The Stress Pattern and Its Acoustic Correlates in Beijing Mandarin

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1. Introduction

Chinese is a tone language, and it also has the feature of stress in syllable-groups (including words and phrases) and sentences. Phonemically, only three different degrees of stress are found: weak stress (i.e. neutral tone), normal stress and contrastive stress.

2. The perceptual result of normal stress

Actually, the syllables in syllable-groups that have neither neutral tone nor contrastive stress do not have the same degree of phonetic stress. The stress in such syllable-groups is defined as normal stress.

In our experiments, 103 two-syllable groups were pronounced with normal stress by ml and f1 and 154 three-syllable groups were spoken by m2 and f2. The normal stress in the speech sounds of the two-syllable groups and of the three-syllable groups was judged by 8 listeners and by 7 listeners (all phoneticians) respectively.

Figure 1 shows the probability distribution histogram on the perceptual result of normal stress in the two-syllable groups judged by 8 listeners. From Figure 1 we can see that in 103 two-syllable groups, there were 95 groups pronounced by ml and 92 groups done by f1 in which the second syllable was judged as having the normal stress by the great majority of 8 listeners.

8 students of linguistics were asked to pronounce the same two-syllable groups and judge normal stress of his or her own speech sounds. The perceptual results of normal stress are represented in Figure 2. Figures 1 and 2 identically demonstrate that the second syllable was judged by the great majority of the listeners as having normal stress.

Some scholars claimed that the contrast between the second syllable and the first syllable with normal stress does exist in such two-syllable groups like 「fortification」vs. 『offensive』, 『register』vs. 『report』, 『cock』vs. 『attack』, 『take a walk』vs. 『spread』, 『get angry』vs. 『vitality』. In order to verify this claim, we put these two-syllable groups into sentences. They were then pronounced by ml and f1. The results show that the second syllable was often judged as having normal stress by our informants. We conclude that in two-syllable groups, normal...
stress usually occurs on the second syllable. It is also the case that there is no such a two-syllable group in which the first syllable carries normal stress.

In three-syllable groups, normal stress is usually on the last syllable. Which is more stressed, the first syllable or the second one? The judgement is not consistent.

3. The acoustic data on normal stress

Figure 3 indicates the relative distribution of syllable duration in the two-syllable groups. There were 71 groups pronounced by m1 and 84 groups by f1 in which the duration of the second syllable was longer than that of the first one. Correlation coefficients of .82 for m1 and .80 for f1 were found between the normal stress and syllable duration.

Figure 4 shows the relative distribution of syllable duration in the three-
syllable groups. The duration in the great majority of the third syllables is longer than that of either the first one or the second one, not only for m2 but also for f2. It must be pointed out that the duration in the majority of the second syllables is longer than that of the first one.

The peak intensity in the second syllable in the great majority of the two-syllable groups or in the third syllable in the great majority of the three-syllable groups is not higher than that of the first one or the preceding ones. This can be seen in Figures 5 and 6.

The pitch contour of the last syllable in the two-syllable groups or in the three-syllable groups frequently approximates the tone pattern of the syllable in isolation. But there is a variation between the pitch contour of the first syllable in the two-syllable groups and that of the first two syllables in the three-syllable groups and their standard tone pattern. These facts are illustrated in Tables 1 and 2, in which the average pitch for each syllable is given.
From the above analysis, it is concluded that in a syllable group the last syllable is the syllable with the normal stress. The acoustic correlates of normal stress are given below: the pitch contour of the syllable with normal stress approximates its tone pattern in isolation; its duration is longer; as for peak intensity, it takes little part in normal stress.

4. The acoustic properties of neutral tone

The acoustic characteristics of neutral tone (cf. Lin and Yan, 1980) will be presented here briefly. A syllable with neutral tone loses the original tone pattern of the syllable, and the duration is shortened by an average of 50%, compared with the stressed syllable. When a syllable is pronounced with neutral tone, the tongue position of the main vowel more or less shifts toward that of the central vowel. But its peak intensity is not always decreased. These results come from the acoustic data of 29 minimal stress pairs, for example, 

- 'east and west' vs. 'thing', 'brothers' vs. 'younger brother', 'lotus seeds' vs. 'curtain', 'to burn' vs. 'baked wheaten', 'the philosopher Lao-zi' vs. 'a father' and 'main paints' vs. 'careless', etc. In each of these pairs, the three constituents (the initial, the final and the tone) of the first syllables are the same, but the second syllables, with identical initial and final constituents, can be

pronounced with normal stress or neutral tone. To mark a neutral tone, a dot has been placed before the Chinese character.

As for the contrastive stress, it implies that an emphasis is put on some syllable or syllable-group.
### Table 1. The average pitch* and its tone in two-syllable groups

<table>
<thead>
<tr>
<th>m speaker</th>
<th>the average pitch and its tone</th>
<th>tone arrangement</th>
<th>f speaker</th>
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<td>tone 4 + tone 4</td>
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* Pitch = fundamental frequency (Hz).
** The value on the five-point scale.
Table 2.1. The average pitch and its tone for tone 3 + tone 3 in three-syllable groups

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Table 2.2. The average pitch and its tone for tone 2 on the second syllable with tone 1 or tone 2 on the first syllable in three-syllable groups

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Table 2.3. The average pitch and its tone (excluding tone 3 + tone 3) in three-syllable groups

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