



# Prosodic Disambiguation of Participle Constructions in English

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## Abstract

We report the results of one written and one auditory study that examined prosodic effects on resolving the ambiguity of participle constructions in English (e.g., Aaron followed a poor guy *drinking his soda*). These participle constructions behave similarly to the ambiguous prepositional phrases that can be attached to the verb phrase or to the immediately preceding noun. In the literature, the prosodic effects on resolving PP ambiguity have been controversial. However, the results from the current experiment extend and confirm the previous findings that demonstrated the effect of prosodic boundaries on resolving this type of syntactic ambiguity.

## 1. Introduction

It is well-established that prosodic structure plays a critical role in spoken language processing (Lehiste, 1973; Price, Ostendorf, Shattuck-Hufnagel & Fong, 1991; Kjelgaard & Speer, 1999; Schafer, 1997; Schafer, Speer & Warren, 2003; Misono, Mazuka, Kondo & Kiritani, 1997, among others). In this paper, we present new findings on prosodic effects on resolving the ambiguity of participle constructions in English.

The materials examined in this paper given in (1) below illustrate a standing ambiguity, which has multiple meanings even at the completion of a sentence.

- (1) Aaron followed a poor guy *drinking his soda*.

Disambiguated versions of this sentence are given below in (2).

- (2) a. Drinking his soda, Aaron followed a poor guy.  
b. Aaron followed a poor guy who was drinking his soda.

The syntactic ambiguity comes from the “-ing” form (as well as “-ed” form) in English; in other words, *drinking his soda* can either describe the action of the main subject (called high attachment) as in (2a) or modify the immediately preceding noun (called low attachment as in (2b)) and describe the action of that noun.

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 (3).

- (3) Mary saw a cop *with binoculars*.

Again, the prepositional phrase *with binoculars* can be attached to the verb phrase (high attachment) so that it is used to describe something about the main subject of the sentence (*Mary*) or it is a modifier of the immediately preceding noun, *a cop* (low attachment).

There is a large body of work on prosodic effects on the interpretation of this PP ambiguity, although not without conflicting results. On the one hand, Schafer and her colleagues (see Schafer, 1997; Schafer, Speer & Warren, 2003, among others) as well as Kraljic & Brennan (2003) showed evidence that naive speakers and listeners used different prosodic structures to intend and retrieve two distinct interpretations. On the other hand, the results from Snedeker & Trueswell (to appear) conflict with those of Schafer et al. in that speakers seemed to produce prosodic cues to attachment of a prepositional phrase only when these were needed.

Prosodic effects on the constructions under discussion have already been noted even by researchers who did not assume the framework of intonation phonology (Beckman & Pierrehumbert, 1986, among others). Stump (1981) as well as Quirk, Greenbaum, Leech & Svartvik (1985), for example, claimed that the high-attached reading is accompanied by a pause or a fall in intonation. However, compared to the large body of work on the PP attachment ambiguity, there are few empirical studies on these ambiguous participle constructions. One exception is Price, Ostendorf, Shattuck-Huffnagel & Fong, 1991, which examined various types of ambiguous sentences, one of which given in (4) below was the same type as the one under discussion.

- (4) Laura ran away with the man *wearing a green robe*.

Their results also demonstrated the listeners’ sensitivity to the distinct prosodic structures for recovering speakers’ intended meanings.

One interesting comparative work is the one by Misono, Mazuka, Kondo & Kiritani, which showed the effects of an Intonation Phrase boundary in Japanese for comparable constructions to English. The relevant example is given below.

- (5) Shoonen-wa *zubunureni-natte* kakemawaru koinu-o oikaketa.  
boy-top 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.

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”, high attachment) or the noun that follows, *koinu-o* (“the puppy”, low attachment). Again, their work demonstrated the similar effects; distinct prosodic phrasings were employed depending on which interpretation was intended and these prosodic differences were used by listeners to recover two different meanings.

In sum, the idea shared by most of these studies is that, in general, prosodic structures are effectively used to resolve attachment ambiguity, and that, more specifically, placing the

strongest prosodic boundary in the sentence before a constituent whose attachment is ambiguous in English tends to give rise to high attachment of the item.

