

THE EFFECT OF EMPHATIC ACCENT ON CONTEXTUAL TONAL VARIATION

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ABSTRACT

The present study examines the effect of emphatic accent on different syllables in disyllabic words in order to learn more about the nature of contextual tonal variation. Comparisons among the three accent conditions suggest that the tone that receives the emphatic accent probably exerts stronger influence on the less emphasized tone than the other way around. A new carryover effect was also found with which a Tone 3 raises the final portion of a tone that follows it.

INTRODUCTION

Recently, Xu [1][2] found that F_0 contour of a tone in Mandarin is perturbed differently by the tone preceding it than by the tone following it. The influence of the preceding tone (carryover effect) is assimilatory: the beginning of the F_0 contour of a tone becomes similar to the ending pitch value of the preceding tone. The influence of the following tone (anticipatory effect) is mostly dissimilatory: the F_0 maximum of a tone dissimilates from the F_0 minimum of the following tone. It was also found that evidence of this kind of asymmetry could be seen in data reported in other studies on Mandarin [3] and on Thai [4]. In order to learn more about the nature of these contextual tonal variations, the present study examines how contextual tonal variation patterns may change under different emphatic accents in disyllabic words. The carryover assimilation effect is expected to be stronger when the first syllable in a disyllabic sequence receives emphatic accent. The anticipatory dissimilation effect, however, is expected to be either strengthened, kept the same, or reduced when the second syllable receives emphatic accent, depending on the nature of the mechanism that causes the dissimilation.

MATERIAL

Mandarin has five lexically stressed tones — tones 1 through 4 — whose

typical F_0 contours are high-level, mid-rising, low-dipping, and high-falling. There is also a lexically unstressed tone — the neutral tone or Tone 5 — whose actual F_0 contour has much greater dependence on the adjacent tones than the stressed tones. In connected speech, however, even the lexically stressed tones show extensive variation due to influence from adjacent tones (Shih [5], Xu [6]).

Following Xu [1][2], disyllabic sequence /mama/ with all sixteen possible combinations of the four lexically stressed tones were used as production material. Four male native speakers of Mandarin produced all those sequences in isolation. The sequences, all but one are nonwords, were printed in Chinese characters on the reading list. Subjects were requested to produce the sequences with emphasis on the first or the last syllable, or with no emphasis on either syllable. A prerecorded pacing tape was used to control the speaking rate. On the tape were groups of six beeps with intervals of three seconds. The speakers thus repeated each sequence six times, each repetition following a pacing beep.

F_0 CONTOUR EXTRACTION

The utterances were digitized at a sampling rate of 16 kHz. A program in a commercial signal analysis package (ESPS by Entropic Inc.) was used to label each vocal pulse in the utterances. The labeled signal files were then hand-edited to correct spurious labeling and to mark segment boundaries between /m/ and /a/. The edited files were further processed by locally developed computer programs to transform the distances between neighboring labels into F_0 values. The F_0 curves thus obtained were smoothed using a simple window function that eliminates any bumps or sharp edges greater than two Hertz. Average segmental duration across the repetitions was also computed. In order to visually examine the F_0 variations, the

F_0 contours were time-normalized within each of the two nasal and two vocalic segments, and then plotted in separate groups. Example plots are shown in Figure 1.

the middle panel shows them produced with emphasis on the second syllable; and the bottom panel shows them produced with emphasis on the first syllable.

