactic structures is. This constraint, called ‘goodness-of-fit’ will add weights to the analysis that has a matching prosodic and syntactic structure and that analysis will be selected. This model correctly predicts a preference for either reading for the sentence in (18). The prosodic break immediately before the prepositional phrase is a better match for the high-attached reading since the prepositional phrase does not form a constituent with the previous noun. On the other hand, the presence of the prosodic break before the noun phrase but not before the prepositional phrase matches better with the structure where the prepositional phrase is a part of the noun phrase constituent. This way, the preference for either interpretation for the sentence in (18) falls directly from Blodgett’s model.
1.6 English materials

An example of the constructions to be used for English experiments is repeated here as (21) below with the relevant ambiguous part italicized and with two possible interpretations.  

(21) Aaron, followed a poor guy drinking his soda.
   a. Aaron was drinking his soda. (high attached reading)
   b. A poor guy was drinking his soda. (low attached reading)

Since these constructions have received very little attention in either written or spoken sentence processing literature, first, a detailed account for their syntactic properties will be provided. Next, we will also see how they behave similarly to or differently from prepositional phrases, which exhibit a similar type of standing ambiguity. Next, I discuss a possible confusion with constructions that are similar to participial constructions only in the surface structure, and the procedure used to select only a homogenous set of materials for inclusion in this study.

The syntactic ambiguity of these constructions comes from the nonfinite “-ing” form of a verb in English. In fact, not only “-ing” but also “-ed” form allows the same type of ambiguity as can be seen in (22).

(22) Aaron went home with his friends disappointed at the results of the game.

However, in this study, only “-ing” form is used to exclude any possible differences in terms of attachment behavior between these two forms. As can be seen in the example, the agent of the action denoted by the ambiguous participial phrase can be coindexed with two different nouns that precede the phrase. The low attached reading in (21b), where the agent is coindexed with the preceding noun, is uncontroversial and is very similar to English relative clauses. The high attached reading as in (21a), called ‘free adjuncts’ by Stump (1981) and Kortmann (1991), mostly have the subject in the matrix clause as the agent, although Kortmann (1991) suggests that this coindexation with the matrix subject is not a syntactic phenomenon but a semantically and/or pragmatically driven one.

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6In the example, a third possible interpretation is that the possessive his can be coindexed with neither of the subject Aaron nor a poor guy. However, that kind of coreference is much less likely in the absence of contextual support.
This type of high/low attachment ambiguity is often considered to be in the same class of standing ambiguities in sentence processing as prepositional phrase ambiguity as exemplified in (23), the type of which we saw in the beginning of this chapter.

(23) Mary saw the cop with binoculars.

Again, the ambiguous prepositional phrase with binoculars can be interpreted in two different ways. When the prepositional phrase is attached to the verb phrase (“high attached”), with binoculars is interpreted as an instrument of seeing. When the same prepositional phrase is attached into the object noun phrase (“low attached”), it indicates that the cop is in possession of the binocuulars.

This similarity between participial phrases and prepositional phrases regarding two possible interpretations and attachments will be most clearly illustrated by syntactic tree structures provided in figures in (24) for participial phrases and (25) for prepositional phrases.  

Version (a) in both figures shows participial phrases and prepositional phrases placed somewhat high in the tree and associated more with the verb phrases of the sentences than the immediately preceding noun. Participial phrases behave similarly to prepositional phrases in that sense although later in Chapter three, I will raise a question on the status of this high-attached participial phrases. On the other hand, in version (b) in both figures, the participial phrase and the prepositional phrase modify the immediately preceding noun and are attached in a lower position in the tree. It seems that we can claim without much doubt that this low-attached structure functions as a modifier of the immediately preceding noun.

Despite the similarity between these two constructions, while prepositional phrases have been widely studied for prosodic disambiguation (Schafer 1997; Straub 1997; Schafer, Speer, and Warren 2005; Snedeker and Trueswell 2003, among others), participial constructions have been given little attention in the literature; the only exception was the study by Price, Ostendorf, Shattuck-Huffnagel, and Fong (1991).

7These tree structures are mainly for illustrative purposes, especially contrasting the high and low attached reading. However, in the literature on prepositional phrases in particular, slightly different structures may be encountered. Still, the point remains that there are two possible sites that both participial phrases and prepositional phrases can land in the syntactic tree.
Figure 1.1: Two tree structures for ambiguous participle phrases
Regarding the selection of materials, I would like to mention a possible confounding factor and explain the procedure taken to exclude that possibility. There were two types of constructions that were deliberately excluded from the test materials, both of which have the same surface structure of “Subject V Object -ing” as the test materials such as (21) given previously. This sequence can be analyzed in multiple ways depending on the type of the main verb used. We already saw that in example (21), the ambiguous participial phrase *drinking his soda* can be attached to the verb...
phrase for the high attached reading or the previous noun phrase for the low attached reading. For this type, it seems that there is little bias toward one or the other meaning due to the meaning of the main verb.

However, the two types to be discussed shortly, which share the same surface structure as the one in (21), seem to be either biased toward a particular structure and meaning or allow more than two possible interpretations. The example for the first type is presented in (26).

(26) Aaron kept a delivery man waiting in the hallway.

This type of sentence does not fall into the same category as the one under discussion. First, the sentence in (26) does not allow the high attached interpretation without changing the meaning of the main verb kept, unlike the one in (21). In other words, if waiting in the hallway is high-attached and describes the action of the subject Aaron as in (27), the main verb kept does not mean ‘causing to continue in a given state, situation, or action’ as in (26) any more but means ‘holding or retaining something in one’s possession’.

(27) Waiting in the hallway, Aaron kept a delivery man.

Secondly, it may look as though the relation between a delivery man and waiting in the hallway is similar to the reading in (21b) in that the one that is waiting in the hallway was a delivery man. However, there are some syntactic differences between (21b) reading and (26). In the account of Head-Driven Phrase Structure Grammar (Pollard and Sag 1994), the object noun a delivery man does not form a constituent with the following participial phrase waiting in the hallway in example (26), unlike the sequence of the noun phrase and the participial phrase in (21) does, as shown in (24b). Rather, the noun phrase a delivery man and the participial phrase waiting in the hallway in (26) are considered two separate complements of the main verb kept. There are some tests that can be applied to distinguish these two constructions as given in the following.

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8 However, these two are claimed to form a constituent in GB theory and are called a small clause in that tradition. See Chapter 5 in (Pollard and Sag 1994) for the detailed arguments for treating these types of non-finite forms as complements of a verb.
(28)  

a. pro-form replacement  
   i. Aaron followed him. (replacing a poor guy drinking his soda by him does not change  
      the meaning of the verb)  
   ii. Aaron kept him. (replacing a delivery man waiting in the hallway by him changes the  
      meaning of kept)  

b. fronting  
   i. A poor guy drinking his soda was followed by Aaron. (no meaning change in followed  
      is preserved)  
   ii. A delivery man waiting in the hallway was kept by Aaron. (meaning change in kept)  

c. the insertion of wh-pronoun be  
   i. Aaron followed a poor guy who was drinking his soda. (no meaning change in followed)  
   ii. Aaron kept a delivery man who was waiting in the hallway. (meaning change in kept)  

d. passivization of the NP  
   i. * A poor guy was followed drinking his soda by Aaron. (bad if this is intended to mean  
      that the subject a poor guy was drinking his soda)  
   ii. A delivery man was kept waiting in the hallway by Aaron.

The distinction in the status of the participial phrases in (21b) and (26) can be seen by comparing  
the tree structure for (21) in the figure in (24b) to the one for (26) shown in the figure in (29).  

(29)  

Figure 1.3: The tree structure for the sentence in (26)

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9I follow the assumption in HPSG that complements of a verb are attached as a sister to the lexical head (in this case, the  
verb) whereas adjuncts are attached as sisters to a phrasal category.
However, although the structures in (26) and (24b) are syntactically distinct from each other, ultimate meanings in terms of the agenthood of the participial phrases may not be differentiated; in both cases, the noun phrases that precede the participial phrases denote the agents of the actions denoted by the participial phrases. Besides, since the sentence in (26) does not allow the high attached reading without changing the meaning of the main verb but (29) and (24b) cannot be distinguished regarding the agenthood of the participial phrases, it is possible to say that (26) is biased toward the meaning that is similar to the low attached reading in (21b). Hence, this type of sentence was not used in the experiments to be discussed.

The other sentence type that was deliberately excluded from the test materials contains a subset of verbs called “perception verbs” as the main verb. Some of these verbs allow more ambiguity than necessary. Not only do they allow two structures as in (24) but they can also manifest the structure in (29). Examples of these verbs include see, watch, hear, among others. For the example in (30), three disambiguated versions for this sentence are provided.

(30) Mary saw a cop jumping wildly.
   a. While jumping wildly, Mary saw a cop.
   b. Mary saw a cop who was jumping wildly.
   c. Mary saw an event of a cop jumping wildly.

That is, the sentence in (30) can have three different syntactic structures and interpretations. The first one in (30a) is the same as (24a), the high attached reading, while the one in (30b) illustrates (24b), the low attached reading. The third one, although very similar to (30b) in its ultimate meaning, in fact, illustrates the same structure as in (29). The difference between keep type verb and see is that unlike keep, the latter allows all three meanings without changing the meaning of the verb. Again, we can make a syntactic distinction (but probably not a truth-conditional semantic one) between (30b) and (30c) using passivization as in below.

(31) a. A cop jumping wildly was seen by Mary.
    b. A cop was seen jumping wildly by Mary.
Furthermore, if the participle does not have any complements or adjuncts with it in that participial phrase, further distinction between (30b) and (30c) can be made by the following way; we can put the participle in front of a noun for the structure (30b) such as Mary saw a jumping cop but not for (30c). In addition, we can put the two structures in (30b) and (30c) together and have the following sentence.

(32) Mary saw a cop jumping wildly wielding a piece of paper.
   a. Mary saw a cop who was jumping wildly wielding a piece of paper.
   b. A cop jumping wildly was seen wielding a piece of paper by Mary.

In this example, the first “-ing” is being used as a modifier of the previous noun whereas the second “-ing” is a separate complement of the main verb. 10 Unlike a verb such as keep we saw above, this syntactic difference seems to have been neutralized semantically, according to Quirk, Greenbaum, Leech, and Svartvik (1985) 11 without changing the meaning of the main verb, since truth-conditionally, (30b) and (30c) do not seem to be different. The only difference I can think of is that in (30b), the focus (in a very naive sense) seems to be on a cop because the participle, as a modifier, is being used to restrict the set of a cop to the subset of a cop that has the property of jump. On the other hand, in (30c), it is the whole event where a cop was jumping that seems to be more emphasized. 12

The reasons that this type of sentence needs to be excluded include, first, avoiding any unknown bias that might be present in these types of materials. A second, related reason is that although it is a very interesting question whether (30b) and (30c) can be differentiated prosodically, in the absence of any prior studies that tested these three structures empirically regarding prosodic effects, it is not desirable to test materials that may confound two separate syntactic structures into one without knowing what structures listeners have in mind. Furthermore, it seems to be a safe

10However, it is possible to use both participles as a modifier of the noun since in theory it is possible to stack modifiers.

11There is, however, a case where the two structures are clearly distinguished from each other for their ability to take certain kinds of lexical adjectives. Unlike participial phrases in (30), which can precede or follow a noun phrase, certain lexical adjectives cannot occur after a noun phrase, that is, as a verbal complement. Thus, it is OK to say “Mary saw a red barn.” but it is not OK to say “Mary saw a barn red.”. Note that this is not about lexical adjectives being unable to follow a noun phrase in general because you can say ‘Mary kept her lunch warm.’

12I thank Kirk Baker, Jianguo Li, and Vanessa Metcalf for a helpful discussion on this.
assumption that each separate syntactic structure can have a distinct prosodic structure although it does not have to, and thus, excluding these materials was a wiser choice. The previous criticism of Fox Tree and Meijer (2000), therefore, in section 1.4 is consistent with this decision. Their examples in (33) are precisely the type we have been discussing so far.

(33)  a. She saw a man-eating fish.
      b. She saw a man eating fish.

The first one in (33a) is intended for the compounding reading for *man-eating*, which together modifies the following noun *fish*. On the other hand, the second one in (33b) can be analyzed as either (30b) or (30c), both of which will fit with their contexts. For one thing, we do not know yet whether the compound reading can be distinguished from their second example. Even if we assume that the compound reading is distinct from the second example, we cannot tell whether the compound reading is distinct from (30b) structure or (30c) structure. Three out of ten of Fox Tree and Meijer (2000)’s test sentences belonged to this type.

The actual process of eliminating these two types of verbs (“keep” type and “perception” verbs) was as follows; first, a set of possible experimental sentences were constructed. Then, these materials were reviewed by native speakers of English 13 with the passivization test especially to exclude the possibility of the structure in (29), which has a very similar to low attachment meaning. Any sentences that were judged to pass the passivization test mentioned in (28d) were excluded.

With these syntactic properties in mind for our participial phrases as well as similarities to ambiguous prepositional phrases, it will be interesting to see which interpretation is preferred for these materials. In a written context, various parsing strategies (Late Closure in Frazier 1987; Recency in Gibson 1991; Attach Low in Abney 1989, among others) under the rubric of local attachment preference predict that low attachment will be preferred for our test materials. In other words, attaching incoming participial phrases to the immediately preceding noun phrase that is being built will be more favored than attaching it to the higher verb phrase. This contrasts with the preference for the high-attached reading of ambiguous prepositional phrases mentioned in section (1.5.1).

13My thanks go to the fellow grad students in Shari Speer’s psycholinguistics lab.
Although participial constructions were not studied extensively compared to prepositional phrases in spoken language processing, a few researchers casually noted the shift in their meaning modulated by prosodic manipulation. Stump (1981), Quirk et al. (1985) and Kortmann (1991), for example, all observed that the high attached reading is characterized by a pause or a fall in intonation immediately before the participial phrase (Stump 1981, pg. 3). As mentioned in section 1.4, to my knowledge, Price et al. (1991) was the first study that tested these constructions empirically although they used only a few items in their production and perception experiment, as provided in (34).

(34) Laura ran away with the man wearing a green robe.

Interesting comparative work worth mentioning include the ones by Misono, Mazuka, Kando, and Kiritani (1997) and Kang and Speer (2005). These two studies examined materials similar to the current English participial constructions in Japanese (Misono et al. 1997) and Korean (Kang and Speer 2005), respectively. In a Japanese example from Misono et al. (1997) provided in (35), the first predicate zu bunureni-natte (“drenched-become”) is ambiguous because it can either describe the action of the main subject shoonen-wa (“the boy”) or of the noun that follows, koinu-o (“puppy”), resulting in a similar high/low attachment ambiguity to the ambiguity of English participial phrases.

(35) Shoonen-wa zu bunureni-natte kakemawaru koinu-o oikaketa .
Shoonen-tōp drenched become run around puppy-acc ran after
a . The boy, becoming drenched, ran after the running puppy.
   b . The boy ran after the puppy that was drenched and running around.

In this study, the presence of the IP boundary immediately after the initial noun phrase resulted in more (35b) readings whereas the IP boundary immediately after the first, ambiguous predicate zu bunureni-natte, resulted in more (35a) readings. Similar results were found for comparable Korean materials in Kang and Speer (2005). In sum, in all three studies, Price et al. (1991), Misono et al. (1997), and Kang and Speer (2005), either in English or in Japanese or Korean, similar
prosodic effects were found that are compatible with other studies; the biggest prosodic break immediately before the ambiguous phrase seems to inhibit the attachment of the following materials to the materials immediately preceding them.

1.7 Korean materials

An example sentence to be used for Korean experiments is repeated here as (36). 14

(36) 영훈이가 입원증인 병원을 방문했어.
Yenghun-ika ipwonjungi-n pyoungwon-ul pangmwunha-yesse.

Yenghun-nom hospitalized-rel hospital-acc visit-past

a. Yenghun visited the hospital where (pro) was hospitalized. (embedded pro interpretation)
b. (pro) visited the hospital where Yenghun was hospitalized. (main pro interpretation)

As is well-known, Korean is a head-final and pro-drop language, which gives rise to more frequent temporary and global syntactic ambiguities, especially in the location of syntactic clausal boundaries. For example, as is typical of a head final language, in Korean, multiple noun phrases are encountered before the verbs to which they are attached. In addition, syntactic clausal boundaries, which are marked by a suffix of a verb at the end of the clause, cannot be detected until this morpheme is encountered. Thus, some or all the noun phrases encountered before any verb are subject to misanalyses in sentences with more than one clause because they can belong to either the subordinate clause or the main, higher clause. Thus, in (37), it is not yet known whether the three initial noun phrases are all arguments of the first verb as in (37b) or (37c) or only two of them as in (37d) or only one of them as in (37e).

(37) a. 미나가 유미에게 사과를 ... 
Mina-ka Yumi-eykey sakwa-rul ...
Mina-nom Yumi-dat apple-acc ...

‘Mina... an apple to Yumi.’

14The following convention is used to mark grammatical morphemes: nom refers to a nominative marker, acc refers to an accusative marker, rel marks a relative clause morpheme, and finally past refers to a past tense morpheme. Note that the relative clause marker, rel, is not a free morpheme like English relative pronouns but an inflectional property of the verb. In addition, the presence of this marker makes Korean relative clauses different from Japanese relative clauses, which do not have this kind of inflectional morphemes.
b. 미나가 유미에게 사과를 주었어
Mina-ka Yumi-eykey sakwa-rul cu-esse
Mina-nom Yumi-dat apple-acc give-past
‘Mina gave an apple to Yumi.’

c. [미나가 유미에게 사과를 준] 사실이 드러났어
[Mina-ka Yumi-eykey sakwa-rul cu-n] sasil-i tulena-esse
[Mina-nom Yumi-dat apple-acc give-rel] fact-nom was revealed-past
‘The fact that Mina gave an apple to Yumi was revealed.’

d. 미나가 [유미에게 사과를 준] 아이를 찾아갔어
Mina-ka [Yumi-eykey sakwa-rul cwu-n] ai-rul jjochaka-sse
Mina-nom [Yumi-dat apple-acc gave-rel] child-acc follow-past
‘Mina followed a child who gave an apple to Yumi.’

e. 미나가 유미에게 [사과를 훔친] 아이를 보여주었어
Mina-ka Yumi-eykey [sakwa-rul humchi-n] ai-rul poeoocwe-sse
Mina-nom Yumi-dat [apple-acc stole-rel] child-acc show-past
‘Mina showed a child who stole an apple to Yumi.’

The pro-drop nature of Korean also lends more syntactic clausal ambiguity. Unlike English, in which all the arguments of verbs are usually realized phonologically, pro-drop languages allow deletion of verbal arguments. Hence, a string of words can be interpreted in many different ways depending on where those dropped arguments, pro, are posited. These dropped elements, phonologically null pronouns, should be retrieved from the previous context or from the general knowledge of the discourse context for the completion of the sentence. Similar to English pronoun resolution, the identification of referents for these empty pronouns in Korean can be subject to many linguistic and non-linguistic constraints.

Similarly, the Korean materials to be examined in this study are potentially ambiguous from the outset. For example, the two-word sentence-initial fragment in example (38) is ambiguous such that the initial nominative marked noun phrase may be the subject of either the immediately following rel-marked verb, or of the sentence-final main verb.
This two-word fragment can be continued as in (39).

(39) 염훈이가 입원증인 병원을 방문했어
Yenghun-ika ipwoncungi-n pyungwon-ul pangmunha-ysse.
Yenghun-NOM hospitalized-REL hospital-ACC visit-PAST

a. Yenghun visited the hospital where (pro) was hospitalized. (embedded pro subject)
b. (pro) visited the hospital where Yenghun was hospitalized. (main pro subject)

As can be seen, the initial noun phrase may or may not be the subject of the immediately following relative verb. The crucial difference for the two interpretations lies in the fact that in (39a), a syntactic clause boundary can be posited between the initial noun phrase and the following embedded verb. Therefore, the initial noun phrase should be the subject of the main verb. This, in turn, leaves the embedded verb subjectless. However, thanks to the pro-drop nature of Korean, the subject of this embedded verb can be retrieved from the sentence. Although theoretically the referents of this pro can be anything, it is natural and often common that the initial noun phrase is the referent of this pro for the embedded verb. The example in (41) illustrate this possibility:

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15Depending on the nature of the head noun that comes after the rel-marked verb, a sentence type different from (39) can be created, too. For example, the following example, similar to (39) in the beginning, illustrates a temporary ambiguity.

(xl) 염훈이가 입원증인 친구를 방문했어
Yenghun-ika ipwoncungi-n pyungwon-ul byungwon-ul pangmunha-ysse.
Yenghun-NOM hospitalized-REL hospital-ACC visit-PAST
‘Yenghun visited the friend who was hospitalized.’

Unlike the example in (39), at the end of the sentence, it is clear that the initial noun phrase should be the subject of the main verb. This type will not be discussed in this study. See Kang and Speer (2004) for discussion of the prosodic and syntactic processing of these constructions.
`Yenghun-ika kongbuha-nun cangso-rul poyecwu-esse. Yenghun-nom study-rel place-acc show-past`  

‘Yenghun, showed the place where he, studied.’

However, this coindexation of *pro* with the main subject is not possible for our sentence in (39) due to pragmatic constraints because one probably would not visit the hospital where they themselves are currently hospitalized. For the experimental materials, care was taken to exclude this possibility.

On the other hand, in (39b), the initial noun phrase is the subject of the embedded verb and this time, *pro* needs to be posited for the subject of the main verb. Again, the same reasoning applies here so that the referent of *pro* and the initial noun phrase cannot be coindexed. The two interpretations can be represented by the tree structures in (42).

The frequency of these two interpretations does not seem to be equal. Intuition suggests that the main *pro* subject interpretation is more natural and common than the embedded *pro* subject interpretation even for an isolated sentence. This is especially so when the referent of *pro* is the speaker. A related case is that of question-answer pairs, where the subject of the main verb *you* in a question is dropped in the answer. As mentioned before, *I* in Korean is often dropped without causing any difficulty or unnaturalness, as illustrated in Examples (43) and (44).

(43) `너는 누가 올거라고 생각하니?`  
    `you-top who-nom will-come-comp think-question`  
    ‘Who do you think will come?’

(44) `미나가 올거라고 생각해`  
    `Mina-nom will-come-comp think-declarative`  
    ‘(pro) think Mina will come’

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16 In theory, although the referent of *pro* in the answer can be anyone in Korean, Mary Beckman pointed out that in Japanese, referents of *pro* other than *I* would be highly unlikely for this kind of verb.
The embedded pro subject does not seem to occur as frequently as the main subject pro in isolation. However, it is not impossible to construct an example using the same question-answer format. Examples are provided in (45) and (46).

(45) 너는 미나가 올기라고 생각하니?
     neo-nun Mina-ka olgeo-rako sangkakha-ni?
     you-top who-nom will-come-comp think-question

‘Do you think Mina will come?’
In this case, the embedded subject Mina is not repeated in the answer but appears as a pro. At the completion of the sentence, since the two completed tree structures do not differ in terms of complexity, Minimal Attachment (Frazier 1987, among others), a parsing strategy that prefers the simplest possible structure with fewest syntactic nodes, does not apply to predict the bias toward the main pro subject reading.

During comprehension, however, the bias toward the main pro subject reading can be explained by a resistance to the restructuring of already established syntactic tree assignments. As already established in the psycholinguistic literature on head-final languages such as Japanese (see Kamide 2006; Kamide and Mitchell 1999; Inoue and Fodor 1995, among others), each incoming word is immediately attached into an ongoing syntactic parse. Furthermore, potentially ambiguous elements tend to become arguments of the same verb as in (37b) or (37c) rather than of a different verb. Thus, when the embedded verb is encountered, it is most likely to be interpreted as a verb for the initial subject, and tends to remain such unless a revision of that analysis is required later in the sentence (see Fodor and Inoue 2000). At the completion of the sentence, the main pro subject can be posited and added to the structure without restructuring the existing parse.

However, such a view of parsing requires that recovery of the embedded pro subject interpretation involves removing the initial subject from the first clause and positing another position for the embedded subject. In addition, according to depth-first models of sentence processing, Minimal Attachment predicts that at the point of the ambiguous verb, the embedded pro subject interpretation will be harder due to structural complexity as the two partial tree structures in (47) show.

For the embedded pro subject reading, by the time the embedded rel-verb is encountered, the structure in (47a) should be posited. The reasoning is as follows. Since the initial noun has the nominative marker, it should be the subject of either the main verb or the embedded verb. In (47a), this initial noun is in the subject position of the main verb. When the rel-marked verb comes, a

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(46) 나는 올기를라고 생각해
Na-nun olgeo-rako sangkakha-e
I-top will-come-comp think-declarative

‘I think (pro) will come’

17 Of course, the main subject I again can be dropped in this case, too.
relative clause, which does not yet have a subject, should be postulated. This, in turn, requires the presence of the following head noun, the N’ in the figure. Then, the relative clause and the N’ form a noun phrase, which serves as an argument for the main verb, prompting attachment of the verb phrase as a sister of the initial noun phrase.

For (47b) on the other hand, if the initial noun is an argument of the rel-marked verb, then the only structure that is necessary so far is the relative clause and possibly the following N’, which forms a noun phrase. Since it is not yet known whether the entire noun phrase is a subject or an argument of the main verb, any further structure need not be postulated yet. 18 In sum, the difficulty of the embedded pro subject seems to be accounted for by the complexity of the syntactic structure.

18I thank Mineharu Nakayama for helpful discussion of this.
In spoken language processing, there have been only a few studies that examine prosodic effects on comprehension of syntactically ambiguous sentences in Korean (see Schafer and Jun 2002; Kang and Speer 2002; Kim 2004; Kang and Speer 2005). Furthermore, the Korean constructions to be examined in this study have never been studied. By investigating these novel constructions from a language other than English, I will try to provide further support that can corroborate prosodic effects in spoken language processing and to find a possibly universal mechanism that can be applicable to at least both English and Korean, the two subject languages in this study.
CHAPTER 2

ENGLISH PARTICIPIAL CONSTRUCTIONS

This chapter examines ambiguous English participial constructions presented without any preceding contexts. An example of these constructions is repeated here as (48).

(48) Aaron followed a poor guy drinking his soda.

The primary goal is to establish that these constructions are also amenable to prosodic effects in resolving syntactic ambiguity. Any positive results from these constructions that have been rarely studied will further generalize the effects of prosody in spoken language processing and expand the already existing body of research that demonstrates this effect.

Although multiple studies have demonstrated prosodic disambiguation effects on PP attachment (see Schafer et al. 2000, for example), these participial constructions have not been given much attention. One exception will be the study by Price, Ostendorf, Shattuck-Huffnagel, and Fong (1991) discussed in the previous chapter. However, even in this study, these participial constructions were only one of 35 sentence types. In addition, although Fox Tree and Meijer (2000) included a possibly similar structure, they did not examine the two interpretations that the current study will discuss.

Furthermore, considering the similarity between prepositional phrases and participial phrases regarding their attachment possibilities, this study will provide a meaningful comparison to results of research that examined prepositional phrase constructions.
Unlike prepositional phrases that have been extensively studied in both written and spoken language processing, little is known about these participial phrases regarding their attachment behavior even in written comprehension. Hence, a written norming test was conducted first to find readers’ attachment preference, if any, of these constructions.

2.1 English written pre-test 1

This pre-test was conducted to evaluate how sentences with ambiguous participles such as (48) are interpreted in the absence of spoken prosody or any prior context.

2.1.1 Materials

Test materials were selected according to the criteria explained earlier in the Introduction chapter. Due to this structure’s confusability with seemingly similar but distinct syntactic structures, which were discussed before, it was difficult to find exactly the same sequence of “V NP -ing”. As such, several slightly different structures were included in the material set. Including the “V NP -ing” structure such as (48), there were a total of five types, which are given in (49). Eventually, 40 test items were created. A complete list of sentences appears in Appendix A.

(49) a. V NP -ing: 12 sentences
    Aaron followed a poor guy drinking his soda.
  b. V prep NP -ing: 15 sentences
    Lori smiled at a neighbor walking her dog.
  c. V NP prep NP -ing: 9 sentences
    Amelia showed a picture to a cop coughing hard.
  d. V adv prep NP -ing: 2 sentences
    Ryan ran away from a farmer shouting loudly.
  e. V prep NP prep NP -ing: 2 sentences
    Laura rested on the floor with her son holding a cup in one hand.

2.1.2 Participants

Participants were recruited from the Linguistics department “Talks and Experiments” pool at the Ohio State University. These subjects participated in this study in partial fulfillment of a course
requirement. In keeping with the pedagogical purposes of the pool, non-native English speakers were included but their data will not be discussed further here. The number of participants given for all English experiments discussed throughout this dissertation only included native speakers of English. For the current pre-test, 116 native speakers participated.

