The focus-independent effect of tonal proximity on the realization of lexical pitch accent in Tokyo Japanese and Bermeo Basque

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ABSTRACT

Tokyo Japanese (TJ) and the Northern Bizkaian dialects of Basque (NBB) are known to have similar pitch accent systems, and in both languages the focus status of words affects the prosodic phrasing. A cross-linguistic experiment was conducted to investigate whether the effect of tonal proximity on the phonetic realization of lexical pitch accent is conditioned by focus-related prosodic phrasing in TJ and Bermeo Basque (one NBB dialect). Acoustic analyses of the F0 traces of the experimental sentences revealed that a small inter-accent-interval (IAI) had two effects: It raised the valley between the two F0 peaks and pushed the second F0 peak rightwards. Although these effects were persistent regardless of the focus status of words in both languages, when the word's pitch range was reset in BB, IAI did not seem to affect the size of the accentual F0 rise. These results indicate that focus-related prosodic phrasing constrains the pitch movement between sequential accents, but it does not completely restrict the effect of tonal proximity on the realization of lexical pitch accents.

1. INTRODUCTION

Tokyo Japanese and Northern Bizkaian Basque have lexical pitch accent systems, which mark the prosodic prominence of words primarily with distinctive pitch movements over lexically accented segments instead of with syllable duration or vowel quality. Despite their historical and geographical separation, TJ and NBB share unique prosodic properties, which have been described in detail [1 2, 3, 4]. These previous works commonly point out that (1) both TJ and NBB have *accented* and *unaccented* words, which are distinguished by the presence or absence of a lexical pitch accent (denoted as H*+L in the ToBI framework [5]), and (2) the smallest prosodic unit called an accentual phrase (AP), is demarcated by an initial pitch rise (%LH-) and can contain at most one pitch accent in both languages.

In both TJ and NBB, APs are grouped into a larger prosodic unit called an *intermediate phrase* (iP). [6] define an iP as a domain of catathesis across APs in TJ, and this definition has been adopted in the analysis of Basque intonation [4, 7, 8]. Although iP boundaries often coincide with major syntactic boundaries, the pragmatic or informational status of words may also affect how APs are grouped into iPs. For example, when a word is under narrow contrastive focus, its pitch range is 'reset' and the focused word initiates a new iP. Thus, a TJ sentence such as *Másaya-ga kagí-o nakushitá-n-dayo* (Masaya-NOM key-ACC lost-COMP-EMPH 'Masaya lost the key.') may have one or two iPs depending on the location of the narrowly focused word, indicated in capital letters in (1).

(1) a. [MÁSAYA-ga kagí-o nakushitá-n-dayo]$_{iP1}$
'It was Masaya who lost the key.'

b. [Másaya-ga]$_{iP1}$ [KAGÍ-o nakushitá-n-dayo]$_{iP2}$
'It was the key that Masaya lost.'

The present study aims to investigate how such focus-related prosodic phrasing interacts with the effect of tonal proximity on the realization of lexical pitch accent in TJ and Bermeo Basque (BB). Previous studies on non-pitch accent languages have shown that tonal crowding causes retraction of the earlier accent. [9, 10, 11] showed that an upcoming phrasal boundary tone causes the pitch peak of nuclear accents to appear earlier in stressed syllables as compared to prenuclear accents. [12] illustrated that the number of postnuclear syllables also affects the size of tonal repulsion of the nuclear accent. [13] further demonstrated that the prenuclear accentual pitch peak tends to appear earlier in the presence of a close, upcoming nuclear accent. One could hypothesize that the phonetic realization of lexical pitch accents in TJ and BB is affected by tonal proximity in a manner similar to that in non-pitch accent languages. At the same time, such an effect of tonal proximity may be restricted within a prosodic unit such as an iP. For example, the distance between two lexical pitch accents may affect the height or location of an F0 peak or the magnitude of F0 movement for the accents when the two accented words are grouped into one iP, but not when an iP boundary separates them. If the distance between sequential accents, the inter-accent-interval (IAI), affects the phonetic properties of lexical pitch accents only within an iP, that may suggest a tight relationship between the pragmatically motivated prosodic phrasing and the execution of phonetic commands for lexical pitch accents. On the contrary, if the effect of IAI is observed across an iP boundary, one may conclude that the phonetic realization of sequential accents is controlled somewhat independently from prosodic phrasing.

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2. EXPERIMENT

In order to test the effect of IAI on the phonetic properties of sequential accents, three target phrases were prepared in TJ and BB. Each target phrase consisted of two accented words (W1 and W2), and there were either one, two, or three morae or syllables between the two accents (IAI= 1,2,3), as shown in (2).

