ACCENTUAL CONTRAST MAINTENANCE AND VOWEL DEVOICING IN TOKYO JAPANESE

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ABSTRACT
Pitch accent realization requires voicing. However, high vowels are sometimes devoiced even though the vowel carries a pitch accent in Tokyo Japanese. This devoicing, then, would obliterate the pitch accent were it not for other effects which preserve the accent information. Previous studies showed that there is either a pitch raising after the devoiced region or an accent shift to nearby moras in those cases. Two production experiments were conducted to see how various conditions, such as tonal context, boundary location, and syllabic environment, affect the pitch accent preservation. Results show that accent shift is strictly governed by the boundary and syllabic conditions but pitch raising does not always make up for the lack of accent shift. Accent location information is lost in such cases where neither pitch raising nor accent shift occurs. This suggests a relatively lower functional load of accentual contrast in Japanese.

2. EXPERIMENT 1
2.1 Method
Experiment 1 focuses on the effect of tonal context on pitch raising. The tonal description system based on [6] is adapted, in which pitch accent (H*L), phrasal tone (H), and boundary tone (L%) are the basic units for description. Figure 1 depicts the tonal context variation caused by the devoicing pattern and word length variation. When the last two moras of a 3-mora final accented word are consecutively devoiced, the phrasal high tone on the second mora cannot be realized (1a). It is realized only when devoicing is singly on the accented mora (1b). When the last two moras of a 3-mora word is devoiced, phrasal high tone cannot be realized (1c). However, it can be realized in a 4-mora word even though the devoicing is consecutive (1d).

Figure 1: (a) Consecutive devoicing, (b) single devoicing (c) 3-mora, (d) 4-mora. Gray italic H indicates the tone on a devoiced mora.

Two experiments were conducted to see how these conditions determine the occurrence of pitch raising and accent shift.

2.2 Results
F0 contours of the same word with different devoicing patterns are plotted in the upper panel in Figure 2. Singly devoiced tokens have a phrasal high tone realized on the penultimate mora, while consecutively devoiced tokens do not. This indicates that pitch raising only occurs when there is no realized phrasal high tone. The pitch after the devoiced region was significantly different between the two devoicing patterns across four speakers (Two-way ANOVA:
3. EXPERIMENT 2

3.1 Purpose

Experiment 2 is designed to (1) verify the occurrence of accent shift, (2) examine factors which might block accent shift, and (3) determine what happens if accent shift is blocked. In addition, based on the results from Experiment 1, tonal context of the devoiced accent is further varied in terms of the distance between the phrasal high tone and pitch accent.

Figure 3 depicts the structure of the material. When there is a boundary before the devoiced accented mora, accent shift to the left is not expected to occur. However, results in Experiment 1 suggest that pitch raising is suppressed after a realized phrasal high tone. Thus, the only option left in this case is a rightward accent shift. On the contrary, when there is a boundary after the devoiced accented mora, there is nothing to prevent the accent from shifting leftward. Pitch raising should still be blocked by the preceding phrasal high tone in this case.

We might also block accent shift by restricting the segmental make up of the words. The second mora in a heavy syllable, such as moraic nasal, first part of a geminate, and the latter half of a long vowel is not a legitimate tone bearing unit in Tokyo Japanese [McCawley:68]. Thus, we can expect that there is no accent shift when the devoiced accented mora occurs between a moraic nasal and a boundary.

In Experiment 1, the phrasal high tone was always adjacent to the pitch accent because the corpus did not contain enough long words. What if there are intervening moras and the tones are not adjacent at the moraic level? The distance between the phrasal H and H* is manipulated to answer this question.

3.2 Method

A corpus of 20 compound words was examined, half of which were control words with no devoiceable moras (Table 1). In order to control the boundary location with minimal difference in segmental material, [Jiken] ‘exam’ and [ken] ‘ticket’ right, area (all homophonous but different morpheme) were chosen for the second element of target compound words. All words have lexical or compound accent on the antepenultimate mora. Four words in the target set contain a moraic nasal right before the devoiceable accented mora in order to give the required syllabic environment for the blocking of accent shift. Word length was varied from 5 to 7 moras for the tonal distance condition.

Words were embedded in a fixed carrier sentence [WORD ga ari masu] ‘There is WORD.’ The speakers read each sentence a total of 12 times for target words and 6 times for control words in a randomized order. Four female speakers different from Experiment 1 participated. All speakers were from the Tokyo area ranging from 25 to 26 years in age. Digitization and measurements were done as in Experiment 1.