2.1.3 Procedure

All 40 test sentences were presented to participants on a PC. E-prime software was used to control the visual presentation of the materials. In each trial, each sentence was presented on the monitor in one line and participants were asked to complete two tasks. First, they answered a comprehension question such as “Who was drinking his soda?” for the sentence such as given in (48). There were 5 possible response choices, including ‘definitely Aaron (1)’, ‘more likely Aaron (2)’, ‘either Aaron or the poor guy (3)’, ‘more likely the poor guy (4)’, and finally ‘definitely the poor guy (5)’. Each question and response choices appeared on the same screen as the target sentence. In the second task, participants were asked to rate the acceptability of two interpretations of the same sentence, one consistent with the high-attached interpretation, and the other, with the low-attached on a 5-point scale with 1 being “acceptable” and 5 being “not acceptable”. For example, for the sentence in (48), the high-attached interpretation ‘Aaron was drinking his soda’ was presented on the screen along with the scale. Once participants responded, a new, separate the low-attached interpretation, ‘A poor guy was drinking his soda’, appeared on the screen along with the same scale. Each of these interpretations appeared in a separate screen and the order of the two readings was counterbalanced. Due to the experimenter’s error, it was found later that filler sentences were not included in this written pre-test. This fact is made less problematic because participants would surely have noticed the ambiguity of the test sentences even had controls been included. This is because they saw two readings for each sentence on every trial.
2.1.4 Results

The mean for the comprehension and rating task for each item is listed in Appendix A. The overall mean for the comprehension question task was 3.23 (remember that 1 is for the high-attached reading and 5, for the low-attached reading), suggesting the ambiguity of these constructions as well as a slight bias toward the low attached reading. This is confirmed by the overall frequency of each response, which is shown in Figure 2.1.

From this graph, we can see that the response type ‘more likely low’ was most frequently chosen, followed by ‘either high or low’ response. The considerable number of the second most response, ‘either high or low’ reflects the indeterminacy of interpretation in these constructions.

These tendencies were also confirmed in the acceptability rating. As Figure 2.2 shows, the most frequent response was “acceptable” and this was true for both readings. However, we can also see that the low attached reading has more “acceptable” responses, which showed that readers considered low attachment readings (mean 1.98) to be more acceptable than high attachment readings (mean 2.38) (lower score means more acceptable). This difference was significant [F₁ (1, 115) = 51.32, p<.001, F₂ (1,39) = 6.17, p<.02]

![Figure 2.1: Overall frequency for each response from English written pre-test 1](image-url)
2.1.5 Discussion

In general, readers showed a slight preference for the low attached reading of ambiguous English participial constructions. These results differ from those for seemingly similar ambiguous prepositional phrases, which show a high attachment preference. One possible reason for this low-attachment preference may be the lack of a punctuation in the sentence materials. This would be the case because in written context high-attached reading is typically signaled by a comma right before participial phrases. Another reason might be that high-attached reading allows a diverse range of meaning such as time, reason or cause, attendant circumstances, condition, concession/contrast, and manner, among others (Quirk, Greenbaum, Leech, and Svartvik 1985; Stump 1981). Some of these meanings may not necessarily be compatible with the meaning denoted by the main verb. As Stump (1981) illustrated, the use of frequency adverbs and modal auxiliary verbs in the main clause can limit the meaning of participial phrases to either temporal, causal or conditional. In addition to these, the type of predicates used in the matrix clause (depending on whether they belong to ‘stage-level’ or ‘individual-level’ predicates, see Carlson (1977)) can also restrict the meaning of participial phrases to causal or conditional. Although these expressions were not explicitly used in
the material set, it is possible that there was some mismatch between matrix predicates and participi-
mal phrases that we failed to control, leading to readers’ reluctance to select high-attached reading. 
Regardless of the reasons for the preference of the low-attached reading, these results provide an
interesting contrast to the preference for high-attached readings previously shown for ambiguous
prepositional phrases.

2.2 English auditory experiment 1: Off-line listening comprehension test

The purpose of this auditory study was to extend the study of Price, Ostendorf, Shattuck-Huffnagel,
and Fong (1991) and to see if distinct prosodic structures had effects on the ultimate assignment of
meaning for the ambiguous participial phrases in English. The same sentences as from the written
norming study were used. In this auditory study, following previous studies that examined either
prepositional phrases (Schafer 1997; Schafer, Speer, and Warren 2005 among others) or participial
phrases (Price et al. 1991), it was hypothesized that distinct prosodic structures would be critically
used to resolve the syntactic ambiguity. For this, the location of an Intonation Phrase boundary (IP,
henceforth) was manipulated; more specifically, in line with Price et al., the IP boundary was put
right before the ambiguous participial phrases for the high attached reading. For the low attached
reading, this IP boundary was in a location other than before the participial phrases, as described in
the materials section below.

2.2.1 Materials

The same test materials as those used in the written pretest were used along with 41 filler sentences
(ambiguous prepositional phrases). As mentioned before, the location of an IP boundary was placed
either before the ambiguous participles (for the late IP conditions) or in locations other than before
participial phrases (for the early IP conditions). The varying location of the early IP boundary for
different syntactic types is provided in example (50).
(50) a. [V]p [NP -ing]: 12 sentences
   [Aaron followed]p [a poor guy drinking his soda]
b. [V]p [prep NP -ing]: 15 sentences
   [Lori smiled]p [at a neighbor walking her dog]
c. [V NP]p [prep NP -ing]: 9 sentences
   [Amelia showed a picture]p [to a cop coughing hard]
d. [V adv]p [prep NP -ing]: 2 sentences
   [Ryan ran away]p [from a farmer shouting loudly]
e. [V prep NP]p [prep NP -ing]: 2 sentences
   [Laura rested on the floor]p [with her son holding a cup in one hand]

These test sentences along with filler sentences were produced by a ToBI-trained, female native speaker of English. ToBI (Tone and Break Indices) is a research tool that was collectively developed in order to transcribe the intonation and prosodic structure of spoken utterances in various languages (see Beckman and Elam 1997; Beckman and Hirschberg 1994; Pitrelli, Beckman, and Hirschberg 1994).

All the recording was conducted in a sound-attenuated recording booth at OSU Linguistics lab space using the Cooledit software at the sample rate of 22.5 kHz. Figure 2.3 (intended for the high attachment reading) and 2.4 (intended for the low attachment interpretation) show the two prosodic renditions of the same sentence.

All of the sentences have the same boundary tone, H-L% for the sentence internal IP and L-L% for the sentence final boundary. Within the same IP, only content words have a pitch accent (mostly H*), and the subsequent H* is downstepped. The last word in the first IP boundary also tends to have the downstepped high pitch accent, followed by high phrasal tone (H-) and low boundary tone (L%). The sequence of H-L% is used to describe the relative high level phrasal and boundary tone in the ToBI system. All these test materials were transcribed by another, ToBI-trained native speaker of English, who labeled all sentences for boundary and tone types. A complete set of transcribed materials is available upon request.

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1I thank Julie McGory for the transcription. The transcription was done post-experimentally due to time constraints. It was found that all the sentences except four were produced as intended. Among the four, two sentences had an intermediate phrase in the second IP whereas the other two had another IP before the expected IP. It seems that these occurred for those long sentences which could potentially have more phrasal boundaries due to the length.
Aaron followed a poor guy drinking his soda.

Figure 2.3: An example of an EarlyIP sentence

Time (s) 0 2.80517

Aaron followed a poor guy drinking his soda.

Figure 2.4: An example of a LateIP sentence

Time (s) 0 2.7571
A phonetic analysis of duration of critical positions (to be discussed below) from all test sentences was conducted. Figure 2.5 shows the scatter plot of two critical locations in the two prosodic conditions.

The explanation of the two critical locations (represented as “early word plus silence” and “late word plus silence” in the graph) is in order. The “early word plus silence” refers to the duration of words and any following pauses that appear in an earlier position of each sentence. In the EarlyIP condition, this refers to the words and pauses right before the IP. On the other hand, in the LateIP condition, this refers to the words and pauses in the same locations but this time only without an IP boundary since now the IP boundary is placed at some later positions. On the other hand, the “late word plus silence” means the duration of the words and pauses that show up in a later position of each sentence, after which there is an IP boundary in the LateIP condition but no such boundary in the EarlyIP condition. For example, in Figure 2.3 and 2.4, the “early word plus silence” refers to the duration of followed plus any following pause, and “late word plus silence” means the duration of guy plus the following pause. In the earlyIP condition, since an IP boundary was supposed to be placed after followed, due to phrase-final lengthening and any following pause, the duration of this word and following pause is longer in this condition (mean 940.73 ms) than in the lateIP condition.

Figure 2.5: Duration of words and pauses in the early and late boundary sentences

I thank Mary Beckman for suggesting this.
(mean 352.58 ms), where an IP boundary was placed after guy. On the other hand, the comparison of guy in these two conditions showed the reverse pattern: The duration of guy and following pause is longer in the lateIP condition (mean 839.03 ms) than the one in the earlyIP condition (mean 360.03 ms).

In addition to this, the duration of each word from the main verb to the ambiguous participle was measured. Since the earlyIP conditions did not have the identical IP location, sentence types with the same IP location were collapsed together. As can be seen in (49), (49a) and (49b) have the IP boundary right after the main verb for the earlyIP condition. Figure 2.6 shows a clear difference between the two prosodic conditions in terms of the verb and the noun duration since those are the two words right at the edge of an IP boundary (the verb in earlyIP and the noun in lateIP). The intervening preposition, which is in parentheses to indicate that it is absent in the other type, does not show any difference.

On the other hand, for the other three types in (49), the verb was not the IP final word and as such, the duration of the verb was not different in two prosodic conditions across the three types. Again the items in the parentheses indicate that they are missing in some types. In addition, to differentiate a distinct sentence type, the same number was used if these items occurred in the same

![Figure 2.6: Mean duration of each word between the main verb and the participle for ‘V NP -ing’ type and ‘V prep NP -ing’ types](image)

Figure 2.6: Mean duration of each word between the main verb and the participle for ‘V NP -ing’ type and ‘V prep NP -ing’ types
type. For example, the same number, 1, was used for adverb, the second preposition and the second noun. This means that this type has an adverb, a preposition, and a noun after the main verb. As explained before, for this type, the earlyIP was located right after the adverb and right before the participle for the lateIP and so the duration differed in these two conditions whereas the main verb and the intervening preposition did not.

In addition, F0 of words in a critical location was measured. Since the early IP boundary is right after the main verb or following prepositions or adverbs, the pitch movement for H phrase and L boundary tones will be realized on these words at the boundary. As such, F0 of words between the main verb and the participle was measured. Following Blodgett (2004), F0 from three points for each word except the participle was taken; beginning, middle and end for one syllable word whereas for multi-syllabic words, the beginning was the middle of the first syllable while the middle and end were from the last syllable. F0 from the beginning will, for one thing, show the relative pitch height against the previous words and the last two points are intended to capture the pitch excursion for the phrase and boundary tone. For the participle, F0 from only one point, the stressed syllable was taken.

![Figure 2.7: Mean duration of each word between the main verb and the participle for ‘V NP prep -ing’, ‘V adv prep NP -ing’ and ‘V prep NP prep NP -ing’ types: the parentheses were used to indicate that those words appear only in some type but not for all types and the words with the same number appear in the same syntactic type](image-url)
Again, since the early IP location varies depending on syntactic sentence types, we divided the materials into two types; one where the IP boundary was right after the main verb, and the other, where the boundary was located after some words other than the main verb.

The following two graphs clearly show the two distinctive pattern of pitch contours for each boundary condition. In Figure 2.8, it is shown that in the early IP boundary, the H-L% tone was realized on the verb whereas in the late IP boundary, the same tone was realized on the noun right before the participle. The presence of a pause is indicated by the lack of the line. In addition, the word in the second IP was set off from the first IP by a relatively higher pitch, reflecting pitch reset.

Figure 2.9 shows that for the other three types, the IP boundary was not right after the verb but after some other words. There were three more intervening values to indicate that measurements were taken from adverbs and another nouns (the adverbs and the first nouns in (49c), (49d) and (49e). These are the words at the IP boundary. Again, the discontinuity is due to an intervening pause. Overall, these two graphs show, first, the H-L% tone at the end of the first IP and second, the pitch reset for the second IP.

Figure 2.8: Mean F0 of words between verbs and participles in ‘V NP -ing’ and ‘V prep NP -ing’ type: V - verb, N - noun, P - participle
2.2.2 Participants

52 native speakers of English from the Linguistics department ‘Talks and Experiment’ pool at Ohio State University participated in this study as a partial fulfillment of a course requirement.

2.2.3 Procedure

Two lists, where each prosodic version of each sentence appeared in only one list, were created so that each participant listened to only one prosodic rendition of each sentence. In each list, the total of 40 test items were mixed with 41 filler items (these contained ambiguous prepositional phrases) that had various prosodic structures and semantic biases. The test sentences and fillers were pseudo-randomized so that no three sentences of the same type occurred consecutively and the order of the presentation of sentences in these two lists was the same.

E-prime software was used to present both auditory and visual materials on a PC computer. Participants sat in front of a computer screen with a set of headphones. In each trial, participants were asked to complete three tasks. The first task was to indicate whether they understood each sentence or not after hearing it. They were asked to press 1 on the keyboard if they understood each
sentence and 2 if they did not. The second task involved answering the same comprehension questions as in the written study, given one prosodic rendition of those ambiguous sentences. The same five options as in the written study were given for participants to choose from. Finally, participants also rated the acceptability of the two interpretations on the same 5-point scale as in the written study.

2.2.4 Results

The results of each task will be provided separately. The mean for each of the three tasks for each item is provided in Appendix A.

2.2.4.1 Results from understandability task

The overall percentage of ‘understood’ responses from the first task ranged from 69.2% to 96.2% in the EarlyIP condition (mean of all items was 87.6%) and from 80.8% to 96.2% in the LateIP condition (mean of all items was 87.9%). Overall, items in these two conditions were of comparable comprehensibility in the listening task.

2.2.4.2 Results from answering comprehension questions

Figure 2.10 shows the result of the second task (answering comprehension questions) in the two prosodic conditions.

Overall, listeners interpreted sentences with IP boundaries just before the ambiguous participle phrase (late IP) differently from sentences with IP boundaries just after the main verb (early IP). The mean response to the comprehension questions for sentences with an early IP boundary was 3.74, and the ‘more likely low’ reading was most frequently chosen for these items. On the other hand, the mean response for sentences with a late IP was 2.82 and significantly lower \( F_1 \) (1,51) = 89.26, \( p<.001 \); \( F_2 \) (1,39) = 231.76, \( p<.001 \). The most frequently chosen response for these items was ‘either high or low’. From this, we can see that listeners interpreted sentences in the early IP condition to have more low attached readings. A little disappointing is the fact that as can be seen
from the distribution of each response in Figure 2.10, the most response in the late IP condition came from ‘either high or low’, indicating that the sentences, while slightly more likely to have a high attached reading, for the most part remained syntactically ambiguous. However, another graph, Figure 2.11, shows the effect not visible from the distribution of overall frequency.

Figure 2.10: Overall frequency for each response in two prosodic conditions

Figure 2.11: Mean response for each item in the auditory and written experiment: 1-high attachment, 5-low attachment, R (earlyIP) = 0.8183 R (lateIP) = 0.7606
Figure 2.11 is a scatter plot of the combined results from the written norming study and auditory study with two prosodic conditions. The comparison of the auditory and written results indicates that prosodic structure did influence the syntactic interpretation to be assigned to each sentence. First, the strong positive correlation between the written and auditory test indicated that although there is variability of meaning bias among the items, the inherent bias of each sentence in reading is still kept in the auditory study. However, and more importantly, this bias is influenced by prosodic structure and swayed into two opposite directions. Sentences with an early IP were more likely to be understood as low attached than the written test and those with a late IP were more likely to be interpreted as high attached than the written test. In addition, it is obvious that the overall tendency from Figure 2.10 is confirmed; the early IP condition has more low attached readings than the late IP condition.

2.2.4.3 Results from the rating task

The overall acceptability ratings showed a consistent pattern with the comprehension results as is observed in Figure 2.12 and 2.13. In the early IP condition, the mean rating of the low attachment reading (1.59) was significantly lower than the mean rating of the high attachment reading (2.82) \( [F_1 (1,51) = 110.75, p < .001; F_2 (1,39) = 292.0, p < .001] \). We can conclude from this that the presence of the early IP boundary effectively biased listeners toward the syntactically preferred, low attached interpretation. In this condition, listeners rated the low attached interpretation as very acceptable, and also did not like the high attached version.

These results differ strikingly from those found in the late IP condition. For sentences with this pronunciation, although the mean rating of the high attachment reading (1.97) showed significantly higher acceptability than the mean rating of the low attachment (2.27) \( [F_1 (1,51) = 6.63, p < .02; F_2 (1,39) = 17.49, p < .001] \), both interpretations were more likely to be acceptable than unacceptable to listeners.

It seems that when the prosody biases toward the less-preferred interpretation (which is the high attached reading), the acceptability of the two interpretations is more comparable. In other

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3 Another thanks go to Mary Beckman for suggesting this.
Figure 2.12: Overall frequency for acceptability for the low-attached reading

Figure 2.13: Overall frequency for acceptability for the high-attached reading

words, even though listeners rated the high attached reading as more acceptable than the low, given the late boundary, they still found the low attached reading fairly acceptable. A more detailed discussion of this effect will be given in the conclusion section.

2.2.5 Discussion

The results from the responses to the comprehension questions in the auditory study demonstrated that the two locations of an Intonation Phrase boundary were used to retrieve two distinct meanings.
In addition, the results from the acceptability ratings showed that even though listeners could in general evaluate both meanings of the ambiguous strings, the availability of two interpretations was not consistent across the two prosodic renditions of the same sentence. When there was an IP boundary in a location other than before the participial phrase, listeners rated the low attached reading to be more acceptable. In contrast, when there was an IP boundary before the participial phrase, listeners considered the low attachment reading to be less acceptable. In spite of this, it is possible that the late IP condition might be less effective in resolving the ambiguity of the participle phrase. From Figure 2.10, it seems that the late IP boundary condition was inherently more ambiguous than the early IP boundary. In addition, the results from the auditory rating task were consistent with this.

The first possible reason for this might be that with an IP boundary before the participial phrase, listeners may have interpreted the ambiguous participle as a type of non-restrictive modifier. An example of the non-restrictive reading of a participle is found in (51) from Quirk, Greenbaum, Leech, and Svartvik (1985), which presents the low attached interpretation with a comma.  

(51) She glanced with disgust at the cat, stretched out on the rug, mewing plaintively.

This may account for the relatively higher ambiguous interpretation in the comprehension question task and also for a small difference between high attached and low attached reading in the rating task. Secondly, frequency might play a role here. As is well-known, the high attached reading for these participial constructions is fairly formal and may not be encountered very often in spoken contexts.

In this chapter, we saw that the ambiguous participle phrases are indeed subject to prosodic disambiguation in an off-line listening experiment. In the next chapter, we will further explore this using an on-line cross-modal naming task and an experiment involving biased contexts.

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The results from the off-line comprehension study reported in the previous chapter demonstrated that the ambiguity of English participial constructions can be resolved prosodically, confirming the results of Price, Ostendorf, Shattuck-Huffnagel, and Fong (1991). These results are comparable to already established effects of prosodic structure on the resolution of ambiguous prepositional phrases, which illustrate similar attachment ambiguity. It was shown that the presence of an IP boundary in a location other than immediately before the ambiguous participial phrases is more compatible with the low-attached syntactic reading of those phrases, whereas the presence of an IP right before the participial phrases is a better match for the high-attached syntax. However, we also found that the late IP, which occurred right before the participial phrases, tended to be more ambiguous for listeners than the earlier IP structures. We argued that the late IP prosodic structure can be used for the non-restrictive interpretation of the low-attached reading.

In this chapter, we will investigate, first, whether prosodic information will have an immediate effect on the comprehension of ambiguous participial phrases using an on-line method, a cross-modal naming task. Although this method is more intrusive than an eye-tracking or ERP method, it is widely used as a way to probe how rapidly and immediately listeners integrate auditory information during the processing of syntactically ambiguous materials.

To make use of this on-line method, participial phrases were slightly modified to make them temporarily ambiguous. In the previous sentences in Chapter 2, the participial phrase described the action of either the main subject of the sentence (high attachment) or the preceding noun (low attachment) and the ambiguity remains unresolved at the completion of the sentence. On the other hand, for the two experiments to be discussed in this chapter, participles contain a reflexive pronoun
and the reflexive pronoun’s gender can be used to determine where the participial phrase in the preceding material is attached, thus resolving the ambiguity. Example sentences are shown in (52).

(52) a. The saleswoman tailed the salesman complaining to herself. (high attachment)  
b. The saleswoman tailed the salesman complaining to himself. (low attachment)

As with previous studies that employed this method (e.g. Kjelgaard and Speer 1999), participants were presented with a spoken fragment first, and then a visual target for naming, in this case, the disambiguating reflexive pronoun. Because the visual target resolves the ambiguous sentence fragment either toward the low attached or high attached reading, response time to name the visual target word can be used as a measure of immediate processing difficulty in processing the participial phrase.

The second goal for this chapter is to examine whether prosodic manipulations are still effective in the presence of biasing discourse contexts. In other words, when there are other cues available to resolve syntactic ambiguity, is prosodic information still utilized or is it considered redundant? As noted in Chapter one, there have been mixed results on this topic. On the one hand, in the studies by Allbritton et al. (1996), Fox Tree and Meijer (2000), Straub (1997), and Snedeker and Trueswell (2003), the speakers did not use prosodic cues to disambiguate syntax when there were other cues available in the preceding discourse context. On the other hand, in the studies by Schafer and her colleagues (Schafer et al. 2000, 2005; Warren et al. 2000) and by Kraljic and Brennen (2005), speakers still produced distinct prosodic patterns for distinct interpretations despite the availability of other cues.

For the current study, the English participial phrases will be presented after a context biased toward either meaning and evaluated as to whether they will fit into those contexts. If prosodic information is considered redundant because of the contextual bias, we should find no differences in comprehension due to the prosodic phrasing of the sentence. On the other hand, if listeners are sensitive to prosodic information despite the biased context, then contrasting prosodic patterns will produce different reactions from comprehenders.

The same materials as from the cross-modal naming task were used. But this time, they were presented after a context which was biased toward the high-attached or low-attached reading for the ambiguous participal phrases. Again, a final reflexive pronoun will be used to indicate the
appropriate syntactic attachment for ambiguous participles. The task used was end-of-the sentence comprehension task, where participants gave ratings on one of two prosodic versions for each sentence. Before the two auditory experiments, a written pretest was conducted to make sure the constructed contexts were indeed biased toward one or the other reading for the ambiguous participial phrases.

3.1 Pre-test 2: A written norming test

3.1.1 Materials

Temporarily ambiguous test sentences such as (52) were created. In this process, the use of proper nouns was avoided for either the subject or the object. The use of a proper noun for the object tends to give a non-restrictive modifier reading to the following participial phrase, even for the low attachment. Thus, the use of a common noun is unavoidable for the object role. The use of a proper noun for the subject place does not pose a problem by itself; however, it was avoided so as not to influence participle attachment by using a proper noun only for the subject. Given these constraints, it was decided that gendered subject and object nouns such as baron/baroness or steward/stewardess were used.

For the target sentences such as (52), two biasing were created as in (53a) and (53b) below. A complete list of all target items with corresponding contexts are provided in Appendix B.

(53) a. HA context (high attachment bias):
A senior saleswoman was once assigned to investigate a junior salesman for bribing local government officials. She was doubtful that he would do such a thing without probable reasons because he was a very honest man. One day, however, she got a tip that he left the office after he rummaged through file cabinets, so she went after him right away. But let me tell you what else she was doing as she tailed him.

b. LA context (low attachment bias):
A senior saleswoman was once assigned to investigate two junior salesmen for bribing local government officials. She was doubtful that they would do such a thing without probable reasons because they were very honest men. One day, however, she got a tip that they left the office after they rummaged through file cabinets, so she went after one of them right away. But let me tell you which one she tailed.
The two contexts are almost identical except two things; one is the number of referents for the object noun phrase *the salesman* and the other is the prompt sentence, which occurs at the end of each passage. It was believed that these two factors combined together would make each of the two contexts biased toward high or low attached reading for the partial phrases. Thus, in (53a), there was only one salesman mentioned in the context whereas in (53b), two salesmen were mentioned. The first manipulation was adopted from the studies of Altmann and Steedman (1988), as was used later in Spivey-Knowlton, Trueswell, and Tanenhaus (1993) in their study of reduced relative clauses in English. Contrary to claims from Garden-path sentence processing models that maintained that the initial parsing is primarily guided by syntactic simplicity (e.g., Frazier 1987), Altmann and Steedman (1988) demonstrated that a prior context can exert its influence in the decision of syntactic attachment at the earliest point. Using ambiguous prepositional phrases that can be attached to a verb phrase or to a previous noun as a post-noun modifier (see the discussion in Chapter 1), Altmann and Steedman (1988) showed that interpretations that are referentially supported by a prior context are easier to process. The two contexts in (54) that Altmann and Steedman constructed are minimally distinct from each other. The NP-supporting context in (54a) contains two referents for a target noun *safe* in (55a) whereas the VP-supporting context in (54b) has only one referent for the target noun in (55b).

(54) a. NP-supporting context:
   A burglar broke into a bank carrying some dynamite. He planned to blow open a safe. Once inside he saw that there was a safe with a new lock and a safe with an old lock.

   b. VP-supporting context:
   A burglar broke into a bank carrying some dynamite. He planned to blow open a safe. Once inside he saw that there was a safe with a new lock and a strongbox with an old lock.

(55) a. NP-attached target:
   The burglar blew open the safe with the new lock and made off with the loot.

   b. VP-attached target:
   The burglar blew open the safe with the dynamite and made off with the loot.

Since there are two possible referents for the target noun *safe* in the NP-supporting context in (54a), the ambiguous prepositional phrase *the new lock* in (55a) can felicitously be used as a post-noun modifier, which singles out the referent that has the property of having the new lock and thus as
an NP-attached phrase. This way, this NP-attached prepositional phrase gets more “referential support” from the preceding context. On the other hand, since the context in (54b) has only one referent for the target noun safe, using the ambiguous phrase with the new lock as a post-noun modifier gets less referential support in this context. The end-of-the-sentence comprehension test and self-paced reading task both showed that the NP-attached target sentence in (55a) was significantly faster in the NP-supporting context (54a) than in the VP-supporting context in (54b) whereas the VP-attached target sentence in (55b) was much faster in VP-supporting context in (54a). There results demonstrated that contextual manipulation can also participate in the early parsing decision.

Since the ambiguous participial phrases under discussion behave similarly to ambiguous prepositional phrases, we used the same strategy for the low attachment target. By providing two possible referents for the target noun salesman, we believed that the ambiguous participial phrase would be used more felicitously as a post-noun modifier (low attachment) than as a verbal modifier (high attachment).

The second manipulation that was used to ensure one of the two readings was the prompt sentence at the end of each passage (this was adopted from the study of Price, Ostendorf, Shattuck-Huffnagel, and Fong (1991)). The one in (53a) asks about the simultaneous action of the main subject of the sentence. This, along with there being only one referent for the object noun salesman, was expected to be effective in bringing about the high attached reading of the participial phrase in the target sentence. On the other hand, the prompt sentence in (53b) specifically asks to select one of the two possible referents for the object noun salesman. Again, in conjunction with the existence of two referents in the context, it was predicted that this would be an effective way to lead to the low attached reading.

Finally, the other function of the prompt sentence was to make the target sentence a natural continuation of the passage. It was believed that this setup would give continuity between the written context and the auditory target sentence.

In addition to these test materials, three different types of filler passages were also used. These fillers included passages for target sentences such as ambiguous prepositional phrases, reduced relative clauses and constructions that can take reflexive pronouns as direct objects of main
verbs (e.g. *The grandfather made himself a cup of tea*). The passages for ambiguous prepositional phrases were from Altmann and Steedman (1988) whereas the passages for the reduced relative clauses were from Britt, Perfetti, Garrod, and Rayner (1992). The rest of the fillers as well as test materials were newly constructed for this experiment by the author with the help of several native speakers of English. Again, the test sentences have the following four types 1.

(56) a. V NP -ing: 12 sentences
   The saleswoman tailed the salesman complaining to herself/himself.
   b. V prep NP -ing: 18 sentences
   The queen motioned to the policeman mumbling to herself/himself.
   c. V adv prep NP -ing: 1 sentence
   The groom called out to the bridesmaid grinning to himself/herself.
   d. V NP prep NP -ing: 1 sentence
   The chairman shook hands with the policewoman fanning himself/herself.

3.1.2 Procedure

A total of 32 context pairs such as (53) for 32 test items were constructed and these were distributed in two different lists. Only one of the two context passages for each target sentence appeared in the same list. In the same list, half of the passages were high attachment context and the other half were low attachment context. In each list, half of the high attachment contexts occurred with female subject NPs and male object NPs while the other half occurred with male subject NPs and female object NPs. The same was true for low attachment contexts. This way, each list had 16 high attached, and 16 low attached contexts. 8 of the high attached contexts had female subject NPs and male objects NPs whereas the other 8 passages had male subject NPs and female object NPs. The same was true for the 16 low attached contexts.

