

A Phonetic Study of the Neutral Tone in Beijing Mandarin

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ABSTRACT

The study investigates the acoustical characteristics, F_0 , duration, and intensity, of the neutral tone in Beijing Mandarin. The neutral tone which is considered as the 5th tone besides the other 4 citation tones [55, 35, 214, 51] usually occurs on the non-initial component syllable of a compound. Results of the analysis show that the F_0 shape of the neutral tone is either level or falling and the F_0 level of the neutral tone varies to a greater extent, both depending on the type or the F_0 of the preceding citation tone. As for duration, on the bisyllabic words, the neutral tone is always shorter than the preceding citation tone, but on the trisyllabic words, the neutral tone may be similar to or longer than the neighboring citation tones. For both the bisyllabic and trisyllabic words, the intensity level of the neutral tone may not necessarily be lower than those of the citation tones.

1. INTRODUCTION

In Beijing Mandarin (BM, henceforth), a 5th tone or the neutral tone is discerned in addition to the four citation tones [55, 35, 214, 51]. According to Chao [1, 2], in BM, a small number of morphemes, such as suffixes and particles, are always in the neutral tone, and when a syllable is completely unstressed, its citation tone disappears and is said to be atonic or in the neutral tone. The pitch range of the neutral tone is described as being flattened to practically zero, so that it does not have a tone shape and a dot is used to indicate the pitch level only. The pitch level of the neutral tone varies, basically determined by the pitch value for the preceding tone. The neutral tone is considered to be associated with a unstressed syllable with a short duration. So, the neutral tone is called *qingsheng* ‘light tone’ in Mandarin Chinese. The description of the characteristics of the neutral tone in BM in Chao [1, 2], however, has not substantiated by any experimental data. This study is a phonetic investigation of the acoustical characteristics, including the fundamental frequency (F_0), intensity, and duration, of the neutral tone in BM.

2. METHOD

In this study, 20 bisyllabic and 32 trisyllabic words in BM, including compounds and word groups, were used as the test material in this study. The test words, bisyllabic and trisyllabic, are from the *Xiandai Hanyu Cidian* (‘A Word Dictionary of Modern Chinese’) [3]. Every test word chosen for this study contains a component syllable, enclitic or non-enclitic, which is associated with the neutral tone in BM. For the 20 bisyllabic test words, such as [çien⁵⁵ sən] ‘Mr.’, [xuan³⁵ kua] ‘cucumber’, [la²¹⁴ pa] ‘trumpet’, and [tʂaŋ⁵¹ fu] ‘husband’, the neutral tone occurs on the second component syllable. For one half of the 32 trisyllabic test words, such as [puo⁵⁵ li tʂ^huaŋ⁵⁵] ‘window’,

[p^hu³⁵ t^hau t^haŋ³⁵] ‘glucose’, [kuo²¹⁴ tsɿ tçiou²¹⁴] ‘fruit wine’, and [tou⁵¹ fu fan⁵¹] ‘bean curd rice’, the neutral tone occurs on the second component syllable. And, for the other half, such as [ʂu⁵⁵ tai⁵⁵ tsɿ] ‘bookworm’, [tʂ^haŋ³⁵ p^hau³⁵ tsɿ] ‘robe’, [çiau²¹⁴ xuo²¹⁴ tsɿ] ‘young man’, and [ta⁵¹ tu⁵¹ tsɿ] ‘big belly’, the neutral tone occurs on the third component syllable.

Three native BM speakers in their early twenties provided the speech data. Digital recording was performed in a sound-proof booth (IAC). The recorded speech data were analyzed, using Kay’s CSL speech analysis software. The neutral tone as well as the citation tones on the test words were analyzed for their F_0 contour and level, intensity, and duration, using the pitch synchronous F_0 and intensity tracing programs provided by the software. The duration of the tones was measured directly from the speech waveforms, with reference to synchronized wideband spectrograms, of the test words. In this study, the duration of the tone on a syllable is equal to the length of the rime of the syllable.