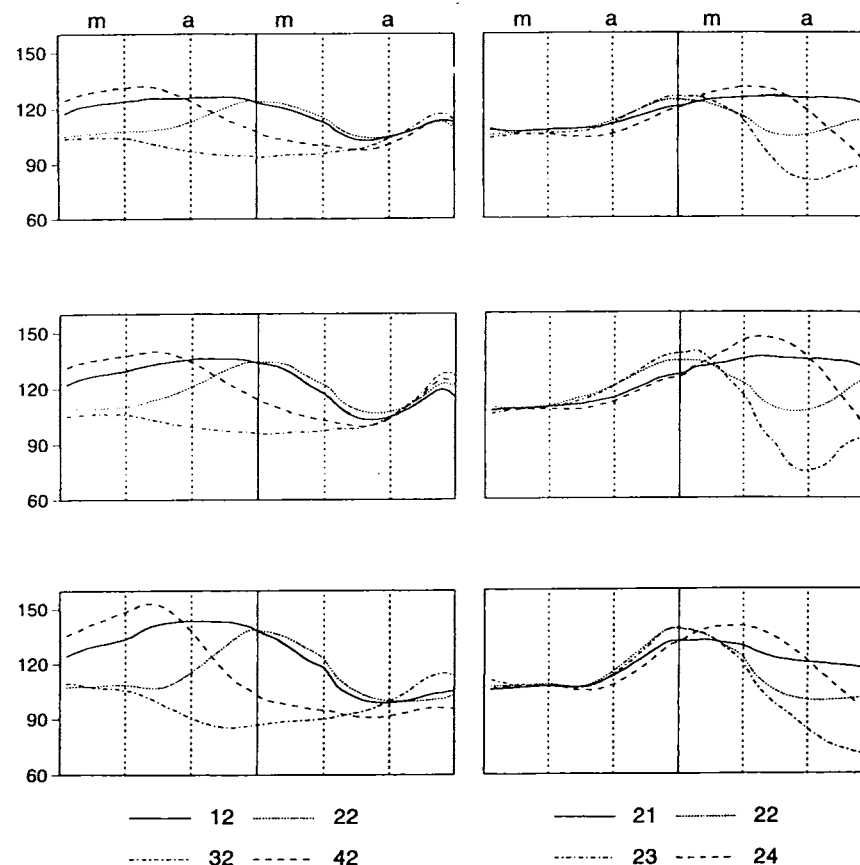


Figure 1. Time-normalized F_0 contours of Tone 2 when preceded (left) or followed by different tones. Those tonal combinations were produced with no particular emphasis (top), emphasis on the second syllable (middle), or emphasis on the first syllable (bottom).

ANALYSIS

In Figure 1, the carryover and anticipatory effects on a target tone are illustrated by the case of Tone 2. In the left column, Tone 2 is shown to be preceded by four different tones; the right column shows Tone 2 followed by four different tones. In each column, the top panel shows the ditonal sequences produced with no particular emphasis;

Carryover Effects

The most obvious carryover effect, as can be seen in Figure 1, is the assimilation of the starting F_0 value of the second syllable to the ending F_0 value of the first syllable. The tones in the first syllable end with distinct F_0 values, whereas the starting F_0 values of the same tone, here Tone 2, closely follow

the ending F_0 of the previous tone, resulting in a wide range of starting F_0 contours for the same tone. The differences caused by the preceding tone remain until about a quarter of the way into the vowel of the second syllable. A three factor (tone of syllable 1, tone of syllable 2, and emphasis pattern) ANOVA found the overall difference in F_0 caused by the tones of the first syllable to be highly significant at the beginning of the vocalic segment, $F(3, 9) = 29.8$, $p < .001$, and still significant by the end of the first quarter of the vocalic segment, $F(3, 9) = 5.9$, $p < .05$.

The effect of different emphasis conditions on the tone of the second syllable also can be seen in Figure 1. In general, the two conditions in which there is emphasis on one of the syllables show stronger influence on the initial portion of the F_0 contour of the second syllable. The effect is the strongest when the first syllable receives emphatic accent. An ANOVA test found interaction between the effect of the tone of the first syllable and the effect of emphasis on the beginning ($F(6, 18) = 9.52$, $p < .001$) and first quarter of the following tone ($F(6, 18) = 3.98$, $p < .05$).

