Default Prosody and Relative Clause Attachment in Japanese

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1. Introduction

Sentences with a complex noun phrase modified by a relative clause (e.g., 'Someone shot the servant of the actress who was on the balcony') can be ambiguous regarding the attachment of the relative clause (RC). The RC can modify the whole NP ('the servant of the actress', i.e. the servant), known as *high* attachment, or the NP immediately adjacent to the RC ('the actress'), known as *low* attachment. In English, speakers in general prefer low attachment (Carreiras & Clifton 1993, 1999; Fernández 2000, 2003), but this attachment preference 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). (See Fernández 2000, 2003, for more detail). 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), which hypothesizes that the human sentence processing mechanism is innate and universal. There have been several attempts to explain the cross-linguistic differences (e.g. Tuning, Two Factor Model, Construal, Attachment-Binding, and Implicit Prosody), and this paper focuses on the Implicit Prosody Hypothesis (IPH) proposed by Fodor (1998, 2002).

The IPH states that a default prosodic contour projected in silent reading favors the syntactic analysis associated with the default prosody for the construction. Since languages differ in their prosody, attachment preferences would differ across languages. This hypothesis is supported by the effect of prosody on attachment resolution. Short RCs tend to attach low and long RCs tend to attach high. Maynell (1999) and Lovri´c et al. (2000, 2001) found that speakers interpret a prosodic break before an RC (in a sequence of NP1 NP2 RC) as a marker of a stronger syntactic boundary, which prompts high attachment (i.e. RC modifying NP1). This suggests that speakers of a language with high attachment preference would tend to produce a prosodic boundary between the RC and the adjacent noun in the default phrasing of a sentence, but not between the two nouns (i.e. NP1 and NP2).

The current study investigates the validity of the IPH in production and perception experiments on Japanese data. In the production experiment, we examine how Japanese speakers, known to prefer high attachment (Kamide & Mitchell 1997), produce the prosodic phrasing of a sentence, especially the default prosodic pattern of a complex noun phrase preceded by an RC. (In Japanese, the word order is the opposite of that in English. In this paper, following the word order in Japanese, we will label the target structure as 'RC NP1 NP2' where NP1 is the noun corresponding to 'the actress' and NP2 is the head noun corresponding to 'the servant' in the English example above. In Japanese, NP1 is followed by the genitive particle *-no*, corresponding to the 'NP1's NP2' structure in English.) The IPH would predict that Japanese speakers produce a larger prosodic break between RC and NP1 than between NP1 and NP2. In the perception experiment, which is preformed about three weeks later, we examine the interpretation (i.e. RC attachment) of the same sentences used in the production experiment by the same subjects who participated in the production experiment. For the target sentences used in both experiments, we changed the length and the accentedness of each RC, NP1, and NP2 as well as the location of the target phrase in a sentence to see if the default phrasing of the target phrase changes depending on these factors, and if so, whether the changed default phrasing is reflected in the speakers' interpretation of RC attachment.

2. Method

2.1. Subjects

Thirty speakers of Tokyo Japanese participated in both the production and the perception experiment. Subjects were randomly divided into two groups (15 speakers each): Group 1 (skimming) and Group 2 (non-skimming).

2.2. Material

Twenty-four sentences were created with six different combinations of accent types for RC, NP1, and NP2, and within each accent type, there were four combinations of length types for RC, NP1, and NP2. Table 1 shows these six types of accents and four types of length combinations. Two combinations of accent, UAU and UUU, were not included since these did not seem to differ from UAA and UUA, respectively, in terms of their influence in phrasing between RC and NP1. It is expected that the accentedness of RC and NP1 would affect the phrasing of the target phrase because it has been found in previous studies that an unaccented word is likely to form one prosodic group with the following word (e.g. Kubozono 1993; Venditti and van Santen 2000).