Given this, this paper extends Price et al's study and tests the effects of prosodic boundaries on the interpretation of sentences such as (1). In doing so, we hope that the results from this study will contribute to our understanding of the role of prosody on these types of high/low attachment ambiguity, which has been controversial. For theoretical background, we assume the framework of intonation phonology developed by Pierrehumbert and her colleagues (Beckman & Pierrehumbert, 1986, among others). In the following section, we briefly discuss prosodic structure of American English. This will be followed by a description of a written and an auditory experiment, and finally the conclusion.

## 2. Intonational structure of American English

According to the analysis of prosodic structure of American English proposed in Beckman & Pierrehumbert (1986), each utterance is hierarchically organized to form constituents of rhythmic units such as feet, words, intermediate phrases (ip, henceforth) and finally Intonation Phrases (IPh, hereafter). In each utterance, there can be one or more IPhs, which, in turn, are composed of one or more ips. Then, each ip consists of one or more prosodic words. The IPh boundary, the biggest prosodic unit, is marked by one of two boundary tones (transcribed as H% or L%) and optionally followed by a pause. Each ip contains one or more prominent words, which are said to pitch-accented (marked by such as H\*, L\*, L+H\*, L\*+H, and H+!H\*), and these pitch accents are anchored on the stressed syllables of these prominent words. The end of an ip is marked by a high or low phrase accent (such as H- or L-), which is transcribed at the end of the last word in an ip, and controls the pitch contour between the boundary tones and the last pitch accent (called nuclear pitch accent).

## 3. Experiments

### 3.1. A written study

To evaluate how sentences with ambiguous participles are interpreted in the absence of spoken prosody, we conducted a written norming study of sentences like (1). 116 native speakers of English participated in this written study as a partial fulfillment of a course requirement. There were 40 test items along with 41 filler sentences (which were of the PP ambiguity type) in a pseudo-randomized list, where no three sentences of the same type occurred consecutively. Participants read the ambiguous sentences from the computer monitor and completed two tasks. First, they answered a comprehension question such as "Who was drinking his soda?" 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)'. 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 reading. Ratings were given on a 5-point scale where 1 corresponded to 'acceptable' and 5 corresponded to 'not acceptable'.

The overall mean to the comprehension question task was 3.23, indicating 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 as can be seen in Figure 1.

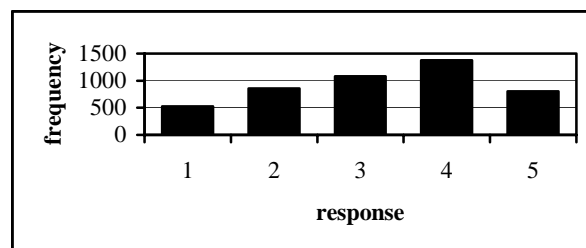


Figure 1: Overall frequency of each response in comprehension question.

From this graph, we can see that the response 'more likely a poor guy' (shown as 4 in the graph) was most frequently chosen, followed by 'either Aaron or the poor guy' (3 in the graph) response. The considerable number of 'either Aaron or the poor guy' reflects the indeterminacy of interpretation in these constructions. These tendencies were also confirmed in the acceptability rating as in Figure 2.

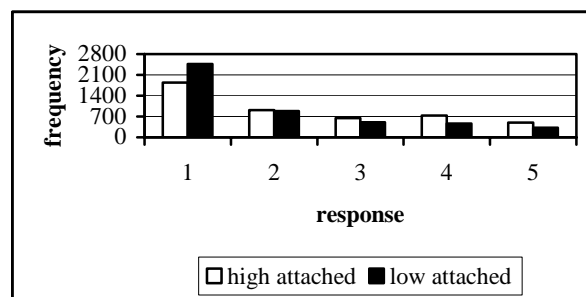


Figure 2: Overall frequency of each response in acceptability task (1-acceptable, 5-not acceptable)

For each reading, the majority of ratings indicated that the sentence was 'acceptable'. However, we can also see that the low attached reading has more 'acceptable' responses, which showed that readers considered the low-attached reading (mean 1.98) to be more acceptable than the high-attached reading (mean 2.38) (lower score means more acceptability). Based on the results from the written test, we conducted an auditory perception study described in the next section.