3. RESULTS

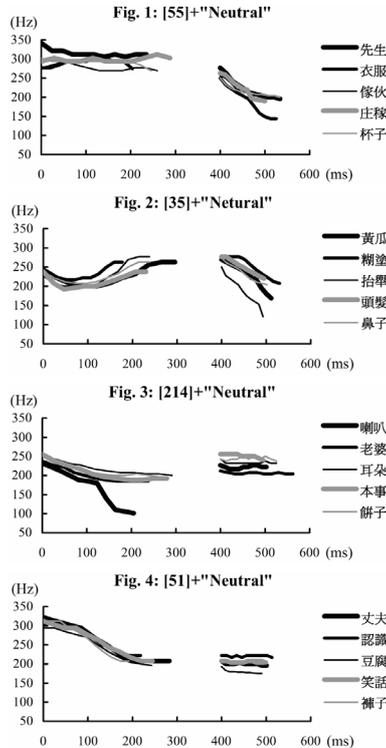
The acoustical characteristics, i.e., F_0 , duration, and intensity, of the neutral tone and the citation tones that occur on the component syllables of all the bisyllabic and trisyllabic test words are presented in the following paragraphs. Due to the space limit, only the speech data from one of the three speakers are presented. It is noted that the acoustical characteristics of the neutral tone for all the three speakers are similar.

3.1. F_0

Figures 1-4 show the F_0 contours of the tones on the 20 bisyllabic test words. Each figure contains 5 test words, for which the first component syllable is associated with the same citation tone [55], [35], [214], or [51] and the second component syllable with the neutral tone. As can be seen in the figures, the F_0 contour of the [55] tone on the first component syllable is ‘level’ and ‘high’. And, the F_0 contours of the [35], [214], and [51] tones on the first syllable are ‘mid-rising’, ‘mid-falling’, and ‘high-falling’, respectively. Thus, with the exception of the [214] tone, the F_0 contours of the other three citation tones are similar to the tone level and tone shape represented in the assigned tone letters. The ‘mid-falling’ F_0 contour for the citation tone [214] is in fact expected, as it has been reported that [214] has a variant [21] when it occurs on a component syllable of a bisyllabic or polysyllabic word ([1, 2]).

As for the neutral tone on the second component syllables, its F_0 contour is either ‘level’ or ‘falling’ and the F_0 level of the contour varies, both depending on the type and the F_0 level of the preceding citation tone. Relative to the F_0 level of the preceding citation tone, the F_0 contour of the neutral

tone may be characterized as ‘mid-falling’ after [55], ‘high-falling’ after [35], ‘mid-level’ after the variant [21] of [214], or ‘low-level’ after [51]. The data demonstrate that the pitch range of the neutral tone is not flattened to zero as reported in Chao [1, 2]. However, our data support Chao’s contention that the neutral tone does not have a fixed pitch pattern ([1, 2]). The F_0 value for the neutral tone is a variable, determined by the F_0 value for the preceding tone.



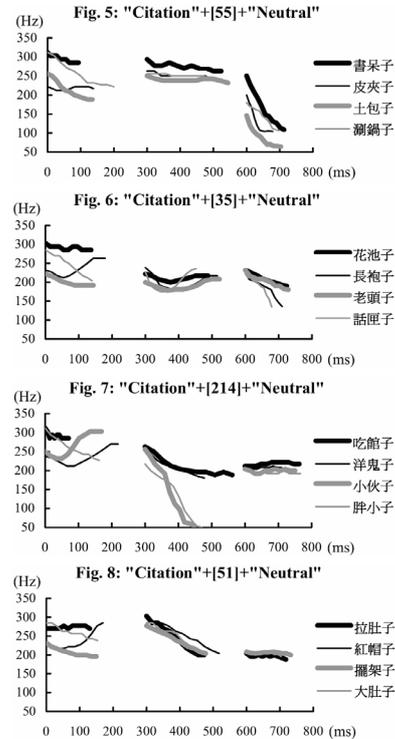
Figures 1-4: F_0 contours of the tones on the bisyllabic words with the neutral tone on the second component syllable.

Figures 5-8 show the F_0 contours of 16 trisyllabic words, for which the neutral tone occurs on the third component syllable, preceded by two citation tones. Figures 9-12 show the F_0 contours of another 16 trisyllabic words, for which the neutral tone occurs on the second component syllable, preceded and followed by a citation tone. Each of these figures contains four trisyllabic words, for which the neutral tone is immediately preceded by the same citation tone [55], [35], [214], or [51].