Eprime software was used to present visual materials and collect participants’ responses. In the experiment, participants sat in front of a computer and read either a high-attachment biased context (HA) as in (53a) or a low-attachment biased context (LA) as in (53b) first. Right below each context, a target sentence with a blank in it was presented along with three choices such as 1

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1The type with prepositions will be split into two subtypes depending on whether the prosodic boundary occurs after or before the preposition.
for readers to choose from. The context stayed with the question and three choices on the same screen until the participant moved to the next trial. To make the passage and the target sentence one coherent context, the following instruction was given. First, participants were asked to imagine that they were being told a story in each passage. They were told that each passage might or might not end with a question at the end. They were also told to assume that the target sentence was a natural continuation of the passage, either as an answer, or just as an addition. Finally, they were asked to imagine that each passage and its target sentence were from the same speaker. Based on the understanding of the context and target sentence, participants were asked to select one choice that they preferred most and to press the corresponding letter (1, 2, 3) on the response box.

(57) The saleswoman tailed the salesman complaining to . . . .

(1) herself (2) himself (3) either is OK

3.1.3 Participants

32 participants from The Ohio State University participated in this experiment in a partial fulfillment of a course requirement.

3.1.4 Results

The mean for each item can be found in Appendix B. It was predicted that without the aid of prosody, the contextual information presented should determine which of the three responses would be chosen. If a passage was biased toward the high attachment reading as in (53a), a reflexive pronoun that matched with the subject of the sentence, herself, would be predominantly chosen for (57). On the other hand, himself would be much preferred in the low attachment biased context such as (53b).

The prediction was borne out. In the high attached context, the reflexive pronouns that were congruent with the high attached contexts were chosen most of the time (the mean proportion was 0.68 and the range was from 0.13 to 1).
On the other hand, in the low attached contexts, the reflexive pronouns that matched with the low attached contexts were what was chosen most frequently (the mean proportion was 0.72 and the range was 0.13 to 1). The graph in (3.1) summarizes the mean proportion of each response choice.

3.1.5 Discussion

The results from the written norming test showed that the manipulation of the number of referents for the object NP and the prompt sentence at the end was effective in making the ambiguous participial phrases biased toward either the high or low attached reading. These are consistent with the results of the previous studies (Altmann and Steedman 1988; Spivey-Knowlton et al. 1993, among others) where two-referent contexts resulted in more low-attached readings, but one-referent contexts resulted in more high attached readings for ambiguous prepositional phrases and reduced relative clauses. Although the current test used an off-line measurement, as Altmann and Steedman (1988) and Spivey-Knowlton et al. (1993) demonstrated the same effect using their self-paced reading paradigm, we believe in the immediate availability of referential support from contexts in determining the ultimate assignment of syntactically ambiguous participial phrases.

Figure 3.1: Mean proportion of each response choice in English pre-test 2 with reflexive pronouns and biasing contexts
Although the referential content and the prompt sentence at the end of each passage was effective in producing a bias toward either reading, there were some items that required changes. For example, one of the target sentences contained a noun *lad* for the object noun phrase. It is true that this noun is not as frequently used in American English as in British English. However, as explained in the previous chapter, as many gender pairs as possible were needed and it was decided that this item should be kept. For the sentence that included this item, *Metropolitan Opera* was mentioned in the context passage. However, considering the more frequent usage of *lad* in British English, it was suggested that a name that is more reminiscent of it should be used. As such, *Metropolitan Opera* was replaced by *the British National Opera*\(^2\). It needs to be mentioned, though, that this change does not have to do with a failure in inducing biases for either reading because this item had 80% bias for HA readings and 73% bias for LA readings. Rather, the change was done to produce a context so that words used in the same context sounded more compatible with each other.

In addition, four participles (*sun, scold, shake, sigh*) were replaced by new ones (*smirk, grin, wet, complain*) either because they did not produce the intended bias for either of the readings or because it was reported that some of them may not be felicitous for the low attached reading. One of such items was ‘scolding’. When this was used for the low attached reading, using it with the reflexive pronoun makes the low attached reading difficult since it is hard to see someone scolding oneself outside. That is, we do not usually see this kind of action outside.

In replacing these participles, although it was unavoidable to change the context slightly, changes were kept to a minimum. In addition, the conjunction *but* at the prompt sentence was also replaced by another conjunction *and* because it was suggested that the latter sounded more neutral. These new materials were used in a cross-modal naming experiment to see whether prosodic structures would exert any influence on the on-line comprehension of the ambiguous participial phrases.

\(^2\)I thank Kathleen Currie Hall for suggesting this.
3.2 Auditory Experiment 2: On-line cross-modal naming experiment

The written pre-test showed that the contexts were indeed biased toward either the high-attached or the low-attached reading. In the previous chapter, we confirmed prosodic disambiguation of participial constructions in an off-line test. Before the participial phrases were tested in the presence of biased contexts that were discussed in the previous section, they were presented in isolation first in an on-line, cross-modal naming experiment. This method allows measurement of how immediately prosodic information is used in syntactic parsing decisions.

3.2.1 Design and materials

A total of 28 test sentences were used. Half of the items (14 sentences) had a female subject and a male object (of the verb or of the preposition) and the other half had a male subject and female object since as discussed before, the gender distinction makes it possible to use the corresponding reflexive pronoun depending on where the participle phrase is attached.

Again, it was hypothesized that the presence of an IP boundary right before the ambiguous participle as in (58a) would bias toward high attachment, making the integration of herself easier. On the other hand, the prosodic structure as in (58b) will induce difficulty for the same pronoun due to prosody/syntax mismatch.

(58) a. Syntax: high attachment
   earlyIP:[The saleswoman tailed]\IP [the salesman complaining to \textit{herself}] 
   lateIP:[The saleswoman tailed the salesman]\IP [complaining to \textit{herself}]

b. Syntax: low attachment
   earlyIP:[The saleswoman tailed]\IP [the salesman complaining to \textit{himself}]\IP
   lateIP: [The saleswoman tailed the salesman]\IP [complaining to \textit{himself}]\IP

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3Chronologically, this experiment was conducted after Experiment 3, to be discussed in the next section. In experiment 3, there were four items that seemed to be too weird or too foreign to participants. Those sentences included nouns such as 	extit{male servant}, 	extit{lass}, 	extit{duchess} or 	extit{marquis}. Because of this difficulty, these four items were not included in this naming experiment.
3.2.2 Recording

All the test sentences along with filler sentences were recorded by a ToBI-trained, female phonetician and native speaker of American English. Since these materials were also used for Experiment 3, which were tested with a contextual effect to be discussed in the next section, the recording was done in a following way. This setup was also to ensure that the speech materials did not sound like read speech in isolation. The speaker was presented with the accompanying context such as (53) before each target sentence such as (58) and asked to read silently the context sentences. After reading each target passage and understanding it, the speaker produced each target sentence in two different versions as indicated in (58) for as many times as she wanted until she was satisfied. All the materials were recorded in a sound-attenuated booth at the sampling rate of 22.1 kHz and saved in .wav format in Praat.

As with Experiment 1, there are four different syntactic types for test sentences. The late IP boundary was placed right before participles for all four types. The locations for the early IP boundary for all four different syntactic types used in this experiment are summarized in (59).

Note that the type in (59b) is split into two subtypes, with the IP boundary occurring either before or after the preposition. Boundary locations for these items were determined according to native speaker judgements using the following procedure. First, both prosodic versions were recorded. Then, three native speakers of English listened to two versions and decided which one of them sounded most natural 4. For 7 out of 18 items, the boundary after the preposition was more natural (especially if the preposition could also be used as a temporal conjunction). For the remaining 11 items, the boundary before the preposition was judged to be more natural. When the three judges did not agree, the version that the two of them preferred was selected.

(59) a. \[V\text{prep} \text{NP -ing}\text{prep}: 12 \text{sentences}\]
   \[\text{The saleswoman tailed}\text{prep} \text{[the salesman complaining to herself/himself]}\text{prep}\]

b. V prep NP -ing: 18 sentences
   • \[V\text{prep} \text{NP -ing}\text{prep}: 11 \text{sentences}\]
   \[\text{The queen motioned}\text{prep} \text{[to the policeman mumbling to herself/himself]}\text{prep}\]

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4Thanks go to Allison Blodgett, Laurie Maynell, and Shari Speer.
• [V prep]p [NP -ing]p: 7 sentences
  [The princess ran after]p [the prince growling to herself/himself]p

c. [V adv]p [prep NP -ing]p: 1 sentence
  [The groom called out]p [to the bridesmaid grinning to himself/herself]p

d. [V NP]p [prep NP -ing]p: 1 sentence
  [The chairman shook hands]p [with the policewoman fanning himself/herself]p

3.2.3 Phonetic and phonological analyses

To make sure all the target sentences were produced as intended, first, the speaker listened to all the recordings and selected the best rendition for each target sentence. Then, another ToBI-trained phonetician and native speaker of English 5 carefully listened to the recordings to decide if any sentence needed to be rerecorded. After rerecording several unsatisfying sentences, all the materials were ToBI annotated by a third, another ToBI-trained phonetician and native English speaker.6 Most of the sentences were judged to have the intended prosody. A few sentences that were judged different from the intended prosody were discussed by the speaker and the second judge, who decided that those sentences were prosodically ambiguous. As such, no more recording was done to those sentences. Figures 3.2 and 3.3 illustrate examples of two different prosodic patterns and a full transcription is available upon request.

As the figures show, there is an IP boundary either after the verb (for early IP condition) or immediately before the participles (for the late IP condition) and the words in the boundary has L-H% tones. In addition to the ToBI annotation, phonetic analyses of duration and fundamental frequency were also conducted. Duration measurements were taken from the following critical locations; verbs, object nouns right before the participial phrases, intervening words such as adverbs, prepositions or another nouns between verbs and object nouns, participles and pauses. As illustrated in (59), for the early IP boundary since the location varied depending on the types of sentences, the materials were grouped in two groups depending on whether the early IP boundary was immediately after the verb or after some other words (such as preposition, or adverbs). As mentioned before, the late IP was consistently placed immediately before the participles across all types.

5Thanks go to Shari Speer.

6I thank Julie McGory for transcribing the materials.
Figure 3.2: An example of an Early IP sentence

Figure 3.3: An example of a Late IP sentence
Figure 3.4 shows the mean duration of each critical word for the first group (12 of ‘V NP -ing’ type and 11 of ‘V prep NP -ing’ type). As can be seen in the figure, two early IP conditions (HAEIP and LAEIP) and two late IP conditions (HALIP and LALIP) show the same pattern regardless of context: the verb in the early IP boundary was longer than that of the verbs in the late boundary conditions reflecting the pre-boundary lengthening before the IP boundary. On the other hand, nouns in the two late IP boundary conditions were longer than those of the ones in the two early IP boundary conditions, supporting the presence of a boundary after these words. However, the duration of the preposition, which is in parentheses to indicate that this is used only for the type ‘V prep NP -ing’, does not differ across two prosodic conditions.

The other types, which include 7 of ‘V prep NP -ing’ when the boundary is after the prep, 1 of ‘V adv prep NP -ing’ and 1 of ‘V NP prep NP -ing’, also show the lengthening of words before the IP boundary location as can be seen in Figure 3.5.

Because some words were not present in all sentence types, parentheses are used to indicate the optionality of these words in the graph.\footnote{The mean duration of the preposition in Figure 3.5 right after the verb in fact includes one adverb and one noun, which occurs in the two syntactic types ((59c) and (59d), for which there is only one sentence each.} Figure 3.5 shows that the duration of the prepositions

![Figure 3.4: Mean duration of verbs, optional prepositions, object noun and participles for ‘V NP -ing’ and ‘V prep NP -ing’ types: the group for which IP boundary was after the verb](image_url)
Figure 3.5: Mean duration of verbs, adverbs, prepositions, nouns and participles for ‘V prep NP -ing’, ‘V NP prep NP -ing’, and ‘V adv prep NP -ing’: the group for which the IP was after prep, the first NP, and after adv after the verbs differ in two prosodic conditions, regardless of whether they are from the high attached or low attached contexts. The two early boundary conditions have longer duration for these prepositions than the two late boundary conditions. On the other hand, the duration of verbs did not differ across the two prosodic conditions. The duration of nouns immediately before the participles reflect the pre-boundary lengthening for the late IP conditions only. As before, the number immediately next to each word type indicates which words should go together. In sum, the durations of words in early and late boundary sentences are clearly distinct from each other because of the different IP location.8

In addition to the analysis of duration, the analysis of fundamental frequency from all test materials was conducted for each of those words between verbs and participles. Again, the materials are split into two groups depending on whether the IP boundary was immediately after the verb or after some other words. As described in Chapter 2, F0 of three points from each of those words between verbs and participles was measured following Blodgett (2004). For one syllable words, F0 of the beginning, middle, and end was measured. The reason for taking three points is to describe

8The duration of ‘adv’ in EIP sentences looks different because there is only one sentence for this type and so only one token of that word.
pitch excursion for the L-H% boundary tone of the syllable at the boundary location. For multi-
syllable words, first F0s from the middle of the first syllable was taken. In addition, the middle of
the last syllable and the end of the last syllable were taken again to describe pitch excursion for the
L-H% boundary tone at the boundary location. The reason for not taking measurements from ac-
cented syllables was that the stress of each word was not constant and so it was decided that taking
measurements from the same part of each word was more important. The mean F0 of those words
from the first group is presented in Figure 3.6.

A “scoop” pattern was found for verbs in the early IP boundary conditions and for nouns
for the late IP boundary conditions reflecting the L-H% boundary tone. In addition, the participles
were set off from the previous phrase to begin a new IP in the late IP conditions. The pattern for
the other group was also similar. In these cases, the early boundary was not after the verb but
after prepositions, adverbs or another nouns and so F0 patterns for these items diverged across two
prosodic conditions. Again, there was a reset for the participles for the late IP conditions.

In summary, the phonetic analyses of duration and fundamental frequency showed expected
pre-boundary lengthening and pitch movements for the L-H% boundary tones, supporting the ToBI
analysis.

![Figure 3.6: Mean F0 of beginning, middle and end from verbs, optional prepositions, object noun
and participles for ‘V NP -ing’ and ‘V prep NP -ing’ types where the IP boundary was after the verb](image)
Figure 3.7: Mean F0 of beginning, middle and end from verbs, adverbs, prepositions, nouns and participles for ‘V prep NP -ing’, ‘V NP prep NP -ing’, ‘V adv prep NP -ing’ where the IP boundary was after prep, the first NP, and adv

3.2.4 Participants

104 participants participated in this experiment in a partial fulfillment of a course requirement.

3.2.5 Procedure

Since this experiment used the same setup as the following experiment with contextual manipulation, but only without preceding contexts, the lists to be used were created in the following way. Each of two prosodic conditions (early versus late IP boundary) was used along with either the high attached reflexive pronoun (high attachment) or the low attached reflexive pronoun (low attachment syntax). This way, four lists were created; early IP high attachment, late IP high attachment, early IP low attachment and late IP low attachment. Test sentences were mixed with the same filler sentences that were used in the written Pre-test 2 discussed in the previous section. In each trial of the main part of the experiment, participants first heard a spoken fragment, then a visual naming target. As soon as the target was named and thus triggered the response box to record and showed the naming time, either the next trial appeared or a comprehension question was asked. In the second part of the experiment, participants heard a carrier sentence, *The next word will be*, and then saw
a visual naming target. The naming target in this second part was always either *himself* or *herself*. Participants were asked to name these targets as soon as possible but reminded that they would not need to add any completions.

Participants sat in front of a computer screen wearing a set of headphones and a standing microphone was adjusted for each participant. E-prime software was used on a PC to present visual and auditory materials. To record the completions that participants gave, an experimenter, a native speaker of English, sat right next to each participant facing the same computer screen. Before beginning each session, the following instructions were given in a written form to a participant. “In each trial in the experiment, first, you will see the trial number on the monitor and at the same time hear the beginning of a spoken sentence. Right after that, a word (or a phrase) will appear on the monitor. First, please say that word (or phrase) into the microphone as quickly as possible and then finish the sentence by adding at least one more word.

Remember that you need to name the visual word(s) first before adding your own word(s). It is important to keep in mind that your naming response will be timed and so we want you to go as quickly as possible. However, you can take as much time as you want to finish the sentence.

When you finish the sentence, remember to press 1 on the response box. Then, sometimes you will see a comprehension question about the sentence you just heard along with two possible choices. Please select one and press the corresponding button on the response box. Other times, you will just go to the next trial.

After this part, in the second part of the experiment, you will see visual targets to name on the screen. Please say that word into the microphone as soon as possible but this time you don’t have to add any word(s).”

A similar instruction was given verbally to each participant by the experimenter before the experiment began. Before the main experiment, participants were given 5 practice trials. During the practice or after the practice, either participants clarified about the procedure or the experimenter corrected participants who did not follow the procedure. The same person sat next to each participant and recorded the completions each participant produced.
3.2.6 Subject exclusion and data replacement

Out of 104 participants, data from two participants could not be used due to excessive missing data (more than half out of the total test sentences). Missing data were due to voice key errors, failure to respond, or naming the wrong word for a visual target. To balance the number of participants for each list, additional 10 participants who had most missing data were excluded. After this, all lists had 23 subjects for each, and 92 total.

The second round of subject exclusion was performed after the examination of completion data. This was done by two native speakers of English, who judged the completions based on the following two criteria. First, they decided whether the completions each subject gave were a grammatical continuation or not (see the next section for the example). Second, they indicated whether the participial phrases had been attached high or low based on the completions.

As for the first criterion, the data was marked ungrammatical only when the two judges both indicated so. The decisions on the second criterion were also used to exclude any qualifying subjects; again this was when both judges agreed that completions clearly indicated that the participants had parsed the participles in a manner opposite the intended meaning (see the next section for example). Based on these criteria, subjects who missed more than half of the items in any of the four conditions were excluded. In this way, five subjects were excluded. In addition, one subject whose overall mean was three standard deviations away from the experiment-wise mean was excluded. Finally, to balance the number of subjects in each list, an additional six subjects were excluded from the analysis. In doing so, the subjects who needed most data replacement were excluded. Eventually, there were 80 subjects whose data were analyzed.

Individual data points were replaced in the remaining subjects’ data for the following reasons: whenever there were no completions, voice key activation errors, naming the wrong targets, when the reaction time was less than 150 ms or more than 3 seconds and finally when the completions were judged ungrammatical or when the completions were judged as the “opposite parse” by both judges. “Opposite parse” refers to cases where it is clear that the participial phrase is attached to modify the NP that is not indicated by the gender of the reflexive pronoun. Because we have

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9I am truly grateful to Vanessa Metcalf and Shari Speer for this long process of going through all of the completions.

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to assume that the naming response reflects processing time for a particular parse, when the com-
pletion showed the opposite parse, those data must be excluded. This procedure is consistent with
those used by other researchers who used cross-modal naming tasks to evaluate syntactic attach-
ment (Kjelgaard and Speer 1999; Marslen-Wilson, Tyler, Warren, Grenier, and Lee 1992). These
data were replaced by the mean of the experiment-wise mean for each subject and each item, using

The table below shows the proportion of all replacements in each condition. 215 out of the
total of 2240 naming response times (28 items times 80 subjects) were replaced. As can be seen
in the table, the condition with a mismatch between syntax and prosody (high attached early IP
boundary) resulted in the highest proportion of replacement, showing the processing difficulty of
this condition.

### 3.2.7 Completions

In this section, let’s take a closer look at the completions. Remember that unlike studies of Kjelgaard
and Speer (1999) or Blodgett (2004), completions in the current study were not meant to finish
uncompleted sentences because the auditory segments and visual stimuli form complete sentences
by themselves. The reason that the completion was required from the participants was to avoid any
wrap-up effects that would otherwise occur if the visual target was at the end of each trial. For this
reason, often times, the completions themselves were not a decisive indication of the attachment site

<table>
<thead>
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<th>Syntax</th>
<th>Prosody</th>
<th>ungrammtical</th>
<th>opposite</th>
<th>no completion</th>
<th>voice error</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
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<td>82</td>
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<td>49</td>
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<td>55</td>
<td>22</td>
<td>100</td>
<td>38</td>
<td>215</td>
</tr>
</tbody>
</table>

Figure 3.8: The number of replaced data in English cross-modal naming experiment: voice error
refers to both voice key error and naming the visual target incorrectly, which occurred only 4 times.
of the ambiguous participle phrases but in most cases, neutral ones that made the participial phrases go either way. As such, the completion data could not be critically used to examine the attachment decision.

In the previous section, it was mentioned that the ungrammatical completions or the mis-parsed completions were replaced. Also, it was indicated that these two cases occurred most often in prosody/syntax mismatched cases. Examples of ungrammatical completions are given in (60) (the bold faced was the naming target and italicized ones were the completions provided by participants).

(60) a. The soprano followed the lad murmuring to himself to her.
   b. The housemaid scrutinized the butler dressing herself was running late.

The more interesting case is when the completions indicated that participants had understood the participle as associated with the noun opposite the one intended. Examples of this kind along with their prosodic condition are provided in (61).

(61) a. [The priestess advanced] towards the boy chanting to herself because herself was not a boy.
   b. [The ballerina collapsed near the male dancer] worrying to himself why am I a male ballerina.
   c. [The stepmother embraced] the stepson crying to herself tightly.

In (61a), the completion indicated that chanting to herself was attached to the immediately preceding noun boy despite the mismatch of the noun boy and herself. Likewise, if the listener in (61b) had understood the participle being attached to the previous noun male dancer, then, the completion as given would not have been produced. Although these kinds of completions seem to be meta-linguistic expressions, they are also clearly showing that these listeners parsed the participles in a manner opposite the way that was indicated by the gender of the reflexive pronoun.

The completion type in (61c) deserves more attention because it is important to understand why these types of completions will not be included in the reaction time analysis. In addition, I believe that this reveals some interesting syntactic constraints and their mediation by prosodic
information. Let’s go through the steps to decide that this kind of completion indicates the low-attachment of the participle. First of all, the reflexive pronoun herself forces the high-attachment of the participial phrase crying to. However, tightly can only go with and so modify the main verb embraced since the meaning of tightly makes it impossible for the adverb to modify the preceding participle crying. This creates a problem if the participle is high-attached due to the following reason. In terms of positioning in a given sentence, we can distinguish two types of adverbial expressions; one is a modifier of verbs or verbal phrases and the other is a modifier of a whole sentence (Quirk, Greenbaum, Leech, and Svartvik (1985)). The sentential modifier is freer in occurring both at the end or the beginning of a sentence whereas verbal modifiers occur normally at the end, although they can sometimes occur in a medial position as the following examples show (the examples are from Quirk et al. 1985).

(62) a. She kissed her mother on the cheek. (verbal modifier)
    b. ? On the cheek, she kissed her mother.

(63) a. She kissed her mother on the platform. (sentential modifier)
    b. On the platform, she kissed her mother.

Furthermore, when the two types co-occur in the same sentence, there is a restriction on the ordering of the two; the verbal modifier occurs before the sentential modifier.

(64) a. She kissed her mother on the cheek on the platform.
    b. On the platform, she kissed her mother on the cheek.
    c. ? She kissed her mother on the platform on the cheek.
    d. ? On the cheek, she kissed on the platform.

The adverb tightly in (65) below shows a similar pattern to (62), as a verbal modifier whereas the participle seems to be a sentential modifier as can be seen in (66).

(65) a. The stepmother embraced the stepson tightly.
    b. ? Tightly, the stepmother embraced the stepson.

I send my sincere thanks to Vanessa Metcalf for a very helpful discussion on this.
(66) a. The stepmother embraced the stepson *crying to herself.*
   
b. *Crying to herself,* the stepmother embraced the stepson.

   In sum, the reason that the sentence in (61c) is judged as an opposite parse and thus excluded is the following: As a verbal modifier, *tightly* cannot occur after the sentential modifier, *crying to herself.* Again assuming that listeners try to make sense of what they heard and to give as grammatical completions as possible, the only way that makes this completion a grammatical continuation of the spoken material is to attach the preceding participle low despite the presence of the conflicting pronoun information. The two judges and one syntactician \(^{11}\) all agreed on the ungrammaticality of sentences like in (61c).

   Not surprisingly, most of these kinds of examples came from the conditions where syntactic and prosodic information conflicted with each other. Although these kinds of completions clearly demonstrated the strong effect of prosodic information on syntactic parsing, naming times from such trials cannot be included in the reaction time analysis. This is because naming times will be used as a measure of processing difficulty in correctly attaching the participial phrase—that is, in a manner consistent with the gender of the reflexive pronoun. In order to compare naming times across conditions, we must be able to assume all naming times in a given condition reflect the same attachment type (to the best of our knowledge).

   The data that had “split” judgments are also worth mentioning. There were 10 instances that one judge gave high attached readings in the low attached condition. Eight out of the 10 came from the late IP, conflicting prosodic condition for this reading. The other judge decided that it was neutral. As can be seen in the examples below, most of these were not as strong an indication of one or the other reading as examples in (61), which is why these received the split judgment.

(67) The soprano followed the lad murmuring to *himself* *I can’t believe he’s in front of me.*

Assuming that the completion functions as a complement of the preceding participle,\(^{12}\) the content of this completion along with the use of the pronoun *he* or *in front of* seems to indicate that the

\(^{11}\) I thank Bob Levine for providing the additional judgment on this.

\(^{12}\) The judges were not sure if this kind of clause can be a complement of these verbs but this seems to be the only grammatical continuation. There were many comparable completions in the data.
whole participle along with the completion should be attached high unless he in this sentence could be referring to a referent that is neither the soprano, albeit weird, nor the lad, in which case the low attached reading is possible. However, without any contexts present, that reading seems to be unlikely. Thus, this kind of completion, although suggestive of the opposite parse, is not as strongly inappropriate as the ones in (61), creating the split decision. The other judge gave neutral reading on this.

Similarly, there were 42 instances of the split decision for the opposite parse in high attached reading. Not surprisingly, two-thirds of them came from the high attached early boundary case.

(68) a. [The monk walked] toward the girl singing to himself to tell her that she is a good singer.
   b. [The showgirl chased] the mailman shouting to herself that somebody was chasing her.

However, again, in deciding to exclude the type discussed above, to avoid too much data replacement and also in an effort to accommodate participants’ completions as much as possible, the data that had split judgement from the two judges were not excluded. In the next section, we will take a look at the reaction time data.

3.2.8 Results of reaction time analysis

It was hypothesized that the prosodic information could be critically used to resolve temporary syntactic ambiguity of participial phrases. Thus, in spite of the morpho-syntactic information from the gendered reflexive pronouns, the conflicting prosody was expected to make it harder to integrate the visual naming target into the spoken fragment.

The prediction was borne out for the high attachment syntax but not for the low attachment syntax. Listeners took longer time in the early IP condition (conflicting prosody) than in the late IP condition (matching prosody) for the high attachment syntax. On the other hand, the two prosodic conditions did not differ from each other for the low attachment syntax. Figure 3.9 shows the mean corrected response times for the two prosodic conditions in both attachment types. The corrected response times were calculated by subtracting, for each subject, the mean response time to herself...
and himself in carrier sentence conditions from the mean of herself and himself in the two different prosodic conditions. The mean corrected response time for each item can be found in Appendix C.

The data were entered into a repeated measures ANOVA with both subjects and items as random factors. Prosody (earlyIP and lateIP) and syntax (high attached and low attached) were the two independent variables. There was a main effect of syntax only in the subject analysis \[F_1(1,79)=4.25, p<.05; F_2(1,27)=3.02, p>.09\]. The main effect of prosody approached significance in both subject and item analyses \[F_1(1,79)= 3.35, p<.08; F_2(1,27)=4.09, p<.06\]. However, there was a significant interaction of syntax and prosody \[F_1(1,79)=7.38, p<.01; F_2(1,27)=8.44, p<.01\] A planned comparison showed that there was a significant difference between high attached matching prosody and high attached conflicting prosody \[F_1(1,79) = 9.71, p<.01; F_2(1,27) = 11.92, p<.01\]. Corrected naming times for matching prosody were shorter than those for mismatching prosody in the high-attached syntactic condition. On the other hand, the difference between matching and conflicting prosody for low attached reading did not reach significance \[for Fs, p>.4\].

![Figure 3.9: Mean corrected response time for two prosodic conditions in two attachment types: earlyIP - conflicting prosody in HA and matching prosody in LA, lateIP - matching prosody in HA and conflicting prosody in LA](image-url)
3.2.9 Discussion

The results of the naming experiment showed that listeners were sensitive to prosodic information even with strong morpho-syntactic cue (such as the gendered reflexive pronouns) available; although the main effect of prosody did not reach significance, the naming time for the conflicting prosody in the high-attached syntax (early IP) was significantly longer than that for the matching prosody in the same syntax. This demonstrates that when the prosodic structure conflicted with the morpho-syntactic pronoun information, the listeners experienced a garden path effect, which showed immediately in the naming time. More specifically, in the early boundary condition in the high-attached syntax, listeners were building a structure where the ambiguous participial phrases were attached to the preceding noun. This initial analysis caused a processing difficulty when the visual naming target, a reflexive pronoun that was coindexed with the subject, appeared. In other words, since the participial phrases were being analyzed to be attached low, in which case, the reflexive pronoun should be coindexed with the noun immediately preceding noun but not the subject, the naming target coindexed with the subject created the mismatch between the initial analysis and pronoun resolution.