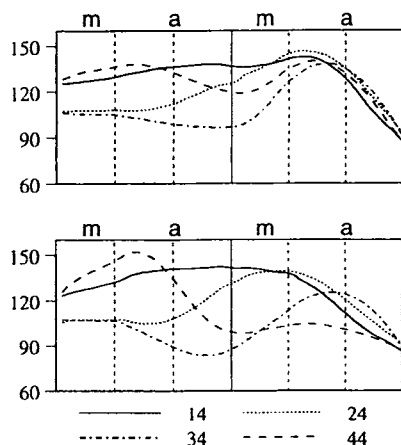


Figure 2. F_0 contours of Tone 4 preceded by four different tones. In the upper panel, the second syllable was emphasized; in the lower panel, the first syllable was emphasized.

There is a second kind of carryover

effect which has not been discussed before: Tone 3, the low tone, raises the F_0 value in certain portions of the following tone. This is a seemingly dissimilatory effect, because the ending F_0 value of Tone 3 is the lowest among all the tones. This raising effect is rather peculiar in that it is the strongest near the end of the following tone. In Figure 1, the final portion of Tone 2 is the highest when preceded by Tone 3 than by the other tones. A similar effect was also found on Tone 1. As shown in Figure 2, Tone 4, which has low ending F_0 , does not show a higher ending F_0 when preceded by Tone 3. Instead, there seems to be a delay effect so that the point of maximum F_0 in Tone 4 appears later when preceded by Tone 3 than by other tones. This phenomenon is the most obvious when the emphasis is on the first syllable. Considering the fact that the canonical form of Tone 3 has a final rise, it is likely that this final boost in the tones following Tone 3 is actually an alternative way of manifesting the canonical final rise in Tone 3, and would explain why an emphasis on the first syllable would produce the biggest raising effect. Interestingly, a re-examination of the F_0 data for one speaker reported by Shih [3] also found that Tone 2 had a higher ending F_0 when following Tone 3 than when following other tones.

Anticipatory Effect

The plots on the right in Figure 1 demonstrate the influence of a following tone on the preceding tone. First, there is a much smaller range of variation in a given tone when it is followed by different tones than when it is preceded by different tones. The only visible anticipatory effect in Figure 1 is dissimilatory: when the tone of the second syllable is Tone 2 or 3, both of which have low starting F_0 values, the maximal F_0 of the preceding Tone 2 is higher than in other two cases. A three factor ANOVA found this difference to be significant, $F(3, 9) = 7.84$, $p < .01$.

Comparison among the three emphasis conditions suggests that this kind of anticipatory dissimilation is strongest when the second syllable is emphasized. However, an overall ANOVA including the measurements from all four speakers

did not show a significant interaction between emphasis condition and the effect of preceding tone, whereas analysis of data on individual speakers did show significant interaction for each speaker. It seems that data from more speakers are needed to reach a more definitive conclusion on this effect.

DISCUSSION

While it is not surprising to see that a tone under emphatic accent exerts a stronger assimilation effect on the tone that follows it, it is quite interesting to see that the anticipatory dissimilation reported before was found to be well preserved and probably even boosted when the tone of the second syllable receives emphatic accent. The finding that the tone of the second syllable did not "spread" its initial pitch value leftward when it is under emphatic accent suggests either a) that the ending portion of the pitch contour of a tone is so important that it is not altered even when the emphasis is on the tone that follows it; or b) that the pitch value of the initial portion of a tone is totally undefined so that even an emphasis on that tone would not help it to impose any particular assimilatory influence on the preceding tone.

More interestingly, the raising of F_0 before a low tonal target does not seem to be unique to the East Asian tone languages. A similar phenomenon was also found in Yoruba, an African tone language [7][8]. Further investigation on the generality of this finding in other languages will be needed.

SUMMARY

Comparisons among the three accent conditions confirms that carryover assimilation is strongest when the first syllable is emphasized. However, a new effect is also observed when the first syllable is emphasized: Tone 3, which has the lowest minimum F_0 , exerts a dissimilation effect on the following tone, raising the final portion of its F_0 contour. As for the anticipatory effect, dissimilation is found in all three accent conditions, but the magnitude of the effect seems to be strongest when the second syllable receives accent. In short, for both carryover and anticipatory effects, the accented syllables seem to exert greater influence on the unaccented syllables than the other way around,

regardless of the nature of the influence.

ACKNOWLEDGMENT

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