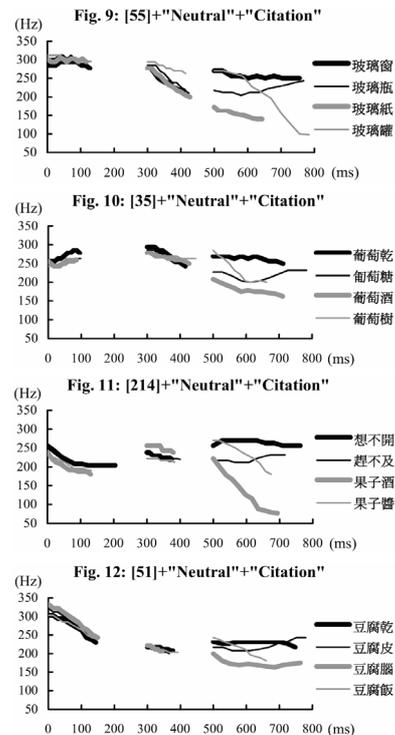
As shown in these figures, the F_0 contours of the four citation tones [55], [35], [214], and [51] on the first, second, or third component syllable of the trisyllabic words may be labeled as ‘high-level’, ‘mid-rising’, ‘mid-falling’, and ‘high-falling’, respectively. As for [214], it may also realize as an F_0 contour of ‘mid-rising’, when it is followed by another [214]. The ‘mid-rising’ variant, i.e., [35], is caused by the well-known tone sandhi rule in BM, i.e., [214]+[214] → [35]+[214] ([1, 2]).

As for the neutral tone, the F_0 contour on it is a variable. A number of F_0 contours materialize and they may be characterized as ‘mid-falling’, ‘high-falling’, ‘mid-level’, or ‘low-level’, depending on whether it is preceded by [55], [35], [21] (a variant of [214]), or [51], respectively. A ‘high-level’ F_0 contour is also identified for the neutral tone. Such an F_0 contour occurs only when the neutral tone is preceded by [55] or [35] and simultaneously followed by

[51]. This indicates that aside from the preceding tone, the following tone may also have an effect on the F_0 contour of the neutral tone. In a majority of cases, however, the F_0 contour of the neutral tone is determined by either the type or the F_0 of the preceding citation tone. Thus, the F_0 contour of the neutral tone varies as the tonal environment changes.



Figures 5-8: F_0 contours of the tones on the trisyllabic words with the neutral tone on the third component syllable.

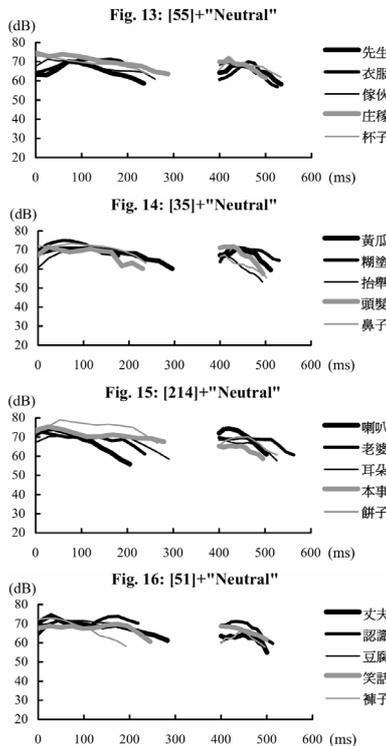


Figures 9-12: F_0 contours of the tones on the trisyllabic words with the neutral tone on the second component syllable.

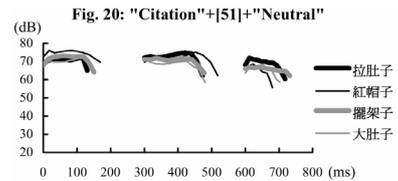
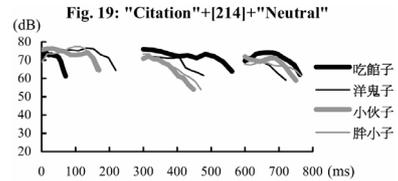
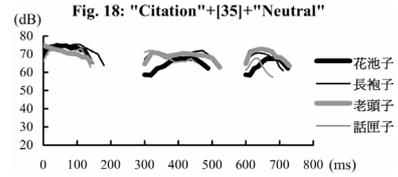
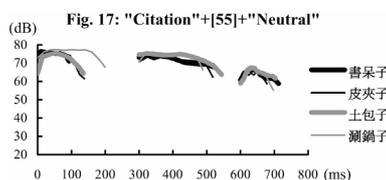
3.2. Intensity