Completion data also confirmed processing difficulty in this condition. In fact, in the early IP, conflicting prosodic condition in the high-attached syntax, more listeners could not overcome the garden-path effect than in any other condition. Thus, their completions indicated that the ambiguous participial phrases should be attached to low despite the ill-matched pronouns, providing a strong support for prosodic effects.

The two prosodic conditions in the low-attached syntax, however, did not produce a significant difference. The hypothesis was that the early IP boundary would be a matching prosody for this reading whereas the late IP boundary would not and thus result in longer processing time in this late IP condition. This is because according to Schafer’s Prosodic Visibility hypothesis, in the latter case, the presence of the IP boundary right before the ambiguous participial phrases would make the immediately preceding noun less visible, and thus, will make the low attachment harder than when the same noun is more visible by being in the same prosodic phrase. The lack of the difference in the naming times in these two conditions gets more interesting when we consider results from both
Experiment 1 and this naming experiment. In the previous chapter, it was suggested that the late IP boundary was more ambiguous and this might be attributable to the creation of the non-restrictive reading for the low attachment syntax. The contrast between restrictive versus non-restrictive readings is well-illustrated in (69) using a relative clause, but we can apply this logic to our participial phrases.

(69)  a. ? My husband who lives in Chicago is visiting me this weekend.
   b. My husband, who lives in Chicago, is visiting me this weekend.

Since the restrictive modifier of a noun has a function of restricting the set of a noun into the subset of a noun that has a certain property X (here living in Chicago), this presupposes that there are other members in that set of a noun that do not have that property X. This would mean that for (69a), there will be other husbands that do not live in Chicago. On the other hand, the non-restrictive relative clause simply provides further information about the preceding noun.

If we assume that in the naming experiment, listeners were also creating the non-restrictive reading in the late IP condition, it is not surprising that there is no difference in the two prosodic conditions. In other words, the early IP condition in the low attached syntax was used for the restrictive reading whereas the late IP was used for the non-restrictive reading. Since each prosodic condition was used for two distinct meanings, neither condition was more difficult than the other. Note, though, that according to the theory of Referential Support proposed in Crain and Steedman (1985) or Altmann and Steedman (1988), to be discussed below, the restrictive reading would be more difficult because there are more presuppositional requirements that this reading has to satisfy.

What would be a motivation for positing the non-restrictive reading for the late IP boundary in the low-attached syntax? First of all, the non-restrictive reading of a relative clause is often signaled by a comma in written language and by a new IP for spoken language. This correspondence between a comma and a prosodic break was empirically confirmed in an interesting study by Laurie Maynell (personal communication). Using an ambiguity of a relative clause with two possible attachment sites (e.g., the daughter of the general who was standing in the balcony), Maynell showed that the presence or absence of a comma before the ambiguous relative clause had the same effect as did a prosodic boundary in the same location in determining the attachment of the relative clause.
Just as a prosodic boundary before the relative clause resulted in more high-attached readings of the ambiguous clause (to the first noun daughter), the presence of a comma in the same location resulted in more high attachment. For the participial phrases, from the example from Quirk et al. (1985) we saw before, repeated here as (70), it was pointed out that the non-restrictive reading is possible for low attachment and furthermore, that reading is indicated by a presence of a comma before the participial phrase.

(70) She glanced with disgust at the cat, stretched out on the rug mewing plaintively.

Given the correspondence between a comma and a prosodic break on one hand and the distinction between the restrictive and the non-restrictive reading for a relative clause created by a differing prosodic pattern on the other, it is not hard to imagine that the late IP boundary in the low-attached syntax for the current materials can be used for the non-restrictive reading. If so, listeners were responding to two different prosodic structures appropriate for two distinct meanings, showing no sign of difficulty for either prosodic condition.

The discussion above, then, seems to suggest that the IP boundary is compatible with both the high-attached reading and the low-attached nonrestrictive reading of participial phrases. In the following section, the general discussion of both an off-line and an on-line experiment will be provided.

3.3 General discussion of English Experiment 1 and 2 without context

The experiments reported above showed a consistent pattern of results; the IP boundary in some locations other than immediately before the ambiguous participial phrases produced a higher proportion of the low-attached reading in the off-line experiment. In addition, in the on-line cross-modal naming experiment, the reaction time in the high attached early IP boundary condition, along with a small portion of completion data, provided evidence that suggests that in this condition, listeners were building the low-attached reading of the participial phrases. The other prosodic condition,

13There might be some terminology confusion with the use of high/low attachment. In Maynell’s study, high attachment means that a relative clause is attached at the first noun phrase in a complex noun phrase that has two nouns whereas the low attachment means that the same relative clause is attached at the second noun phrase.
the IP boundary right before participial phrases, also pointed to the same direction. Although this condition seems to be used for a more high attached reading of participial phrases, it also seems to suggest that this condition is compatible with another reading, the non-restrictive reading. This was shown by the most ambiguous responses in the off-line experiment and no significant difference between the early and late IP conditions in the on-line naming experiment.

The effects of an early IP boundary (for the low-attached reading) are successfully predicted by several processing accounts. In Schafer (1997)’s account, the low-attached reading is easier in this condition because the noun preceding the ambiguous participial phrases is within the same prosodic phrase and thus, has a higher visibility than the main verb, which results in the high-attached reading. Although Prosodic Visibility Hypothesis is for phonological phrases (an intermediate phrase in Beckman and Pierrehumbert (1986)), there is no other break in the materials and also since the IP boundary entails the Phonological phrase boundary, this hypothesis is applicable here.

However, the lateIP condition is problematic for Schafer’s account, as was predicted in Chapter 1. The presence of a boundary right before ambiguous participial phrases make both preceding nouns and main verbs equally accessible for attachment. However, as with the current results, listeners in Schafer (1997) preferred a high-attached reading of ambiguous prepositional phrases when a prosodic break (a phonological phrase in her term) occurred immediately before the prepositional phrases. If both nouns and verbs are equally visible according to Prosodic Visibility Hypothesis, there is no reason for the preference to the high-attached reading. To account for this, Schafer had to rely on the ‘default’ preference in reading. In other words, when multiple attachment sites are equally visible, the ‘default’ preference in reading should prevail. For her prepositional phrases, this idea nicely captures the resulting preference for the high-attached reading in this condition because it was claimed that there was a preference for the high attachment of prepositional phrases.14

However, this account makes a wrong prediction for the current materials in the lateIP condition, which suggests a more general problem with this part in Schafer’s hypothesis. The written account makes a wrong prediction for the current materials in the lateIP condition, which suggests a more general problem with this part in Schafer’s hypothesis. The written

14However, as mentioned before, more evidence is emerging that this so-called high attachment preference is not firmly established.
pre-test conducted revealed that there was a bias toward the low-attached reading of participial phrases. Since this is the default preference in reading, the hypothesis should predict preference for the low-attached reading. On the other hand, the results from two auditory listening tests suggest otherwise; although the low-attached reading was not completely excluded possibly due to the non-restrictive reading, the reaction time data (lateIP high-attached pronoun condition) from the naming experiment provided a strong evidence that listeners were attaching these participles high.

What does Anti-Attachment Hypothesis predict for this problematic late IP condition? According to this hypothesis, listeners prefer not to attach an ambiguous post-prosodic boundary word to the immediately preceding word. However, if the post-boundary phrase is not attached to the preceding word, where should it be attached? Because there are two more readings other than the restrictive reading assuming the non-restrictive reading is possible, this hypothesis does not predict which of the two attachment sites the participles should go to.

In contrast to these two accounts, Blodgett (2004) can be used to predict high attachment preference. As discussed in Chapter 1, Blodgett (2004) assumes Boland (1997)’s constraint-based model, in which multiple syntactic analyses are generated at the point of ambiguity. Among these multiple alternatives, one analysis is selected by the syntactic processor although other alternatives will be reactivated when information compatible with those alternatives arrives. The selection of one analysis is guided by not only syntactic information but also other non-syntactic types of information, including frequency and semantic/pragmatic plausibility, among others. Blodgett adds to this model a phonological processor, which will generate an abstract prosodic structure. When selecting one analysis to pursue, the parser looks at how good the match between the prosodic structure and possible syntactic structures. This constraint, called ‘goodness-of-fit’ will add weights to the analysis that has matching prosodic and syntactic structure and will be selected. Unlike Schafer’s Prosodic Visibility Hypothesis, this will predict more high-attached readings in the late IP condition for the current materials because the prosodic boundary at this location matches better with the high-attached syntax.

The prosodic boundary before the ambiguous participle phrase coincides with a completed syntactic structure (VP2) in (71a), whereas the same prosodic boundary in (71b) is not contained
Figure 3.10: Two tree structures for ambiguous participle phrases with prosody
within a completed syntactic constituent, an object noun phrase in this case. Furthermore, Blodgett’s ‘goodness-of-fit’ constraint seems to well account for the non-restrictive reading for the late IP conditions. Assuming the phrase structure in (72) for the non-restrictive reading, the prosodic break coincides with the completed syntactic constituent noun phrase.\(^{15}\)

Unlike Schafer, who had to assume the ‘default’ preference in reading, Blodgett correctly captures the fact that the presence of a prosodic break right before participial phrases can be compatible with two distinct meanings. Then, the question remains which of the two interpretations, the high-attached reading or the low attached, non-restrictive reading, the late boundary is more compatible with. That discussion will be deferred until the next chapter.

It will be interesting if these non-restrictive readings are also present in ambiguous prepositional phrases although the author is not sure if all post-noun modifiers will have non-restrictive

![Figure 3.11: A tree structure for the non-restrictive reading of the low-attached reading](image)

\(^{15}\)The same structure can be posited for a non-restrictive relative clause and in addition, the often attested uses of a proper noun in a non-restrictive relative clause supports positing an NP structure as a sister of a relative clause. The same can be true for participial phrases.

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readings. For example, in the study of Price, Ostendorf, Shattuck-Huffnagel, and Fong (1991), the far-near attachment type, which include both ambiguous prepositional phrases and participial phrases, showed below average accuracy and confidence rating. Again, the non-restrictive reading might have been recovered for the prosodic break before those ambiguous phrases, and thus this reading was conflated with the high-attached reading.

In this section, first, we confirmed prosodic effects on the attachment decision of ambiguous participial phrases. These results are also in line with previous work on ambiguous prepositional phrases including studies by Schafer and her colleagues. In addition, we also saw that the prosodic boundary immediately before participial phrases can be still ambiguous. However, so far, we have only considered those constructions in isolation. In the next section, these constructions will be embedded in a biasing context and we will examine how prosodic structures interact with contextual information in determining the attachment of those constructions.

3.4 Experiment 3: Auditory Listening test

3.4.1 Materials

The same context sets used in Pre-test 2 as in (53) were used with some changes in the contexts and the participles explained at the discussion of the previous section. Target sentences such as (73) were presented auditorily. In contrast to the written presentation, reflexive pronouns were included in each target sentence. The IP boundary was placed in two different places in each target sentence as the example in (73) shows.

(73) a. [The saleswoman tailed the salesman]\p [complaining to herself]\p (lateIP condition)
    b. [The saleswoman tailed]\p [the salesman complaining to herself]\p (earlyIP condition)

Although the transition from a visual sentence paragraph to a spoken target sentence might reduce the continuity between prior contexts and the target sentences, contexts were presented visually to control for the prosodic complexity inherent in auditorily presented contexts. For example, although the author trusts the speaker’s ability to produce consistent prosodic patterns, due to the lengthy
nature and lexical variability of the contexts, it was not possible to specify a single appropriate prosodic pattern that could be used for all contexts. Besides, unlike Korean, English has a very complicated structure for the placement of pitch accents that is not yet well-understood, and this, in turn, could potentially affect the ultimate interpretation of each discourse. 16

Another difference needs to be mentioned on the design of the auditory experiment. In the written norming test we just discussed in the previous section, participants were given two choices of reflexive pronouns that can be coindexed either with the subject noun phrase, indicative of the high attached reading or with the object noun phrase, which signals the low attached reading of participial phrases. We also saw that the number of referents for the object noun phrases and the prompt sentences at the end of each context served to resolve the ambiguity of the participial phrases. In the written test, sources of information that can affect the resolution of the ambiguous phrases come from only prior contexts.

The exactly same setup would have been used in the auditory test. This would have meant that along with two biasing contexts and prosodic factors to be manipulated, each target sentence uttered with two differing prosody would have contained two differing reflexive pronouns as in (74).

(74) a. HA context (high attachment bias):
   A senior saleswoman was once assigned to investigate a junior salesman for bribing local government officials. She was doubtful that he would do such a thing without probable reasons because he was a very honest man. One day, however, she got a tip that he left the office after he rummaged through file cabinets, so she went after him right away. And let me tell you what else she was doing as she tailed him.

b. target sentences in HA context:
   • high attached pronouns:
     [The saleswoman tailed the salesman]\textsubscript{IP} [complaining to herself]\textsubscript{IP}
     [The saleswoman tailed]\textsubscript{IP} [the salesman complaining to herself]\textsubscript{IP}
   • low attached pronouns:
     [The saleswoman tailed the salesman]\textsubscript{IP} [complaining to himself]\textsubscript{IP}
     [The saleswoman tailed]\textsubscript{IP} [the salesman complaining to himself]\textsubscript{IP}

c. LA context (low attachment bias):
   A senior saleswoman was once assigned to investigate two junior salesmen for bribing local government officials. She was doubtful that they would do such a thing without probable reasons because they were very honest men. One day, however, she got a tip that they left

16Despite this, as Fodor (1998) suggests, readers could produce their own prosody, albeit silently.
the office after they rummaged through file cabinets, so she went after one of them right away. And let me tell you which one she tailed.

d. target sentences in LA context:

• high attached pronouns:
  [The saleswoman tailed the salesman]_{IP} [complaining to herself]_{IP}
  [The saleswoman tailed]_{IP} [the salesman complaining to herself]_{IP}

• low attached pronouns:
  [The saleswoman tailed the salesman]_{IP} [complaining to himself]_{IP}
  [The saleswoman tailed]_{IP} [the salesman complaining to himself]_{IP}

However, it was decided that contextual manipulation would be so strong for each reading that the use of the wrong reflexive pronouns would render the target sentences almost uninterpretable. For example, in the high attached context where the explicit inquiry of the actions of the subject noun phrase was being mentioned along with there being only one referent for the object pronoun, the use of the low attached pronouns would make the target sentence too infelicitous and garden-pathy to observe any effects of prosodic manipulation for. Therefore, only reflexive pronouns that are compatible with each context were used in the auditory experiment.

3.4.2 Procedure

A total of 32 test sentences along with 32 contexts were used. As explained in the previous section, only four lists were created for this experiment. In each list, 16 items were presented as an HA context and the other 16 were presented as a LA context. For HA contexts, half of them were presented with the lateIP prosodic condition as in (73a) and the other half, with the earlyIP condition as in (73b). The same was true for LA contexts. As said before, only target sentences contained pronouns that were matched with the contextual manipulation. In other words, if participants were given a HA context, the target sentence was presented with one of two prosodic forms in (75) whereas if an LA context was presented, one of two versions in (76) was provided.

(75) a. lateIP condition in HA context:
  [The saleswoman followed the salesman]_{IP} [complaining to herself]_{IP}

b. earlyIP condition in HA context:
  [The saleswoman followed]_{IP} [the salesman complaining to herself]_{IP}
(76) a. lateIP condition in LA context:
[The saleswoman followed the salesman]p [complaining to himself]p
b. earlyIP condition in LA context:
[The saleswoman followed] p [the salesman complaining to himself]p

In addition, the gender of the subject and object noun phrase was counter-balanced; half of the HA contexts had female subject and male object and the other half of HA contexts had male subjects and female objects. The same was true for the LA contexts. These test sentences were mixed with the three different types of filler sentences, which were explained in the previous section (see the discussion of the cross-modal naming task in the previous section).

Participants sat in front of a computer screen and wore a set of headphones. Both written and spoken materials were presented on a PC computer by Eprime software. Each context was presented as a written form whereas the target sentence was presented auditorily. As with the Pre-test 2 described earlier, participants were asked to imagine that the passage they read was the beginning of a story. After reading each context, participants heard one of the two prosodic versions of each target sentence, which was played two times in a row. Participants were told that this spoken fragment would continue the context passage they read as if both each passage and the spoken sentence were from the same speaker. Their main task was to evaluate as quickly as possible the naturalness of the spoken sentence as a continuation of the passage they read. For this, the rating scale ranging from 1 to 5 (1 being most natural and 5 being most unnatural) was presented on the monitor right after the spoken sentence. They were also encouraged to use the full range of the scale to indicate the range of their judgments. To make sure they paid attention to the context, a comprehension question, which did not concern the ambiguity, was asked from time to time.
3.4.3 Participants

76 subjects participated in this study in a partial fulfillment of a course requirement.

3.4.4 Results

It was predicted that if listeners relied only on contextual information and ignored prosodic structures, there should be no difference between participants’ rating of earlyIP and lateIP conditions in either contexts. If, on the other hand, listeners were sensitive to prosodic information even in the presence of contextual bias, the matching prosody condition should be easier and considered more natural than the conflicting prosody in either case.

The results confirmed the hypothesis. Figure 3.12 shows the mean rating of acceptability for two prosodic conditions in two contexts and Figure 3.13 and 3.14 shows the total frequency of each response. The mean rating for the earlyIP boundary (conflicting for HA) and the lateIP boundary (matching for HA) in high attachment context was 3.94 and 2.74 respectively. Thus, even in the presence of the biased contexts and of the morpho-syntactic information, if prosodic information was able to render a particular version (earlyIP) of a target sentence unnatural. On the other hand, the mean rating for the lateIP boundary (conflicting for LA) and the earlyIP boundary (matching for LA) in low attachment context was 3.18 and 3.07. This pattern was consistent with the previous naming experiment. That is, the two prosodic conditions did not seem to result in difference in the rating.

ANOVA with two independent variables Context (high or low) and Prosody (matching or conflicting) showed that there was a main effect of prosody \( [F_1 (1,75) = 62.83, p<.001; F_2 (1,31) = 112.11, p<.001] \). There was also a main effect of context \( [F_1 (1,75) = 8.98, p<.01; F_2 (1,31) = 8.62, p<.01] \). The interaction between prosody and context also reached significance \( [F_1 (1,75) = 70.25, p<.001; F_2 (1,31) = 117.74, p<.001] \). A planned comparison between matching and conflicting prosody for the high-attached reading was significant \( [F_1(1,75) = 167.19, p<.001; F_2 (1,31) = 284.66, p<.001] \). However, the difference between matching and conflicting prosody in low-attached reading was not significant \( [for F_3, p>.1] \).
3.4.5 Discussion

The hypothesis that prosody would still be effective even in a biasing context was partially supported. However, the overall results showed exactly the same pattern as those found in the two previous experiments. First of all, in the high attached context, despite the strong morpho-syntactic cue from gendered reflexive pronouns, it was clear that the conflicting prosody made difficult the
integration of the spoken sentence into the context when the contextual information and prosodic information did not match. The spoken sentences with conflicting prosodic information were rated inappropriate as a continuation of the context despite the biased contextual information and the syntactic information from the reflexive pronoun that were matched with the main subjects. These results pose a problem to any claim that prosodic information is not utilized when there is other information to use for syntactic attachment decision (Straub 1997; Fox Tree and Meijer 2000, among others). Since the contextual and reflexive pronoun information made clear that the ambiguous participial phrases should be attached high, if prosodic information had been ignored, then there should not have been any difference in the two prosodic conditions.

However, the same effect was not found in the low attachment condition. Again, these results are reminiscent of the first two experiments. The two prosodic conditions did not differ from each other in terms of appropriateness of the spoken materials as a continuation of the preceding context.

Figure 3.15 shows the correlation between the naming times from Experiment 2 and the ratings from the current experiment. The figure confirms differing results for the high attached and low attached cases. The two prosodic conditions for the high-attached reading showed a positive, although weak, correlation between the naming and the rating experiments (R-Sq=0.1033, F[1,52]=
As the naming time for an item increased, the item was judged more inappropriate. In addition, the figure shows that the variability of items within the same prosodic condition was responsible for the lack of strong correlation.

On the other hand, Figure 3.16 shows that the two prosodic conditions in the low attached case did not show any correlation (R-Sq = 0.0155, F[1,52] = 0.82, p = 0.369).

From these results, we might argue against any role for prosodic information in determining a syntactic attachment decision. This would be consistent with Straub (1997), who suggests that the prosodic information is not used when there is contextual information to use. Thus, listeners need not distinguish between the two prosodic structures. On this view, even if the two prosodic structures are distinct, the availability of contextual information renders the difference useless. However, such an explanation only holds for the low-attached readings in the current results. Why should we see such a pattern of effects?

Results from the early boundary, high-attached biasing context condition strongly suggest that the participial phrases with the early boundary are better matches with the low attached reading. Thus, when the reflexive pronouns were not coindexed with preceding nouns, which are indicative of

![Figure 3.15: The correlation between naming time and auditory rating for HA reading](image)

17 One outlier, *wet* was excluded in the correlation
the low attached reading, those spoken materials were considered inappropriate. If the two prosodic versions are both good for the low attached reading, then logically, the lateIP boundary case should also be rated similarly as inappropriate.

Another possible interpretation for the lack of difference for the low attached reading would be that for the preferred reading, the low attached case for the current materials, prosodic structures simply do not matter and so prosodic information does not play any role in the attachment decision. However, we will see later that this hypothesis is not tenable when we discuss Korean results, which clearly shows listeners’ sensitivity to two different prosodic patterns even for the preferred reading.

As suggested in the previous chapter, if we attribute this lack of difference in the results for the low attached reading to the creation of the non-restrictive reading for the post-noun modifier, then, all of the data from all three experiments will be nicely accounted for.

However, if this late boundary does create the non-restrictive reading on the listener’s part, there are two questions that can be raised. The first one is on the effectiveness of the low attached contexts. It is believed that based on the results from the Pre-test 2, the manipulation of the number of referents for the object noun phrase and the prompt sentence at the end of each context was

\[18\] I thank EunJong Kong for pointing this out.

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successful in making these contexts biased toward the low attached reading. Furthermore, in the current materials, it is thought that the bias got stronger by the addition of the prompt sentence at the end. Then, even with this strong contextual manipulation, if listeners do create the non-restrictive reading, we may be tempted to conclude that the prosodic information can outweigh the biasing context. This possibility is not that far-fetched, considering the results from high attached contexts. In the high-attached contexts, despite the two sources of information (morpho-syntactic and contextual), which strongly suggest the high attached reading, listeners were having difficulty in integrating the spoken materials into the context when prosodic information did not match with other information.

It is possible, however, that the contextual manipulation of the low attached reading may not have been as successful as it was expected. Although it was believed that the manipulation of the number of referents and the prompt sentence at the end of the context would be enough to result in more low attached reading, some of the felicity conditions suggested by Crain and Steedman (1985) may not have been satisfied. Crain and Steedman claimed that the reason that the use of a referential definite expression as in ‘The horse raced past the barn fell’ sounds so bad is because there are presuppositional requirements that need to be met for this sentence to be felicitous, which include at least the following three: (1) that a set of individuals be identified by the head nominal (2) that it is already given or implicit that the relative clause applies to some individual in that set and finally (3) that the whole expression identifies a single individual. According to these criteria, our low attached contexts may lack the second requirement. The first criterion was met by introducing two referents for the object noun phrase. However, the context did not specify or imply that the participial phrase used in the target sentence applies to one of the two referents. This may make the target sentences a little less felicitous for the strictly restrictive reading although we can assume that comprehenders are able to make inference when they are presented with nouns modified by the following modifiers. Thus, even if one of the salesmen complaining in our context above was not mentioned or implied in the context, by the time it was presented, listeners would be able to infer that they need to refer to that salesman who was complaining but not the other.
Things seem to be more complicated than they look. Even though this is not explicitly specified in Crain and Steedman, it seems that actions described in the relative clauses (participial phrases in our case) need to be contrasted with other actions in the context in order for those post-noun modifiers to be felicitously used as restrictive modifiers. In other words, restrictive modifiers are not just restricting the whole set to a subset that has some property. Rather, the use of restrictive modifiers along with definite noun phrases seem to imply some contrastiveness among referents. Thus, it is not enough to contrast just the presence of some property for one referent and the absence of it for the other but the presence of two different properties. Hence, in our low-attached case, first, the property of ‘complaining’ should have been mentioned or implied in the context and in addition, some other property such as ‘talking’ should have been used to apply for the other referent to have a felicitous context for restrictive reading.

Interestingly, a paper by Meroni and Crain (2002) seems to have already noticed this problem. In a reply to a study by Trueswell, Sekerina, Hill, and Logrip (1999), which examines young children’s use of referential context to resolve prepositional phrase ambiguity, Meroni and Crain (2002) claimed that a small change in the display setup changed young children’s ability to use referential context. In the original study by Trueswell et al., for the target sentence such as ‘Put the frog on the towel in the box’, there were two frogs, one of which was on the towel and the other was not in the two-referents contexts. Unlike adult’s performance which demonstrated the early effect of referential context to resolve the prepositional ambiguity, young children in Trueswell et al. were shown to fail to use this information.

However, Meroni and Crain argued that the frog which was not on the towel invited some pragmatic inference that that frog was salient, which made following prepositional phrase unnecessary as a post-noun restrictive modifier. When Meroni and Crain changed the visual display this way, children were able to use this information to resolve the prepositional phrase ambiguity.

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19 Thanks to Mineharu Nakayama for pointing this out.
20 Shari Speer and Mineharu Nakayama both suggested this.
21 It is not clear, however, why that frog was more salient than the other frog, which was on the towel. Besides, adults in Trueswell et al. still showed the sensitivity to this referential context, weakening Meroni and Crain’s argument. Interestingly, however, the work by Tanenhaus et al. (1995) demonstrated the exact same effect of referential context using a two-frogs display where one of the frogs was on the towel while the other was on the napkin.
It is possible that understanding linguistic expressions themselves differs from understanding the actual situations denoted by those linguistic expressions visually. Thus, even if restrictive readings do not entail the contrast of multiple properties for the multiple referents in a context, the visual realization might force such entailment for reasons not relevant to the nature of the linguistic expressions. Hence, in the case of two frogs, one on a towel and one not, the frog which was not on anything might be most salient to viewers. If so, it could be uniquely referred to by the definite noun ‘the frog’ without any restrictive modifiers. So this is not the best environment to use restrictive modifiers. On the other hand, in a context where the two frogs were on two different objects, neither of them was salient to viewers and so to uniquely refer to one of them by using the definite noun phrase, the following modifier is needed as a restrictive modifier.

Indeed, studies that explored the idea of Principle of Referential Support used contexts where multiple referents for head nouns were mentioned and two contrastive actions were done by those multiple referents (Crain and Steedman 1985; Altmann and Steedman 1988, among others). However, it is not clear whether this is a necessary condition for the low attached reading for the current materials. Without mentioning them, the current contexts can still provide a felicitous condition for the low attached reading still following the Principle of Referential Support. Two salesmen were introduced in the context. In the target sentence, a definite noun phrase ‘the salesman’ was used. However, this expression fails to refer uniquely to the referent since there were two salesmen in the context. Therefore, the following participial phrase will be more likely used as a modifier to satisfy the Principle of Referential Support than as a high attached sentential modifier. Furthermore, although the action of ‘complaining’ was not implied or specified in the context, the last prompt sentence containing ‘which’ provides an environment that invites the restrictive reading. In fact, this use of ‘which’ was also used in the study of Price, Ostendorf, Shattuck-Huffnagel, and Fong (1991) to induce the low-attached reading of participial phrases in their investigation of prosodic effects on resolving the ambiguity of participial phrases.

Hence, it is not clear at this point whether the creation of the non-restricted reading is due to the improper manipulation of the context mentioned above, to the effects of prosodic phrasing or
to the combination of both. In fact, the results from the three experiment seem to suggest that the effects are due to prosodic phrasing, since the same pattern was found without any biasing contexts.

The discussion above leads us to reexamine the results of Price et al. (1991), which investigated prepositional phrases and participial phrases. The type that included both prepositional and participial phrases had a below average accuracy (71% for this type versus 84% overall). Confidence rating was also consistent with this relatively lower accuracy: the rating for this type was 23% compared to 52% for all. It is possible that both speakers and listeners in this study were retrieving an additional interpretation for these two constructions.

