Prosodic Phrasing and Attachment Preferences*

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Abstract

The attachment of a relative clause (RC) has been found to differ across languages when its head noun is a complex NP. One attempt to explain the attachment differences is the Implicit Prosody Hypothesis (IPH) proposed by Fodor (1998, 2002). The goal of this paper is to show how the default phrasing of a sentence (explicit prosody), defined phonologically, differs across seven languages (English, Greek, Spanish, French, Farsi, Japanese, and Korean), and how the prosodic phrasing of a sentence in each language, both default and non-default, matches the interpretation of RC attachment by individual speakers. Observed tendencies show that there is a direct relationship between the prosodic phrasing and the interpretation of RC attachment, strongly supporting the IPH. In addition, the paper discusses the status of default phrasing and the factors affecting the default phrasing, including rhythmic and syntactic factors and their interactions.

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1. Introduction

Prosodic phrasing is the grouping of words within an utterance. An utterance is divided into one or more prosodic groupings which can be further divided into one or more smaller prosodic groupings. These prosodic groupings, though not isomorphic to syntactic groupings, are heavily influenced by the syntactic structure of the utterance (e.g., Selkirk, 1986; Nespor & Vogel, 1986; Hayes, 1989; Truckenbrodt, 1999). However, as suggested by studies in prosodic phonology (e.g., Selkirk 1986, Nespor & Vogel 1986), languages differ in the mapping between a syntactic structure and a prosodic structure.

Prosodic phrasing is also influenced by semantic and pragmatic/discourse factors such as focus and old/new information, by phonological factors such as rhythm and phrase length, and by performance related factors such as speech rate (e.g., Ferreira, 1993; Jun, 1993; Delais-Roussarie, 1995; see Shattuck-Hufnagel & Turk, 1996; and Cutler, Dahan, & Donselaar, 1997, for a review). However, the effects these factors may have on phrasing is not the same across languages. Focus often dephrases, i.e, deletes a prosodic phrase boundary, and/or deaccents words after focus, but in some languages focus does not affect the phrasing after the focused word. In some languages, a focused word begins a new phrase, but in others, it ends a phrase. Similarly, a word with new information tends to form a new phrase or get pitch accent while a word with old information tends not to form a new phrase or get accented, but this is not universal across languages (see Ladd, 1996, for examples). Furthermore, other things being equal, phrasing is also influenced by the length of a phrase and the rhythmic pattern of an utterance. When a sentence has two or more phrases, each phrase tends to be equal in length (Gee & Grosjean, 1983). Though a phrase boundary often matches a syntactic

boundary, it can be adjusted if the phrase is too short or too long. The limit or the range of phrase length, however, differs across languages, and it depends on the level of the phrase in the prosodic hierarchy. For example, the Accentual phrase in Korean (see below for a definition) includes an average 3 syllables, but the Intonation phrase in Korean tends to include 7-15 syllables (Kim et al., 1997; Jun, to appear). On the other hand, an Intonation phrase in Greek tends to include 20 syllables (Jun, to appear).[1] Finally, phrasing is influenced by speech rate. In general, a phrase tends to include more words at a fast rate, but the interaction of speech rate and other factors is also language specific.

Since the prosodic phrasing of an utterance is influenced by syntactic, semantic, and pragmatic factors, it is possible that listeners use information about prosodic phrasing in parsing a sentence. Studies on auditory sentence processing have shown that prosody affects sentence processing; it has been particularly interesting to examine the effect of prosodic boundaries on syntactic disambiguation. Speer and colleagues (Speer, Kjelgaard, & Dobroth, 1996; Schafer, 1997; Kjelgaard & Speer, 1999; Schafer, Speer, Warren, & White, 2000; also see Cutler et al., 1997, for a review) have found that the cooperating prosody of a sentence (i.e., prosodic phrase boundary cues matching a syntactic phrase boundary) prevents garden path effects and facilitates sentence processing, while the conflicting prosody of a sentence (i.e., a mismatch between the prosodic boundary and the syntactic boundary) slows down sentence processing.

The cues of a prosodic boundary also help to resolve attachment ambiguities. In English, sentences such as 'Someone shot the servant of the actress who was on the

[1] The data are based on reading a story 'The North Wind and the Sun'; 4 speakers in each language.

balcony' can be ambiguous regarding the attachment of the relative clause. But the ambiguity can disappear with prosodic disambiguation -- if there is a phrase boundary before the relative clause, listeners interpret the relative clause as modifying 'the servant' (known as 'high attachment'). However, when there is no explicit prosody (as when reading a sentence silently), native speakers of English prefer to interpret the relative clause as modifying 'the actress' (known as 'low attachment') (Carreiras & Clifton, 1993, 1999; Fernández, 2000, forthcoming). This relative clause attachment preference, however, has turned out to be language-specific. High attachment is preferred by speakers of Dutch (Brysbaert & Mitchell, 1996), French (Zagar, Pynte, & Rativeau, 1997), German (Hemforth, Konieczny, Scheepers, & Strube, 1998), Japanese (Kamide & Mitchell, 1997), and Spanish (Cuetos & Mitchell, 1988), while low attachment is preferred by speakers of Arabic (Quinn, Abdelghany & Fodor, 2000), English (Frazier & Clifton, 1996), and Norwegian, Romanian and Swedish (Ehrlich, Fernández, Fodor, Stenshoel & Vinereanu, 1999), to name a few (cf. Fernández, 2000, forthcoming).

This apparent cross-linguistic difference in ambiguity resolution preference has raised some dilemmas for the universalist view of sentence processing (Kimball, 1973; Frazier & Fodor, 1978; Frazier, 1979; Frazier & Rayner, 1988; Frazier & Clifton, 1996), a view that hypothesizes the human sentence processing mechanism to be innate and universal. There have been several attempts to explain the cross-linguistic differences (cf. Tuning (Mitchell, Cuetos, Corley, & Brysbaert, 1995), Two factor model (Gibson, Pearlmutter, Canseco-González, & Hickok, 1996), Construal (Frazier & Clifton, 1996), Attachment-Binding (Hemforth, Konieczny, Scheepers, & Strube, 1998), and Implicit Prosody (Fodor, 1998, 2002)), and among these, this paper will focus on the Implicit

Prosody Hypothesis (IPH) proposed by Fodor. The IPH, stated in (1), was based on the fact that attachment preferences in silent reading are influenced by prosody, i.e., short RCs tend to attach low and long RCs tend to attach high.

(1) The Implicit Prosodic Hypothesis (IPH; Fodor, 1998, 2002):
In silent reading, a default prosodic contour is projected onto the stimulus, and it may influence syntactic ambiguity resolution. Other things being equal, the parser favors the syntactic analysis associated with the most natural (default) prosodic contour for the construction.

The claim is that the reason why languages differ in their attachment preferences is because languages differ in their prosody. Maynell (1999) and Lovrić, Bradley, & Fodor (2000, 2001) found that speakers interpret a prosodic break before an RC as a marker of a stronger syntactic boundary, which prompts high attachment.

So far, studies on several languages have shown the effect of phrase length in RC-attachment, thus indirectly supporting the IPH.[2]. Among these, some studies (e.g., Hirose, 1999, this volume; Quinn et al., 2000; Lovrić et al., 2001) examined phonetic data to see if the explicit prosody correlates with the attachment preference of a language, assuming that implicit prosody computed during silent reading is the same as (default) explicit prosody. Quinn et al. found that, for English, French and Arabic, f0 (fundamental frequency) peaks on NP1 and RC were higher than those on NP2 (in 'NP1 NP2 RC')

[2] Arabic (Quinn, Abdelghany, & Fodor, 2000), Croatian (Lovrić, Bradley, & Fodor, 2001), English (Quinn, Abdelghany, & Fodor, 2000); French (Pynte, 1998; Pynte & Colonna, 2000; Quinn et al., 2000), German (Walter et al., 1999), Spanish (Fernández, 2000) and Japanese (Hirose, 1999, this volume), to name a few. See Fernandez (2000, forthcoming) for more examples and references.

when the RC attaches high, but the f0 peak of NP2 was higher than that of RC when it attaches low. They concluded that there is a clear correlation between prosody and attachment preference for the languages they tested, and speculated that the *prominence* relation of NP1, NP2, and RC determines the attachment. That is, universal high RC-attachment is cued by prominent (e.g., a higher f0 peak) NP1 and prominent RC while universal low RC-attachment is cued by prominent NP2 and non-prominent RC.

Lovrić et al. (2001) examined the duration of NP1 and NP2 in Croatian varying the length of the RC, the attachment of the RC (by morphological agreement), and the existence in the complex NP of a genitive preposition *od*, which often triggers a prosodic break between N1 and (*od*) NP2. They found lengthening of NP1 before *od* (signaling a prosodic break) and lengthening of NP2 before a long RC -- mirroring low and high attachment preference, respectively -- regardless of whether the RC was forced to attach high or low by morphological agreement. They conclude that overt prosodic breaks correlate with RC-attachment tendencies in silent reading.

These studies examined phonetic data (f0 and duration) and showed that they reflect the prosodic structure of the sentences. However, phonetic data alone can be misleading in representing the prosodic structure of a sentence and not desirable for cross-linguistic comparisons for several reasons. First, as pointed out in Quinn et al, the pitch accent of a word, indicating prominence, is not necessarily realized as a f0 peak. Possible pitch accent types are language specific and sentence type specific (see examples below). Furthermore, when pitch accent types are not high (e.g., L*+H), it is not always clear which point should be measured to represent the prominence of the word.