(2) TJ target phrases		IAI
ha.dé.-na. mí.do.ri.-no	'loud green'	1
ha.dé.-na. ki.mí.do.ri-no	'loud lime green'	2
ha.dé.-na. fu.ka.mí.do.ri.-no	'loud dark green'	3

BB target phrases		IAI
Á.nan. má.llu.e	'Ana's hammer'	1
Á.nan. ja.ná.rri.je	'Ana's meal'	2
Á.nan. ar.kon.dá.ri.e	'Ana's shirt'	3

The experimental sentences were produced in two dialogue contexts: (a) broad focus over the two accented words, (b) narrow contrastive focus of the second word. (3) shows example questionprompts for the BB target IAI=1.

(3) a. Broad focus: BB IAI=1
Zér topaz u tallerran?
'What did you find in the garage?'

b. Narrow contrastive focus on W2: BB IAI=1
Tallerran Ánan zerrie topaz u?
'Did you find Ana's saw in the garage?'

Answer sentence: BB IAI=1
Ba/Ez, Ánan mállue topa dot.
'Yes/No, I found Ana's hammer.'

The experimental utterances were recorded with two male and two female TJ speakers (age 18-24) and one male and three female BB speakers (age 19-34).

Each of the six target dialogues (3 IAI conditions x 2 focus conditions) was recorded 12 times with each speaker. A stack of dialogue slips containing the experimental dialogues in a random order was given to the speaker so that s/he could read the context of each dialogue before the experimenter prompted the utterance by reading aloud the question. The utterances were recorded with a Tascam DA-P1 Digital Tape Recorder with a head-mounted microphone at the sampling rate of 48 KHz. These original utterances were then down-sampled at 16 KHz using Praat 4.0.5 [14].

For each target utterance, F0 values were measured at the peak in W1 (Peak 1), the lowest point or the valley between W1 and W2, and the peak in W2 (Peak 2). The locations of the accentual F0 peaks were also measured with respect to the offset of the lexically accented mora or syllable. All these measurements were done using Praat 4.0.5.

3. RESULTS

Both TJ and BB speakers produced expected intonational patterns for each focus condition. The most commonly observed F0 contours in the two focus conditions are represented in Figure 1. When W1 and W2 were under broad focus, Peak 2 was typically downstepped as in the upper panel of the figure. When W2 was under narrow contrastive focus, Peak 2 was often higher than Peak 1 as shown in the lower panel of the figure.

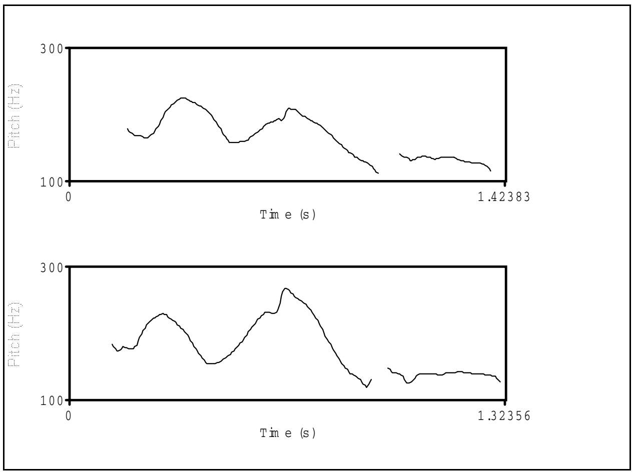

Figure 1: Typical F0 contours for broad focus utterances (upper panel) and the utterances with narrow contrastive focus on W2 (lower panel). These were produced by TJ Speaker 1 (IAI=1: *ha.dé.-na. mí.do.ri.-no*…).

3.1. IAI Effect on Valley

The results of F0 measurements showed an interesting similarity in the effect of IAI for TJ and BB. First, no speaker showed an effect of IAI on Peak 1. That is, the distance between the first and the second accent did not affect the height of earlier accentual peaks. However, a strong main effect of IAI on the valley between the two accents was found for all TJ and BB speakers. Table 1 shows the mean F0 valley in three IAI conditions and the results of ANOVA and posthoc pairwise comparisons.

TJ	Speaker 1	Speaker 2	Speaker 3	Speaker 4
IAI 1	167 (33.7)	253 (41.8)	113 (9.5)	284 (44.3)
Pairwise:(1)	<.01	<.01	.054	<.0005
IAI 2	157 (5.5)	230 (17.9)	108 (8.7)	250 (14)
Pairwise:(2)	.11	1.0	.155	.074
IAI 3	163 (4.7)	227 (17)	103 (8.2)	265 (12.2)
ANOVA *F* df=(2,69) *p*	7.1 <.01	9.63 <.0005	9.58 <.0005	13.1 <.0005

Table 1a: IAI effect on F0 valleys, and statistic results for TJ speakers. Pairwise (1) is a Bonferroni posthoc comparison between IAI=1 and IAI=2. Pairwise (2) is a posthoc comparison between IAI=2 and IAI=3. The ANOVA result for the main effect of focus is shown at the bottom of each table.