Furthermore, the results of Snedeker and Trueswell (2003) can be explained this way. In their experiment 2, the one referent and two referents contexts did not produce any difference in speakers’ prosodic structures. However, in their two referents contexts, one frog was holding a flower but the other was not holding anything. If the discussion about salience above is correct, then, even these two referents contexts might not be a good context for the restrictive reading. As such, it is possible that the post-nominal prepositional phrase is used as a non-restrictive modifier. Now, the question is then, what about the results in their experiment 1, where there is ambiguity between modifier reading and instrument reading and speakers do produce differing prosodic patterns. Suppose that the speakers are still using the postnominal prepositional phrase as a non-restrictive modifier because of the same reason. In addition, suppose further that the non-restrictive reading is also differentially produced from instrument reading. So those two patterns are not for restrictive versus instrument patterns but non-restrictive patterns versus instrument patterns. Then, it is not surprising that the two prosodic structures differ in this context. So this reasoning can account for the fact that there are two distinct prosodic patterns. The remaining question is, why do speakers produce the distinct patterns only when there is an ambiguity (Experiment 1) but not when the ambiguity disappeared (Experiment 2). It seems that what Kraljic and Brennen (2005) pointed out was most relevant. In experiment 2 in Snedeker and Trueswell, speakers saw only one demonstration in each group. This was unavoidable to prevent speakers from being aware of the ambiguity; if they saw both demonstrations, they would figure out the presence of ambiguity. However, as Kraljic and Brennen suggested, this repetition also made speakers use the same pattern over and over again,
reducing any difference between two prosodic patterns. Interestingly, the results of Schafer and her colleagues did not show any such reduction. As suggested by Kraljic and Brennen, this difference between these two studies may be due to the different experimental design. In Schafer et al’s studies, participants were freely able to interact with each other with communicative goals whereas in Snedeker and Trueswell, speakers only gave verbal instructions and listeners were told to act out those instructions without any feedback.

The argument for the non-restrictive reading above does not invalidate results of Schafer and her colleagues if we assume that the non-restrictive reading is prosodically distinct from the instrument reading. In other words, speakers in their study may have been producing the non-restrictive reading when they used the square with the triangle rather than as a restrictive modifier. In their game set, there was a square without anything attached to it and the square with a triangle as opposed to a square with something else and a square with a triangle.

The discussion above now leads us to the question about distinct prosodic structures between restrictive, non-restrictive and instrument meaning of prepositional phrases. This along with the compatibility of the late IP boundary with both the high attached reading and the low attached non-restrictive reading will be discussed in the following, general discussion of all three English experiments.

3.4.6 General discussion

We saw that all three experiments show the same general pattern of results for English participial constructions, repeated here as (77).

(77) Aaron followed a poor guy drinking his soda.

The presence of an early IP boundary makes the object noun phrases more accessible to the participial phrases for the attachment decision. The late IP boundary, on the other hand, seems to be more ambiguous at first sight; in Experiment 1, the most frequent choice for the late IP boundary was the ambiguous one (either describing the main subject for the high attached reading or describing the preceding noun for the low attached reading).
Given that there is only one referent for the object noun phrase, the non-restrictive reading for the low attached case is not surprising at all. Then, if we assume that this late IP boundary is compatible with both high attached reading and the non-restrictive low attached reading, choosing the ambiguous option will be explained. In addition, in the second, cross-modal naming experiment, unlike the two prosodic conditions in the high attached reading, the early and late IP boundary did not result in naming time difference in the low attached reading. Since the results for two prosodic conditions in high attached sentences were significantly different from each other in naming latency, it cannot be claimed that prosodic information is ignored when morpho-syntactic information (reflexive pronouns for the current materials) strongly indicates one or the other reading. As such, again, for this experiment, it is reasonable to suggest that the lack of difference for only the low attached case can be attributable to the non-restrictive reading in this condition. The results from the third experiment that manipulated contextual information also showed the same pattern. The difference in the rating of two prosodic conditions appeared only in the high attached case. Again if we assume that listeners are creating the non-restrictive reading, then, these results also be nicely captured although this assumption can make contextual information weaker than expected.

Although Schafer (1997)’s Visibility Hypothesis makes a correct prediction for the early boundary case, the compatibility of the late IP boundary with more than one structure makes Blodgett (2004)’s ‘goodness-of-fit’ constraints a better option as described in the previous section. As mentioned previously, Visibility Hypothesis predicts that the late IP boundary makes both high and low attachment equally accessible, in which case, the choice defaults to syntactic preferences. This stipulation makes a correct prediction for ambiguous prepositional phrases assuming that high attachment is the ‘default’ syntactic preference. However, that prediction does not work for the current materials because the written norming showed that the preference was on the low attached reading. Besides, as we will see later in discussing Korean materials, this reliance on a default reading makes the wrong prediction again for the Korean materials.

Unlike Schafer’s reliance on the default preference, Blodgett (2004)’s ‘goodness-of-fit’ between prosodic and syntactic structures can correctly account for all the patterns. The early IP
boundary is a better match for the low attached reading because the prosodic and syntactic boundary match, which accounts for the inappropriateness of the early boundary for the high attached reading and appropriateness of the low attached reading. The problematic late IP boundary is a good match for the high attached reading, but we argued that it is also compatible with the low attached, non-restrictive reading. The remaining question is, then, which interpretation is the late IP boundary a better match for?

To answer that question, I propose that Blodgett’s ‘goodness-of-fit’ should be modified in a way that indicates that a stronger prosodic boundary is a better match for a higher-level syntactic boundary. This will work as follows. Based on the three experiments, it was argued that the late IP boundary is compatible with both the high attached reading and the non-restrictive low attached reading. The fact that the late IP but not the early IP is a better match for the high attached reading will be explained by ‘goodness-of-fit’ constraint. However, this late IP boundary seems to be better for the high attached reading intuitively than for the low attached non-restrictive reading. In addition, in the naming experiment, there are two kinds of completions that further motivate this hypothesis. The first is the fact that in the late IP boundary in the high attached case, no participants gave any completions that suggest the low attached reading, which is not surprising since the reflexive pronoun is a very strong indication of the high attached reading in the first place. However, the same late IP boundary in the low attached reading, despite the mismatched reflexive pronouns (that is, the reflexive pronouns are matched with the preceding nouns but not the main subject), a few completions indicated that the participial phrases should be attached high. Hence, even though the late IP can be used for the non-restrictive low attached reading, probably the preference will be on the high attached reading.

The other type of completions that makes this proposal attractive is what makes the status of high attached participial phrases not a verbal modifier but a sentential modifier. As discussed in the previous chapter, some of the completions revealed that the high attached participial phrases should be treated as sentential modifiers rather than as verbal modifiers. This means a further syntactic boundary exists before the participial phrases. Based on these, I propose that the higher-level prosodic boundary before ambiguous phrases corresponds to a higher-level syntactic boundary.
This will capture nicely the possibility that there are three distinct prosodic patterns; the no boundary for the restrictive modifier, possibly an intermediate phrase boundary for the non-restrictive modifier and the IP boundary for the high-attached sentential modifier. In addition, this also can account for the preference for the high attached reading with the late IP since that involves a bigger syntactic boundary. This modification to ‘goodness-of-fit’ can also explain Korean data to be discussed in the following two chapters.
CHAPTER 4

KOREAN PRO TYPE CONSTRUCTIONS

So far, we have discussed prosodic effects on the comprehension of syntactically ambiguous sentences in English. Ideally, any mechanism of a processing model of language comprehension should be tested using as many languages as possible to suggest and find a more general spoken language processing model. In the current chapter and the next one, we will examine Korean, a language substantially different from English in its syntactic and prosodic structures.

Unlike English, it is only recently that prosodic information is shown to affect syntactic disambiguation in Korean (see Schafer and Jun 2002; Kang and Speer 2002; Kim 2004; Kang and Speer 2005). These studies confirmed that spoken language processing in Korean crucially relies on prosodic information, in particular, prosodic phrasing information in the resolution of syntactic ambiguity. The current and next chapter will also show that prosodic phrasal boundaries can play a fundamental role in restricting the possible number of (preferred) interpretations for syntactically ambiguous strings in Korean in spoken language processing. An example sentence to be examined is repeated here as (78). Again, the initial noun phrase may or may not be the subject of the following embedded verb. Depending on for which verb the initial noun phrase becomes the subject, an empty pronoun, pro should be posited for either the embedded clause (embedded pro interpretation) or the main clause (main pro interpretation).

(78) 영훈이가 입원중인 병원을 방문했어.
Yenghun-ika ipwonjungi-n pyoungwon-ul pangmwnha-ysse.
Yenghun-NOM hospitalized-REL hospital-ACC visit-PAST

a. Yenghun visited the hospital where (pro) was hospitalized. (embedded pro interpretation)
b. (pro) visited the hospital where Yenghun was hospitalized. (main pro interpretation)
4.1 Pre-test 3: a written norming test

Since the constructions to be examined were never discussed in either written or spoken processing, a written norming test was conducted first to investigate readers’ preferred interpretation of sentences like those in (78). This experiment was conducted in conjunction with another experiment investigating similar but different structures.

4.1.1 Materials

36 test items with the same structure as (78), were mixed with additional 36 filler sentences in a pseudo-randomized list. All the test items are provided in Appendix D. No three sentences of the same type occurred consecutively. Since the critical information distinguishing the two possible interpretations is about who did the action of the embedded verb in each sentence, each test sentence was followed by a comprehension question, such as “Who got exiled?” for (78) along with three choices. The three choices given were the initial noun phrase (NP1 in Figure (4.1)), someone other than the initial noun phrase (NP2: as a referent of pro), and either the initial noun phrase or someone other than NP1 (either). The initial NP choice was for the interpretation in (78b) whereas ‘someone other than NP1’ was for the (78a) interpretation. The third option was given to allow the ambiguity. The order of the occurrence of these three options was counterbalanced.

4.1.2 Procedure

E-prime Software was used to present materials and to collect participants’ responses. Each participant sat in front of a PC. Each sentence was presented in one line in Hangul, Korean orthography. After participants read each sentence one by one, they were asked to complete two tasks; first, to indicate whether they understood each sentence or not by pressing one of the two buttons on the response box. Next, they were asked to answer a comprehension question such as “Who got exiled?” that appeared along with three choices on the monitor by selecting one of three possible options on the response box.
4.1.3 Participants

24 native Seoul Korean speakers from the OSU community participated in this study and were paid $7.

4.1.4 Results

It was predicted that readers would be biased toward the main pro subject reading. Results confirmed this prediction but at the same they also showed that readers were aware of the ambiguity of the current materials. As Figure 4.1 shows, both ‘NP1’ and ‘either’ response were chosen more than 45% of the time, while very few ‘NP2’ responses were chosen. The mean proportion to each response for each item appears in Appendix D. The very few NP2 responses also confirm our intuition that the embedded pro subject interpretation is unlikely in the absence of an appropriate context.

4.1.5 Discussion

It was found that readers had a bias toward the main pro subject reading for ambiguous pro sentences. In addition, although readers were not committed enough to the embedded pro subject

![Figure 4.1: Mean proportion of each response in the first Korean written pre-test](image-url)
interpretation to select the NP2 response (‘someone other than NP1’) as the referent of pro, the comparable rate of selecting the ‘either’ and ‘NP1’ responses suggests that having pro for the embedded subject is not impossible, even without context. These results were replicated in the study by Kang, Speer, and Nakayama (2006) for Japanese readers, which used exactly parallel structures in Japanese.

Although there have been multiple psycholinguistic studies of sentence comprehension that have examined pro-drop of verbal arguments, few have concerned structures with embedded pro subjects. The current results suggest that we should consider this possibility in examining how readers and/or listeners process pro-drop sentences.

Finally, the accessibility of the embedded pro subject reading gives us the opportunity to examine how prosodic structures are used to retrieve those two distinct meanings in auditory sentence processing. We examine this subject in the next section.

4.2 Experiment 4: Auditory listening test

An auditory experiment was conducted to examine the effects of prosodic phrasing on the comprehension of sentences such as (78) presented in isolation. Since the current materials have not, to the author’s knowledge, been studied for auditory language processing, it will be important to establish prosodic effects first.

Although not in Korean, there is an encouraging study by Venditti (1993) that reports results from a production study on similar constructions in Japanese, which shares many syntactic properties with Korean. In this study, Venditti showed that Japanese speakers marked the syntactic clause boundary between main and embedded clauses prosodically for sentences like those in (79). Similar to the Korean constructions, these sentences are ambiguous as to whether the earlier noun phrases are arguments of the embedded verb, or of the sentence-final main verb.  

1 A square bracket is used to indicate the subordinate clause boundary. A comma indicates that the preceding mora is accented.

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Here, the noun phrases within square brackets are all arguments of the verbs within the subordinated clauses. Thus, for sentence (79a), the first three noun phrases are all arguments of the embedded verb whereas in (79b), only the second and the third noun phrases and in (79c), only the third is an argument for the embedded verb. Venditti found that the duration of the nominative marker *ga* and the dative marker *ni* was significantly longer only when they immediately preceded a syntactic clausal boundary (in example (79b) and (79c)). The syntactic boundary was also marked by an inserted silent duration. F0 analyses showed no downstep on the words that began a new clause, indicating a beginning of a new higher level phrase (an intermediate phrase in her terms). These results showed that speakers of Japanese marked a syntactic clause boundary prosodically by lengthening the last syllables at the boundary and also by resetting the pitch level for a new syntactic clause.

Similarly, Misono, Mazuka, Kondo, and Kiritani (1997) confirmed similar prosodic effects on the comprehension of the ambiguous embedded predicates discussed in Chapter 1. Examples are repeated here as (80).
(80) a. attachment to the initial subject bias prosody

[Shoonen-wa zubunureni-natte]\IP [kakemawaru koinu-o oikaketa].
[Shoonen-to]\IP [run-around puppy-acc ran-after]

‘(intended) The boy, becaming drenched, ran after the running puppy.’

b. attachment to the following object bias prosody

[Shoonen-wa]\IP [zubunureni-natte kakemawaru koinu-o oikaketa].
[Shoonen-to]\IP [drenched-become run-around puppy-acc ran-after]

‘(intended) The boy ran after the puppy that was drenched and running around.’

Here the first predicate zubunureni-natte (“drenched-become”) is ambiguous in that it can either describe the action of the main subject shoonen-wa (“the boy”) (attached to the subject) or of the noun that follows, koinu-o (“puppy”) (attached to the object). For these constructions, an Intonation Phrase boundary, the biggest prosodic unit in Japanese (see Venditti 2005) was placed either immediately before (for the object attachment) or after (for the subject attachment) the ambiguous embedded verb zubunureni-natte. Results found that Japanese listeners were sensitive to the difference in prosodic structures and used this difference to make a decision about the attachment of ambiguous embedded verbs. Furthermore, they utilized this prosodic information even in the presence of biased pragmatic information available, contra Straub (1997)’s predictions.

From these two Japanese studies, it would be reasonable to assume that Korean will manifest similar prosodic effects on syntactic ambiguity. In particular, the presence of an Intonation Phrase boundary immediately after the initial noun phrase is expected to be critically used to resolve the ambiguity toward the embedded pro subject reading whereas the absence of such boundary will be used to recover the main pro subject interpretation.

4.2.1 Materials

Using the insights and results from the two Japanese studies, this study manipulated the presence of an IP boundary with the HL\% boundary tone. The IP boundary was placed at the location of a possible syntactic clause boundary, immediatly after the initial noun for the embedded pro subject
interpretation (see (81a)). No prosodic boundary was placed for the prosodic rendition intended for the main pro subject interpretation (see (81b)). The pitch contour of these conditions can be viewed in Figure 4.2 and 4.3.

(81) a. embedded pro subject

[Yenghun-ika]IP [ipwonjungi-n pyoungwon-ul pmgwunha-yss]IP

‘(intended): Yenghun visited the hospital where (pro) was hospitalized.’

b. main pro subject

[Yenghun-ika ipwonjungi-n pyoungwon-ul pmgwunha-yss]IP

‘(intended): (pro) visited the hospital where Yenghun was hospitalized.’

Figure 4.2: An example for an IP condition in Experiment 4
4.2.2 ToBI and phonetic analyses

36 experimental and 36 filler items were recorded by a female native speaker of Seoul Korean, who is a KToBI-trained phonetician. Materials were recorded using Praat in a sound-attenuated booth at a sampling rate of 22.5 kHz. Recordings were examined visually and auditorily by both the speaker and the author, both of whom are native speakers of Korean and ToBI-trained phoneticians. Sentences were rerecorded if they were judged not to be produced with the intended prosodic phrasal structure. Re-recordings were repeated until both of the speaker and the author agreed.

ToBI annotation was conducted by the author and in addition, phonetic analyses of duration and F0 contour were performed. The full ToBI transcription of materials is available upon request.

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2Again, ToBI analysis was conducted post-experimentally.
The analysis of duration of each word confirmed the presence of phrase final lengthening on the initial noun phrase and considerable pause duration only in the IP condition (refer to Figure 4.4). 3

Since the difference between the two structures was the presence or absence of an IP boundary immediately after the initial noun phrase, F0 contour should differ sharply for the first two words. As such, F0 measurements were taken from 5 points of the initial noun and 1 point of the following REL-marked verb. These measurements were motivated on the basis of the intonation structure of Korean (for details, see section 1.3 in Chapter 1). In Korean, there is an underlying tonal pattern for each Accentual Phrase (AP), THLH (the initial T can be L or H depending on the laryngeal feature of initial consonants). Thus, if a four syllable word forms its own AP, then the underlying four tones will all be realized. Since the initial noun phrases for the current materials all have four syllables, all of the four tones will be realized as long as they form an AP. However, if the final syllable in an AP coincides with an IP boundary, then the AP final H will be replaced by one of boundary tones. For the IP boundary for the current materials, the final H tone was replaced by HL% boundary tone. To

![Figure 4.4: Mean duration of each word in two prosodic conditions in Experiment 4](image)

3For the no boundary case, the pause duration is coded zero. Although some stimuli have a brief pause duration, this was due to stop closure. The author decided that unless that duration exceeded 100ms, this silence duration was ignored and attributed to the following closure.
show this pattern, F0 measurements were taken from the middle of a vowel (and sonorants if there is one) from the first three syllables of the initial nouns. In addition, to show the pitch excision for HL% boundary tone, F0 from the following points were taken; the highest point of the last syllable, which occurred within the first half of the syllable, and the final lowest point of that syllable.

Similarly, F0 measurements from the middle of a vowel and any following sonorants from the first three syllables of the initial noun were taken for the noIP boundary condition. For the fourth syllable, it was impossible to match the exact point of the peak for the HL% tone in the IP condition. Therefore, F0 values were taken from the beginning and end of that syllable. In addition, the first syllable of the relative verb was also measured to see the relative pitch height of that syllable in two prosodic conditions. Figure 4.5 shows two distinct patterns for the two conditions.

As can be seen in Figure 4.5, the mean F0 values for the IP boundary condition show the expected LHL tonal sequence for the initial three syllables of the initial noun and the HL% boundary tone for the final syllable. In addition, there was silence duration, as indicated by the discontinuity in the graph and pitch reset was observed for the REL-marked verbs, which suggests the beginning of a new IP. In contrast, F0 values for the noIP condition show a continuous fall through the first syllable.

Figure 4.5: Mean F0 analysis of four syllables of the initial noun and the first syllable of the relative verb in Experiment 4: N - initial noun, R - relative verb. Two points, beginning and end, were measured for the fourth syllable of the noun and the discontinuity of the IP boundary condition indicates silence duration between the initial noun and the following REL-marked verb.
of the \textit{rel}-marked verb. This suggests that the initial nouns and the following \textit{rel}-marked verbs form one AP. In summary, the analyses of both duration and pitch patterns supports the intended prosodic phrasing for these two conditions.

4.2.3 Participants

44 native speakers of Seoul Korean from the OSU community participated in the experiment for a payment of $7. None of them had participated in the written pre-test described in the previous section.

4.2.4 Procedure

Two prosodic versions for all test sentences were distributed via a Latin square design in four different lists along with additional 36 filler sentences. One version of each sentence appeared in each list. E-prime was used to present both auditory and visual stimuli and collect participants’ responses. The experiment was conducted in a quiet room. Participants sat in front of a computer wearing a set of headphones. In each trial, they were instructed to complete same two tasks as in the written test. First, immediately after hearing one prosodic version of each sentence over the headphones, they indicated whether they understood the sentence or not. Second, they answered the same comprehension question about the sentence as in the written study about the sentence, such as “Who got exiled?” Each question and three answers appeared on the same screen and stayed there until participants pressed one of the three corresponding numbers for the three choices on the response box.

4.2.5 Results

It was predicted that given the prominence of prosodic phrasings in Korean, this prosodic information would be critically used to resolve global ambiguity in Korean \textit{pro} type sentences that contain an ambiguous syntactic clausal boundary. Results showed that Korean listeners were sensitive to prosodic phrasing information in determining syntactic clausal boundaries.
Figure 4.6 summarizes the results for Experiment 4. The mean percentage of each response choice in the IP condition was 20.95% for the initial noun (NP1), 51.25% for someone other than the initial noun (NP2), and 20% for the either is possible (either). On the other hand, for the noIP condition, the mean percentage of the NP1 choice was 63%, 11% for NP2 and 25% for either option. The mean proportion to each response choice for each item is provided in Appendix D.

The results were entered into a repeated measures ANOVA with subjects and items as random variables. The independent variables were prosody (IP and noIP) and NP choice (NP1, NP2, either). There was a main effect of prosody \( F_1(1,43) = 7.56, p<0.01; F_2(1,35) = 4.96, p<0.04 \), and NP choices \( F_1(2, 86) = 10.64, p<0.001; F_2(2, 70) = 9.86, p<0.001 \). Interaction also reached significance \( F_1(2,86)=39.96, p<0.001; F_2(2,70) = 79.21 , p<0.001 \).

A planned comparison between different NP choices for each prosody was conducted. The difference between the number of NP1 and NP2 choices was significant in the IP condition for both subject and item analyses \( F_1(1,43)=20.66, p<0.001; F_2(1,35)=40.59, p<0.001 \). This means that as predicted, the IP could lead to the interpretation where \textit{pro} is posited as the subject of the embedded verb. Planned comparisons showed significantly more NP1 choices than NP2 choices in the proNoIP condition \( F_1(1,43)=65.52, p<0.001; F_2(1,35)=129.85, p<0.001 \), and more NP1 choices in the

![Figure 4.6: Response choice in each prosodic condition in Experiment 4](image-url)
NoIP condition than in the IP condition \(F_1(1,43)=47.8.03, p<0.001; F_2(1,35)=80.39, p<0.001\). This indicates that, in the absence of an IP boundary, listeners were most likely to interpret the initial NP as the subject of the embedded verb. Finally, there were significantly more NP2 choices in IP than in NoIP conditions \(F_1(1,43)=32.78, p<0.001; F_2(1,35)=77.44, p<0.001\).

4.2.6 Discussion

The results from the auditory study showed that prosodic phrasing information can be used to retrieve two distinct meanings for the ambiguous *pro* type sentences in Korean. Depending on the presence or absence of a prosodic boundary, listeners assigned a different syntactic analysis to the same word sequence. They did this even if it required them to posit a null pronoun as a subject for the embedded predicate. The fact that the embedded *pro* subject reading was retrievable by listeners simply from prosodic information is remarkable, considering the difficulty of recovering this reading in the absence of any helpful context. As we saw before in the written pre-test, readers seldom retrieved this interpretation for isolated sentences. These results do not only demonstrate the fundamental importance of prosodic phrasal structure to the assignment of syntactic constituency during sentence comprehension. This also leads us to consider structures with embedded *pro* subjects in Korean sentence processing, as discussed in the previous section on the written norming test.

So far, we have discussed the effects of prosodic information on the comprehension of ambiguous Korean sentences presented in isolation. As with English materials before, we would be interested to see whether this information has any effect on syntactic parsing decisions for materials presented in biased contexts, the subject to be discussed in the next chapter.
CHAPTER 5

KOREAN PRO CONSTRUCTIONS IN CONTEXTS

The previous chapter showed that prosodic phrasing is critically used to resolve the syntactic ambiguity of Korean pro type sentences despite the difficulty and infrequency of one of the two possible interpretations. In this chapter, we examine whether given a biased context toward one or the other reading, Korean listeners will make comparable use of prosodic information to resolve the syntactic ambiguity. As Straub (1997) suggests, if the availability of contextual information makes prosodic information unnecessary and redundant, then, in biased contexts where comprehenders get relevant information for syntactic attachment before they receive the prosodic phrasing, prosodic information will not exert any influence in the resolution of syntactic ambiguity.

To test the effectiveness of prosodic phrasing in the presence of contextual information, an off-line listening comprehension experiment similar to the English experiment discussed in Chapter 3 was conducted with Korean materials. Before the auditory experiment, another written norming test was conducted to ensure that each context was indeed biased toward one or the other meaning of the ambiguous sentences.

5.1 Pre-test 4: A written norming test

This written norming test was conducted to ensure that the context sentences to be used in the auditory experiment (Experiment 5) had the desired bias toward one interpretation or the other by examining readers’ preference on the test materials.
5.1.1 Materials

The same type of target sentence as in the previous experiment was used. To construct contexts that sounded more natural, some of the items from the previous experiment were replaced by new ones. All the test sentences and contexts are available upon request. An example sentence is provided in (82).

<table>
<thead>
<tr>
<th>(82)</th>
<th>Yenghun-ika ipwoncung-in byungwon-ul pangmunha-yss.</th>
<th>Yunghun-nom hospitalized-rel hospital-acc visit-past</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Yenghun visited the hospital where (pro) was being hospitalized. (embedded pro)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. (pro) visited the hospital where Yenghun was being hospitalized. (main pro)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Again, depending on where the empty pronoun is posited, two interpretations are possible although as mentioned before, the embedded pro subject reading is less likely. Two biasing contexts were created for each test item. Two contexts for (82) are given in (83) below.

<table>
<thead>
<tr>
<th>(83)</th>
<th>embedded pro bias (HA: high attachment of the initial noun to the main verb):</th>
</tr>
</thead>
<tbody>
<tr>
<td>“You know that Yenghun had a severe fight with his roommate and got really upset. Things got worse when he heard the rumor that his roommate said that he couldn’t live with Yenghun anymore, which made the possibility of reconciliation slimmer. But then, it was said that the roommate had a car accident and do you know what happened yesterday afternoon?”</td>
<td></td>
</tr>
</tbody>
</table>

‘영훈이가 지난주에 병원에 입원중이였던 사우고 나서 몰라 화가 나 있었거든요. 심지어는 병원에 더 이상 갈이 삶지 못하겠다다는 얘기까지 나오고 나서는 화해 가능성은 더욱 희박해졌죠. 근데 병원에 갈아 교통사고가 난다는 소식이 전해지자 마자 무슨 일이 있었는지 알아?’

| b. main pro bias (LA: low attachment of the initial noun to the embedded verb): |
| “You know that Yenghun’s roommate had a severe fight with Yenghun and got really upset. He was even heard to say that he couldn’t live with Yenghun anymore. But then, he heard about Yenghun’s car accident. Everybody thought that he wouldn’t care because of their fight but do you know what he did yesterday afternoon?” |

‘영훈이의 스무고 나서 엄청 화가 나 있었거든요. 심지어는 더 이상 갈이 삶지 못하겠다고까지 말했었지. 근데 병원에 갈아 교통사고가 난다는 소식이 전해지자 마자 무슨 일이 있었는지 알아?’

Each context contains two referents for the two noun phrases in the target sentence; one is intended for the initial noun phrase while the other is for the referent of pro. (83a) is biased toward the (82a) reading since the roommate but not Yenghun had a car accident and so it will be natural that
the roommate, who will be a referent for pro in the target sentence, is hospitalized in the target sentence. On the other hand, in (83b), since Yenghun’s car accident was mentioned, he is more likely to be hospitalized and thus will be interpreted as the subject of the embedded verb, which in turn means that there should be a pro for the main subject. Thus, there will be a bias toward the (82b) reading.

It may be noticed that the contexts in two conditions are not exactly parallel. Most notably, Yenghun is not being repeated as the subject of each sentence in (83a) as often as roommate in (83b). In addition, the question in (83a) is not directly about Yenghun whereas it is about the roommate in (83b). The reason for this is as follows. For (83a) to be biased toward (82a) reading, the initial NP in (82) should be the subject of the main verb. In this case, the repetition of that NP in the context including the question at the end will render the use of that NP in the answer infelicitous in Korean because typically an NP in a question is dropped in its answer. On the other hand, for (83b), the initial NP should be the subject of the embedded verb and thus, the repeated use of roommate in the context and in the question at the end will make its appearance in the answer unnecessary and realized as a small pro, the (83b) reading.

5.1.2 Procedure

Two lists were created. In each list, only one context for each target sentence appeared along with each target sentence. A total of 36 test items were mixed with 3 different types of filler sentences (48 sentences in total). Half of the target sentences in each list were presented with embedded pro subject bias contexts and the other half with the main subject pro bias contexts. Participants were given a questionnaire that contained all of these sentences in Hangul, Korean orthography. In the questionnaire, each context and target sentence was followed by a comprehension question such as (84) and three choices and participants were asked to choose the most probable one. The questionnaire was either sent by email or delivered to participants in person and the completed questionnaire was collected by email or in person.
Who was hospitalized?

(1) Yenghun (2) The roommate (3) either Yenghun or the roommate

5.1.3 Participants

22 native speakers of Korean completed the task for the payment of $10. None of them participated in any of the other Korean experiments.

5.1.4 Results and Discussion

It was predicted that without the help of prosody, readers would choose a response solely based on preceding contextual information. Thus, given (83a), which is biased toward the embedded pro subject interpretation, readers would choose roommate response for a referent of the embedded pro. On the other hand, after (83b), Yenghun would be dominantly chosen.