In some languages such as Greek and Spanish, the most common pre-nuclear pitch accent type is late rise (L*+H) and the f0 peak is realized *after* the pitch accented syllable (Arvaniti & Baltazani 2000, to appear; Beckman, Diaz-Campos, McGory, & Morgan, 2002). Second, the prosodic phrasing of a sentence can have more than one level, and not all prosodic boundaries can be marked by duration (see below). How a prosodic unit is marked phonetically is specific to both the prosodic unit and the language. Therefore, comparing phonetic data across languages can be meaningless. Finally, the perception of a prosodic boundary is not absolute but relative. As shown in Carlson, Clifton, & Frazier (to appear), the strength of a prosodic boundary is influenced by the strength of the preceding prosodic boundary. The organization of prosodic grouping shows its effect globally, and measuring phonetic data from a local sequence may not be sufficient.

To avoid these problems, the prosodic phrasing of a sentence needs to be analyzed phonologically based on the intonation contour of a sentence and the degree of juncture between words. Phonetic measurements accompanying phonological analyses would be the best way to prove phrasing. In this paper, the prosodic phrasing of a sentence is analyzed phonologically following the framework of intonational phonology proposed by Pierrehumbert and colleagues (Pierrehumbert, 1980; Beckman & Pierrehumbert, 1986; Pierrehumbert & Beckman, 1988; see Ladd 1996 for a comparison with other models). Prosodic phrasing analyzed this way defines a prosodic hierarchy and serves as the domain of prominence relations among the words. Languages whose prosodic phrasing is analyzed in the same framework can then be compared with one another.

In this paper, I attempt to show how languages differ in the realization of prosody and the relationship between prosody and syntax, whether there is any relationship

between the prosodic phrasing of an utterance analyzed in intonational phonology and the RC-attachment resolution as reported by informants in each language, and whether this relationship holds across seven languages. The languages surveyed are English, Greek, Spanish, French, Farsi, Japanese, and Korean. Among these languages, Greek, Spanish, French, and Japanese have been found to prefer high attachment while English prefers low attachment. Attachment preferences for Farsi and Korean have not been documented before this paper.

The organization of the paper is as follows. The next section describes a phonological model of English intonation based on the framework of intonational phonology. Later, I will show, for each of the seven languages, how prosodic phrasing of an individual speaker, defined phonologically, reflects the attachment resolution, supporting the IPH. Finally, I will discuss the status of the default phrasing and factors affecting the default phrasing and conclude the paper.

2. Prosodic Phrasing in Intonational Phonology

Phonologically, prosody represents both a structure and the prominence relations within the structure. A structure defines a grouping within an utterance, and prominence relations within a group define the head of the group. Groupings exist above the word as well as below the word (e.g., foot, syllable, mora). In this paper, we will focus on the prosodic structure above the word.

An utterance can have more than one level of prosodic grouping or unit, reflecting the different degrees of juncture between words. It is assumed that prosodic units are hierarchically organized so that one or more prosodic units at one level form a prosodic

unit at an immediately higher level. Researchers disagree on exactly how many levels of prosodic groupings there are above the word, but two levels are commonly assumed by researchers: an Intonation Phrase (IP) and a level intermediate between the IP and the word. But this does not necessarily mean that every language has two levels above the word. The intermediate level has been referred to by various names: Phonological Phrase, Intermediate Phrase, Accentual Phrase, or Minor Phrase.

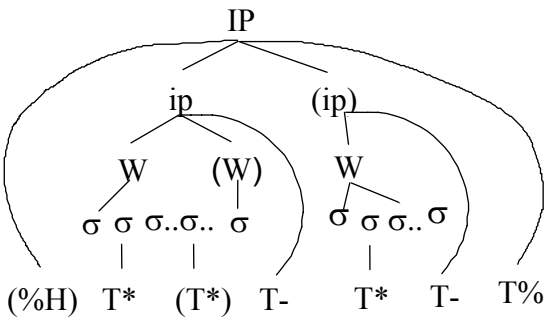
Phonologically, these groupings are marked by tone or intonation.[3] In the framework of Intonational phonology proposed by Pierrehumbert and colleagues (Pierrehumbert, 1980; Beckman & Pierrehumbert, 1986), an intonational tune is composed of a sequence of distinctive pitch movements and levels which are categorized by High and Low tones or their combinations. Each tone is linked to a syllable which is either metrically strong, thus marking a prominent word (e.g., pitch accent), or marks the boundary of a prosodic unit (e.g., boundary tone). It is assumed that not all syllables are specified as having a tone, and tonally unspecified syllables get their surface f0 patterns by interpolating between two adjacent tonal targets. The prosodic units marked by intonation are hierarchically organized.

The intonation structure of English is shown in (2). The highest prosodic unit defined by intonation is an Intonation Phrase (IP). An IP is marked by a boundary tone, obligatory L% or H% at the end (realized on the phrase final syllable) and an optional H% at the beginning (realized on the phrase initial syllable); an IP is also marked by phrase final lengthening and is optionally followed by a pause. IPs can contain one or more Intermediate Phrases (ip), which are marked by phrase accents (L- or H-; realized

[3] In some languages, some or all of the groupings are the domain of segmental phonological rules (Selkirk, 1986; Nespor & Vogel, 1986; Jun, 1993, 1998).

over syllables right after the last pitch accented word up to the last syllable of an ip) and can contain at least one pitch accent (e.g., H*, L*, L+H*, !H*; indicated by T* in (2); realized on the stressed syllable of a prominent word, 'W' in (2)). In this model, an ip is the domain of downstep (i.e., pitch range is reset across an ip boundary) and nuclear pitch accent (NPA) (i.e., the last pitch accent in an ip). Any pitch accent, except for a downstepped pitch accent (e.g., !H*, L+!H*), can come at the beginning of an ip.

(2) Intonational structure of English (Beckman & Pierrehumbert, 1986).



An example pitch track of the sentence 'The child with asthma outgrew the condition last year' is shown in Figure 1. The utterance is transcribed following the conventions of English ToBI (Tones and Break Indices; Beckman & Ayers-Elam, 1997), a prosodic transcription system based on English intonational phonology. Here, the sentence is produced in one IP with L% and three ips inside the IP, each with L-. Each ip has two pitch accents: H* and/or !H*. Here, the words 'asthma' and 'the condition',

having a downstepped pitch accent (i.e., !H*), would not be the first pitch accent of an ip, i.e., no prosodic boundary exists right before these words.[4]

Figure 1 here.

3. Prosodic phrasing and RC attachment resolutions across languages

In this section, I will describe how the prosodic phrasing of a sentence could differ across several languages, and how the prosodic phrasing of a complex head noun followed by a relative clause (RC), when produced at normal rate with five different prosodic conditions, could affect native speakers' interpretation of RC attachment. The observed tendencies suggest that the prosodic phrasing of a sentence, whether default or focused, is not the same across languages, and that the prosodic phrasing of a sentence reflects and may determine the interpretation of the RC attachment, supporting Fodor's IPH.

The languages examined are English, Greek, Spanish, French, Farsi, Japanese, and Korean. These languages were chosen because there are published data on RC attachment preference (High: Spanish (Cuetos & Mitchell, 1988; Carreiras & Clifton, 1993, 1999; Fernández, 2000, forthcoming); French (Zagar, Pynte, & Rativeau, 1997); Japanese (Kamide & Mitchell, 1997)[5]; Greek (Papadopoulou & Clahsen, 2002a) vs. Low: English (Carreiras & Clifton, 1993, 1999; Fernández, 2000, forthcoming)) and/or there is

[4] English ToBI includes four tiers (words, tones, break, miscellaneous), with each tier providing information about the utterance. The figure shows two tiers only (words and tones). The vertical lines on the words tier mark the end of each word, and the lines on the tones tier mark tonal events: the H* pitch accent is labeled on the f0 peak of the stressed syllable, L- is labeled at the end of an ip, and L% is labeled at the end of an IP.

[5] Studies have shown that Japanese speakers show a preference for low attachment at the initial stage of processing (Kamide, Mitchell, Fodor, & Inoue, 1998), suggesting that the cross-linguistic difference does not exist at all levels of processing but emerges in post-syntactic phases. See Fernández (2000, forthcoming) for a detailed discussion of the stages of processing.

an established model of intonational phonology (English: Beckman & Ayers-Elam, 1994; Greek: Arvaniti & Baltazani, 2000, to appear; Japanese: Venditti, 1997, to appear; Korean: Jun, 1993, 1998, 2000; Spanish: Beckman et al., 2002; French: Jun & Fougeron, 1995, 2000, 2002). All, except for French and Farsi, have their own ToBI system. Farsi does not have any published work on RC attachment or intonational phonology, to my knowledge, but it was chosen to increase the diversity in syntax and language groups. Among the seven languages, Japanese, Korean, and Farsi are head-final languages, while the others are head-initial languages. The word order is in general more fixed in the head-initial languages compared to that in the head-final languages. Among the head-initial languages, Greek has a relatively free word order. Four to seven informants of each language were consulted. They were mostly undergraduate or graduate students at UCLA and were naïve to the investigation.