Factors	Type	RC	NP1	NP2
Accent	AAA	Accented	Accented	Accented
	AAU	Accented	Accented	Unaccented
	AUA	Accented	Unaccented	Accented
	AUU	Accented	Unaccented	Unaccented
	UAA	Unaccented	Accented	Accented
	UUA	Unaccented	Unaccented	Accented
Length	ddd	Default	Default	Default
	ldd	Long	Default	Default
	sls	Short	Long	Short
	ssd	Short	Short	Default

Table 1. Types of Accent and Length of each phrase (RC, NP1, and NP2)

Length combinations were chosen focusing on the length of RC and NP1 so that each length combination may or may not trigger a prosodic break after an RC. For example, 'ldd' would more likely trigger a break after the RC than the default length, 'ddd', while 'ssd' or 'sls' would less likely trigger a break after the RC than 'ddd'. The 'default' length was defined as a 3-4 mora NP and a 7-8 mora RC; the 'short' length was

defined as a 1-2 mora NP and a shorter than 6 mora RC, and the 'long' length was defined as a longer than 6 mora NP and a longer than 10 mora RC. The 24 sentences varying in terms of accent types and length types were then located either at the beginning of a sentence (i.e. Sentence initial) or the middle of a sentence (i.e. Sentence medial), resulting in a total 48 target sentences. Example sentences of three types of the Accent-Length combinations are shown in (1). The target structure is italicized, and the location of Accent is shown with an apostrophe.

(1) a. AUA-ddd type; sentence medial
Senshuu Ta'roo wa *joyuu ni na'tta* *koohai no*
Last week Taro-TOP actress into to become-past *junior student-GEN*
one'esan ni guuzen a'tta.
older sister with accidently to meet-past
=> 'Last week Taro happened to meet *the older sister of the junior student who became an actress*.'

b. UAA-ldd; Sentence initial
Kookoo de oshiete-iru one'esan no fi'anse/fia'nse wa
high school at to teach-prog older sister-GEN fiancé-TOP
ryo'ori to karaoke ga shu'mi rashi'i.
cooking and karaoke-NOM hobby seem
=> '*The fiance of my older sister who is teaching at high school* seems to like cooking and karaoke as hobbies.'

c. AAU-ssd type; sentence medial
Yamamoto-kachoo wa *ji'ko de shinda* *bu'ka no*
Yamamoto-section chief-TOP *accident by to die-past subordinate-GEN*
musume-san to ichido denwa de hana'shita koto' ga a'ru.
daughter with once telephone on to have talked
=> 'The section chief Yamamoto had talked once on the phone with *the daughter of his subordinate who died in an accident*.'

2.3. Procedure

2.3.1. Production

The 48 target sentences were randomized together with 36 filler sentences, resulting in a total of 84 sentences. Subjects in Group 1 were instructed to read each sentence after briefly skimming the sentence, and subjects in Group 2 were instructed to read each sentence without skimming first. Each sentence was written on an index card in Japanese orthography, and speakers read each sentence two times in the sound booth at the UCLA Phonetics Lab. We varied the option of skimming vs. non-skimming in order to match closely the default prosody employed by native speakers in their silent reading during the off-line and on-line sentence processing experiment, respectively. Allowing time to skim the sentence before

reading and asking subjects to repeat each sentence two times allowed us to investigate how stable the default prosody was -- if there is any default prosody at all for each sentence or structure -- given the different amount of semantic information available to them before reading. All utterances were digitized using PitchWorks (*Scicon*), and the prosodic phrasing was determined by the intonation pattern of the utterance and the degree of juncture between words following the conventions described in Japanese ToBI (Pierrehumbert and Beckman 1988; Venditti 1995, in press; Maegawa et al. 2002)

2.3.2. Perception

The subjects who participated in the production experiment also participated in the perception experiment. Each subject was arranged to come back to the lab about 3 weeks after his/her production experiment. The perception experiment was an off-line questionnaire experiment. The questionnaire consisted of the 48 target sentences used in the production experiment randomized with 57 filler sentences. A comprehension question was added below each sentence (e.g., who was on the balcony?) and two choices were given as a possible answer (e.g. the actress, the servant). The questionnaire was displayed on a computer screen as an html file with each page listing 10 questions and only a forward button shown at the bottom of the page. Subjects were asked to mark an answer on a paper. The experiment took about 30 minutes.