The prediction was borne out. The mean proportion of embedded pro interpretation reached 0.85 and the mean proportion of main subject pro interpretation was 0.95. The mean proportion of each reading for each item in each corresponding context is provided in Appendix E. As shown before, the embedded subject pro interpretation was more difficult than the main subject pro interpretation even with the help of the context. However, compared to the case without contextual information, this result showed many more choices for this reading.

Furthermore, the results even showed that the intended bias was too strong to allow for any possibility of the alternate reading, as shown by the relative proportion of each reading (especially main pro subject interpretation). This can be due to the following process. To establish the context for each reading, it was necessary to imply that one of the two characters in the context was involved in one of the actions denoted by the embedded verb. For example, in sentence (82), the fact that either Yenghun or roommate had a car accident can be used to infer that the one who had a car accident was hospitalized. This inference results in the bias of each context toward either (83a) or
(83b) depending on who had a car accident. However, for some of the items, this indirect inference was not possible. For example, if the embedded verb was “chongsaltangha-n (shot to death)”, then, one of the two characters in the context should be killed by a gun in the context. In the original set up of contexts, this embedded verb was directly used for one of the two characters. Thus, only one character could satisfy the assumptions in the context, which can account for such a high proportion of either reading.

After careful consideration, direct mentions of the embedded verbs were replaced by the use of verbs similar to the embedded verb or by just providing a series of events that allowed an inference on the comprehender’s part. The disadvantage of this manipulation was that it complicated context. Still, this may be desirable since we do not want the context so established for one reading that nothing can change it. Based on the results of the pre-test and with some modification of contexts, an auditory comprehension test was conducted.

5.2 Experiment 5: Auditory listening test

This auditory experiment was designed to examine whether prosodic information can be used to resolve syntactic ambiguity even when prior contextual information is available to do so.

5.2.1 Materials

As before, it was hypothesized that the presence of an Intonation Phrase (IP) boundary immediately after the initial noun phrase as in (85) was more likely to induce the embedded pro subject interpretation by setting off the initial subject from the rest of the sentence. On the other hand, the inclusion of the initial noun phrase along with the embedded verb in the same Intonation Phrase would more likely indicate that the initial noun phrase is the subject of the embedded verb rather than of the main verb. Example sentences of these two conditions can be seen in Figure 5.1 and 5.2.
(85) a. earlyIP (embedded pro subject prosody: HA):

\[
\begin{array}{c}
\text{[}[\text{영훈이가}]\text{AP}]\text{IP} & \text{[}[\text{입원중인}]\text{AP} & \text{[}[\text{병원}]\text{AP} & \text{[}[\text{방문했어요}]\text{AP}]\text{IP} \\
\text{[}[\text{Yenghun-ika}]\text{AP}]\text{IP} & \text{[}[\text{ipwoncung-in}]\text{AP} & \text{[}[\text{byungwon-ul}]\text{AP} & \text{[}[\text{pangmunha-ysse}]\text{AP}]\text{IP} \\
\text{[}[\text{Yenghun-nom}]\text{AP}]\text{IP} & \text{[}[\text{hospitalized-REL}]\text{AP} & \text{[}[\text{hospital-ACC}]\text{AP} & \text{[}[\text{visit-PAST}]\text{AP}]\text{IP} \\
\end{array}
\]

‘(intended): Yenghun visited the hospital where (pro) was hospitalized.’

b. lateIP (main pro subject prosody: LA):

\[
\begin{array}{c}
\text{[}[\text{영훈이가}]\text{AP} & \text{[}[\text{입원중인}]\text{AP} & \text{[}[\text{병원}]\text{AP} & \text{[}[\text{방문했어요}]\text{AP}]\text{IP} \\
\text{[}[\text{Yenghun-ika}]\text{AP} & \text{[}[\text{ipwoncung-in}]\text{AP} & \text{[}[\text{byungwon-ul}]\text{AP} & \text{[}[\text{pangmunha-ysse}]\text{AP}]\text{IP} \\
\text{[}[\text{Yenghun-nom}]\text{AP} & \text{[}[\text{hospitalized-REL}]\text{AP} & \text{[}[\text{hospital-ACC}]\text{AP} & \text{[}[\text{visit-PAST}]\text{AP}]\text{IP} \\
\end{array}
\]

‘(intended): (pro) visited the hospital where Yenghun was hospitalized.’

The pattern in (85b) differs slightly from that used for the same condition in Experiment 4 discussed in Chapter 4. The difference is that in Experiment 4, there was no IP boundary placed after the object noun phrase. Instead, auditory sentences consisted of only one IP in the main pro subject condition. In addition, in Experiment 4, there was no Accentual Phrase (AP) boundary

Figure 5.1: An example of an early IP sentence: HL% boundary tone and pause is present right after the initial noun

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Figure 5.2: An example of a late IP sentence: HL% boundary tone and pause is present after the third word, the object noun.

between the initial noun phrase and the following embedded verb. Prosodic patterns were altered for Experiment 5 due to the presence of contexts in the current experiment. Typically, each content word in Korean can constitute its own AP in Korean prosodic structure (Jun and Fougeron 2000). The separation of each word by an AP boundary can be changed by introducing a focused word in a sentence. Focused words often initiate their own AP and post-focused words tend to be merged into the prior AP, thereby removing the AP boundary between the focused word and post-focused word. Because of these, the absence of an AP boundary between the initial noun phrase and the following embedded verb in each test item can be interpreted to signify the initial noun phrase is the focused element. This did not seem to pose a problem for isolated sentences used in the previous experiment. However, when this prosodic rendition was heard after each context, both the speaker and the author agreed that the hint of this focus structure seemed to render the spoken version infelicitous.

In order to increase the felicity of these sentences in context, the prosodic pattern for this context was changed into the one in presented in (85b). The reasoning was that although the initial
noun phrase and the following embedded verb was separated by an AP boundary, because both of them were within the same IP, the initial noun would be more likely to be interpreted as the subject of the following rel-marked verb, biasing the interpretation toward the main pro subject interpretation.

5.2.2 Recording

All test materials and filler sentences were produced by the same speaker as for the previous experiment, a native speaker of Seoul Korean, who is also a phonetician trained in K-ToBI annotation. Materials were recorded in a sound-attenuated booth at a sampling rate of 22.5 kHz and saved in Praat. The speaker produced each version for each target sentence as many times as she wanted until she was satisfied with the production. After the recording, both the speaker and the author visually and auditorily examined the recorded materials. Materials were rerecorded until both the speaker and the author agreed on the prosodic structure of the utterance.

5.2.3 ToBI and Phonetic analysis

All test materials were ToBI-labeled by the author before the experiment, and are available upon request. In addition to the ToBI analysis, phonetic analyses of duration and F0 were conducted. Figure 5.3 shows the mean duration of each word in the two prosodic conditions. For the early IP condition, the IP boundary immediately after the initial noun phrase produced greater duration of that word as compared to the same word in the late IP condition. In contrast, the object noun phrase has a greater duration in the late IP condition than in the early IP condition. Both differences are due to phrase-final lengthening effects associated with the presence of the IP boundary. Other words not in the boundary location did not differ in the two different conditions. In addition, silence duration differed across the two conditions depending on the location of the IP boundary.

In addition, the analysis of F0 was conducted to examine an overall pitch contour for the two conditions. Remember that in Korean, each syllable in each AP is assigned either a high or a low tone and that the underlying tonal pattern for each AP is THLH. The AP initial T can be
either a high or a low tone depending on laryngeal features of the initial segment. When there are less than four syllables in an AP, however, not every underlying tone is realized due to insufficient number of syllables. This ‘undershoot’ results in various forms of tonal patterns depending on which tone is undershot, which, in turn, means that different numbers of syllables for words in the same positions across all items may produce distinct tonal patterns that cannot be averaged. For the current materials, the initial nouns used were all four syllable words but not all target items have the same number of syllables for the rel-marked verbs or the object nouns. However, 23 out of 36 test items had four syllables for the rel-marked verbs and three syllables for the object nouns and therefore, F0 measurements were taken only from these items.

The results are illustrated in Figure 5.4. As with Experiment 4, F0 measurements were taken from five points of the initial nouns (three from the first three syllables and two from the last syllable), four points of the rel-marked verbs, four points of the object nouns and two points of the main verbs. F0 measurements were taken from the middle of each vowel including any sonorants. Again, the reason that taking F0 measurements from five points of four syllable initial nouns was to capture the pitch excursion for the HL% boundary tone in the last syllable of those words in the early IP condition. To make a comparison, the same number of points were taken of the initial nouns in the late IP condition. The two points from the last syllable of the initial nouns in the early

Figure 5.3: Mean duration of each word in two prosodic conditions in Experiment 5
IP condition was taken from the pitch peak that occurred within the first half of the syllable and the following lowest point. Since it was impossible to locate the same position for the same words in the late IP condition, the two points in this condition were the beginning and end of the last syllable of those words. The same reasoning goes for F0 measurements of the object nouns because these words occurred in the IP boundary in the late IP condition, and thus had the HL% tone. The overall patterns for the two prosodic conditions are distinctive from each other; in the early IP condition, the last syllable clearly shows the pitch excursion for the HL% tone and is followed by silence duration shown by the discontinuity in Figure 5.4. The pitch reset of the following rel-marked verbs suggests the beginning of a new IP. Within the second IP, each word forms its own AP. On the other hand, in the late IP condition, pitch continues to fall through the first syllable of the rel-marked verb and then slightly rises, which suggests that the rel-marked verb forms an AP. The object nouns are followed by the HL% tone and silence duration. In summary, the analysis of F0 confirmed the two intended phrasings.

![Figure 5.4: Mean F0 for each word in 23 items in two prosodic conditions in Experiment 5: S - subject noun, R - rel-marked verb, O - object noun, V - main verb. Each number indicates the n-th syllable. b and e indicates the beginning and end of a syllable.](image-url)
5.2.4 Procedure

Four lists (two contexts X two prosodic version) were created. In each list, one of the two contexts was presented along with either early IP version or late IP version of the target sentence. The same context and target sentence pair used in one list did not appear on the other lists. This way, each list had 18 main pro subject contexts and 18 embedded pro subject contexts and 9 of the 18 contexts had the early IP target sentence and the other 9 sentences had the late IP target sentences.

Eprime software was used to control the presentation of auditory and visual stimuli. Participants sat in front of a computer wearing a set of headphones. The instructions for this experiment were very similar to those given to English listeners described in Chapter 3. First, participants were asked to read each context, which ended with a question. After they understood each context, they pressed a button to hear a spoken sentence, which was played two times. Participants were asked to consider both the contexts and the target sentences from the same speaker. The participants’ task was, like the English participants’, to evaluate the naturalness of the spoken sentence as a continuation of the context they read and press one of the five buttons on the response box. For this rating, they were given a five-point scale with 1 being natural and 5 being unnatural.

The Korean materials differed from the English participial constructions with reflexive pronouns in that the ambiguity of Korean materials potentially remained unresolved at sentence end. Thus, it was necessary to check whether participants understood each context and target sentence in one way or the other. For this purpose, a comprehension question was asked for 5 out of 9 test items in each condition. This also ensured that participants paid attention to the content of contexts. The comprehension question, this time, asked about the subject of the main verb rather than the embedded verb. This was done to avoid drawing direct attention to the ambiguity of the embedded verb. An example question is provided in (86).

(86) 누가 병원을 방문했나?
(1) 영훈 (2) 옷매트 (3) 영훈 혹은 옷매트
Who visited the hospital?
(1) Yenghun (2) The roommate (3) either Yenghun or the roommate

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5.2.5 Participants

60 native speakers of Korean from the OSU community participated in this experiment and were paid $10. None of these participants participated in any other of the Korean experiments.  

5.2.6 Results

If prosodic information was ignored because of the biased contexts, the difference in prosodic structure in (85) would not result in any difference in the rating or comprehension questions in either context. In contrast, it was predicted that even when contextual information was available, prosodic information could be utilized for syntactic disambiguation and thus would be reflected in the ratings and the choices participants selected in the comprehension questions.

5.2.6.1 Rating task

As before, Korean listeners were sensitive to prosodic information even in the presence of biased contexts. When they heard the early IP version after the embedded pro subject biased contexts (HA context), the spoken fragment with the early IP (mean rating 3.18) was rated more natural than the late IP version (mean rating 3.92). On the other hand, after the main pro subject contexts (LA context), the late IP (mean rating 2.01) was rated more natural than the early IP (mean rating 3.36). The mean rating of each reading for each item in each corresponding context is provided in Appendix E. Figure 5.5 summarizes the mean rating for each prosodic version in two contexts and Figure 5.6 and 5.7 show the total frequency of each response in the rating task. These results showed that the early IP was more consistent with HA contexts than the late IP whereas the late IP was better for LA contexts than the early IP. This also confirmed that prosodic information was not being ignored even when there was contextual information available to resolve the ambiguity.

The data was entered into a repeated measures ANOVA with two independent variables, prosody (early IP or late IP) and context (high or low attached). There was a main effect of context

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1Most of participants were Seoul speakers but speakers of other dialects of Korean were included except speakers of Kyungsang dialect, which has a lexical pitch accent.
Figure 5.5: Mean rating of two prosodic conditions in each context: HA - the embedded subject pro context, LA - the main subject pro context, earlyIP - matching for HA and conflicting for LA, lateIP - conflicting for HA and matching for LA, 1 - natural, 5 - unnatural

Figure 5.6: Total frequency of each rating for two prosodic conditions in each context: HA - the embedded subject pro context, match - earlyIP, conflict - lateIP
Figure 5.7: Total frequency of each rating for two prosodic conditions: LA - the main subject pro
context, match - lateIP, conflict - earlyIP

$[F_1(1,59) = 111.59, p<.001; F_2(1,35) = 81.57, p<.001]$. The main effect of prosody also reached
significance $[F_1(1,59) = 74.74, p<.001; F_2(1,35) = 175.36, p<.001]$ and was probably due to the
large difference between the two late IP conditions because the two early IP did not differ from each
other. The interaction between context and prosody was significant, too, $[F_1(1,59) = 19.38, p<.001;
F_2(1,35) = 22.86, p<.001]$.

A planned comparison between the early IP and late IP in the embedded pro subject con-
texts showed a significant difference $[F_1(1,59)=63.32, p<.001; F_2(1,35) = 68.08, p<.001]$. Another
planned comparison between the early IP and the late IP in the main pro subject contexts also
reached significance $[F_1(1,59)=201.17, p<.001; F_2(1,35) = 225.4, p<.001]$.

5.2.6.2 Comprehension task

Results of the comprehension question task revealed the influence of prosodic information even in
the presence of biased contexts; even when there was contextual information that could be used to
resolve the syntactic ambiguity, Korean listeners could not ignore prosodic information that did not
match with context. Figure 5.8 shows the overall pattern of response choices by all participants.
Figure 5.8: Mean proportion of each response choice in comprehension questions: HA - the embedded pro subject context, LA - the main pro subject condition

Remember that the comprehension question was about the subject of the main verb. According to our hypothesis, the early IP boundary would be better for the embedded pro subject and so in this condition, the initial noun phrase (NP1 in the figure) would be more likely interpreted as the subject of the main verb. In the embedded pro subject contexts, the early IP conditions resulted in more NP1 responses than in the late IP condition. Conversely, in the main pro subject condition, since the initial noun phrase (NP1) was analyzed as the subject of the embedded verb, NP2 (the referent of pro) would be interpreted as the subject of the main verb. Again, two prosodic conditions resulted in difference in the number of NP choices. However, it is true that the overall pattern of the response choice did not change across two prosodic conditions, suggesting that contextual bias could not completely overridden.

Arcsine transformed proportion data were entered into a repeated measures ANOVA with three independent variables, prosody (early IP or late IP) and context (high or low attached) and response choice (NP1, NP2, either). There was a main effect of context only on item analysis [$F_1(1,59) = 1.56, p>.2; F_2(1,19) = 6.87, p<.02$]. The main effect of prosody reached significance on both subject and item analysis [$F_1(1,59) = 37.35, p<.001; F_2(1,19) = 43.87, p<.001$]. The main effect of response choice was significant on both subject and item analysis [$F_1(2,118) = 73.8,
The interaction between context and prosody approached significance on subject analysis and reached significance on item analysis. \([F_1(1,59) = 3.55, \ p<.07; \ F_2(1,19) = 4.58, \ p<.05]\). All the other interactions were significant at a level of .001.

A planned comparison of NPI response between the early IP (84%) and late IP (59%) in HA context showed a significant difference at the level of \(p\) value .001 on both subject and item analyses. Another comparison of NPI response in the two prosodic conditions (61% in the earlyIP and 85% in the lateIP condition) in LA context reached significance at the same level on both subject and item analyses. This suggests that although the ultimate assignment of meaning was mostly based on the contextual information, prosodic phrasings could significantly change the correct meaning assignment.

5.2.7 Discussion

We confirmed that Korean listeners could not ignore prosodic information even in the presence of biased contexts; when the target sentence was heard with a matching prosody, the rating of those sentences was higher than of sentences with a conflicting prosody. However, it was also found that in the ultimate assignment of meaning, contextual information could not be ignored. In addition, unlike English materials, prosodic effects were also evident in the main \(pro\) subject reading, the ‘default’ preferred reading. Therefore, it cannot be claimed that prosodic information plays a role only for the dispreferred readings.

How can these results be accounted for by sentence processing models that incorporate prosodic information? Interestingly, unlike for English materials, Schafer (1997)’s Prosodic Visibility Hypothesis seems to make a correct prediction for these Korean materials. ² First, in the high attached context, the context was strongly biased toward the embedded \(pro\) subject. After this, if the spoken target sentence contained an IP boundary immediately after the initial noun phrase, the initial noun phrase is less visible to the following \(REL\)-marked verb, and thus the parser is less likely to attach the verb to the initial noun phrase, and thus, the target sentence will be more likely interpreted

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²This hypothesis is for English intermediate phrase boundaries but let’s assume that the hypothesis is applicable to Korean materials with an Intonation Phrase boundary.
as containing the embedded pro subject. This interpretation is consistent with the bias present in the context and therefore, this prosodic boundary will be rated good. On other hand, the late IP prosodic condition makes the initial noun phrase available to the rel-marked verb, in which case the parser will be more likely to attach the verb to the initial noun phrase. This results in the main pro subject interpretation, which gives rise to a conflict with a prior context. Thus, this prosodic condition was rated worse than the early IP condition.

In the low attached context, the bias was toward the main pro subject interpretation, which means that the initial noun phrase should be interpreted as the subject of the following rel-marked verb. As such, the early IP condition produced a conflict with the preceding context because according to Schafer’s hypothesis, the earlyIP boundary makes the initial noun less visible and thus that noun phrase is less likely to be attached to the following rel-marked verb. This contradicts with the contextual information. On the other hand, in the late IP condition, since the initial noun phrase is within the same IP boundary as the rel-marked verb, the verb will be more likely to be attached to the initial noun. As such, the initial noun will be interpreted as the subject of the rel-marked verb and pro will be posited for the subject of the main verb. As predicted, in the low attached context, the late IP boundary was rated better than the early IP boundary.

On the other hand, Blodgett (2004)’s original ‘goodness-of-fit’ hypothesis predicts that the interpretation where prosodic and syntactic constituents coincide will be preferred and thus easier to process. According to this hypothesis, neither of the interpretations should be preferred over the other because the IP prosodic boundary would coincide with syntactic constituents in both cases (see the two trees in (42) in Chapter 1); in (42a), the prosodic boundary would coincide with a syntactic boundary that separates the preceding noun phrase from the following relative clause and thus the entire VP boundary and in (42b), the IP boundary would also coincide with the completed noun phrase constituent this time within the relative clause. Thus, Blodgett’s original account should not predict any difference between the two prosodic conditions in either high or low attached contexts unless we assume that prosodic information is entirely ignored in the presence of biased contexts. However, we saw these two conditions did produce differences in the rating of Korean materials and also that Blodgett’s account is better at predicting English results. As such, rather than giving up
the original ‘goodness-of-fit’ because of the Korean data, if we choose its modified version, both English and Korean data will be nicely explained. Recall from Chapter 2 and 3 that the modified version states that a stronger prosodic boundary coincides with a higher-level syntactic boundary. According to this, the IP boundary after the initial noun phrase (the early IP) will prefer the embedded pro subject reading than the main pro subject reading since the former structure introduces a higher-level syntactic boundary (e.g., clausal as opposed to phrasal as in initial noun phrase and the following verb phrase in (42b)). This preference for the embedded pro subject will nicely match with the contextual bias in the high attached case and the spoken target sentence was rated better than the one with the late IP. On the other hand, this modified version also predicts the preference for the main pro subject reading (the initial noun being attached to the following rel-marked verb) because that structure involves a lower-level syntactic boundary. This preference matches with the bias in the low attached context and thus, the late IP was rated better than the early IP in this condition.

5.3 General discussion of two Korean experiments

Two Korean auditory experiments confirmed that the comprehension of Korean pro type sentences can be influenced by prosodic information during the resolution of syntactic ambiguity. In addition to this, it was found that prosodic information can influence the way listeners understand ambiguous sentences even in the presence of preceding biased contexts that could be used to resolve the ambiguity. However, we also saw that strong contextual information could not be ignored in assigning the ultimate meaning of ambiguous strings.

These results, however, demonstrated that prosodic phrasing can be applied to two very different languages despite the difference in their prosodic and syntactic structures. Hence, this component of language should be considered and incorporated critically in discussing models of spoken language processing.

In addition, we saw that the modification of Blodgett (2004)’s ‘goodness-of-fit’ was able to account for Korean results, too, which lends more generality to this constraint. In the final chapter, a summary of the results of all experiments will be provided and a discussion of other constructions that can be explained by the modified version of ‘goodness-of-fit’ and future study will follow.
CHAPTER 6

CONCLUSION

This dissertation was designed, first, to examine prosodic effects on syntactic disambiguation for materials that have either rarely been studied before (English participial constructions) or never been tested before (Korean pro type sentences). Secondly, the current study also tested whether prosodic information is still utilized when there are other sources of information available, in particular, contextual information, that can be used to resolve syntactic ambiguity.

Three English experiments confirmed that prosodic manipulation was successful in inducing distinct meanings for an otherwise identical string of words in English. Thus, for ambiguous English sentences such as (87), the location of an Intonation Phrase boundary was critical in retrieving two distinct meanings in an off-line listening comprehension task.

(87) Aaron followed a poor guy drinking his soda.
   a. Aaron was drinking his soda.
   b. A poor guy was drinking his soda.

These results extended the results of Price, Ostendorf, Shattuck-Huffnagel, and Fong (1991), who showed effects of a prosodic boundary for various ambiguous constructions in English, one of which was the same as the one in (87). These results are also in line with the results of studies that investigated similar high/low attachment ambiguity, the ambiguity of prepositional phrases (Schafer, Speer, and Warren 2005; Warren, Schafer, Speer, and White 2000; Kraljic and Brennen 2005, among others). Furthermore, similar effects were found when sentences such as (87) were made temporarily ambiguous by using participial verbs that take reflexive pronouns such as (88).
The saleswoman tailed the salesman complaining to *herself/himself*.

Reflexive pronouns were matched either to the subject of the sentence, indicating the high-attached reading of the participial phrase, or to the noun phrase that immediately precedes the participial phrase, indicating the low-attached interpretation of the same participial phrase. In a cross-modal naming task, listeners took longer to name a visually presented reflexive pronoun when the prosodic information did not match with the intended attachment—though this was so only for the high-attached interpretation, the condition in (89a) with *herself*. Thus, for this condition, despite the presence of reflexive pronouns indicating the high-attached reading, due to the mismatch between prosodic and morpho-syntactic information, listeners experienced difficulty integrating the visual targets into the spoken fragment.

(89) a. [The saleswoman tailed]p [the salesman complaining to *herself/himself]*p
   b. [The saleswoman tailed the salesman]p [complaining to *herself/himself]*p

However, similar, expected results were not obtained for the low-attached reading; the two prosodic conditions did not result in naming time differences for this reading. To account for this pattern, it was proposed that the late IP creates the non-restrictive reading in the low-attached interpretation. If this is the case, then it is not surprising that the two prosodic conditions did not differ from each other for the low-attached reading, since listeners were retrieving two distinct meanings with those two prosodic versions. This led to the possibility that the late IP boundary was compatible with both the high-attached reading and the non-restrictive low-attached reading.

This pattern of results was not unique to isolated sentences but also found in Experiment 3, which included contextual information. The overall results were very similar to Experiment 2; even with the biased contexts, the early IP boundary in the high-attached context and high-attached reflexive pronoun rendered the spoken target sentence an unnatural continuation of the preceding context.

On the other hand, in the low-attached context and low-attached reflexive pronoun conditions, the two prosodic phrasings did not result in a significant difference in the rating of naturalness, reminiscent of results from Experiment 2. Therefore, across all three English experiments,
we seem to have the same general pattern; the early IP condition was better used to retrieve the low-attached reading whereas the late IP was compatible with both the high-attached reading and the non-restrictive, low-attached reading.

In terms of processing account for these effects of prosodic structure on syntactic disambiguation, it was pointed out that Schafer (1997)’s Prosodic Visibility Hypothesis makes a wrong prediction on the current English materials, especially for the high-attached interpretation. According to the hypothesis, since the presence of the IP boundary (hence, the late IP condition) immediately before the ambiguous participial phrase makes both attachment sites less visible, the preference will be given to the ‘default’ interpretation, the low-attached reading for the current materials. However, the results from all three experiments demonstrated that the late IP was better for the high-attached reading, although it seems to give rise to the non-restrictive reading of the low-attached reading. Based on these, it was suggested that Blodgett (2004)’s ‘goodness-of-fit’ is better at making correct prediction for both the high and low attachment interpretation. According to this hypothesis, when a prosodic boundary coincides with a syntactic boundary, the resulting interpretation will be given more weight than when the two boundaries do not match. Unlike Schafer (1997)’s account, this constraint correctly predicts the preference for the high-attached reading in the late IP condition since prosodic and syntactic boundary for the high-attached reading match and thus that reading. Likewise, in the early IP condition, where the participial phrase is within an NP constituent, the two boundaries coincide with each other and thus, the low-attached reading is preferred.

A modification to the ‘goodness-of-fit’ was also proposed. In order to account for the compatibility of the late IP boundary with both the high-attached and non-restrictive readings, ‘goodness-of-fit’ should be extended to take into account relative boundary size. That is, an interpretation where stronger prosodic boundaries coincide with higher-level syntactic boundaries will be preferred. The modified version of ‘goodness-of-fit’ can account for the compatibility of the late IP boundary with both the high-attached reading and non-restrictive reading because this prosodic boundary coincides with completed syntactic constituents for both cases (VP or S constituent for the high-attached reading and NP constituent for the non-restrictive reading). In addition and more
importantly, the modification can capture the intuition, further supported by empirical findings from Experiment 2, that this late IP boundary was better for the high-attached reading because this reading has a higher-level syntactic boundary than the non-restrictive reading.

Furthermore, this modified version was also found to work well for Korean data. First of all, two Korean experiments showed results similar to the ones from English experiments. The location of a prosodic boundary was critical in assigning an ultimate meaning for the ambiguous string of words in sentences such as (90) in isolation.

(90) 영훈이가 입원중인 병원을 방문했어.
Yenghun-ika ipwoncung-in pyungwon-ul pangmunha-ysse.

Yunghun-nom hospitalized-rel hospital-acc visit-past

a. Yenghun visited the hospital where (pro) was being hospitalized.(embedded pro)

b. (pro) visited the hospital where Yenghun was being hospitalized.(main pro)

The IP boundary immediately after the initial noun phrase resulted in a preference for the (90a) reading, whereas the absence of the same boundary resulted in a preference for the (90b) reading. These results are remarkable because it has been considered that in the absence of any context that helps to retrieve the referent of the embedded pro subject, dropping the embedded subject was very rare and unnatural.

Furthermore, even with biased contexts, the location of a prosodic boundary resulted in the significant difference in the rating of the naturalness of the spoken target sentence as a continuation of the preceding context. In other words, despite the contextual information that highly suggested one or the other reading, when the prosodic information did not match with the intended interpretation, listeners considered them an unnatural continuation. This contradicts the hypothesis that when another source of information is available, prosodic information is not utilized by language users (see Allbritton, McKoon, and Ratcliff 1996; Snedeker and Trueswell 2003).

The modified version of ‘goodness-of-fit’ also makes a correct prediction for Korean data. Since for both readings, there is a syntactic boundary between the initial noun phrase and the embedded verb (a clausal boundary for the (90a) and a phrasal boundary for the (90b)), Blodgett (2004)’s original account does not predict any preference for either reading. However, if we assume that a
stronger prosodic boundary corresponds to a higher-level syntactic boundary, the preference for the
eMBEDDED pro subject reading will be able to be handled correctly. In fact, it seems that this modifi-
cation will be able to work better for left-branching languages such as Korean or Japanese, in which
the depth of an embedded clause can be anything between zero and infinite in theory. According to
the proposed modification, the stronger a prosodic break is, the deeper the embedded clause will be.

Of course, I do not claim that a syntactic factor is the only one that predicts a location of
a prosodic boundary. Rather, as Schafer and her colleagues showed, speakers consistently produce
utterances that observe phono-syntactic constraints for a given language, and listeners make better
use of those utterances in the ultimate assignment of meanings.