BB	Speaker 1	Speaker 2	Speaker 3	Speaker 4
IAI 1	189 (13.3)	208 (11.6)	97 (5.8)	198 (14.8)
Pairwise:(1)	<.0005	<.0005	<.0005	<.0005
IAI 2	171 (8.3)	195 (9.6)	89 (5.4)	183 (9.9)
Pairwise:(2)	1.0	1.0	1.0	.58
IAI 3	171 (14.8)	194 (11)	90 (7.4)	179 (14.1)
ANOVA F df=(2,69) *p*	25.91 <.0005	20.45 <.0005	17.34 <.0005	20.09 <.0005

Table 1b: IAI effect on F0 values of valley and statistic results in BB speakers. The statistical results are presented in the same manner as Table 1a.

In both TJ and BB, the mean F0 of the valley was highest for IAI=1. However, the IAI=3 valley was not lower than IAI=2. This indicates that a longer phonological distance between two sequential accents does not monotonically lead to a lower F0 for a valley between the accentual peaks. Further analysis showed that the IAI effect was present in both focus conditions across most TJ speakers at $p<.05$ (except for Speaker 2 $F_{W2}(2,33)=1.10$, $p=.35$) and across most BB speakers at $p<.01$ (except for Speaker 3: $F_{W2}(2,33)=1.72$, $p=.19$). Thus, the valley between the two lexical accents tended to be raised when IAI=1 even when W1 and W2 were separated by an iP boundary.

3.2. IAI Effect on Peak 2 Location

The measurement of the locations of accentual F0 peaks also revealed interesting similarities between TJ and BB. First, none of the speakers showed an effect of IAI on the location of Peak 1. On the other hand, both TJ and BB speakers showed an effect of IAI on the location of Peak 2, which tended to appear later with respect to the offset of the accented mora/syllable for smaller IAI. Table 2 summarizes the results of Peak 2 alignment.

The IAI effect was robust across TJ speakers who showed much later locations of Peak 2 when IAI=1 than when IAI=2 or 3. The IAI effect on Peak 2 alignment was somewhat weaker in BB, but all speakers showed the latest mean location of Peak 2 when IAI=1 while it was the earliest when IAI=3. Such an effect of IAI on Peak 2 alignment was consistently found in both focus conditions in TJ ($p<.01$), i.e., the location of the second accentual peak was affected by the distance between the two accents regardless of prosodic phrasing. In BB, two speakers showed a null effect of IAI in the broad focus condition (Speaker 1: $F_{broad}(2,33)=.27$, $p=.77$; Speaker 4: $F_{broad}(2,33)=2.61$, $p=.09$), but all speakers showed a significant IAI effect on Peak 2 alignment when W2 was under narrow contrastive focus ($p<.05$). Again, this finding suggests that an iP boundary between W1 and W2 does not prevent Peak 2 from protracting when IAI is very small.

TJ	Speaker 1	Speaker 2	Speaker 3	Speaker 4
IAI 1	55 (24)	108 (7)	46 (16)	88 (33)
Pairwise:(1)	.9	<.0005	<.0005	<.0005
IAI 2	46 (32)	71 (47)	11 (28)	46 (42)
Pairwise:(2)	<.0005	<.0005	<.0005	<.0005
IAI 3	2 (41)	31 (30)	-37 (24)	17 (35)
ANOVA *F* df=(2,69) *p*	26.18 <.0005	38.36 <.0005	117.75 <.0005	48.59 <.0005
BB	Speaker 1	Speaker 2	Speaker 3	Speaker 4
IAI 1	-39 (19)	8 (43)	-46 (21)	14 (31)
Pairwise:(1)	1.0	.71	.51	.178
IAI 2	-40 (27)	-2 (36)	-53 (29)	2 (32)
Pairwise:(2)	.11	<.0005	.066	<.0005
IAI 3	-50 (18)	-61 (24)	-58 (16)	-65 (11)
ANOVA F df=(2,69) *p*	2.83 .064	39.88 <.0005	2.74 .069	6.59 <.0005

Table 2: IAI effect on mean location (ms.) of Peak 2, and statistic results in TJ and BB speakers. The negative values indicate that the mean location of Peak 2 was earlier than the accented mora/syllable offset, i.e., Peak 2 was aligned within the accented mora/syllable. Positive values indicate that the peak appeared later than the accented mora/syllable.