Before collecting the attachment data, a sentence containing a relative clause with a simple NP head noun was elicited to see if there is any difference in the prosodic phrasing of the sentence across these languages. The sentence corresponding to 'John chased the dog that bit the cat' was chosen since this type of sentence in English is known to illustrate that a syntactic boundary mismatches a prosodic boundary (cf. Chomsky & Halle, 1965). Syntactically, the head noun 'the dog' and the relative clause are governed by the same maximal projection, but the most common prosodic boundary of this sentence, if there is any, comes between the head noun and the relative clause. To see if a prosodic phrase boundary comes in a similar place in other languages, the informants in each language were asked to produce a similar sentence in their native language by putting a pause (i.e., Intonation Phrase) in the most natural place. Sentences

in each language and the prosodic phrasing (an Intonation Phrase grouping, marked by '{ }') are given in (3).[6] The complementizer of a relative clause, a word or a morpheme, is in bold.[7]

(3) Example sentence in each language showing the location of pause

English: John chased the dog that bit the cat.
Prosodic grouping -> {John chased the dog} {**that** bit the cat}

Greek: O Giannis kinigise to skilo **pu** dagose ti gata
The John chased the dog that bit the cat
Prosodic grouping -> {O Giannis kinigise to skilo} {**pu** dagose ti gata}

Spanish: Juan vio al perro **que** persiguió al gato
John saw the dog that followed the cat
Prosodic grouping -> {Juan vio al perro} {**que** persiguió al gato}

French: John a poursuivi le chien **qui** a mordu le chat
John chased the dog that bit the cat
Prosodic grouping -> {John a poursuivi le chien} {**qui** a mordu le chat}

Farsi: John saga-ro **ke** gorbeha-ro gaz gereft ta?qib kard
John dog-acc that cat-acc bite took chase did
Prosodic grouping -> {John sagaro **ke** gorbeharo gaz gereft} {ta?qib kard}
also possible -> {John sagaro} {**ke** gorbeharo gaz gereft} {ta?qib kard}

Japanese: John-ga neko-ni kamitzuita inu-o oikaketa
John-nom cat-at bit dog-acc chased
Prosodic grouping -> {Johnga} {nekoni kamitzita inuo} {oikaketa}

Korean: John-i koyangi-lul mu**n** kangaji-lul ccochatta
John-nom cat-acc bit-that puppy-acc chased
Prosodic grouping -> {Johni} {koyangilul mu**n**} {kangajilul ccochatta}

As shown in (3), speakers of Greek, Spanish, French, and Farsi put a prosodic break between the head noun and the complementizer of a relative clause, as in English.

[6] The prosodic phrasing of the sentences given is not necessarily the same for other sentences containing a relative clause. As discussed later, the phrasing can change depending on many factors including the length of the word and the lexical item.

Among these, all but Farsi are head-initial languages. Farsi is a head-final language like Japanese and Korean, but unlike Japanese and Korean, its head noun comes before the relative clause as in the head-initial languages. In Japanese and Korean, the head noun comes after the relative clause. Interestingly, however, the prosodic break comes *after* the head noun (*inu-o*) in Japanese, but *before* the head noun (*kangaju-lul*) in Korean. That is, the relative clause and the head noun form one prosodic unit in Japanese, but not in Korean.

The distribution of phrase breaks in (3) suggests that languages of different syntactic configurations can have the same prosodic grouping regarding the head noun and the relative clause (e.g., English, Farsi, and Korean), while languages of the same syntactic configuration can have different prosodic groupings (e.g., Japanese and Korean). That is, prosodic phrasing is language specific and is not always predictable from the syntactic structure.

Next, to examine the relation between the RC attachment preference and prosodic phrasing, the sentence 'Someone shot the servant of the actress who was on the balcony' was chosen for a few reasons. First, since the attachment of the RC in this sentence has been reported in the literature, its preference can be compared with that of the informants consulted here. Second, the sentence, having two singular head nouns, does not need to include morphological information of number, which would have forced either high or low attachment (for languages having a gender morpheme, e.g., Spanish, the gender for the word 'servant' was female). This will make a direct comparison across languages possible (i.e., not all languages tested here have gender/number agreement morphology), and the sentence will be free from any possible effect of the morphological marker on

[7] Japanese does not have any morphological marker for a relative clause complementizer.

phrasing. That is, any difference found in prosodic phrasing must be due to the attachment, not due to a morphological marker (see Ladd 1996).

The informants in each language were asked to produce the sentence in (4) in the five different prosodic conditions in (5).

(4) Example sentence of RC attachment in each language

English: Someone shot the servant of the actress who was on the balcony.

Greek: Kapios pirovolise ton ipireti tis ithopiu pu itan sto balkoni
Someone shot the servant the actress that was on the balcony

Spanish: Alguien disparó contra la criada de la actriz que estaba en el balcón
Someone shot against the servant of the actress who stood on the balcony

French: Quelqu'un a tiré la servante de l'actrice qui se trouve sur le balcon
Someone has shot the servant of the actress who herself finds on the balcony

Farsi: Yeki xedmatkare honarpisha-ro ke tu balkon bud tir zad
One servant-of actress-acc that in balcony was bullet hit

Japanese: dareka-ga barukonii-ni-iru joyuu-no mesitsukai-o utta
Someone-nom balcony-on-be actress-gen maid-acc shot

Korean: Otton saram-i palkoni-e innun yobeu-e phachulbu-ul sswatte
Someone balcony-on be-RC actress-gen maid-acc shot

(5) (i) a default reading

(ii) put pause or a phrase break between the first NP and the second NP

(iii) put pause or a phrase break between the RC and the immediately adjacent NP

(iv) put contrastive focus on NP1 'servant'

(v) put contrastive focus on NP2 'actress'

Production of the sentence in the five different prosodic conditions was elicited in the following way. For (5i), informants were asked to silently read the sentence in (4), written in their native language orthography, and asked to answer the question 'Who was on the balcony?'. Then, they were asked to produce the sentence in the default condition two times. Their speech was digitized directly to a computer using *PitchWorks* (Scicon); then, their own utterance was played back to them, and they were asked to answer the question 'Who was on the balcony?' again. Their answers were always the same, except for one Korean speaker.[8] This procedure was chosen to find out about the informants' attachment resolution in their silent reading (the attachment preference is not known from the sentence itself because there is no morphological marker) so that it could be compared with their interpretation after the default reading.[9] It is assumed that the default phrasing of the sentence produced by the informants is close to the prosodic structure the informants would project in silent reading in off-line processing experiments.[10] (See the last section for a discussion of the prosodic structure in on-line processing.)

For the prosodic conditions (5ii) and (5iii), informants were told to put a pause as indicated, but not to put a pause in any other position of the sentence. The location of

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[8] Except for a few cases, the informants mentioned that the RC can modify either noun but they slightly prefer one against the other. They were more confident about their choice in the non-default prosodic conditions (5ii-v), except for two out of four Farsi informants in the focus condition.

[9] As one of the reviewers has pointed out, this procedure has a danger of biasing their default production, but native speakers are in general good at producing their default pattern when they are asked to read a sentence in their default style. Moreover, it is often hard to elicit a non-default pattern in this lab-speech style of reading a sentence. In fact, the default phrasing of Korean informants was similar to that of Korean reported in Schafer & Jun (2002). Furthermore, a few additional informants were asked to produce the sentence without first giving their interpretation, and it was found that their default phrasing was the same as that of the majority of other informants in the same language.

[10] The difference in attachment preference across languages is found in both on-line and off-line processing data. If the default phrasing assumed in Fodor's IPH intends to cover both types of processing data, the

pause was marked in the written text as a slash (e.g., … the servant / of the actress who ..). For focus conditions (5iv) and (5v), they were given a context to trigger contrastive focus (e.g., not the MANAGER of the actress but (the SERVANT of the actress)), and the focused word was circled in the text. Informants repeated the sentence in each prosodic condition two times and were asked to answer the question 'Who was on the balcony?' for each prosodic condition.

The intonation contours of all utterances were analyzed phonologically (by observing pitch tracks and waveforms/spectrograms generated by *PitchWorks* (Scicon) and by listening to the sound) based on the intonational phonology model of each language. For Farsi, the prosodic phrasing was determined based on the intonation contour of the given utterance while consulting the informant's judgment on juncture between words.

Prosodic phrasing of each language is discussed below in three prosodic groups (default, focus, and pause) under two language groups (head-initial vs. head-final languages).

3.1 Head initial languages

3.1.1 Default phrasing

Among the head-initial languages observed here, all except for English are known to have high attachment preference. A majority of informants of Spanish and French produced a prosodic boundary (larger than the default word boundary, but smaller than

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default phrasing would include two types. One is the type tested in Hirose (this volume) reflecting on-line processing, and the other is the type tested here reflecting off-line processing.

IP[11]) before the RC, while English informants did not put any phrase boundary (i.e., Intermediate or Intonation Phrase) in this position. An example pitch track of the English sentence produced in the default condition is shown in Figure 2. The pitch accent on the relative clause (i.e., on the word 'balcony') is L+!H*, a downstepped pitch accent, indicating no ip or IP phrase boundary before this word.

Figure 2 here

Greek is known to have high attachment (Papadopoulou & Clahsen, 2002a, b). Greek informants observed here, however, did not agree in their attachment in the default prosodic condition. Two preferred the high site, and the other two preferred the low site.[12] Interestingly, those who preferred low attachment produced no prosodic boundary before the RC, while those who preferred high attachment produced a prosodic boundary. This suggests that there is a direct relationship between the default prosodic phrasing and the attachment resolution. Figure 3 shows two patterns of prosodic phrasing of the Greek sentence, corresponding to high attachment with a prosodic break before the RC (Fig. 3a) and low attachment with no break before the RC (Fig.3b).