It is encouraging that the same constraint can be used to describe processing of two substan-
tially different languages. As has been explained throughout this dissertation, English is a language
where the head of a phrase comes before the arrival of its arguments, and all arguments of a verb are
realized phonologically by default. In contrast, Korean is a head-final, pro-drop language, where the
verb information comes at sentence end, and all arguments of the verb can be dropped without caus-
ing any ungrammaticality. These two languages differ in their prosodic structures, too; English is a
pitch prominence driven language, whereas Korean is a prosodic phrasing driven language. Further-
more, the reason that the constraint predicts a preference for one interpretation over the other seems
to be different in these two languages. In English, what matters is the relative syntactic boundary
size to the left of a prosodic boundary, whereas in Korean what matters more is the size of a syn-
tactic boundary to the right of a prosodic boundary. Despite these differences, the two did not differ
much from each other in that listeners of these languages were sensitive to prosodic information in
processing syntactically ambiguous sentences. This is more desirable because we would like to find
a more general processing mechanism that can be applicable to as many languages as possible.

Having shown that prosodic information was not ignored in the comprehension of ambigu-
ous sentences even in the presence of biased contexts, what can we say about the role of our biased
contexts? It seems that we have contradictory results regarding the availability of contextual infor-
mation. In Experiment 3 (English with contexts), the contextual information did not seem to be very
effective because first, in the high-attached context, target sentences produced with a mismatched
prosody were rated significantly lower than the ones with a matched prosody. This was the case even when the gendered reflexive pronouns strongly indicated the high-attached reading. Thus, despite the availability of two sources of information (contextual and morpho-syntactic), prosodic information exerted a stronger influence on the way listeners assessed spoken target sentences as a continuation of a preceding context. A second reason comes from results of the low-attached reading. It was hypothesized that because of the bias toward the low-attached reading, one of two prosodic conditions would be a better match for this reading. However, the results produced exactly the same pattern as the ones from Experiment 2 and possibly Experiment 1. That is, no difference was found between the two prosodic conditions either in Experiment 2 or Experiment 3. Both prosodic versions were rated similarly (better than the mismatched high-attached prosodic condition) in Experiment 3 and both versions were relatively easier (again than the mismatched high-attached prosodic condition) in Experiment 2. These patterns can be accounted for if we assume that listeners retrieve an additional meaning for the late IP low-attached condition. However, this means that contextual information was not effective in understanding these constructions.

On the other hand, in Experiment 5 (Korean with contexts), although the rating results showed that the mismatched prosodic condition was rated worse than the matched condition even with a biased context, results from the comprehension questions for subset of materials indicated that prosodic information did play a role but the ultimate assignments of meanings was probably based on contextual information.

The difference in the effectiveness of contexts for English and Korean seems to lie in the degree of bias present in the contexts. The English pre-test for contextual manipulation showed that the average for each high and low attached reading for each context was about 70% whereas the original Korean pre-test for the context experiment was more than 90% for the low-attached reading and about 85% for the high-attached reading. Thus, for Korean materials, contextual manipulation may have been too strong to be overridden by prosodic information. However, we note that despite this strong bias, it is remarkable that prosodic information was still effective in the rating task.

The discussion so far strongly suggests that any model of sentence processing should incorporate prosodic components. Given the critical use of this component by the comprehension
system, any model (Frazier 1987, for example) that does not consider non-syntactic information in initial parsing is not viable. It would seem easiest to include prosodic information as one of many constraints that can be used in parsing in constraint-based models (Altmann and Steedman 1988; Taraban and McClelland 1988; Britt 1994; Sedivy and Spivey-Knowlton 1994; MacDonald, Pearlmutter, and Seidenberg 1994, among others).

In the remainder of this chapter, I will discuss how the modified ‘goodness-of-fit’ fares in accounting for other constructions and possible future study. First, remember that Blodgett’s original account can handle the ambiguity of prepositional phrases, early/late closure ambiguity and probably the high/low attachment of ambiguous relative clauses in English. Since the first two constructions are explained in Blodgett (2004), we will see how this constraint is applied to the ambiguity of relative clauses in English. In addition, I also provide an account of how the proposed modified version of ‘goodness-of-fit’ can distinguish three distinct meanings for relative clauses including the high and low attachment of the relative clauses for the restrictive meaning and non-restrictive reading.

The relative clause constructions under discussion illustrate a standing ambiguity regarding which noun the clause is attached to when there are two possible attachment sites in a complex noun phrase that has two nouns. An example phrase is provided in (91).

(91) the daughter of the general who was on the balcony
    a. the daughter was on the balcony (high attachment)
    b. the general was on the balcony (low attachment)

In this example, it is possible that either the daughter or the general was on the balcony. Maynell (Maynell 2001 and see also Schafer, Carter, Clifton, and Frazier 1996) found that depending on the presence or absence of an IP boundary, there was a significant difference in the proportion of the attachment of the relative clause. The presence of an IP boundary immediately before the relative clause resulted in more high attachment readings than the no IP boundary. As can be seen in the two tree structures in (92), the original ‘goodness-of-fit’ can correctly capture this pattern since the IP immediately before the relative clause coincides with a syntactic constituent for the high attached reading whereas it does not with the low attached reading.
Figure 6.1: High and low attachment of an ambiguous, restrictive relative clause
At the same time, as figures in (93) shows, we can also capture the fact that the non-restrictive reading of the relative clause is often accompanied by a prosodic boundary because again, it does coincide with a syntactic constituent boundary.

The question is whether we are dealing with two truly distinct meanings for the high-attached restrictive and the non-restrictive reading, each of which corresponds to (92a) and (93a). Theoretically, they should be distinct if we assume the existence of both restrictive and non-restrictive relative clauses. However, that means there should be four distinct meanings for the same string, high/low restrictive meanings and another high/low non-restrictive meanings. Suppose this is the case. How do we account for these four distinct meanings with prosodic boundaries? According to Blodgett (2004)’s account, first, the presence of an IP boundary suggests the high-attached reading of the restrictive meaning. In addition, it also predicts a preference for the non-restrictive reading over the restrictive reading because of the matched syntactic and prosodic boundary. However, it does not distinguish between these two.

On the other hand, the modified version of ‘goodness-of-fit’ will predict that in addition to the preference of the high-attached restrictive reading and of the non-restrictive reading over the restrictive reading, between these two, the non-restrictive reading will be preferred to the high-attached restrictive reading because the former involves a higher-level syntactic boundary. What is unclear is whether both high and low attached readings are possible for the non-restrictive reading as two trees in (93) show. If both are possible, between these two, the high-attached reading will be preferred. In sum, the order of the preference with an IP boundary before the relative clause would be the high-attached non-restrictive, the high-attached restrictive and the low-attached non-restrictive reading. Since all three cases have syntactic constituent boundaries, the original ‘goodness-of-fit’ will not be able to distinguish among these three.

Similarly, assuming that English prepositional phrases also allow non-restrictive interpretations, the modified ‘goodness-of-fit’ will correctly predict the preference for the high-attached reading, non-restrictive low-attached reading (refer to the tree structures in (94)) to the restrictive low-attached reading (the tree structure in (95)) and in addition, the preference for the high-attached reading to the non-restrictive low-attached reading.
Figure 6.2: Two tree structures for the non-restrictive reading of a relative clause
Building on this, we can make a prediction on how prosodic structure interacts with prepositional phrases that can function as arguments or adjuncts of a main verb or a preceding noun. Examples in (96) are adapted from Clifton, Speer, and Abney (1991).

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1I thank Shari Speer for pointing out this.
Figure 6.4: A tree structure for an ambiguous prepositional phrase: the restrictive low-attached reading

(95) \begin{center}
\begin{tikzpicture}
  \node {S}
  child {node {NP} child {node {Mary} edge from parent node {V}}}
  child {node {VP} child {node {det} child {node {a}} child {node {N'}} edge from parent node {cop]} edge from parent node {NP} edge from parent node {PP} edge from parent node {N} edge from parent node {with binoculars}}}
\end{tikzpicture}
\end{center}

(96) a. Ian interested the man in a wallet. (an argument of the verb)
b. Ian interested the man in a hurry. (an adjunct of the verb)\textsuperscript{2}
c. Ian expressed his interest in a wallet. (the argument of the object noun)
d. Ian interested the man with red hair. (an adjunct of the object noun)

First, the prepositional phrase in (96a) is an argument of the verb whereas the one in (96b) is an adjunct of the verb. To distinguish these two from each other, we can refer to tree structures in (97).

Similarly, a prepositional phrase can be attached to a different node in the tree structure depending on whether it is an argument or an adjunct of a noun, as can be seen in the tree structures in (98a) and (98b).

With a prosodic break immediately before the prepositional phrases, the order of preference according to our hypothesis will be the high-attached verbal adjunct, the high-attached verbal argument, the low-attached adjunct of the preceding noun and finally the low-attached argument of the noun.

\textsuperscript{2}The prepositional phrase can also be an adjunct to the preceding noun
The modified ‘goodness-of-fit’ can also make correct predictions on various types of syntactic ambiguity in Korean or Japanese. As mentioned before, since a stronger prosodic boundary should coincide with a higher-level syntactic constituent boundary, this hypothesis is particularly useful for these languages, which have massive syntactic clausal ambiguity. In addition to our pro type sentences, the hypothesis can make a correct prediction on examples from Kim (2004).
Figure 6.6: Two tree structures for a prepositional phrase as an argument or adjunct of the preceding noun

(99) a. SR bias: *kkoc-ul* is the object of the rel-marked verb in a square bracket

\[
\text{나는 [꽃을 [좋아하는 [민지에게]]] 장미를 주었다.}
\]
\[
\text{na-nun [kkoc-ul cohaha-nun Minci-eykey] canmi-rul cwuessta.}
\]
\[
\text{I-TOP [flowers-ACC like-REL Minci-DAT] roses-ACC gave}
\]

‘I gave roses to Minci, who likes flowers.’

b. SOR bias: *kkoc-ul* is the object of the main verb

\[
\text{나는 [꽃을 [좋아하는 [민지에게]]] 주었다.}
\]
\[
\text{na-nun kkoc-ul [cohaha-nun Minci-eykey] cwuessta.}
\]
\[
\text{I-TOP flowers-ACC [like-REL Minci-DAT] gave}
\]

‘I gave flowers to Minci who I like.’
If an IP boundary occurs immediately after the initial noun phrase, the prosodic structure coincides with the syntactic structure in (99a). Thus the SR bias reading will be preferred. On the other hand, if the IP boundary occurs immediately after the *kkoc-ul ‘flowers-acc’*, then, this prosodic structure will match with the syntactic structure in (99b), preferring the SOR bias reading.

We can extend this idea to compare the two sentences provided in the tree structures in (100). According to our hypothesis, an IP boundary will be more often used with (100b) than with (100a), since (100b) involves a higher-level syntactic constituent boundary. In addition, regarding a prosodic boundary at the point of ambiguity, a stronger prosodic boundary such as an IP will be used for either structure than a smaller boundary such as an Accentual Phrase. Conversely, listeners will prefer a prosodic structure with an IP to with an AP for these two structures.

So far, I have discussed how the modified version of ‘goodness-of-fit’ can be applied to other constructions in English and Korean. We now turn our attention to problems regarding restrictive versus non-restrictive reading and their interactions with contexts for English materials. This may have implications on the idea of Principle of Referential Support, proposed by Crain and Steedman (1985) and Altmann and Steedman (1988). First, let’s think about our English participial constructions with the low-attached reading. An example is repeated here as (101).

(101) The saleswoman tailed the salesman complaining to himself.

The reflexive pronoun makes it clear that the ambiguous participial phrase should be attached low. In this case, we saw that it is possible to have both restrictive and non-restrictive readings not only based on our intuition and theoretical possibility but also on the experimental results that were obtained. In Experiment 2, we found that the two prosodic conditions in the low attached condition did not differ from each other and proposed that that’s because the late IP was being used for the non-restrictive reading. Now, according to Principle of Referential Support hypothesis, when a definite noun phrase is followed by a post-nominal, restrictive modifier, there are presuppositional

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3Remember that participial phrases behave very similarly to relative clauses, which also has both restrictive and non-restrictive readings. Furthermore, a non-restrictive relative clause typically forms its own Intonation Phrase.

4It was proposed to account for restrictive relative clauses but we can apply this to our low-attached participial phrases, too
requirements to be met for the whole complex noun phrase to be felicitous. According to Crain and Steedman (1985), they include first, a set of individuals identified by the head nominal, second, it is
already given or implicit that the relative (participial phrases in our case) applies to some individual in that set and finally that the whole expression identifies a single individual. According to this, the low-attached, restrictive reading for (101) in isolation is predicted to be more difficult than the non-restrictive reading, which does not carry the requirements mentioned above. However, the results from Experiment 2 seemed to show no difference between these two readings assuming that listeners do retrieve the non-restrictive reading for the late IP boundary condition. Since this idea was not directly tested in this study, we can just make a guess that a matched prosodic structure ameliorated the infelicity for this reading and was used by listeners.

Probably the first thing to test is if the non-restrictive reading is indeed easier in reading either in isolation or in the presence of a felicitous context (see the study by Grodner, Gibson, and Watson 2005 for English relative clauses). In addition, comparison between restrictive and non-restrictive participial phrases with felicitous contexts in spoken language will need to be conducted. From these, we can factor out what roles prosodic structure play in processing these constructions.

In conclusion, we seem to have obtained answers to questions that were raised in the beginning of this study. First, it was confirmed that prosodic information is critical in retrieving distinct meanings for otherwise ambiguous sentences in English and Korean using materials rarely (English participial phrases) or never (Korean prototype sentences) examined before. These results add further support for the role of prosodic structure in spoken language processing.

Secondly, it was demonstrated that despite biased contextual information, prosodic structure can exert a strong influence on the way listeners understand ambiguous strings. Given these results, it is unavoidable to incorporate prosodic component into models of spoken language processing.

Finally, this study proposed that Blodgett (2004)'s ‘goodness-of-fit’ constraint should be modified to account for the patterns that emerged from those experiments. We also saw that this modified version can be applied to other constructions to make predictions on the preference of one interpretation or the other.
Appendices
APPENDIX A

RESULTS FOR ENGLISH MATERIALS WITHOUT REFLEXIVE PRONOUNS

The first triplet: mean for comprehension task for written, earlyIP, lateIP
The second triplet: mean rating for the high-attached for written, earlyIP, and lateIP
The third triplet: mean rating for the low-attached for written, earlyIP, and lateIP
The pair: mean proportion of understood response for earlyIP and lateIP

(1) Minie turned to a flight attendant asking questions.
   (2.2, 2.88, 2.54) (1.61, 2, 1.69) (3.01, 2.3, 2.54), (0.81, 0.85)
(2) Elli answered the phone for her roommate brushing her teeth.
   (3.71, 3.88, 3.38) (3.16, 2.73, 2.31) (1.8, 1.35, 2), (0.92, 0.88)
(3) Neal opened the door for a visitor cleaning his glasses.
   (3.58, 4.27, 2.73) (2.83, 3.73, 1.92) (1.86, 1.27, 2.35), (0.81, 0.85)
(4) Marie motioned to her niece climbing a ladder.
   (3.91, 4, 3.54) (3.2, 3.04, 2.62) (1.56, 1.54, 2), (0.85, 0.85)
(5) Amelia showed a picture to a cop coughing hard.
   (3.23, 4.08, 2.88) (2.33, 3.19, 2.04) (2.07, 1.42, 1.92), (0.92, 0.81)
(6) Melanie neared a person demonstrating the product.
   (4.02, 4.19, 3.31) (3.16, 3.73, 2.85) (1.44, 1.38, 1.65), (0.81, 0.92)
(7) Ross challenged a man dribbling a basketball.
   (3.84, 4, 3.31) (2.66, 2.92, 2.73) (1.47, 1.27, 1.92), (0.88, 0.96)
(8) Aaron followed a poor guy drinking his soda.
   (3.07, 3.88, 2.54) (2.03, 2.96, 1.85) (2.21, 1.42, 2.42), (0.96, 0.85)
(9) Eddy strolled by a tourist eating a donut.
(10) Norah spoke to her daughter filed her nails.

(11) Larry interviewed a woman gripping the microphone.

(12) Laura rested on the floor with her son holding a cup in one hand.

(13) Mary sent a letter to an agent hoping for a reply.

(14) Will pushed against some people hurrying to get to work.

(15) Renee frowned at a customer intending to walk away.

(16) Ellen glared at a stranger making everyone uncomfortable.

(17) Lily hung up the phone on a reporter muttering obscenities.

(18) Anna openly criticized a lawyer planning to draw attention to the case.

(19) Eileen entered the room with a student putting on her coat.

(20) Lauren sat near a young lady reading her book.

(21) Mike taught a game to his friend scratching his head.

(22) Nelly arrived at the hospital with her aunt screaming in pain.

(23) Molly welcomed a new member shaking hands with everyone.
(24) Ryan ran away from a farmer shouting loudly.
(25) Wayne approached a clerk singing an old pop song.
(26) Lenny conversed with a postman sitting on his bike.
(27) Annie complained about a bank teller raising her voice.
(28) Emily reprimanded an employee standing in the doorway.
(29) Amy talked to her uncle sweeping the porch.
(30) Leo walked toward a little girl swinging a bag.
(31) Raoul explained the problem to a policeman tapping his foot.
(32) Ian tripped a bully threatening to cause more troubles.
(33) Elaine unlocked the chest for her cousin trembling visibly.
(34) Erin greeted a guest trying to force a smile.
(35) Ronny knelt next to a boy tying his shoes.
(36) Eleanor yelled at an athlete using the megaphone.
(37) Lori smiled at a neighbor walking her dog.
(38) Mia said goodbye to a foreigner waving her hand.

(39) Harry confronted a thief wielding a bat.

(40) Roy described the event to a waitress yawning repeatedly.
APPENDIX B

ENGLISH MATERIALS WITH REFLEXIVE PRONOUNS

Target sentences and two context sentences for each target sentence used in the English written pre-test with reflexive pronouns. Items that changed for the auditory test were indicated by new words in the parenthesis. The number next to each context is the corresponding mean proportion of the context calculated by counting the number of reflexive pronouns that are matched to the context.

(1) The stepmother embraced the stepson crying to . . . .
HA: A stepmother loved her stepson very much. They were very poor, and sadly, one day she found that there was no food left in the house. She didn’t know what to do. She felt so guilty that she hugged the stepson warmly. But let me tell you what else she was doing as she embraced him. (0.8)
LA: A stepmother loved her stepsons very much. They were very poor, and sadly, one day she found there was no food left in the house. The stepmother didn’t know what to do. She felt so guilty that she hugged one of the stepsons warmly. But let me tell you which one she embraced. (0.47)

(2) The soprano followed the lad murmuring to . . . .
HA: A soprano for the Metropolitan Opera was in a hurry because she was late for the rehearsal for the new show. Near the opera theater, she bumped into a lad who looked very familiar. He glanced at her but then hurried away. Although she couldn’t remember where she had seen him, she thought he was hiding something and so went after him. But let me tell you what else she was doing as she followed him. (0.8)
LA: A soprano for the Metropolitan Opera was in a hurry because she was late for the rehearsal for the new show. Near the opera theater, she bumped into two lads who looked very familiar. They glanced at her but then hurried away. Although she couldn’t remember where she had seen them, she thought that they were hiding something and so went after one of them. But let me tell you.
which one she followed. (0.73)

(3) The milkmaid helped the milkman grumbling to . . . .

HA: A milkmaid was ordered to help a milkman pour buckets of milk into a big barrel. Because it was a freezing day, their hands quickly became numb. Although neither of them was very happy about working in the cold, they decided to get the job done right away. Because the milkmaid had more experience than the milkman, she helped the milkman with the task. But let me tell you what else she was doing as she helped him. (0.33)

LA: A milkmaid was ordered to help two milkmen pour buckets of milk into a big barrel. Because it was a freezing day, their hands quickly became numb. Although none of them were very happy about working in the cold, they decided to get the job done right away. Because the milkmaid had more experience than the milkmen, she helped one of the milkmen with the task. But let me tell you which one she helped. (0.71)

(4) The groom tapped (called out to) the bridesmaid scolding (grinning to) . . . .

HA (written): On the day of his wedding, a groom couldn’t find the bridesmaid in charge of the decorations. He searched the church, but couldn’t find her. Finally, he went outside and found that she was playing with a stray cat on the steps. After he took a deep breath, he tapped her on the shoulder. But let me tell you what else he was doing as he tapped her. (0.6)

LA (written): On the day of his wedding, a groom couldn’t find the bridesmaids in charge of the decorations. He searched the church, but couldn’t find them. Finally, he went outside and found that they were playing with a stray cat on the steps. After he took a deep breath, he tapped one of the bridesmaids on the shoulder. But let me tell you which one he tapped. (0.53)

HA (auditory): On the day of his wedding, a groom found that a bridesmaid hadn’t arrived yet. It was almost time for the wedding to start and in addition, she was supposed to bring the bride’s bouquet. The groom decided to wait for her at the entrance of the church and so he went out. After 30 minutes, he was almost ready to give up when he saw in the distance that the bridesmaid was running toward the church. The groom was so relieved that he called out to her excitedly. And let me tell you what else he was doing as he called out to her.

LA (auditory): On the day of his wedding, a groom found that two bridesmaids hadn’t arrived yet.
It was almost time for the wedding to start and in addition, they were supposed to bring the bride’s bouquet. The groom decided to wait for them at the entrance of the church and so he went out. After 30 minutes, he was almost ready to give up when he saw in the distance that the bridesmaids were running toward the church. The groom was so relieved that he called out to one of them excitedly. And let me tell you which one he called out to.

(5) The boy scout clung to the girl scout shaking (wetting) . . . .

HA: A boy scout once went on a hike in the woods with a girl scout. At some point, they found an entrance to a small cave and decided to go inside. All at once, they heard a shrieking sound from the inside of the cave. They both got scared and the boy scout grabbed the girl scout in his panic. But let me tell you what else he was doing as he clung to her. (0.79)

LA: A boy scout once went on a hike in the woods with two girl scouts. At some point, they found an entrance to a small cave and decided to go inside. All at once, they heard a shrieking sound from the inside of the cave. They all got really scared and the boy scout grabbed one of the girl scouts in his panic. But let me tell you which one he clung to. (0.6)

(6) The chairwoman spoke to the baritone scratching . . . .

HA: A chairwoman for a big company once went to a garden party hosted by a famous baritone from the Metropolitan Opera. In the middle of the party, she observed that the decorations on the buffet table seemed to have given some of the guests poison ivy. The chairwoman decided to inform the baritone of this and so went to talk to him. But let me tell you what else she was doing as she spoke to him. (0.73)

LA: A chairwoman for a big company once went to a garden party hosted by two famous baritones from the Metropolitan Opera. In the middle of the party, she observed that the decorations on the buffet table seemed to have given some of the guests poison ivy. The chairwoman decided to inform the baritones of this and so went to talk to one of them. But let me tell you which one she spoke to. (0.13)

(7) The servant knelt near the heiress crossing . . . .

HA: A servant once accompanied an heiress to a nearby church. Some time after they arrived, the servant saw that a pack of wild dogs were approaching the church. Frightened, the heiress collapsed
on the floor. The servant hurried over to her and knelt down beside her, but let me tell you what else he was doing as he knelt near her. (0.73)

LA: A servant once accompanied two heiresses to a nearby church. Some time after they arrived, the servant saw that a pack of wild dogs were approaching the church. Frightened, the heiresses collapsed on the floor. The servant hurried over to them and knelt down beside one of them, but let me tell you which one he knelt near. (0.67)

(8) The queen motioned to the policeman mumbling to . . .

HA: A queen got tired of crime in her kingdom, so one day she decided to investigate. She was disguised as a beggar and went out into the kingdom. On the street, she saw that a policeman ignored a nearby mugging because he was doing something else. She tried to hint at the policeman about the mugging by motioning to him. But let me tell you what else she was doing as she motioned to him. (0.47)

LA: A queen got tired of crime in her kingdom, so one day she decided to investigate. She was disguised as a beggar and went out into the kingdom. On the street, she saw that two policemen were ignoring a nearby mugging because they were doing something else. She tried to hint at the policemen about the mugging by motioning to one of them. But let me tell you which one she motioned to. (0.67)

(9) The king pointed to the lady pinching . . .

HA: A king once held a masquerade to celebrate his birthday. Among the guests, he noticed a lady who was wearing a beautiful swan costume. While she was dancing, someone knocked her mask off and so the king was able to see her in the eye. Both of them were shocked because it was the girl he secretly got engaged to before when he was in exile. Out of astonishment, he pointed to the lady. But let me tell you what else he was doing as he pointed to her. (0.73)

LA: A king once held a masquerade to celebrate his birthday. Among all the guests, he noticed two ladies who were wearing swan costumes. While they were dancing, someone knocked their masks off and the king was able to see them in the eye. All three were shocked because it was the girl he secretly got engaged to before when he was in exile and her sister. Out of astonishment, he pointed to one of the ladies. But let me tell you which one he pointed to. (0.73)
(10) The baron entertained the noblewoman sketching ....

HA: A baron once went to a party at the house of a famous artist. Soon he got tired of the party, so he wandered around the house. In a large drawing room, he found a noblewoman who was reclining on the couch. He began to talk with her and told her a very funny joke. But let me tell you what else he was doing as he entertained her. (0.6)

LA: A baron once went to a party at the house of a famous artist. Soon he got tired of the party, so he wandered around the house. In a large drawing room, he found two noblewomen who were reclining on the couch. He began to talk with them and told one of them a very funny joke. But let me tell you which one he entertained. (0.93)

(11) The showgirl chased the mailman shouting to ....

HA: A Vegas showgirl went backstage and found a mailman near her purse. When she asked what was going on, the mailman hurried out of the room with her purse. The showgirl got very upset because this was the second time that this thing happened. But there was no time to lose and so she ran after him right away. But let me tell you what else she was doing as she chased him. (0.8)

LA: A Vegas showgirl went backstage and found two mailmen near her purse. When she asked what was going on, the mailmen hurried out of the room with her purse. The showgirl got very upset because this was the second time that this thing happened. But there was no time to lose and so she ran after one of them right away. But let me tell you which one she chased. (0.53)

(12) The bachelorette waved to the bachelor sunning (smirking) to ....

HA: There once was a big party for singles at the beach. It was a sunny day but a little cold, so not many people wanted to tan. In the middle of the party, a famous bachelorette realized a good looking bachelor kept looking at her. Although she didn’t want him to think that she was easy, she decided to show a little interest and waved at him. But let me tell you what else she was doing as she waved at him. (0.33)

LA: There once was a big party for singles at the beach. It was a sunny day but a little cold, so not many people wanted to tan. In the middle of the party, a famous bachelorette realized that two good-looking bachelors kept looking at her. Although she didn’t want them to think that she was easy, she decided to show a little interest and waved at one of them. But let me tell you which one
she waved at. (0.87)

(13) The steward winked at the stewardess whispering to . . . .

HA: A steward had just finished a long flight. Although the flight was tiring, he felt good because he became closer to a stewardess he had a crush on. When he walked out of the plane, he turned around and winked at her. But let me tell you what else he was doing as he winked at her. (0.67)

LA: A steward had just finished a long flight. Although the flight was tiring, he felt good because he became closer to two stewardesses he had a crush on. When he walked out of the plane, he turned around and winked at one of them. But let me tell you which one he winked at. (0.67)

(14) The priest glanced at the nun counting to . . . .

HA: A priest in the local church accompanied a nun and 20 Sunday school kids on a museum excursion. All of them were having a good time in the museum when the priest and the nun realized that some of the kids were missing. However, before the priest said anything, he looked quickly at the nun. But let me tell you what else he was doing as he glanced at her. (0.67)

LA: A priest in the local church accompanied two nuns and 20 Sunday school kids on a museum excursion. All of them were having a good time in the museum when the priest and the nuns realized that some of the kids were missing. However, before the priest said anything, he looked quickly at one of the nuns. But let me tell you which one he glanced at. (0.8)

(15) The saleswoman tailed the salesman sighing (complaining) to . . . .

HA: A senior saleswoman was once assigned to investigate a junior salesman for bribing local government officials. She was doubtful that he would do such a thing because he was a very honest man. One day, however, she got a tip that he had left the office with an important envelope, so she went after him right away. But let me tell you what else she was doing as she tailed him. (0.87)

LA: A senior saleswoman was once assigned to investigate two junior salesmen for bribing local government officials. She was doubtful that they would do such a thing because they were very honest men. One day, however, she got a tip that they had left the office with an important envelope, so she went after one of them right away. But let me tell you which one she tailed. (0.53)

(16) The lass neared the horseman whistling to . . . .

HA: One afternoon, a lass went to the barn to check on her horses. It was a sunny, pleasant day
for horseback riding. In the barn, there was a horseman who was tending to the horses. The lass
decided to ask him to ready her favorite horse for her ride, so she walked over to him. But let me
tell you what else she was doing as she neared him. (0.67)

LA: One afternoon, a lass went to the barn to check on her horses. It was a sunny, pleasant day for
horseback riding. In the barn, there were two horsemen who were tending to the horses. The lass
decided to ask them to ready her favorite horse for her ride, so she walked over to one of them. But
let me tell you which one she neared. (0.87)

(17) The niece poked the nephew babbling to . . . .