3. Results

3.1. Production

The sequence of RC, NP1, and NP2 was phrased in many ways but grouped into three categories depending on the sub-grouping among the three phrases. The first category was RC//NP1-NP2 (a prosodic break between RC and NP1 and a grouping of NP1 and NP2), which we call 'early' boundary. This includes when the prosodic boundary is either an Intonation Phrase (IP) (i.e. $\{RC\}_{IP}\{NP1\text{-}NP2\}$) or an Accentual Phrase (AP), a phrase smaller than an IP and is defined by an initial rising tone (H-) and the lexical pitch accent (H*+L), if there is one (i.e. $\{RC\}_{AP}\{NP1\text{-}NP2\}$) (See Pierrehumbert and Beckman 1986 and Venditti 1995, in press, for more detail). An example pitch track of the latter is shown in Figure 1. The second category was RC-NP1//NP2 (a prosodic break between NP1 and NP2 and a grouping of RC and NP1), which we call 'late' boundary. Again, the prosodic boundary can be an IP or an AP, and a pitch track example of the AP boundary is shown in Figure 2. Finally, the third category was RC/NP1/NP2 (no sub-grouping among the three), which we call 'neutral' boundary. The third case included three types of phrasing: (1) when the

prosodic boundary was an IP, {RC}$_{IP}${NP1}$_{IP}${NP2}, (2) when it was an AP, {RC}$_{AP}${NP1}$_{AP}$ {NP2}, and (3) when all three phrases together formed one AP, {RC-NP1-NP2}$_{AP}$. A pitch track example of (2) is shown in Figure 3.

Table 2 shows the percentage of each category of default phrasing in the production of the structure RC NP1 NP2, both in sentence-initial (Initial) and sentence-medial (Medial) position of a sentence, separated by the Groups. Speakers in Group 1 and Group 2 produced different phrasing between the two repetitions, 17.8% and 20.8% of the time, respectively, suggesting that the default phrasing can, but not substantially, change across repetitions. Since the difference between each repetition within each Group does not differ significantly and since the first repetition of Group 2 (no skimming) includes more speech errors in general, the phrasing data from the second repetition of Group 2 were compared with those of the first repetition of Group 1.

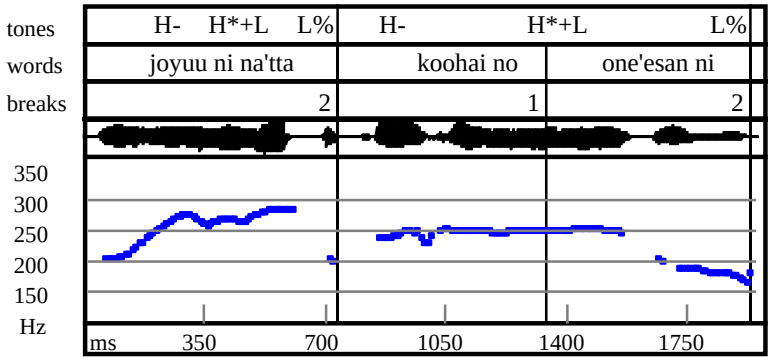

Figure 1. Pitch track of the RC-NP1-NP2 phrase of the sentence in (1a), produced in {RC}$_{AP}${NP1-NP2} phrasing.