The intonation structure of Greek is the same as that of English (i.e., Intonation Phrase (IP) > Intermediate Phrase (ip) > Word), but the types of pitch accents differ between the two. In English, each of five pitch accents (H*, L*, L+H*, L*+H, H+!H*)

[11] The intonational phonology model of Spanish adopted here did not propose an intermediate phrase level between the Word and an IP. Informants claimed that the juncture before the RC was bigger than that before NP2, but not as big as that between clauses. The NP2 showed a rising pitch and the peak f0 was higher than that of the preceding rising pitch (on NP1) and that of the following one (on RC), suggesting a possible intermediate phrase boundary tone after the NP2.

can come in any order, but in Greek, which also has five pitch accents (H*, L*, L*+H, L+H*, H*+L), the most typical prenuclear pitch accent (non-final pitch accent within an ip) is L*+H, which is realized as a rising f0 throughout the stressed syllable with the f0 peak realized right after the stressed syllable. Thus, having L*+H on a stressed syllable means the word is not the last pitch accented word within an ip; i.e., there is no ip boundary after the word. NP2 'the actress' (*ithopiu*) in Fig. 3b has L*+H, while the same NP in Fig. 3a has L* followed by H- (sharply rising pitch from the low minimum f0 during the stressed syllable, and the f0 peak is realized on the same syllable, not on the next syllable (*pu*) as in Fig. 3b's L*+H on the same word), a boundary tone of an ip.[13]

Figure 3 here

In sum, a direct relation between the default phrasing and the attachment resolution seems to exist at the level of individual speakers as well as at the level of languages. In fact, one or two informants in each language produced a default phrasing different from other informants' in the same language, but their default phrasing was predictable from their attachment resolution, i.e., high attachment if a prosodic break occurs before the RC, low attachment if not. The procedures employed in the current study do not tell whether the default phrasing produced by informants is the same as their

[12] It is possible that the informants' proficiency in English might have influenced their attachment preferences (cf. Fernández, 2000, forthcoming)

[13] The pitch tracks in Figure 3 illustrate the problem of measuring the peak f0 values of NP1, NP2, and the RC. In Fig. 3a, the peak f0 on NP1 (*ipi**re**ti*: stressed syllable in bold), NP2 (*itho**piu***), and the first accent on the RC (***i**tan*) are slowly declining, while, in Fig. 3b, the peak f0 on NP2 is lower than the one on the RC. These f0 patterns are the opposite of what is predicted from high and low attachment data in English, respectively. A higher f0 peak on ***i**tan* than the peak on ***pu*** (the H part of L*+H on *itho**piu***) is due to tone clash or tone crowding phenomena. When L*+H syllables are separated by one or no syllable, the L of the

silent prosody. They can only suggest that the default phrasing produced by an individual speaker reflects his or her attachment interpretation. So far, the existence of silent prosody has been proven indirectly in such a way that attachment preference changes due to prosodic factors such as the length of a constituent (see references in Introduction), focus (Schafer, Carter, Clifton, & Frazier, 1996), and a prosodic break (Maynell, 1999; Lovrić et al., 2000, 2001). Further studies are needed to find out what a default phrasing of a sentence is and if this phrasing is predictable from the attachment preference pattern of each language. See more discussion about the default phrasing in the final section of the paper.

3.1.2 Pause

For prosodic conditions (5ii) and (5iii) -- a pause (i.e., a prosodic break) after NP1 and after NP2, respectively -- informants of all head-initial languages behaved the same. Regardless of the language they speak, all informants of head-initial languages preferred low attachment for the (5ii) condition, i.e., the prosodic phrasing: {Someone shot the servant}IP {of the actress who was on the balcony}IP, and high attachment for (5iii) condition, i.e., the prosodic phrasing: {Someone shot the servant of the actress}IP {who was on the balcony}. In fact, as discussed later, this was true for head-final languages as well. This suggests that, as in the default phrasing examples, what is important in RC attachment is the prosodic phrasing, i.e., how the two head nouns and the RC are prosodically grouped.

3.1.3 Focus

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second L*+H is often undershot (i.e., highish low), and as a result, the following H tone is realized even higher than the preceding H tone.

For prosodic conditions (5iv) and (5v), contrastive focus on NP1 and NP2, respectively, all preferred low attachment except for a few Spanish speakers. These tendencies can be predicted from the effect of focus on prosodic phrasing. In English, Greek, Spanish, and French, focus dephrases and/or deaccents a post-focus sequence. That is, when NP1 is focused, NP1 becomes the nuclear pitch accent (assuming there is no other focused item in the sentence), and all words coming after NP1 lose a prosodic boundary. The transcription of phonological tones in each language when NP1 is focused is given in (6a). All four languages have the same phrasing, but have different types of pitch accents. The parentheses in French indicate a prosodic unit (e.g., Accentual Phrase in Jun & Fougeron, 1995, 2000, 2002), larger than a word and smaller than an ip. The tonal transcription would be the same when NP2 is focused except that NP2 receives the nuclear pitch accent and NP1 receives the pre-nuclear pitch accent. To save space, (6b) shows the tonal transcription for English only. Post-focus words, dephrased and deaccented, are underlined. An example pitch track of the Greek sentence in (4) produced with the 'focus NP1' condition is shown in Figure 4. NP1 (*ipi**re**ti*) gets the nuclear pitch accent, L+H* and is followed by a low plateau, labeled as L-L%.

(6) a. intonation transcription of languages when NP1 is focused:

(Someone shot the SERVANT <u>of the actress who was on the balcony</u>)

English	H*	!H*	H*	L-	L%
Greek	L*+H	L*+H	L+H*	L-	L%
Spanish	L*+H	L*+!H	L+H*	L-	L%
French	(H*)	(H*)	(H*	L-	L%)

b. intonation transcription of English when NP2 is focused:

(Someone shot the servant of the ACTRESS who was on the balcony)

English	H*	!H*	!H*	H*	L-	L%

Figure 4 here

Since focus deletes all prosodic boundaries after a focused word, there was no prosodic break before the RC whether focus was on NP1 or NP2, triggering a low attachment interpretation. Two out of five Spanish informants, however, did not show this phrasing pattern of focus. Instead of dephrasing after focus, they put a phrase break right after a focused word (thus low attachment for focusing NP1, i.e., **NP1$_{FOC}$** / NP2 + RC, and high attachment for focusing NP2, i.e., NP1 + **NP2$_{FOC}$** / RC). This again shows the same mapping between phrasing and attachment resolution. This suggests that, contrary to Schafer et al.'s (1996) claim, a focused head noun did not attract RC attachment. Instead, at least for those informants tested here, the existence of a prosodic boundary before a RC seems to be more important than the prominence in determining the attachment. It is possible though that the prominence of a word and a phrase boundary interact with each other in attachment resolution, and the ranking between the two could be language specific. More data are needed to confirm this.

3.2 Head-final languages

3.2.1 Default phrasing

The mapping between the prosodic phrasing and RC attachment resolution observed in the head-final languages was found to be similar to that in the head-initial languages

described in the previous section. Farsi, though verb final, is similar to head-initial languages with respect to the order of the head noun and the RC (i.e., NP1 'servant' + NP2 'actress' + RC). Three out of four Farsi informants preferred low attachment and produced no prosodic boundary before the RC, while one preferred high attachment and produced a prosodic boundary before the RC.

The word order of the head noun and the RC in Japanese and Korean is opposite (i.e., RC + NP2 'actress' + NP1 'servant'). (Though 'the actress' comes *before* 'the servant' in Japanese and Korean, I will call 'the actress' "NP2 'actress'" and 'the servant' "NP1 'servant'" to facilitate the cross-linguistic comparison.) In both Japanese and Korean, a prosodic break *after* the RC was mapped to high attachment (i.e., RC / NP2 'actress' + NP1 'servant') while a break after NP2 'actress' was mapped to low attachment (i.e., RC + NP2 'actress' / NP1 'servant'). Seven Japanese informants preferred high attachment and produced a prosodic break after the RC and no break between NP2 and NP1. For Korean, four out of five informants preferred high attachment, and one preferred low attachment. The informant who preferred low attachment produced a large prosodic break after NP2 'actress', but those who preferred high attachment produced a small phrase boundary (Accentual Phrase; see below) after every word, i.e., RC, NP2, NP1. A summary of the intonation system of Japanese and Korean and their default phrasing are given below.

According to Jun (1993, 1998) and Venditti (1997, to appear), both Korean (Seoul) and Japanese (Tokyo) have two prosodic constituents above the word. These are an Accentual Phrase (AP) and an Intonation Phrase (IP). An AP can have more than one

word, and an IP can have more than one AP. But these two languages differ in how these two units are marked, both in terms of tones and duration.

Korean does not have lexical stress or lexical pitch accent, and the AP in Korean is marked by a phrase initial rise and a phrase final rise, thus typically showing a LHLH tone pattern (or HHLH pattern) when there are at least four syllables in the phrase.[14] When there are fewer than four syllables, a simpler rising pattern is found, e.g., LH, LLH, or LHH. The phrase initial syllable is realized as H when the syllable begins with aspirated or tense consonants, but otherwise, as L (see Jun, 1996, 1998). Unlike the ip in English or Greek, the AP final syllable is not lengthened. The IP in Korean is marked similarly as in English and Greek: by tone (%), lengthening, and pause. Schafer & Jun (2002) found that the default phrasing of Korean is to produce one word in one AP.

The AP in Japanese is also marked by a phrase initial rise (H-) and a phrase final fall (L%). But unlike Korean, the AP can be accented or unaccented. An accented AP contains a word with lexical pitch accent realized as a sharp pitch fall (H*L) and an unaccented AP contains a word without lexical pitch accent, showing a slow falling pitch over the phrase. An accented AP is downstepped following another accented AP, but not after an unaccented AP. Since downstep is blocked across an IP boundary, no downstepped AP means the presence of an IP before the AP. As in Korean, the AP final is not lengthened, but IP final is typically lengthened and optionally followed by a pause. IP final is also marked by a boundary tone such as H%, LH%, and HL%.

Figure 5 shows a pitch track of Korean default phasing produced by an informant who preferred high attachment. Tones are transcribed according to Korean ToBI: an AP

initial rising tone is labeled as 'L' and '+H', and the final rising tone is labeled as 'L+' and 'Ha'. 'Ha' marks the end of an AP. The RC (*balkoni-einnun*), NP2 'actress' (*yobeu-e*), and NP1 'servant' (*pachulbu-lul*) each form separate APs.