HA: At the annual family reunion, my brother-in-law’s niece had a fight with my husband’s nephew.
Other family members stopped the fight, but the niece and nephew pouted all evening. Finally, the
parents of the niece forced her to talk to the nephew. She reluctantly went towards the nephew and
poked him. But let me tell you what else she was doing as she poked him. (0.67)

LA: At the annual family reunion, my brother-in-law’s niece had a fight with my husband’s nephews.
Other family members stopped the fight, but the niece and nephews pouted all evening. Finally, the
parents of the niece forced her to talk to the nephews. She reluctantly went towards the nephews
and poked one of them. But let me tell you which one she poked. (0.87)

(18) The gentleman turned to the landlady drying . . . .

HA: A gentleman was introduced to a landlady for a tour of a prospective apartment. Unfortunately,
during the tour, the water tank in the house broke and both of them got soaked. When everything
calmed down, the gentleman turned to the landlady to complain. But let me tell you what else he
was doing as he turned to her. (0.8)

LA: A gentleman was introduced to two landladies for a tour of a prospective apartment. Unfortu-
nately, during the tour, the water tank in the house broke and all of them got soaked. When
everything calmed down, the gentleman turned to one of the landladies to complain, but let me tell
you which one he turned to. (0.93)

(19) The ballerina collapsed near the male dancer worrying to . . . .

HA: After four hours of practice, the ballerina who had been practicing with a male dancer finally
told him how hard that day’s practice had been. They both agreed they needed a break, but with an
upcoming performance, they danced for another two hours. Finally, the ballerina sank down near
the male dancer. But let me tell you what else she was doing as she collapsed near him. (0.73)
LA: After four hours of practice, a ballerina who had been practicing with two male dancers finally
told them how hard that day’s practice had been. They all agreed they needed a break, but with an
upcoming performance, they danced for another two hours. Finally, the ballerina sank down near
one of the male dancers. But let me tell you which one she collapsed near. (0.8)
(20) The congresswoman grabbed the fireman muttering to . . . .
HA: One day a fire broke out in a congresswoman’s office. The office filled with smoke in no time
and the congresswoman’s eyes watered. She began to worry that she might not make it out. Then,
through the heavy smoke, she spotted a fireman and tried desperately to reach for him. But let me
tell you what else she was doing as she grabbed him. (0.73)
LA: One day a fire broke out in a congresswoman’s office. The office filled with smoke in no time
and the congresswoman’s eyes watered. She began to worry that she might not make it out. Then,
through the heavy smoke, she spotted two firemen and tried desperately to reach for one of them.
But let me tell you which one she grabbed. (0.67)
(21) The chairman shook hands with the policewoman fanning . . . .
HA: The chairman of a company was supposed to be interviewed by a policewoman, but unfortu-
nately the air conditioning in the building suddenly broke down and the building got very hot. At
the same time, the chairman was told that the policewoman had arrived and so he went to meet her.
When he saw her at the door, he shook hands with her cheerfully. But let me tell you what else he
was doing as he shook hands. (0.67)
LA: The chairman of a company was supposed to be interviewed by two policewomen, but unfortu-
nately the air conditioning in the building suddenly broke down and the building got very hot. At
the same time, the chairman was told that the policewomen had arrived and so he went to meet
them. When he saw them at the door, he shook hands with one of them cheerfully. But let me tell
you which one he shook hands with. (0.87)
(22) The monk walked toward the girl singing to . . . .
HA: A monk wanted to take a break from several hours of meditation. He decided to go to the
nearby park. In the park, he saw a small girl near a swing. He felt like having a chat and so went towards her. But let me tell you which else he was doing as he walked towards her. (0.53)

LA: A monk wanted to take a break from several hours of meditation. He decided to go to a nearby park. In the park, he saw two small girls near a swing. He felt like having a chat and so went towards one of them. But let me tell you which one he walked towards. (0.87)

(23) The priestess advanced towards the boy chanting to . . . .

HA: A Mayan priestess was asked to train an altar boy to sing songs for an upcoming festival. After a couple of practices, however, both of them realized the songs were much harder to master than they thought. To learn the songs, the altar boy decided to have extra practices. Early morning, the priestess went to the place where the boy practiced. She was surprised to see him there and went to talk to him. But let me tell you what else she was doing as she approached him. (0.8)

LA: A Mayan priestess was asked to train two altar boys to sing for an upcoming festival. After a couple of practices, however, they realized the songs were much harder to master than they thought. To learn the songs, the altar boys decided to have extra practices. Early one morning, the priestess went to the place where the boys practiced. She was surprised to see them there and went to talk to one of them. But let me tell you which one she approached. (0.8)

(24) The congressman approached the hostess calming . . . .

HA: A congressman was once invited to a party hosted by a rich couple. In the middle of the party, a gunshot was heard from the garden. Everybody in the room panicked; the hostess even tried to run out of the room. When the congressman saw this, he decided to stop her, so he moved towards her. But let me tell you what else he was doing as he approached her. (0.8)

LA: A congressman was once invited to a party hosted by two rich couples. In the middle of the party, a gunshot was heard from the garden. Everybody in the room panicked; the hostesses even tried to run out of the room. When the congressman saw this, he decided to stop them, so he moved towards one of them. But let me tell you which one he approached. (0.8)

(25) The princess went after the prince growling to . . . .

HA: One day, a princess decided to go hiking in the woods with a prince and her servant. After hours of walking, both the princess and the prince got tired and so decided to rest. Five minutes
later, the servant told the princess that they had to hurry because it was getting dark. The prince rose first and the princess followed him. But let me tell you what else she was doing as she went after him. (0.8)

LA: One day, a princess decided to go hiking in the woods with two princes and her servant. After hours of walking, the princess and the princes got tired and so decided to rest. Five minutes later, the servant told the princess that they had to hurry because it was getting dark. The princes rose first and the princess followed after one of them. But let me tell you which one she went after. (0.73)

(26) The housemaid scrutinized the butler dressing . . . .

HA: A housemaid for a rich family became suspicious of a new butler. Since she was convinced he was up to no good, she decided to watch him constantly. One day, when both of them were getting ready for the day, she watched him very closely. But let me tell you what else she was doing as she scrutinized him. (0.71)

LA: A housemaid for a rich family became suspicious of two new butlers. Since she was convinced they were up to no good, she decided to watch them constantly. One day, when all of them were getting ready for the day, she watched one of them very closely. But let me tell you which one she scrutinized. (1)

(27) The man photographed the woman smiling to . . . .

HA: A man was in need of a good picture for his magazine. One day he took a walk in the park with his camera and found a bench where an old woman sat in meditation. She looked so peaceful in her meditation that he decided to take a picture of her. He should have asked permission first, but since he didn’t want her to know that she was being photographed, he went ahead and took a picture of her. But let me tell you what else he was doing as he photographed her. (0.8)

LA: A man was in need of a good picture for his magazine. One day, he took a walk in the park with his camera and found a bench where two old women sat in meditation. They looked so peaceful in their meditation that he decided to take a picture of them. He should have asked permission first, but since he didn’t want them to know they were being photographed, he went ahead and took a picture of one of them. But let me tell you which one he photographed. (0.73)

(28) The actor moved towards the actress humming to . . . .
HA: A movie actor wanted to practice his lines with an actress on the movie set before the shooting of a critical scene. The scene was supposed to be very funny but required both of them to work together. The actor found that the actress was practicing the scene alone, so he went towards her to discuss the scene. But let me tell you what else he was doing as he moved towards her. (0.8)

LA: A movie actor wanted to practice his lines with two actresses on the movie set before the shooting of a critical scene. The scene was supposed to be very funny, but required all of them to work together. The actor found that the actresses were practicing the scene themselves, so he went towards one of them to join the discussion. But let me tell you which one he moved towards. (0.87)

(29) The waiter ran after the waitress yelling at . . .

HA: A waiter in a local restaurant suspected that a waitress in the same restaurant was responsible for the food missing from the kitchen. One day, he heard something near the kitchen, so he tiptoed closer. As he was about to open the door, the waitress suddenly dashed out and he ran hurriedly after her, but let me tell you what else he was doing as he ran after her. (0.93)

LA: A waiter in a local restaurant suspected that two waitresses in the same restaurant were responsible for the food missing from the kitchen. One day, he heard something near the kitchen, so he tiptoed closer. As he was about to open the door, the waitresses suddenly dashed out. He ran hurriedly after one of them, but let me tell you which one he ran after. (0.8)

(30) The duchess hurried towards the tenor hitting . . .

HA: At a royal luncheon for opera singers, a duchess noticed a tenor who was sitting at the end of the table. She thought he looked familiar, but couldn’t remember which opera she saw him in. Suddenly she realized that he was in the opera she saw in Paris, so she walked quickly towards him to say hello. But let me tell you what else she was doing as she hurried towards him. (1)

LA: At a royal luncheon for opera singers, a duchess noticed two tenors who were sitting at the end of the table. She thought they looked familiar, but couldn’t remember which opera she saw them in. Suddenly she realized that they were in the opera she saw in Paris, so she walked quickly towards one of them to say hello. But let me tell you which one she hurried towards. (0.8)

(31) The marquis passed by the baroness talking to . . .

HA: A marquis at a ball decided to speak to a baroness who was standing alone near the wall. He
soon discovered that, although the baroness looked a little plain at first, she had a wide range of interests. He even thought it might be a good idea to invite her to his place later. After a while, he felt thirsty. He told the baroness that he would get some water from the fountain nearby, and passed by her on his way to the fountain. But let me tell you what else he was doing as he passed by her.

LA: A marquis at a ball decided to speak to two baronesses who were standing alone near the wall. He soon discovered that although the baronesses looked a little plain at first, they had a wide range of interests. He even thought that it might be a good idea to invite them to his place later. After a while, he felt thirsty. He told the baronesses that he would get some water from the fountain nearby, and passed by one of them on his way to the fountain. But let me tell you which one he passed by.

HA: A duke at one of Queen Elizabeth’s parties noticed a countess who was standing next to the queen. Although he was a little shy, he thought that the countess was very attractive and wanted to get to know her. He mustered his courage and asked the queen to introduce him to her and chatted with her for a while. But let me tell you what else he was doing as he conversed with her.

LA: A duke at one of Queen Elizabeth’s parties noticed two countesses who were standing next to the queen. Although he was a little shy, he thought they were both very attractive and wanted to get to know them. He mustered his courage and asked the queen to introduce him to them and chatted with one of them for a while. But let me tell you which one he conversed with.
APPENDIX C

RESULTS FOR ENGLISH MATERIALS WITH REFLEXIVE PRONOUNS

The first pair indicates the mean corrected naming time (ms) in the naming experiment. The second pair is the mean rating for two prosodic conditions in the auditory listening experiment with contexts. In each pair, the first number is from the earlyIP condition and the second number is from the lateIP condition.

(1a) HA: The stepmother embraced the stepson crying to herself. (204, 120) (4.21, 2.37)
(1b) LA: The stepmother embraced the stepson crying to himself. (176, 210) (2.89, 3.28)
(2a) HA: The soprano followed the lad murmuring to herself. (277, 125) (4.11, 2.61)
(2b) LA: The soprano followed the lad murmuring to himself. (248, 206) (2.63, 2.59)
(3a) HA: The milkmaid helped the milkman grumbling to herself. (257, 128) (4.56, 3.32)
(3b) LA: The milkmaid helped the milkman grumbling to himself. (92, 171) (3.78, 3.89)
(4a) HA: The groom called out to the bridesmaid grinning to himself. (127, 148) (4.05, 2.74)
(4b) LA: The groom called out to the bridesmaid grinning to herself. (105, 182) (3.21, 3.63)
(5a) HA: The boy scout clung to the girl scout wetting himself. (424, 415) (3.37, 2.42)
(5b) LA: The boy scout clung to the girl scout wetting herself. (146, 243) (3.11, 3.74)
(6a) HA: The chairwoman spoke to the baritone scratching herself. (166, 204) (3.95, 2.63)
(6b) LA: The chairwoman spoke to the baritone scratching himself. (261, 187) (2.53, 3.11)
(7a) HA: The servant knelt near the heiress crossing himself. (3.95, 2.63)
(7b) LA: The servant knelt near the heiress crossing herself. (4.21, 3.5)
(8a) HA: The queen motioned to the policeman mumbling to herself. (196, 162) (3.79, 3.11)
(8b) LA: The queen motioned to the policeman mumbling to himself. (172, 172) (3.26, 3.11)
(9a) HA: The king pointed to the lady pinching himself. (204, 229) (4.06, 2.74)
(9b) LA: The king pointed to the lady pinching herself. (73, 132) (3.32, 3.68)
(10a) HA: The baron entertained the noblewoman sketching himself. (280, 186) (4.44, 3.47)
(10b) LA: The baron entertained the noblewoman sketching herself. (235, 235) (3.5, 3.47)
(11a) HA: The showgirl chased the mailman shouting to herself. (191, 185) (3.89, 2.72)
(11b) LA: The showgirl chased the mailman shouting to himself. (174, 191) (4.16, 3.47)
(12a) HA: The bachelorette waved to the bachelor smirking to herself. (174, 94) (3.78, 1.89)
(12b) LA: The bachelorette waved to the bachelor smirking to himself. (89, 148) (2.39, 3.26)
(13a) HA: The steward winked at the stewardess whispering to himself. (269, 204) (3.79, 2.74)
(13b) LA: The steward winked at the stewardess whispering to herself. (235, 193) (2.95, 3.26)
(14a) HA: The priest glanced at the nun counting to himself. (241, 148) (3.89, 2.47)
(14b) LA: The priest glanced at the nun counting to herself. (127, 127) (2.37, 2.32)
(15a) HA: The saleswoman tailed the salesman complaining to herself. (128, 202) (3.74, 2.58)
(15b) LA: The saleswoman tailed the salesman complaining to himself. (197, 186) (3.58, 3.74)
(16a) HA: The lass neared the horseman whistling to herself. (3.79, 1.74)
(16b) LA: The lass neared the horseman whistling to himself. (2.05, 3)
(17a) HA: The niece poked the nephew babbling to herself. (161, 100) (4.11, 2.89)
(17b) LA: The niece poked the nephew babbling to himself. (182, 115) (3.16, 3)
(18a) HA: The gentleman turned to the landlady drying himself. (315, 247) (3.63, 2.32)
(18b) LA: The gentleman turned to the landlady drying herself. (124, 199) (2.74, 2.58)
(19a) HA: The ballerina collapsed near the male dancer worrying to herself. (197, 161) (3.89, 2.42)
(19b) LA: The ballerina collapsed near the male dancer worrying to himself. (241, 207) (3.22, 3.37)
(20a) HA: The congresswoman grabbed the fireman muttering to herself. (167, 117) (4, 3.11)
(20b) LA: The congresswoman grabbed the fireman muttering to himself. (232, 97) (3.26, 3.37)
(21a) HA: The chairman shook hands with the policewoman fanning himself. (230, 195) (3, 2.84)
(21b) LA: The chairman shook hands with the policewoman fanning herself. (179, 105) (2.58, 2.79)
(22a) HA: The monk walked toward the girl singing to himself. (174, 132) (3.37, 2.11)
(22b) LA: The monk walked toward the girl singing to herself. (135, 196) (2.05, 2.21)
(23a) HA: The priestess advanced towards the boy chanting to herself. (233, 164) (4.42, 2.11)
(23b) LA: The priestess advanced towards the boy chanting to himself. (158, 142) (2.21, 3)
(24a) HA: The congressman approached the hostess calming himself. (325, 164) (4.11, 3.16)
(24a) LA: The congressman approached the hostess calming herself. (236, 205) (3.53, 3.42)
(25a) HA: The princess went after the prince growling to herself. (134, 79) (3.79, 3.05)
(25b) LA: The princess went after the prince growling to himself. (248, 130) (3.68, 3.47)
(26a) HA: The housemaid scrutinized the butler dressing herself. (154, 143) (4, 3.58)
(26b) LA: The housemaid scrutinized the butler dressing himself. (188, 167) (3.26, 3.26)
(27a) HA: The man photographed the woman smiling to himself. (107, 142) (4.05, 2.58)
(27b) LA: The man photographed the woman smiling to herself. (80, 94) (2.47, 2.16)
(28a) HA: The actor moved towards the actress humming to himself. (129, 125) (3.68, 1.84)
(28b) LA: The actor moved towards the actress humming to herself. (128, 96) (3.17, 2.58)
(29a) HA: The waiter ran after the waitress yelling at himself. (122, 150) (4.58, 4.11)
(29b) LA: The waiter ran after the waitress yelling at herself. (87, 92) (3.53, 3.89)
(30a) HA: The duchess hurried towards the tenor hitting herself. (3.95, 3.21)
(30b) LA: The duchess hurried towards the tenor hitting himself. (3.74, 3.47)
(31a) HA: The marquis passed by the baroness talking to himself. (4, 3.11)
(31a) LA: The marquis passed by the baroness talking to herself. (3, 3.05)
(32a) HA: The duke conversed with the countess frowning to himself. (184, 193) (4, 3.37)
(32a) HA: The duke conversed with the countess frowning to himself. (210, 121) (3.07, 3.18)
APPENDIX D

RESULTS FOR KOREAN MATERIALS WITHOUT CONTEXTS

The first triplet: the mean proportion of each response choice (np1, np2, either) in the written test (Pre-test 3)
The pair: the mean proportion of understood responses in the auditory experiment (Experiment 4)
The second triplet: the mean proportion of each response choice (np1, np2, either) in the earlyIP condition in the auditory experiment (Experiment 4)
The third triplet: the mean proportion of each response choice (np1, np2, either) in the noIP in the auditory experiment (Experiment 4)

(1) 민영이가 물어봤던 수업을 정점했어요.(0.54, 0.08, 0.38) (0.82, 0.82)(0.56, 0.22, 0.22) (1, 0, 0)
(2) 민상이가 일상다운 도시를 떠났어요.(0.29, 0.08, 0.63) (1,1)(0.18, 0.55, 0.27) (0.45, 0.09, 0.45)
(3) 우영이가 찾아온 소식을 듣게됐어요.(0.5, 0, 0.5) (0.91, 1) (0.3, 0.3, 0.3) (0.73, 0, 0.27)
(4) 나영이가 문했있는 장소를 돌려보았어요.(0.54, 0.04, 0.42) (0.82, 1)(0.11, 0.56, 0.33) (0.82, 0.09, 0.09)
(5) 해영이가 화장당한 미용을 불렀어요.(0.5, 0.08, 0.42) (0.82, 0.82)(0.11,0.78, 0)(0.33, 0, 0.67)
(6) 우진이가 잡힌있는 장고를 포위했어요. (0.54, 0, 0.46) (0.91, 1)(0.5, 0.4, 0.1)(0.91, 0, 0.09)
(7) 제훈이가 잡혀있다고 고요했어요.(0.29, 0.13, 0.58) (0.82, 0.73) (0.11, 0.89, 0)(0.38, 0.38, 0.25)
(8) 정민이가 박수치는 지의를 의심했어요.(0.38, 0.08, 0.54) (0.82, 0.91)(0.22, 0.78, 0)(0,0.3, 0.3)
(9) 영민이가 잡혀있는 오두막을 수색했어요.(0.5, 0, 0.5) (0.73, 0.91)(0.13, 0.63, 0.25)(0.7, 0.1,0.1)
(10) 민정이가 엄지당한 불운을 진했어요 (0.21, 0.13, 0.67) (0.64, 0.73) (0, 0.71, 0.29)(0.25, 0.38, 0.38)
(11) 재원이가 고통하는 이유를 추측했어요(0.29, 0.04, 0.67)(0.82, 1)(0.44, 0.33, 0.22)(0.55, 0, 0.45)
(12) 은영이가 죽은 사실을 물았어요(0.58, 0.04, 0.38)(0.91, 1)(0.1, 0.2, 0.5)(0.64, 0, 0.36)
(13) 미연이가 즉시한 자리로 망들었어요(0.46,0.04,0.5)(0.82,0.91)(0,0.89,0.11)(0.4,0.3,0.3)
(14) 동족이가 적사한 뉴스를 보도했어(0.42,0.17,0.42)(0.91,0.91)(0.0,0.7,0.3)(0.4,0.2,0.4)
(15) 전민이가 요절한 애도를 이겨냈어(0.54,0.08,0.38)(0.82,0.82)(0.33,0.33,0.11)(0.67,0.0,0.33)
(16) 정춘이가 사라진 지역을 봉쇄했어(0.42,0.08,0.5)(0.91, 1)(0.3, 0.4, 0.3)(0.82, 0.09, 0.09)
(17) 방춘이가 익사한 호수를 찾았어(0.58, 0.08, 0.33)(0.82, 1)(0.56, 0.22, 0.11)(0.82, 0, 0.18)
(18) 정진이가 허우적거리며 장사를 발견했어(0.67,0.13,0.21)(0.64,0.82)(0.0,0.29,0.29)(0.56,0.22,0.22)
(19) 중신이가 구급한 지적을 보냈다(0.58, 0, 0.42)(0.82, 0.91)(0, 0.44, 0.56)(0.8, 0.1, 0.1)
(20) 영은이가 사형당한 사인을 부인했어(0.33,0.08,0.58)(0.91, 0.73)(0, 0.7, 0.1)(0.63, 0, 0.38)
(21) 진원이가 유배당한 심장은 공격했어(0.42, 0.08, 0.5)(1, 1)(0, 0.91, 0.09)(0.55, 0.27, 0.18)
(22) 우성이가 사살당한 원인을 조사했어(0, 0.46, 0.54)(1, 1)(0.18, 0.73, 0.09)(0.73, 0.18, 0.09)
(23) 형춘이가 입원중인 방원을 방문했어(0.63,0.03,0.38)(1.1)(0.45,0.45,0.09)(0.73,0.027)
(24) 영춘이가 수감된 감옥을 습격했어(0.5,0.0,0.5)(0.91,0.91)(0.1,0.7,0.1)(0.8, 0, 0.2)
(25) 영춘이가 격리된 수용소를 침공했어(0.21, 0.08, 0.71)(1, 0.91)(0.09, 0.82, 0.09)(0.5, 0.2, 0.2)
(26) 기춘이가 납치당한 화랑을 조사했어(0.46, 0.13, 0.42)(0.82, 1)(0.11, 0.89, 0)(0.82, 0, 0.18)
(27) 민욱이가 살해당한 참사를 알았어(0.58, 0.04, 0.38)(0.82, 0.82)(0.44, 0.44, 0.11)(0.67, 0, 0.22)
(28) 제민이가 결혼하는 소문을 못들었어(0.46, 0.04, 0.5)(0.91, 0.91)(0.3, 0.4, 0.3)(0.4, 0.5)
(29) 민신이가 술진 이유를 폭로했어(0.42, 0, 0.58)(0.91, 0.91)(0.1, 0.5, 0.4)(0.4, 0.3, 0.3)
(30) 유춘이가 출연중인 음악회를 보러갔어(0.75, 0, 0.25)(0.91, 0.91)(0.5, 0, 0.5)(0.8, 0.1, 0.1)
(31) 영민이가 화상당한 해를 기념했어(0.58, 0, 0.42)(0.82, 0.73)(0.22, 0.56, 0.22)(0.63, 0.13, 0.25)
(32) 동영이가 출살당한 햇간을 불태웠어(0.5, 0.13, 0.38)(0.91, 0.82)(0.3, 0.4, 0.3)(0.78, 0, 0.22)
(33) 하영이가 울고있는 빛을 지나갔어(0.71, 0.04, 0.25)(0.73, 0.82)(0.38, 0.13, 0.5)(0.78, 0.11, 0.11)
(34) 민원이가 호느끼는 장면을 목격했어(0.33, 0.08, 0.58)(0.91, 0.91)(0.3, 0.4, 0.3)(0.9, 0, 0.1)
(35) 민영이가 아사한 곳간을 수리했어(0.5, 0.04, 0.46)(0.73, 0.45)(0.13, 0.63, 0)(0, 0.2, 0.8)
(36) 미란이가 자살한 현장에 가보았어(0.46, 0.08, 0.46)(0.73, 1)(0.5, 0.25, 0.25)(0.64, 0.36)
APPENDIX E

RESULTS FOR KOREAN MATERIALS WITH CONTEXTS

The first pair: the mean proportion of the high attached and the low attached reading in the written test in each corresponding context (Pre-test 4)

The second pair: the mean rating for the early IP and late IP conditions in the high attached context (Experiment 5)

The third pair: the mean rating for the early IP and late IP conditions in the low attached context (Experiment 5)

(1) 기춘이가 수면중인 거실을 걱정하겠어요(0.8, 0.82) (4.07, 4) (3.8, 1.86)
(2) 정춘이가 사라진 지역을 봉쇄했어요(0.82, 1) (3.13, 3.73) (3.14, 1.8)
(3) 해영이가 환장한 마음을 폄로셨어요(1, 0.91) (2.27, 4) (3.87, 2.57)
(4) 영춘이가 수감된 감옥을 드나들었어요(0.91, 1) (2.8, 4.8) (3.23, 1.2)
(5) 진원이가 유배중인 시골집을 탐방했어요(1, 0.91) (1.87, 2.86) (4.33, 2.13)
(6) 민정이가 암살당한 흑돼지를 불질었어요(0.91, 1) (3.47, 4.13) (3.67, 3)
(7) 은영이가 두명중인 사람을 듣게하셨어요(0.91, 1) (2.73, 3.47) (2.86, 1.8)
(8) 영민이가 걷어쓴 오두막을 잠호했어요(1, 0.91) (3.36, 3.93) (4.2, 2.53)
(9) 방훈이가 익사한 호수를 찾아봤어요(1, 0.91) (3.53, 3.47) (3.67, 2.2)
(10) 우진이가 잠자리에 창고를 나와박혔어요(1, 1) (2.79, 4.53) (3.73, 1.73)
(11) 하영이가 줄고있는 순간을 포착했어요(0.73, 0.82) (3.27, 2.4) (3, 2.36)
(12) 영훈이가 사형당한 사람을 부인했어요(1, 1) (3.57, 4.07) (3.33, 2.33)
(13) 진춘이가 자고있는 침대를 총처낼때(0.64, 1) (3.67, 3.47) (4.07, 1.86)
(14) 영춘이가 입원증인 병원을 방문했어요(1, 1) (2.53, 4.2) (3.13, 1.33)
(15) 민신이가 숨져있는 아파트를 밀히겠어요(0.82, 0.91) (3.67, 4.4) (3.07, 1.8)
(16) 민영이가 누워있는 방심을 지나갔어요(1, 0.82) (4.2, 4.07) (3.6, 3.07)
(17) 중산이가 구급당한 지각을 경호했어요(1, 0.91) (2.47, 3.07) (3.33, 2.13)
(18) 동영이가 충실당한 교회를 볼 때였어요(0.92, 1) (3.33, 4.27) (3.67, 2.13)
(19) 민영이가 흐느끼는 장면을 목격했어요(0.73, 1) (2.47, 4.4) (2.13, 1.79)
(20) 재현이가 익고있는 사무실을 보았어요(0.9, 0.82) (3.67, 4.14) (2.93, 1.93)
(21) 나영이가 묻혀있는 장소를 둘러보았어요(0.55,1) (3.71, 4.07) (3.27, 1.6)
(22) 민영이가 쉬고있는 여관을 발견했어요(0.9, 1) (4.2, 4.27) (2.4, 1.27)
(23) 민영이가 회의중인 연구실을 찾아갔어요(1,1) (3.67) (3.33, 1.47)
(24) 우영이가 절식한 원인을 조사하고 있었어요(0.91, 1) (2, 3.53) (2, 1.27)
(25) 민영이가 운동중인 제육관을 피해갔어요(0.36, 1) (2.6, 3.73) (3.07, 1.4)
(26) 재현이가 연설중인 장담을 들었어요(0.82, 1) (3.47, 3.8) (3.73, 2.93)
(27) 민영이가 졸사한 자리를 떠나버렸어요(0.82, 1) (4.6, 4.53) (4.13, 3.6)
(28) 재현이가 낙서중인 교실을 들었어요(0.91, 0.91) (3.6, 4.13) (3.2, 2.2)
(29) 유진이가 숨어있는 성당을 보았어요(0.73, 1) (3.93, 4.53) (3.87, 3.07)
(30) 민영이가 살해된 소식을 발표해버렸어요(1, 0.91) (3.13, 4.13) (2.67, 1.73)
(31) 영훈이가 요양중인 마을을 찾아봤어요(0.9, 0.73) (3.27, 3.93) (3.2, 1.4)
(32) 민영이가 고통받는 지하실을 순찰했어요(0.91, 1) (2.47, 4) (3.47, 1.73)
(33) 민영이가 굴이축은 곳곳을 뒤적쳤어요(0.9, 1) (3.6, 3.79) (3.73, 2.2)
(34) 영훈이가 훈련중인 공원을 지나갔어요(0.64, 1) (2.87, 4.27) (3.73, 1.53)
(35) 우영이가 조경중인 경사를 알아봤어요(0.91, 0.91) (3, 3.73) (3.53, 1.6)
(36) 동욱이가 자난한 뉴스를 보기도했어요(0.73, 1)(2.27, 3.87) (3, 1.73)


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