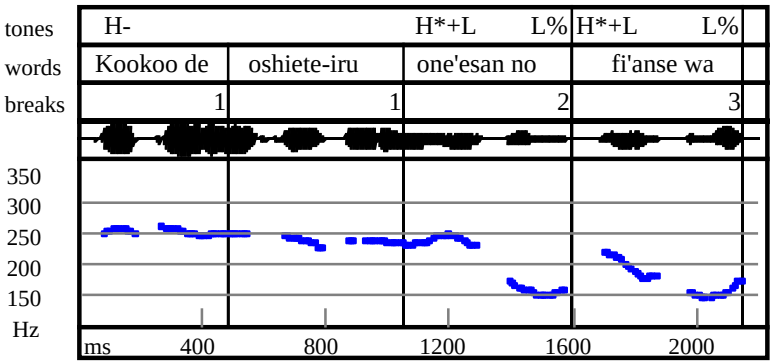

Figure 2. Pitch track of the RC-NP1-NP2 phrase of the sentence in (1b), produced in {RC-NP1}$_{AP}${NP2} phrasing.

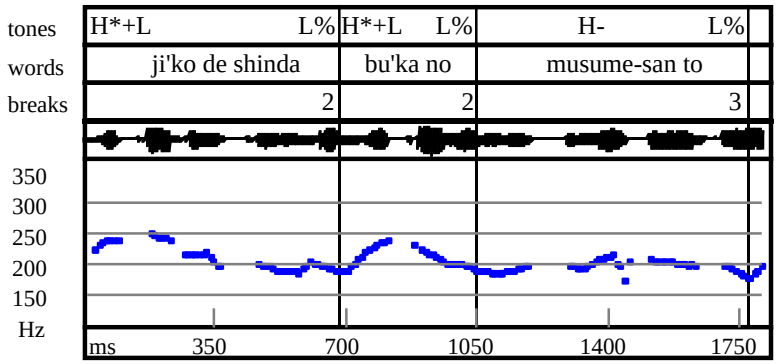

Figure 3. Pitch track of the RC-NP1-NP2 phrase of the sentence in (1c), produced in $\{RC\}_{AP}\{NP1\}_{AP}\{NP2\}$ phrasing.

Results show that, in both Groups, Japanese speakers produced 'early' boundary (RC//NP1-NP2) two thirds of the time (66~67%) and the 'late' boundary (RC-NP1//NP2) only 7~10%. For the rest (22~26%), no grouping was made. This result in itself would support Fodor's IPH because it predicts that the default phrasing of a high attachment language would place a prosodic break between the RC and the adjacent NP, i.e. RC//NP1-NP2.

	Location in S	RC//NP1-NP2	RC-NP1//NP2	RC/NP1/NP2
GR1	Medial	63.88%	10.0%	26.11%
	Initial	69.16%	4.44%	26.38%
	GR 1 Total	66.52%	7.22%	26.25%
GR2	Medial	65.55%	11.94%	22.5%
	Initial	70.0%	8.61%	21.38%
	GR 2 Total	67.77%	10.27%	21.94%
All	Total	67.15%	8.75%	24.09%

Table 2. Percentage of each boundary type of the target structure in each Group (Data for Total for each Group are based on 720 tokens and data for all are based on 1440 tokens).

Logistic Regression analyses show that there is a significant difference between Groups in production data (Chi-square=6.718, p=.0348). Group 1 (skimming) produced more cases of 'neutral' boundary and fewer 'late' boundary cases than Group 2 (non-skimming). Furthermore, there is a significant difference in the Location in Sentence for Group 1 (Chi-square= 8.653, p=.0132). Speakers produced more 'late' boundaries in sentence-medial than sentence–initial position. Speakers in both groups showed the