Figure 5 here

When each word, RC, NP2, NP1, is separated by an AP boundary, informants preferred high attachment. This may be explained by Frazier's Relativized Relevance principle which claims that a RC is attached to a noun which is more central in the discourse, i.e., the object of the matrix verb, NP1 'servant' (Frazier, 1990). For this type of phrasing, Fodor (2002) predicted either neutral or low attachment due to syntactic locality. It is possible that Korean speakers may prefer low attachment following the locality principle if the task is on-line. But, at least for the off-line interpretation tested here, Korean informants preferred high attachment when there was no helpful prosodic cue indicating how the RC, NP2, and NP1 were grouped.

Figure 6 shows a pitch track of Japanese default phrasing produced by an informant who preferred high attachment, transcribed according to Japanese ToBI (Venditti, 1997, to appear). Each AP ends with L%, and an accented AP has H*L pitch accent. When an AP has no pitch accent (i.e., *joyuu-no* 'actress-gen'), H- phrase accent comes on the second mora of an AP. The RC (*barukoniiniiru*) is produced in one AP, and the next AP (including both NP2 and NP1) is not downstepped, suggesting the

[14] The AP in Korean is also the domain of segmental sandhi rules such as Post Obstruent Tensing (Jun 1998) and Lenis Stop Voicing (Jun, 1993). See Choi & Mazuka, this volume, for the role of AP in children's sentence processing.

existence of an IP boundary after the RC.[15] An IP boundary is marked by a break index '3' in the breaks tier (2 for AP boundary and 1 for a word boundary). The separation of the RC from the following noun, NP2 'actress', …(RC) / (NP2)(NP1)…, is linked to high attachment.

Figure 6 here

3.2.2 Pause

As mentioned in section 3.1.2, informants in all three languages behaved the same way. They preferred high attachment when there was a pause between the RC and the following NP (Japanese and Korean; RC / NP2 + NP1) or the preceding NP (Farsi; NP1 + NP2 / RC) and preferred low attachment when there was a pause between the two head nouns (i.e., no pause between the RC and the adjacent NP). This suggests that the informants, regardless of which language they speak, interpret the RC as modifying the adjacent NP in the same prosodic phrase, but modifying the head of the complex NP when there is no adjacent NP in the same prosodic phrase.

3.2.3 Focus

The prosodic realization of focus in head-initial languages, discussed in section 3.1.3, was to dephrase and/or deaccent a post-focus sequence. A similar realization of contrastive focus was found in Farsi. Words after the focused word were deaccented and dephrased up to a major syntactic juncture (i.e., between RC and the main verb) and the

[15] Here, the NP2 'actress' is an unaccented word, which often forms an AP with the following accented word (Kubozono, 1993; see Hirose, this volume). When the NP2 was an accented word (e.g., sense'i 'teacher'), the NP2 formed its own AP and the following AP (NP1 'servant') was downstepped. The IP boundary after the RC remained the same, i.e., no downstepping after the RC.

pitch was reset after the RC. Focusing NP1 generated low flat intonation with no prosodic break after NP1, i.e., no break before RC. The phrasing is shown in (7).

(7) Prosodic phrasing of Farsi when focusing NP1 and NP2

Yeki xedmatkare honarpisha-ro ke tu balkon bud tir zad
One servant-of actress-acc that in balcony was bullet hit

-> { H* L-L%} { }: focus NP1 'servant'

-> { H* L-L%} { }: focus NP2 'actress'

All the Farsi informants interpreted the utterance with NP2 'actress' focus as low attachment, probably because NP2 is adjacent to the RC in the same phrase. However, they did not agree on the attachment resolution for NP1 'servant' focus. One preferred low attachment, one preferred high attachment, and the other two could not decide. The informants did not seem to put a prosodic break after the focused NP1, as in Spanish. This suggests that the prominence of the focused word might have interfered with the effect of prosodic phrasing in determining the RC attachment in Farsi. With the prosodic phrasing, low attachment is expected (since NP2 is adjacent to the RC in the same phrase), but as in Schafer et al.'s (1996) study of English, the focused word may become the target of attachment since it is more central in the discourse (cf. Frazier's Relativized Relevance principle). Further research needs to be done to find out how focus in Farsi is realized and how focus interacts with attachment preferences.

Unlike Farsi or other languages discussed so far, focus creates a prosodic boundary in Japanese and Korean. In Korean, the most common way is to create a prosodic boundary (AP or IP) *before* the focused word and dephrase all following

prosodic boundaries up to a major syntactic boundary.[16] For Japanese, a prosodic boundary is created either before or after the focused word.[17] This difference in the prosodic realization of focus between Korean and Japanese and the difference among the speakers of Japanese can generate different phrasing of the sentence and thus influence attachment resolutions.

In Korean, when NP1 'servant' is focused, all five informants produced a prosodic boundary *before* NP1, and formed the preceding RC and NP2 'actress' one prosodic phrase (i.e,. RC + NP2 'actress' / **NP1$_{FOC}$** 'servant'), providing low attachment. When NP2 'actress' is focused, they produced a prosodic boundary *before* NP2 (i.e., RC / **NP2$_{FOC}$** 'actress' + NP1 'servant'), resulting in high attachment. Figure 7 shows an example pitch track of a Korean utterance when NP2 'actress' is focused. NP2 and the two following words (NP1 'servant' and the main verb) form one long AP with expanded pitch range on the word 'the actress' (*yobeu-e*).

Figure 7 here

In Japanese, two patterns of focus phrasing were found. When NP1 'servant' is focused, five out of seven informants produced a prosodic boundary *after* NP1, i.e., before the main verb. In this case, the NP2 'actress' and the NP1 'servant' formed one major prosodic phrase, IP, separated from the RC (i.e., RC / NP2 + **NP1$_{FOC}$** / Verb), leading to high attachment. When NP2 'actress' is focused, they produced the RC and

[16] Another way to produce focus in Korean is to keep the same phrasing as the default phrasing but to expand the pitch range of the focused word while substantially reducing the pitch range of the post-focus sequence, thus providing the effect of dephrasing.

NP2 in the same prosodic group, separated from NP1, resulting in low attachment (i.e., RC + **NP2$_{FOC}$** / NP1). The other two informants produced a boundary *before* NP1 as in Korean, and their attachment resolution was the same as that in Korean. An example pitch track of a Japanese utterance with a prosodic boundary coming *after* focused NP2 'actress' is shown in Figure 8. The final mora (genitive marker '-no') of NP2 'actress' (*joyuu-no*) is realized with H% boundary tone, marking focus on the host noun and an IP boundary after the word. An AP boundary is marked by 'L%' with a break index of '2', and an IP boundary is marked by 'L%' or 'H%' with a break index of '3'[18].

Figure 8 here

The results of the focus condition in Japanese and Korean suggest that what seems to determine attachment in these languages is prosodic phrasing, not prominence. For Korean, where a prosodic boundary comes *before* the focused word, the RC modified NP2 in the NP1 focus condition, but modified NP1 in the NP2 focus condition. For Japanese, there were two attachment patterns. When a prosodic break comes *after* the focused word, the RC modified NP2 in the NP2 focus condition but modified NP1 in the NP1 focus condition. The attachment here could be interpreted either as prosodic phrasing driven or prominence driven, but if we consider the other attachment pattern in Japanese (i.e., NP1 is modified in the NP2 focus condition when a prosodic break comes

[17] The two patterns are equally common but there is no known quantitative or statistical survey comparing the two patterns in terms of the frequency or conditions (Haruo Kubozono, personal communication).
[18] The break index '3' at the end of 'mesitsukai-o' could be labeled as '2m' (mismatch between tone and juncture) because there is an IP boundary tone, H%, but the degree of juncture is similar to '2'; there is no phrase final lengthening and no pitch reset after the phrase.

before the focused word, as in Korean), the attachment in Japanese also seems to be determined by prosodic phrasing.

4. Discussion and Conclusion

Though the data examined are very limited, the phonological phrasing observed across seven languages in five prosodic conditions suggest that phrasing is language specific and that the prosodic grouping, whether it is the default or triggered by pauses or focus, influences the attachment of a relative clause. For a complex noun phrase modified by a relative clause examined here, attachment of the relative clause seems to be determined by the presence or the absence of a prosodic boundary between the relative clause and the immediately adjacent noun phrase. That is, being grouped in the same prosodic unit seems to be the key to the local (low) attachment interpretation across languages. This appears to hold for both head-initial and head-final languages, and for languages with both relatively fixed and relatively free word order.

The prosodic grouping, however, should be evaluated relative to the strength of other prosodic boundaries in the utterance. A small prosodic boundary (such as an Intermediate Phrase in English and Greek or an Accentual Phrase in Japanese and Korean) would not be perceived as a boundary if there were a larger prosodic boundary nearby. The utterance in Japanese with focus on NP2 'actress', shown in Figure 8, was interpreted as having a low-attached RC. Here, the RC and NP2 'actress' were separated by an AP, but NP2 was separated from NP1 'servant' by an IP, a larger prosodic unit in Japanese prosodic hierarchy, i.e., {(RC)+(NP2)} {(NP1)}. Thus, though RC and NP2 'actress' were separated by an AP boundary, they were perceived as being in the 'same'

prosodic grouping, triggering low attachment. On the other hand, the phrasing of focus NP2 'actress' in Korean was (RC) (NP2+NP1), i.e., an AP boundary between RC and NP2 but no boundary between NP2 and NP1, triggering high attachment. In both examples, the prosodic boundary between the RC and NP2 was the same, an AP, but depending on the strength of the following prosodic boundary, the attachment interpretation changes (cf. Carlson, Cliftton, & Frazier, to appear).[19]

For the non-default prosodic conditions examined in the paper, the informants were asked to produce utterances with certain phrasing (i.e., pause conditions) or with certain meaning (i.e., focus conditions). Thus, their interpretation of RC attachment can be said to be influenced by the phrasing (and for a few speakers, by prominence). For the default condition, the results in the current paper do not provide direct evidence of whether the default phrasing in oral reading is the same as the prosodic structure projected by a speaker in silent reading or whether the phrasing influences the interpretation. But, given that the attachment tendencies of English, French, Spanish, and Japanese reported here closely match what has been reported in the literature based on silent reading, we can infer that speakers' prosodic structure in silent reading is similar to their default phrasing in oral reading, and their implicit prosody guides their parsing of RC attachment, supporting the Implicit Prosody Hypothesis.