### 3.2. An auditory comprehension study

In this auditory study, it was hypothesized that if the sentence was pronounced to contain an IP boundary, which denotes the right edge of an Intonation Phrase right before the ambiguous phrase, then the participle phrase would be understood to describe the action of the main subject (high attachment). In contrast, if an IP boundary was not placed right before the participle phrase but in some other locations, then the ambiguous phrase would be grouped with the immediately preceding noun as a modifier of the noun and describe the action of that noun (low attachment).

52 native speakers of English participated in this auditory study as a partial fulfillment of a course requirement. Each sentence was recorded either with an IP boundary right before the ambiguous phrases or in some other locations by a female trained phonetician, who is a native speaker of English. Figures 3 (intended low-attached) and 4 (intended high-attached) show the two prosodic renditions of the same sentence, repeated here as (6) with the prosodic bracketing.

- (6) a. [Aaron followed]IP [a poor guy drinking his soda].  
 b. [Aaron followed a poor guy]IP [drinking his soda].

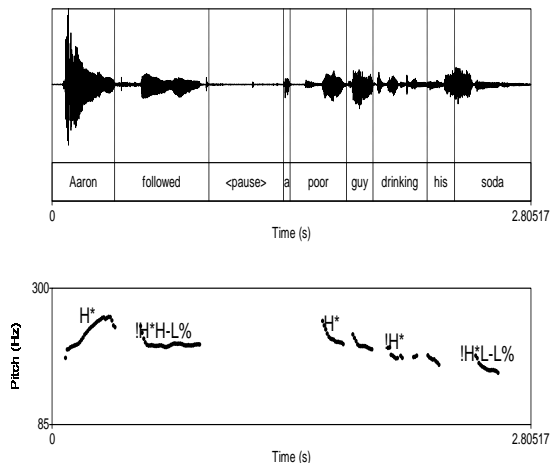


Figure 3: Waveform and fundamental frequency contour for EarlyIP boundary sentence.

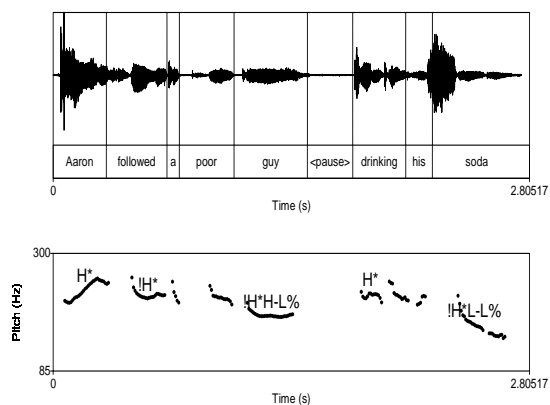


Figure 4: Waveform and fundamental frequency contour for LateIP boundary sentence.

Figure 5 shows the phonetic analysis of two critical locations (to be discussed below) in the two prosodic conditions.

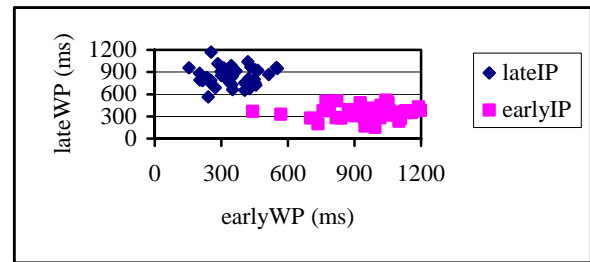


Figure 5: Duration of words and pauses in the early and late boundary sentences (WP refers to words plus pauses)

In the graph, the “earlyWP” refers to the duration of words and any following pauses of such as “followed” in (6a) and (6b). The graph shows that due to phrase final lengthening and any following pauses, the duration of “earlyWP” is longer in the earlyIP condition than in the lateIP condition since the IP boundary was placed after this word in the former condition. On the other hand, the duration of “lateWP” such as “guy” was longer in the LateIP condition than in the EarlyIP condition since the IP boundary was placed after this word in the lateIP condition. From this, we can conclude that overall, two prosodic versions of all test sentences were produced as intended.