effect of Length (Gr1: Chi-square=35.434, p<.0001; Gr2: Chi-square= 16.629. p=.0107). Compared to the default length (=ddd), speakers produced more 'early' boundaries when the RC was long (=ldd) and fewer 'late' boundaries when RC was short (=ssd or sls). Finally, speakers in both groups showed the effect of Accent (Gr1: Chi-square=114.089, p<.0001; Gr2: Chi-square=149.575. p<.0001). Compared to the AAA type accent, they produced more 'early' boundaries when NP1 was unaccented (=AUU or AUA) and more 'late' boundaries when RC was unaccented (=UAA). The number of 'early' boundary tokens is, from the highest to the lowest: AUU (22.1%), AUA (20.8%), AAU (16.5%), UUA (16.4%), AAA (15.49%), and UAA (8.5%); data based on 967 tokens. This confirms the previous finding that an unaccented word tends to form one prosodic unit together with the following word (e.g. Kubozono 1993; Kondo & Mazuka 1996; Venditti & van Santen 2000; Hirose 2003).

The phrasing of the UAA pattern was very different from other Accent patterns. For all the phrasing data of UAA (240 tokens), 34.58% was 'early' boundary, 27.5% was 'late' boundary, and 37.9% was 'neutral' boundary. The number of 'early' boundaries for this accent pattern was lower than those of other Accent patterns, but the number of 'late' and 'neutral' boundaries was higher than those of others. This suggests that there is an interaction between the accent effect and the syntactic constraint on phrasing. Though a UA sequence often forms one prosodic group, in the UAA pattern where the RC is Unaccented and NP1 is Accented, a clause boundary between RC and NP1 seemed to prevent RC and NP1 from forming one prosodic grouping. The conflict between the accent factor and the syntactic constraint seemed to yield the highest percentage of the 'neutral' boundary for this Accent pattern.

3.2. Perception

Results show that Japanese speakers interpreted the RC as modifying NP2 66% of the time (when combining Group 1 and Group 2); that is, they prefer high attachment, confirming previous findings by Kamide and Mitchell (1997). Table 3 shows the percentage of low and high attachment within each Group and across Groups when the structure was located at the beginning of a sentence (Initial) and in the middle of a sentence (Med).

Logistic Regression analyses show that there is no significant difference between Groups (Chi-square=1.639, p=.2005). The effect of Location on perception was not significant in each Group, but the effect of Length was significant in Group 1 (Chi-square=8.645, p=.0344). The RC in ldd (long RC) was interpreted as high attachment more often than that in the default length (ddd). Finally, the effect of Accent was significant only in Group 2. The RC was interpreted as high attachment more often for AUA and AUU

compared to that for AAA. In sum, longer RCs in general generated more high attachment than shorter RCs, and a sequence of Accented RC and Unaccented NP1 generated more high attachment than other Accent types.

Location in S	Group1		Group2		Total	
	Low	High	Low	High	Low	High
Med	32.8%	67.2%	35.0%	65.0%	33.9%	66.1%
Initial	31.9%	68.1%	36.1%	63.8%	34.0%	66%
Total	32.4%	67.6%	35.5%	64.4%	33.9%	66%

Table 3. Percentage of Low and High attachment in each Group and Total (there were 720 tokens in each Group (= 24 sentences x 15 speakers x 2 Locations).

4. Discussion: Default Prosody and the Comparison between Perception and Production

As shown in Jun (2003), speakers in Japanese do not put a phrase break between a relative clause and a head noun when the head noun is a single noun. For example, the prosodic grouping of a sentence *John-ga neko-ni kamitsuita inu-o oikaketa* ('John-NOM cat-at bit dog-ACC chased'=> 'John chased the dog that bit the cat.') is {John-ga} {neko-ni kamitsita inu-o} {oikaketa}. The head noun *inu-o* 'the dog-ACC' forms one prosodic group with the preceding word, the verb of the relative clause. This may be due to a morpho-syntactic fact of Japanese that there is no complementizer marking the boundary of a relative clause. If there is a prosodic break after the verb *kamitsuita*, the verb could be interpreted as a sentence final verb, i.e., 'John bit the cat'. However, when the head noun is complex having the structure of NP1's NP2 as shown in the current experiment, speakers preferred to put a prosodic break after the relative clause, producing RC//NP1-NP2 phrasing. This suggests that the default phrasing changes depending on the internal structure of a sentence. It would be interesting to see if the prosodic phrasing and the interpretation change when the predicate of a relative clause is an adjective, not a verb.