However, connecting the attachment preference with the default phrasing for a language needs some clarification. As shown in the previous sections, speakers of the same language do not always have the same default phrasing of the same sentence. The default phrasing of a sentence differs across speakers depending on the speaker's

[19] This suggests that the RC attachment of NP2 focus at an early stage (before hearing the end of NP2) would be the same for both Japanese and Korean: low attachment. Then, the attachment will change to

previous experience, assumptions about the typical background of the sentence, and his/her general speaking habits including preferred speech rate. However, it is also not true that every speaker's default phrasing is different for a certain sentence. Rather, it is very often the case that one type of prosodic phrasing of a sentence is more common than other types across speakers. So, if the default phrasing of a language determines the attachment preference for that language, it would be the most common default phrasing among native speakers of that language which determines the attachment preference for that language. Thus, it is possible that the degree of attachment preference reported in the literature (e.g., about 60% high attachment in Spanish; Cuetos & Mitchell 1988) may reflect the percentage of native speakers producing the most common default phrasing. The most common default phrasing, which I call DEFAULT phrasing, is language specific, and seems to be responsible for different attachment preferences across languages.[20]

The challenging part of the DEFAULT phrasing proposal lies in the fact that DEFAULT phrasing itself changes, influenced by multiple factors. It is influenced by syntax, but the DEFAULT phrasing of the same syntactic structure changes depending on the semantic relation among the words; the location or the function of the phrase within a sentence; the length of the word, the phrase, and the sentence; and the speech rate.

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high for Korean speakers when hearing the NP1. An on-line parsing experiment could clarify this point.

[20] This view is similar to Mitchell and colleagues' tuning theory (Mitchell & Cuetos, 1991; Mitchell, Cuetos, Corley, & Brysbaert, 1995) which claims that the RC attachment is guided by the speaker's previous exposure to unambiguous attachments, in that both views consider individual speakers' experience in determining the attachment preference. But, the DEFAULT phrasing view differs from the tuning theory because the latter relies on structural principles for RC attachment and the former relies on prosody. Since syntax affects prosody, it is possible that the most common default phrasing is influenced by individual speakers' default (more exposed) syntactic structure. But as discussed in the next paragraphs, prosodic phrasing is also influenced by semantic and pragmatic factors as well as by length and rate factors. Thus, the DEFAULT phrasing view could account for more variations in the attachment preference within a language as well as across languages.

Sentences of the same syntactic structure with the same semantic weight (same old/new information and same focus structure) can still be phrased differently depending on the length of a word or a phrase. This is a rhythmic constraint on phrasing. In general, prosodic units tend to have equal length. Thus, sentences, when not short, in general are phrased in two prosodic units (Gee & Grosjean, 1983), but if a prosodic boundary triggered by some factor comes at one third of a sentence, it is likely to have another prosodic boundary at two thirds of the sentence. Furthermore, each prosodic unit is formed so that it is not too short, nor too long. APs in Korean shorter than 3 syllables or longer than 6 syllables are less common (Kim et al., 1997). In Japanese, two or three APs in general form one IP. If there are four APs, they arrange to form two IPs (Kubozono, 1993; Inoue & Fodor, 1995; Hirose, 1999). Inoue and Fodor (1995) found that, for a Japanese phrase corresponding to 'kind student's sister', 'kind' often modifies 'student', but for a longer modifier as in 'extremely kind student's sister', 'kind' modifies 'sister' more often than 'student'. They maintain that this shift is due to the change in prosodic phrasing: {kind student's sister} vs. {extremely kind}{student's sister}. Similarly, studies on sentence processing of several languages found a stronger tendency toward low attachment when the RC is short (e.g., *who cried*) than when it is mid-to-long (e.g., *who cried all through the night*) (e.g., Fernández & Bradley, 1999; Walter et al, 1999; Quinn et al., 2000; Lovrić et al., 2000; Pynte & Colonna, 2000; Fernández, 2000, forthcoming; see footnote 2 for more references). As discussed in Fodor (2002), the effect of RC length on attachment suggests that the length of the RC changes the prosodic phrasing, which, in turn, triggers a certain type of syntactic analysis.

DEFAULT phrasing is also influenced by the interaction between a rhythmic constraint and syntax. Data on Croatian (Lovrić et al., 2000, 2001) show that a prosodic boundary before the RC triggered by RC length (i.e., NP1 *od* NP2 / long RC) could disappear in the presence of the preposition *od*, which triggers a prosodic boundary before it, i.e., a syntactic constraint (i.e., NP1 / *od* NP2 long RC). This shows that a rhythmic constraint on phrasing is weaker than a syntactic constraint on phrasing (i.e., a long RC may attach low if a prosodic break triggered by syntax is maintained), but it also shows that a prosodic unit with only one word (i.e., *od* NP2) is not preferred, another rhythmic constraint. Hirose (1999, this volume) presents the role of prosodic phrasing in parsing where the phrasing is influenced by the constituent length more strongly than by the syntactic boundary. In a sentence fragment of Japanese, consisting of five or six words (i.e., single or double subject NP + object NP + adverb + verb + dative NP), a major prosodic boundary (IP) comes after a double subject NP, thus matching a syntactic boundary, i.e., Verb Phrase. But when the subject is a single NP, it comes after the object NP, violating a syntactic grouping but satisfying a rhythmic constraint. This major prosodic boundary was later used ("recycled" in her term) as a marker of the left edge of RC, thus facilitating the processing of a sentence where the RC begins after the double subject NP compared to a sentence where the RC begins after the single subject NP.

Hirose's phrasing data of a sentence fragment was achieved by telling subjects to read aloud without reading through the entire stimulus first, thus reflecting what could happen in on-line processing. The data in Kondo & Mazuka (1996) and Hirose (this volume) suggest that the domain of look-ahead is about one word in this type of reading. However, if the subjects were allowed to read the whole sentence, not just the beginning

of a sentence fragment, the default phrasing of the sentence might have been different. This is so because informal observations of Korean data show that the type of an anticipated prosodic boundary influences the phrasing of the preceding material. In Korean, when the 'RC+NP2+NP1' structure is followed by an IP boundary, the RC is more likely to be followed by an IP than when there is no IP after the NP1. This happens when the whole sentence is shown. If only the beginning two words, RC+NP2, are shown, this phrasing would not happen. A similar effect can be seen in manipulating the size and the location of segmentation of the stimulus input in sentence processing experiments. As discussed in the literature (e.g., Cuetos et al., 1996), the size and the location of segmentation seem to affect the attachment resolution, and prosody could be argued to be one of the main factors (see Fernández, forthcoming, section 2.4.1 for detailed discussion).

In sum, the default phrasing of an individual speaker reflects his or her attachment preference and the attachment preference of the languages reported in the literature can be predicted from the common default phrasing among the speakers in each language, suggesting that the DEFAULT phrasing reflects the attachment preference of the language. However, the default/DEFAULT phrasing is not fixed for all types of sentences. Even though it reflects a syntactic grouping, it is influenced by other factors such as the length of a phrase (rhythmic constraints), the interaction between syntax and the length, and the method of stimulus presentation and the degree of look-ahead. Further research is needed to investigate the interaction between prosody and other factors. Furthermore, prosody should be considered a major factor in sentence processing research, from experiment design to the interpretation of the data collected. Finally, since the observations reported

in this paper are based on the observed tendencies from only several informants in each language, further research is needed to determine if the tendencies hold across a wider set of items and greater number of speakers. It is hoped that this paper provides guidance for future research.

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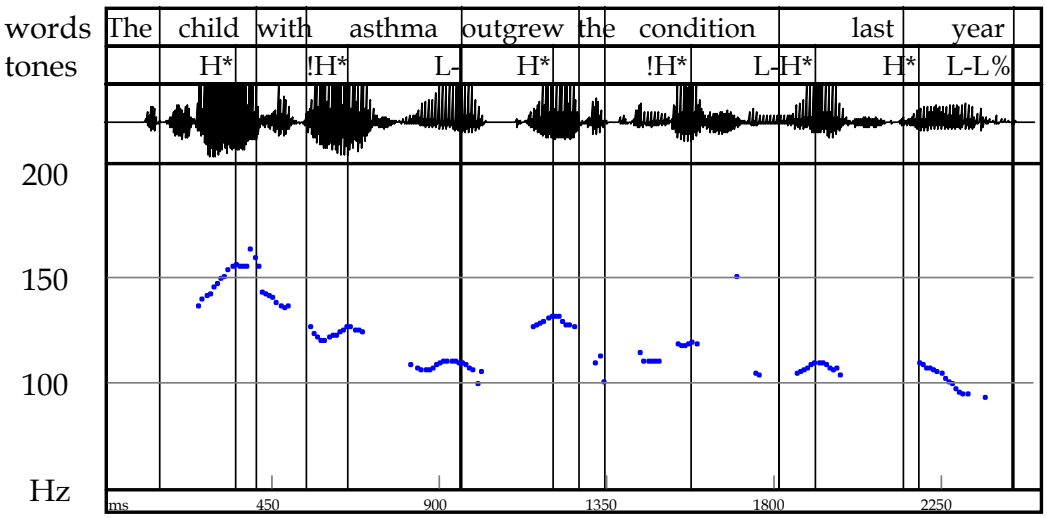

Figure 1. A pitch track of the sentence, 'The child with asthma outgrew the condition last year', transcribed using American Mainstream English (AME) ToBI. L- marks the end of an ip, and L% marks the end of an IP.