Figures 13-24 show the intensity curves for the neutral tone and the citation tones on the 20 bisyllabic (Figures 13-16) and 32 trisyllabic (Figures 17-24) test words. As shown in the figures, the difference between the intensity levels for any one of the four citation tones and the neutral tone is not pronounced. In the cases where the neutral tone occurs on the final component syllable of a bisyllabic or trisyllabic word, the intensity levels for the neutral tone are only slightly lower than those for the citation tones. This may not be the case in which the neutral tone occurs on the medial component syllable of a trisyllabic word, where the intensity level for the neutral tone may be higher than that for a citation tone, especially when the citation tone occurs on the final component syllable of the trisyllabic word. This indicates that the intensity level varies according to the position of the component syllable in the word. The intensity level is lower for the component syllable that occurs in the word-final position.

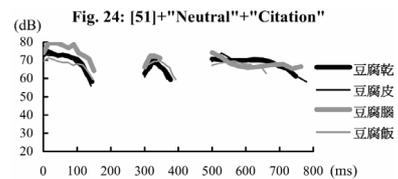
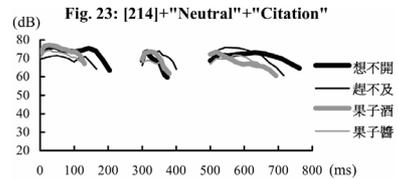
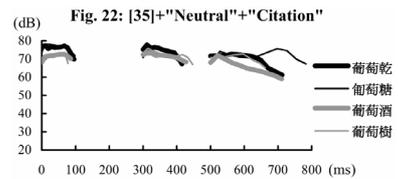
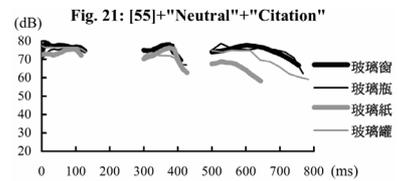
In any case, the intensity of the neutral tone may not necessarily be lower than that of a citation tone. Thus, the intensity for the neutral tone is not so weak as suggested in the Chinese word *qingsheng* meaning 'light tone', used to characterize the neutral tone as being low in loudness. That the neutral tone is perceived not so loud as the citation tones may be due to the fact that the duration of the intensity for the neutral tone is usually but not always shorter than those for its neighboring citation tones.



Figures 13-16: Intensity curves of the tones on the bisyllabic words with the neutral tone on the second component syllable.



Figures 17-20: Intensity curves of the tones on the trisyllabic words with the neutral tone on the third component syllable.



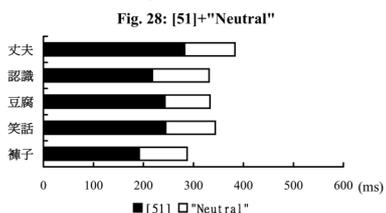
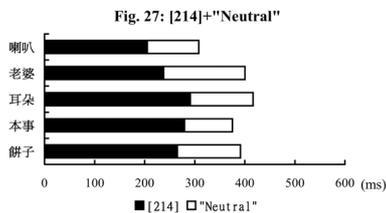
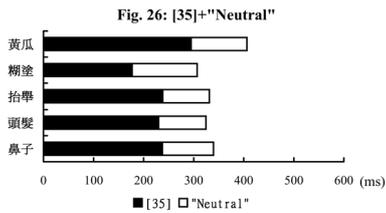
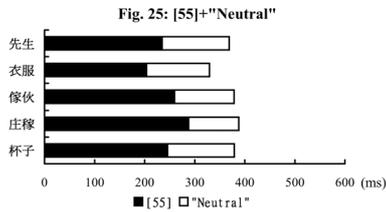
Figures 21-24: Intensity curves of the tones on the trisyllabic words with the neutral tone on the second component syllable.