The results from the production and perception experiment show that, though default phasing and interpretation of RC attachment change depending on factors such as Accent and Length, a majority of Japanese speakers produced a prosodic boundary after an RC and preferred high attachment of the RC. This seems to indicate that there is a good match between production and perception as predicted by the IPH.

If the IPH predicts a correlation between production (i.e. prosodic phrasing) and perception, the strongest claim of the IPH would be a perfect

match between production and perception. That is, a token produced as RC//NP1-NP2 would be perceived as high attachment, and a token produced as RC-NP1//NP2 would be perceived as low attachment. When individual tokens were examined, however, the match was not very good. Among the 75.9% where speakers produced a grouping (67.15% for RC//NP1-NP2 and 8.75% for RC-NP1//NP2; see Table 2), 63.1% showed matching (i.e. RC//NP1-NP2 with high attachment and RC-NP1//NP2 with low attachment) and 36.8% showed the opposite. When the structure did not show any sub-grouping (24%), subjects preferred high attachment 16.3% and low attachment 7.8%. That is, when there was no prosodic cue for either grouping, subjects preferred to attach the RC to NP2, i.e. the head of the noun phrase, the non-adjacent noun, which is not predicted by the Late Closure Hypothesis (Frazier & Fodor 1978, Frazier 1979). Instead, this may support Frazier's Relativized Relevance Principle (Frazier 1990) because the RC modifies the topic of the complex noun phrase, i.e. the head noun. Mismatch was also observed when we compared the effect of Accent on the production and the perception. The AUU type showed the highest frequency of the RC//NP1-NP2 pattern and the highest percentage of high attachment, thus showing the highest degree of matching (22.8%, 158 out of 691). However, the UAA type showed the lowest frequency of RC//NP1-NP2 while showing the second highest percentage of high attachment, thus showing the lowest degree of matching (11.7%, 81 out of 691).

Given that RC-NP1//NP2 was produced in only 8.75% of the data, a majority of the mismatch cases must have come from the tokens produced with the RC//NP1-NP2 phrasing interpreted as low attachment. At the same time, the higher matching cases could also be a by-product of the common default phrasing and high attachment preference in Japanese. In other words, there may not be a direct connection between the production and the perception of the same sentence token. Rather, the results seem to imply a group behavior as a whole. This view can be supported by the default phrasing patterns of individual speakers. We found that the pattern of default phrasing of the group as a whole was very similar to that of individual speakers, suggesting that there is default phrasing produced for a majority of the time by every speaker, and that this default phrasing is correlated with the attachment preference of the group. A given sentence was not always phrased the same way across all 30 speakers, but when we look at the 48 sentences as a whole, about 70% of them were produced with RC//NP1-NP2 phrasing by every speaker, about 20% of them with RC/NP1/NP2 phrasing, and about 10% of them with RC-NP1//NP2 phrasing. Out of 30 speakers, four did not show the similar ratio (i.e., the RC//NP1-NP2 pattern was 45-60% and the RC/NP1/NP2 pattern was 35-41%), but they still demonstrated a similar perception pattern as the rest of

the subjects. It seems that a direct mapping between production and perception of an individual subject is not a way to test the IPH. Instead, the data seem to suggest that there is a gross correlation or mapping between production and perception in a speech community.

In sum, current findings support Fodor's IPH in that there is a correlation between the prosodic pattern of a structure and the interpretation of the structure. But, the data do not show whether the default phrasing is the cause of the perception as claimed by the IPH. In order to generalize the current findings, the prosody of low attachment languages should be examined in a similar way.

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