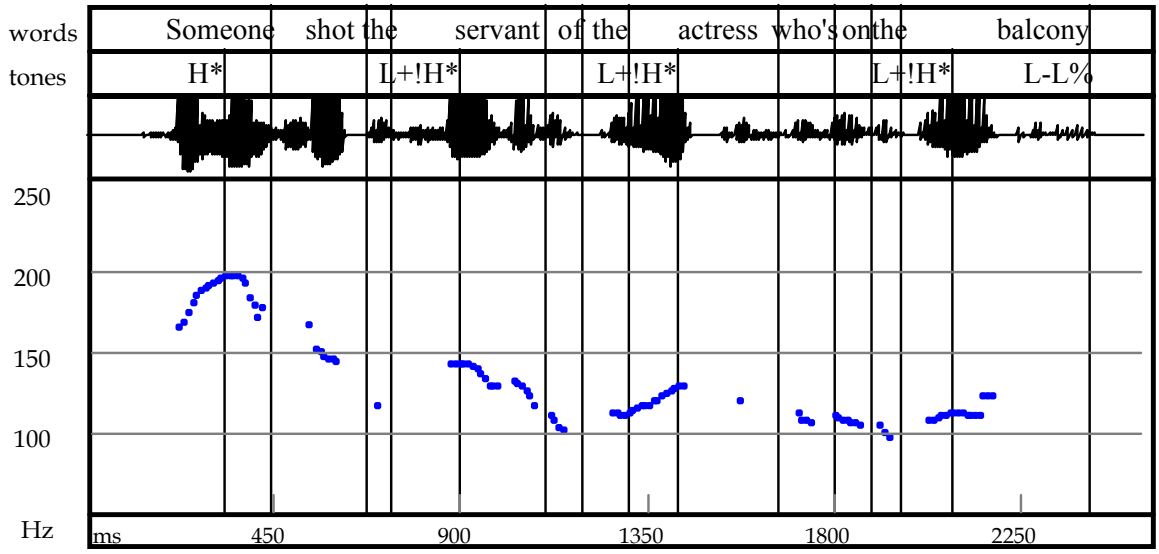

Figure 2. A pitch track of the English sentence (4) produced with the default phrasing. It shows no phrase boundary between NP2 (the actress) and the relative clause.

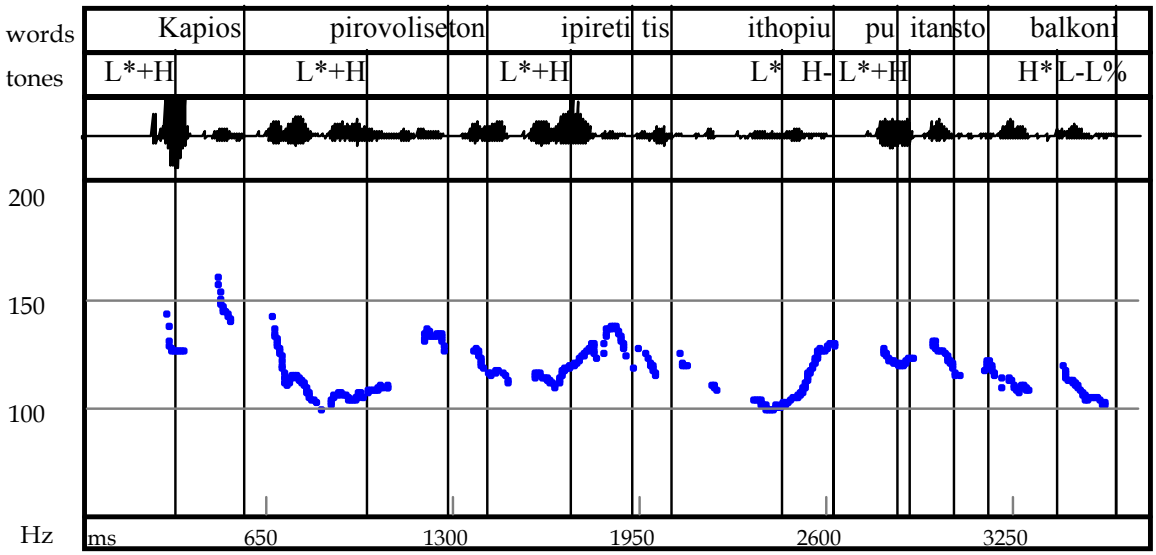

Figure 3a. A pitch track of the Greek sentence in (4) produced with the default phrasing of a speaker who prefers high attachment. The whole utterance forms two ips and one IP. The ip boundary comes before the RC (*pu itan sto balkoni*) and is marked by an H- boundary tone. Tones are transcribed based on Greek ToBI (Arvaniti & Baltazani, 2000, to appear).

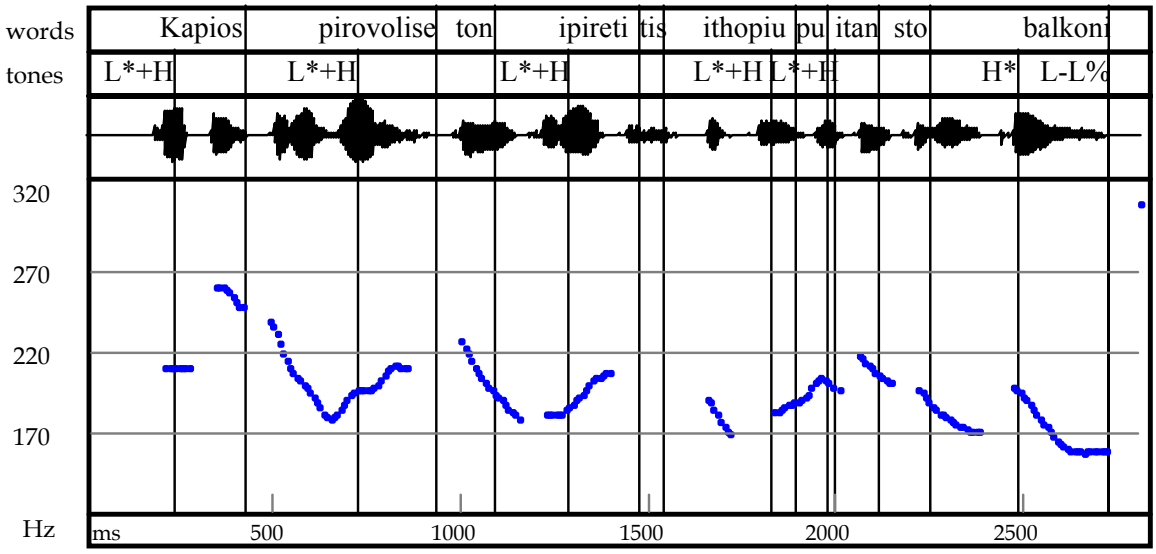

Fig. 3b. A pitch track of the Greek sentence in (4) produced with the default phrasing of a speaker who prefers low attachment. The whole utterance forms one ip and one IP, i.e., no prosodic break before the RC.

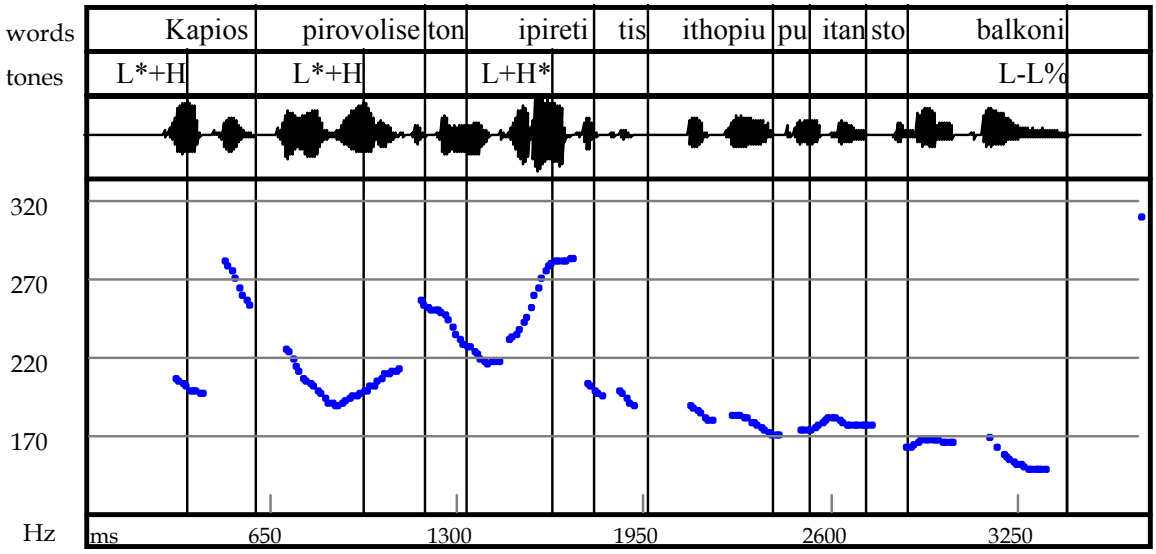

Figure 4. A pitch track of the Greek sentence produced with focus on NP1 'servant' (*ipereti*). NP2 (*ithopiu*) and RC (*pu itan … balkoni*) are deaccented and dephrased.