Two measurement points were extracted from the pitch contour and compared in the following analyses. F0
Table 1: Corpus for Experiment 2

<table>
<thead>
<tr>
<th>Dist between H &amp; H*</th>
<th>0</th>
<th>1</th>
<th>2</th>
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<td></td>
<td>L</td>
<td>%</td>
<td>H</td>
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<tr>
<td>Bnd before</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Dev</td>
<td>kari # jiken</td>
<td>hatsuruwa # jiken</td>
<td>somurie # jiken</td>
</tr>
<tr>
<td>Dev</td>
<td>provisional exam</td>
<td>pronunciation exam</td>
<td>exam for wine tasting</td>
</tr>
<tr>
<td>Ctrl</td>
<td>t'iri # d'siken</td>
<td>kimura # d'siken</td>
<td>kaedama # d'siken</td>
</tr>
<tr>
<td>Nas</td>
<td>hoN # jiken</td>
<td>hasoN # jiken</td>
<td></td>
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<td></td>
<td>final exam</td>
<td>destructive test</td>
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<tr>
<td>Bnd after</td>
<td>naN # d'giken</td>
<td>sumoN # d'giken</td>
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<td>No Dev</td>
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<td>difficult case</td>
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<td>Ctrl</td>
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<td>Dev</td>
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at the voicing offset and the voicing onset were those which were extracted to see the effect of accent shift and pitch raising respectively.

3.3 Results

Sample results from one speaker are shown in Figure 4. Pairs of devoiced and control words in the non-nasal condition are compared in each panel. The upper row shows the "boundary-before" condition where the word boundary is supposed to block the accent shift to the left and the realized phrasal H on the second mora of the phrase should block the pitch raising after the devoiced region. As expected, there is virtually no difference between devoiced and control words in F0 both at voicing offset and onset.

In "boundary-after" condition in the lower row, the expected result is the leftward accent shift since there is no boundary on the left side of the devoiced accented mora to block the accent shift. Pitch raising is not expected to occur in this condition either because of the realized phrasal H. However, the results show only a slight difference in F0 between devoiced and control words at the voicing offset point. The difference is not statistically significant in a 4-way ANOVA across all speakers. Although the main effect of devoicing is significant \((F(1,337) = 22.491, \ p < 0.01)\), the boundary condition and its interaction with devoicing has no significant effect at the voicing offset \((F(1,337) = 6.608\) and 3.810 respectively. Both are not significant after Scheffe's method for groupwise correction.) Results in moraic nasal condition are quite similar. There was basically no effect of pitch raising nor accent shift both in "boundary-before" and "boundary-after" conditions. Distance between phrasal H and H* has no major effect.

3.4 Discussion

Results in Experiment 2 show basically no effect of devoicing. Devoiced words have about the same pitch pattern as voiced control words. However, the fact that there is no pitch raising nor accent shift in devoiced words has a significant implication: the accent location information is lost in those words.
4. General Discussion

The results from two experiments suggest that speakers do not always compensate for the obliterated accent location by either pitch raising or accent shift. Multiple conditions such as boundary locations, tonal context, and syllable structure have to be satisfied for either one of them to occur. However, given that listeners can tolerate those devoiced words without explicit accent location marking, why do pitch raising still occur when conditions are met?

Devoiced moras are said to have shorter duration than voiced ones [3]. This might be considered as the reason for pitch raising after the devoiced region. Assuming that tones have some intrinsic duration, the pitch accent aligned to the devoiced mora may spill over to the following mora. However, that was not the case in the data obtained from Experiment 2.

Figure 5 shows the mean duration of the devoiced region in all “boundary-before” words compared with the corresponding region in the control words. That is, [fik] in [fiken] and [d3ik] in [d3iken] are compared for each speaker in Experiment 2. Two speakers indeed show that the devoiced mora (CV) is shorter than the corresponding voiced mora. However, the entire duration of the devoiced region (CVC) is marginally shorter than the corresponding part in control words (Two-way ANOVA: F(1,355) = 4.853, p = 0.28). Considering the small effect size (4 msec difference in means) with respect to the tonal alignment, the “spill-over” hypothesis cannot be supported.

A more likely situation is depicted in Figure 6. Taking a consecutively devoiced word as in Experiment 1 for example, the magnitude of the pitch range of the word with pitch raising (left panel) is enough for listeners to at least recover the accentedness. However, if there is no pitch raising in cases where the phraseal H is also devoiced, the magnitude of the pitch range is under represented and listeners cannot detect whether it is accented or not. Therefore, pitch raising may occur as the last resort to save the accentedness of the word.

ACKNOWLEDGEMENTS

Many thanks to Ken de Jong, Keiichi Tajima, Natsuya Yoshida and all the subjects participated in the experiments.

NOTES

1. Not all 12 speakers show consecutive devoicing including accented mora. Thus, the results reported in this paper about the difference between pitch contours are based on the 4 speakers who produced enough material for a systematic comparison. Other detailed results of Experiment 1 are reported elsewhere [2].

REFERENCES