3.3. IAI effect on F0 movement between Peak 1 & 2

In order to further test whether the effect of IAI on F0 movement between the two accents is restricted within an iP or persists across an iP boundary, the sizes of the F0 falls and rises between the two F0 peaks were calculated (Fall=Peak 1 to Valley; Rise= Valley to Peak 2), and the interaction between IAI and focus effects was tested for each measurement. Only one TJ speaker showed significant interaction between the two effects for Rise (Speaker 2: $F_{rise}(2,66)=5.90$, $p<.0005$). For this speaker, the effect of IAI on Rise was present only when W2 initiated a new iP ($F_{rise}(2,33)=9.62$, $p<.01$), but not when W1 and W2 were in the same iP ($F_{rise}(2,33)=1.98$, $p=.16$). Other speakers did not show an effect of IAI on Rise in either focus condition. For Fall, no TJ speaker showed significant interaction between IAI and focus effects. In fact, an IAI effect on the size of Fall was found across speakers (all $p<.05$) in both focus conditions (except for Speaker 2: $F_{W2}(2,33)=.99$, $p=.91$ and Speaker 4: $F_{W2}(2,33)=1.26$, $p=.30$). Thus in TJ, IAI primarily affected the size of the fall from Peak 1 to the Valley, but not the rise toward Peak 2, and this effect was relatively persistent across focus conditions.

In BB, only one speaker showed a reliable interaction between IAI and focus effects for the fall and rise (Speaker 3: $F_{fall}(2,66)=3.65$, $p<.05$; $F_{rise}(2,66)=9.23$, $p<.01$). For this speaker, the effect of IAI was present for both Fall and Rise

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when two words were under broad focus, i.e., when W1 and W2 were in the same iP ($F_{fall}(2,33)=10.98$, $p<.01$; $F_{rise}(2,33)=22.53$, $p<.01$), but not when W2 was under narrow contrastive focus and initiated a new iP ($F_{fall}(2,33)= 2.07$, $p=.14$; $F_{rise}(2,33)=.79$, $p=.46$). A significant effect of IAI on Fall was observed in both focus conditions across the other three BB speakers at p<.05 level (except for Speaker 2 $F_{broad\text{--}fall}(2,33)=1.78$, $p=.18$). Also, all BB speakers showed a significant IAI effect on Rise under the broad focus condition ($p<.01$). Interestingly, however, the IAI effect on Rise weakened or disappeared in all BB speakers when W2 was under narrow focus (Speaker 1: $F_{W2\text{-}risel}(2,33)=.80$, $p=.46$; Speaker 2 $F_{W2\text{-}risel}(2,33)=3.11$, $p=.06$; Speaker 3 $F_{W2\text{-}risel}(2,33)=.79$, $p=.46$; Speaker 4 $F_{W2\text{-}rise}(2,33)=1.87$, $p=.17$). Thus in BB, IAI tended to affect the size of the rise toward Peak 2 when W1 and W2 were in the same iP, but the distance between the two accents did not affect the size of the rise when pitch range was reset for a narrowly focused W2.

4. CONCLUSION

The above results demonstrate remarkable similarities and differences in the effects of tonal proximity between the two pitch accent languages. First, the close distance between the two lexical pitch accents raised the tonal valley between the two accentual F0 peaks in both languages, which may be straightforwardly interpreted as an undershooting of a low tone between APs. Second, the close distance between two sequential accents delayed the latter accentual F0 peak in both TJ and BB, in contrast to previously studied non-pitch accent languages in which tonal crowding led to repulsion of earlier accents. This seemingly interesting contrast in the resolution of tonal crowding between pitch accent languages and non-pitch accent languages may actually be attributed to the differences in the prosodic structures of experimental materials. In the present experiment, W2 was not in final position in an iP ending with a clear boundary tone. Although present findings may suggest a unique directionality of phonetic execution of lexical pitch accents, further investigation is required to determine the effect of boundary tones on the tonal alignment in pitch accent languages.

One important finding of the present study is that the above effects of tonal proximity are not restricted within iPs. That is, the tonal valley between sequential accents is raised and the latter accentual F0 peak is pushed rightward even when the word that carries the second accent initiates a new prosodic phrase. These results seem to suggest that phonetic realization of lexical pitch accents is controlled somehow independently of the pragmatic prosodic phrasing. However, attention should be paid to the fact that BB speakers showed no effect of IAI on the size of the rise for the second accent when its pitch range was 'reset'. In sum, the focus-related prosodic phrasing in TJ and BB seems to reset the size of F0 movement at an iP boundary, but it may not 'reset' the timing of tonal achievement across iP boundaries.

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