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. The test and filler items were the same as the ones in the written test and these were pseudo-randomized so that no three sentences of the same type occurred consecutively. The first task for the participants 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 used in the written study.

The overall percentage of ‘understood’ responses from the first task ranged between 69.2% and 96.2% for the EarlyIP condition (the mean of all items was 87.6%) and between 80.8% and 96.2% for the LateIP condition (the mean of all items was 87.9%). This suggests that overall, all items in these two conditions were understood fairly equally.

Figure 6 shows the results of the second task (answering comprehension questions) in the two prosodic conditions.

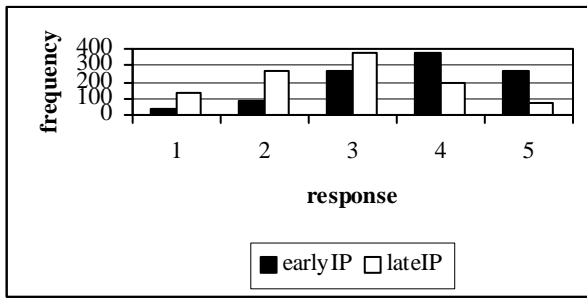


Figure 6: Overall frequency of each response in comprehension questions.

The mean response to the comprehension questions for sentences with an early IP boundary was 3.74, and in this condition, 4 ('more likely a poor guy', intended low attached) was most frequently chosen. On the other hand, the mean response for sentences with a late IP was significantly low, 2.82 ( $t=9.28$ ,  $p<0.01$ ). The most frequently chosen response in this condition was 3 ('either Aaron or a poor guy'). It might be thought that this LateIP condition was not effective as intended. However, Figure 7 shows the effect not visible from the distribution of overall frequency.

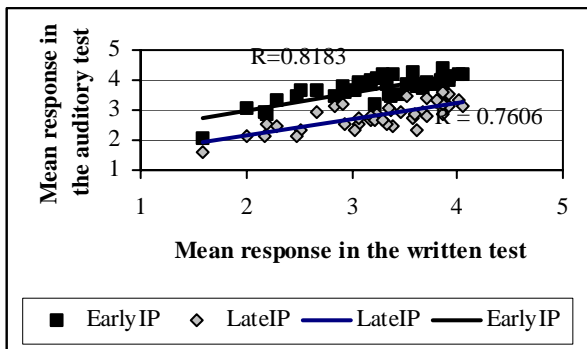


Figure 7: The mean response of each item in answering comprehension questions in the written and auditory study (1-definitely high, 5-definitely low)

First, the strong positive correlation between the written and auditory results indicated that although there is variability of meaning bias among the items, the inherent bias of each sentence in reading is still preserved in the auditory study. However, more importantly, this bias is influenced by prosodic structure and swayed into two opposite directions. Sentences with an early IP boundary were more likely to be interpreted as low-attached than the written test and those with a late IP were more likely to be understood as high-attached than the written test. In addition, it goes without saying that the overall tendency from Figure 6 is confirmed; the EarlyIP condition has more low attached readings than the LateIP condition.

We can think of some reasons why the LateIP looked less effective. For one thing, at the end of the sentence, the participle phrases may have been confused with a type of non-restrictive relative clause. Secondly, it seems that the high-attached reading of these constructions are not as frequent as

the low-attached reading. A further study will be needed to address these possibilities.

The overall acceptability ratings showed a consistent pattern with the comprehension results; In the EarlyIP condition, the mean rating of the high attachment reading (2.82) was significantly higher than the mean rating of the low attachment reading (1.59) ( $t=13.2$ ,  $p<0.01$ ). On the other hand, the opposite was found in the LateIP condition; The mean rating of the high attachment reading (1.97) was significantly lower than the mean rating of low attachment (2.27) ( $t=-3.34$ ,  $p<0.01$ ).

#### 4. Conclusion

The results from the written test showed that the participle constructions are ambiguous with a slight bias toward the low attached reading. On the other hand, 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 rating showed that when there is an IP boundary in some other locations but not before the participle phrases, listeners rated the low attached reading to be more acceptable. In contrast, when there was an IP boundary before the participle phrases, listeners considered the low attachment reading to be less acceptable.

#### 5. References

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