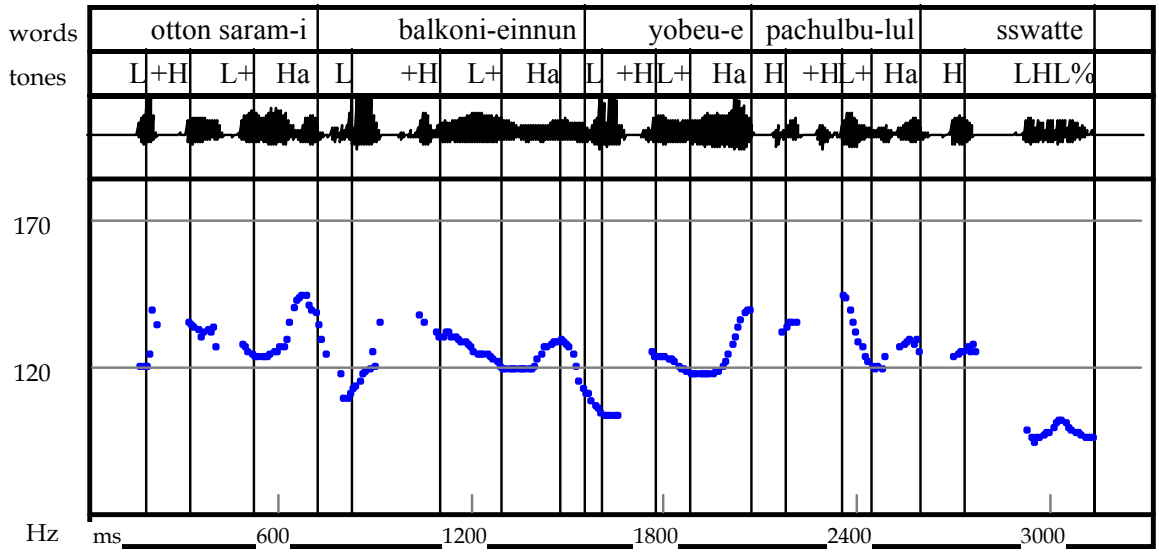

Figure 5. A pitch track of Korean default phrasing produced by an informant who preferred high attachment. The RC (*balkoni-einnun*), NP2 (*yobeu-e*), and NP1 (*pachulbu-lul*) each forms one AP. Tones are transcribed following Korean ToBI (Jun, 2000).

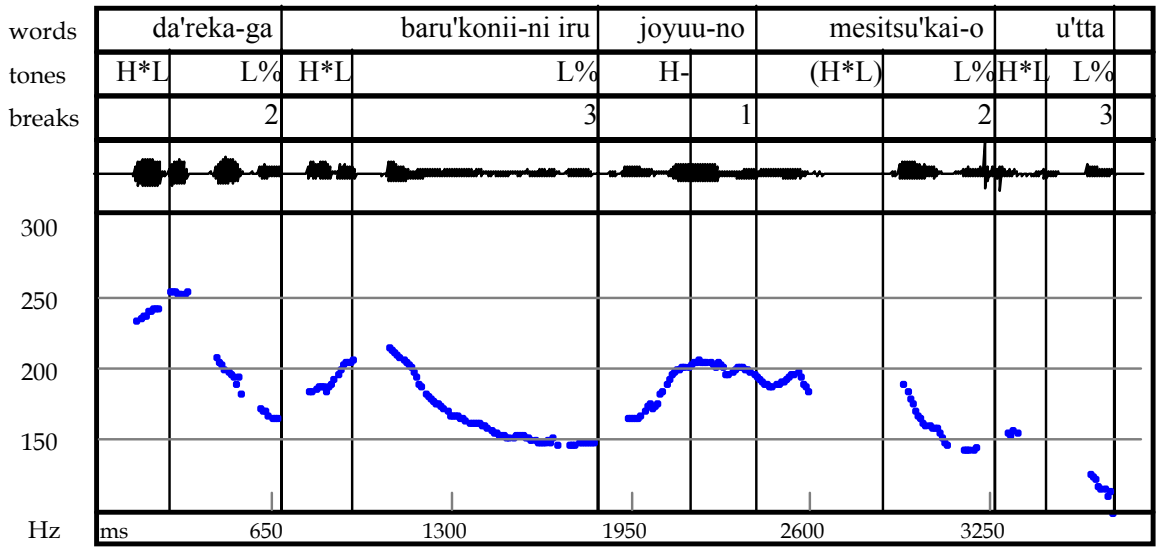

Figure 6. A pitch track of Japanese default phrasing produced by an informant who preferred high attachment. The RC forms one AP and the NP2 'actress' (*joyuu-no*) and NP1 'servant' (*mesitsu'kai-o*) form another AP, and these two are separated by an IP boundary (i.e., break 3). Tones and break index are transcribed using Japanese ToBI.

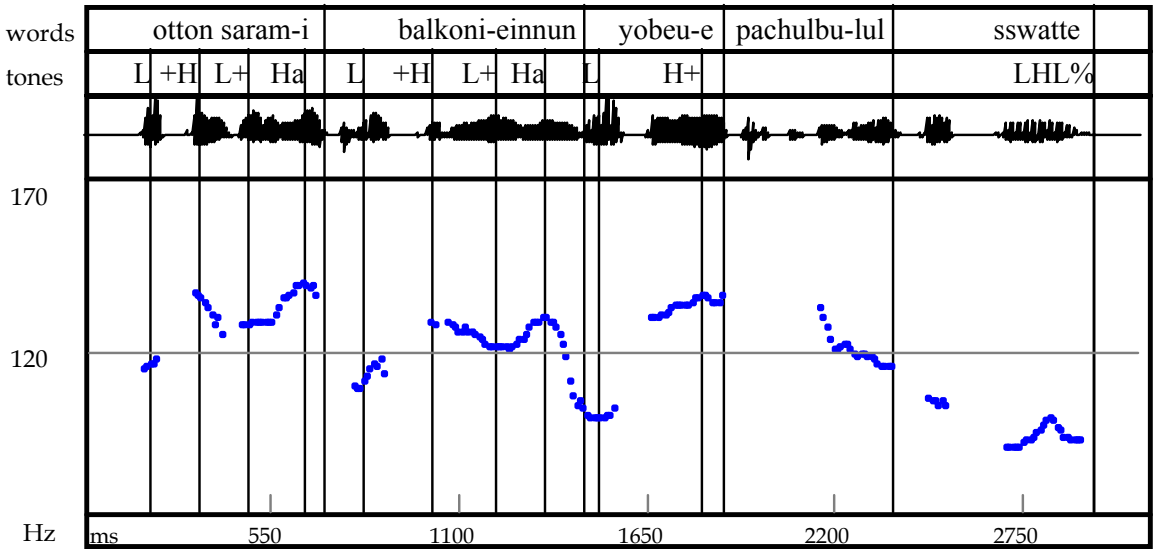

Figure 7. A pitch track of a Korean utterance when NP2 'actress' (*yobeu-e*) is focused. An AP boundary comes before NP2, i.e., after RC (*balkoni-einnun*), and the NP2 and the following two words (NP1 *pachulbu-lul* and main Verb *sswatte*) form one AP, providing the interpretation of high attachment.

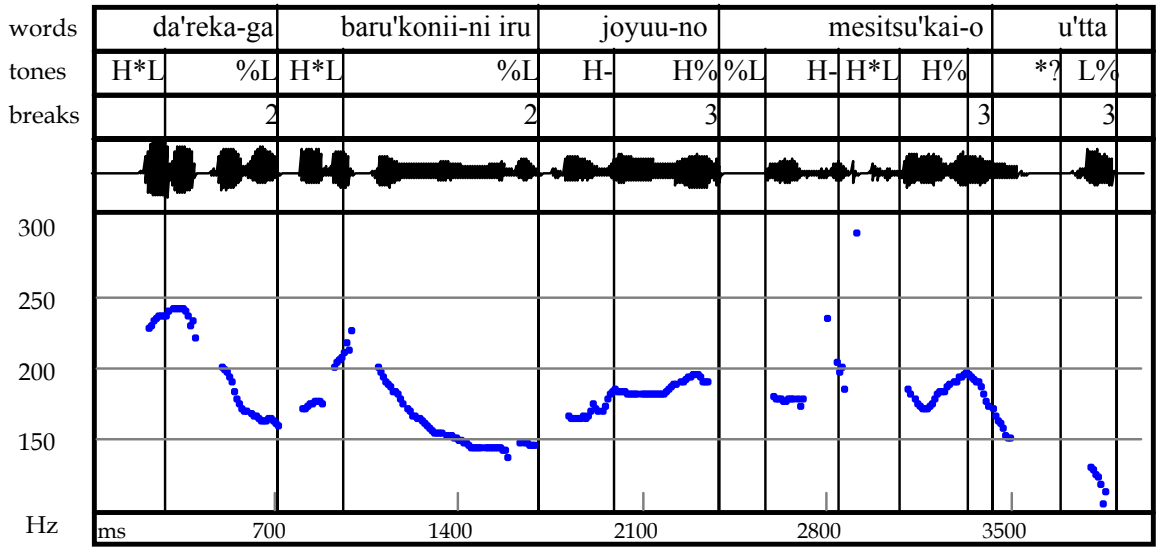

Figure 8. A pitch track of a Japanese utterance when NP2 'actress' (*joyuu-no*) is focused. The RC (*baru'konii-ni iru*) and NP2 'actress' each form one AP, but are separated from NP1 'servant' (*mesitsu'kai-o*) by an IP boundary (H%), rendering low attachment.