3.3. Duration

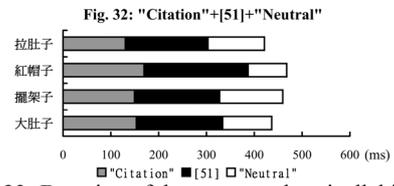
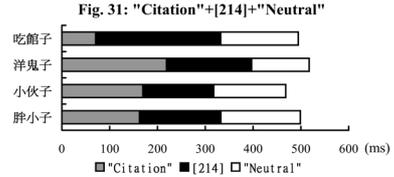
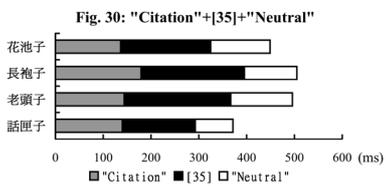
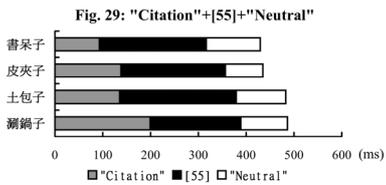
Figures 25-36 show the duration of the neutral tone as well as the citation tones on the 20 bisyllabic and 32 trisyllabic test words. In the figures, the black and gray bars represent the duration of the citation tones and the empty bar represents the duration of the neutral tone. As shown in Figures 25-28, on the bisyllabic words, the neutral tone is always shorter than the preceding citation tone, whether the citation tone is [55], [35], [214], or [51]. The duration of the neutral tone ranges from 100-120 ms, while the duration of all the four citation tones is approximately 240 ms.

As for the trisyllabic words (Figures 29-36), the duration of the neutral tone may not necessarily be shorter than the duration of the citation tones. On the trisyllabic words, the

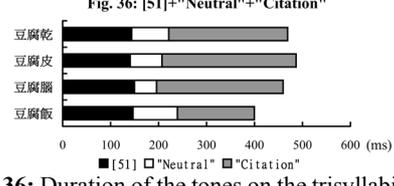
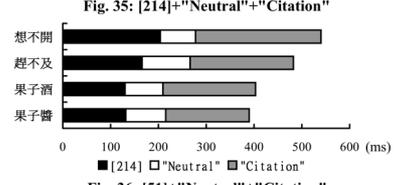
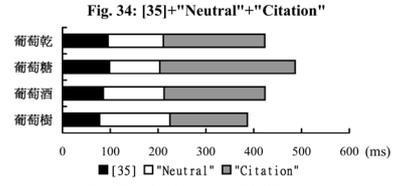
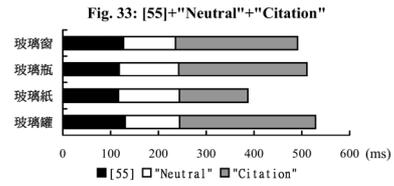
duration of the citation tones varies, depending on the location of the citation tones in the words. The citation tones that occur on the first, second, and third component syllables have the ranges of 90-170 ms, 190-220 ms, and 200-260 ms, respectively. Thus, the duration of the citation tones increases as the tones move from the initial toward the final position in the word. The duration of the neutral tone on the trisyllabic words is also a variable and it increases as it moves toward to the final position in the word. It has a duration range of 70-120 ms when it occurs on the second component syllable, but 100-150 ms when it occurs on the third component syllable. As for the difference in duration between the citation tones and neutral tone, although there is a general tendency for the neutral tone to be shorter regardless of its location in the word, there are a few cases where the neutral tone is in fact longer than the citation tones, especially when the duration of the neutral tone is compared with those of the citation tones which occur on the first component syllable.



Figures 25-28: Duration of the tones on the bisyllabic words with the neutral tone on the second component syllable.



Figures 29-32: Duration of the tones on the trisyllabic words with the neutral tone on the third component syllable.



Figures 33-36: Duration of the tones on the trisyllabic words with the neutral tone on the second component syllable.

4. CONCLUSIONS

The paper has presented the acoustical characteristics of the neutral tone in BM. The uniqueness of the neutral tone lies in the fact that its F₀ contour, duration, and intensity are all variables. They vary according to its tonal environment or its position in a bisyllabic or polysyllabic word. The traditional depiction of the neutral tone as 'light tone' may not be fitting according to the data presented in this study, though the term 'neutral tone' sounds appropriate.

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- [1] Yuen-Ren Chao, *Mandarin Primer*, Cambridge: Harvard University Press, 1948.
- [2] Yuen-Ren Chao, *A Grammar of Spoken Chinese*, Berkeley: University of California Press, 1968.
- [3] *Xiandai Hanyu Cidian* (Extended edition) (*A Word Dictionary of the Modern Mandarin Chinese*), Beijing: Commercial Press, 2002.