

Prosodic Prominence and Phrasing in Spoken Mandarin: The Case of the 3rd Tone

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Abstract

Prosodic prominence and phrasing have some general principles which can be observed in languages of the world, but their implementation is language-specific, especially in tone languages like Chinese. The key question is how the pitch manifestation of individual tones manages to coexist with prominence and phrasing in a given prosodic domain. This paper tries to explore the peculiarity of pitch alignment of the 3rd tone in Mandarin Chinese by examining its F0 movements in different accent contexts. The primary result suggests that the pitch patterns for prominence and phrasing may greatly depend on the register distinction among the tones, even without regard to other context environments.

Index Terms: prominence, phrasing, pitch manifestation, 3rd tone, Mandarin Chinese

1. Introduction

Prosodic prominence has attracted more and more attention both in speech science and technology. Certain patterns of pitch manifestation are used as one of the main parameters for both prominence and phrasing. For example, the expression of focus in previous studies has generally been assumed to be a raising of the pitch of certain tones, in many tone languages. Nevertheless, some doubts about this were raised and discussed recently. For example, is the pitch behavior for prosodic prominence similar in all tone languages, and are all tones in the same language affected in the same way [1, 2]?

In the case of spoken Mandarin, the main debate is about the pitch behavior of the 3rd tone. Just as in other languages, tones in accent condition in Mandarin are generally manifested by a raising of pitch level and an expansion of pitch range, and this is achieved by raising the peak of the F0 excursion [3, 4]; the 3rd tone, however, is an exception, it exhibits a quite different behaviour from that of other tones.

Many studies have reported the peculiarity of the 3rd tone's pitch movement, but the conclusions are inconsistent up to date. The main question is whether its pitch level is raised or lowered in accented condition, and how this is carried out in real speech. Specifically, there are at least two types of viewpoint. The first suggests that the pitch level of the 3rd tone is driven down in reverse to the case of other tones, and it is mainly manifested by lowering the L-point of F0, instead of rising the H-point (i.e., the peak) of F0 [4, 5, 6, 7], because the 3rd tone has a distinctive feature of low pitch register [8], which is remarkably different from the other tones in Mandarin.

Another point of view claims that focus information in the case of the 3rd tone does not embody on the tone itself directly, but by raising the F0 peak of neighbouring tones, which has the indirect effect of providing the focal information for the 3rd tone [9, 10, 11]. For example, Chen [11] found that pitch prominence of the 3rd tone cannot be executed through pitch

regulation of the tone itself, though there are some cases which show a lowering of the L-point of F0, but mostly manifested through raising the F0 H-point of its neighbouring tones', particularly that of the following tone.

However, the major attention of these studies has often been directed to the prominence of the focal effect in general, regardless of the effect of a register distinction among the tones. Thus, the exact behaviour of pitch prominence, especially in the case of the 3rd tone, is still not clear in Mandarin.

This study tries to further examine whether the pitch behaviour for prosodic prominence is affected by the register distinction of the tones. With this purpose in view, cases of the 3rd tone both in accented and unaccented contexts were inspected to see if its prominence pattern is comparable or not to that of other tones. Since unaccented tokens are generally not expected to trigger a pitch prominence, it may be of benefit to take a closer look at the focal effects in the case of the 3rd tone.

2. Test materials and methods

In previous work, the speech material used for studies on prosodic prominence in Mandarin have been mostly designed for a comparison between typically focused vs. non-focused examples. In real speech, however, influences coming from several different factors are unavoidable, so that any results obtained from designed materials need to be verified by an examination of natural speech.

Test materials and methods employed in this study will, therefore, try to come closer to the prominence situation occurring naturally in discourse, instead of using some deliberately designed paired tokens. The examination will, consequently, be made through the comparison of different degrees of prominence, instead of between typically focal and non-focal cases.

In addition, research into the relationship between prominence and phrasing is also taken into consideration.

2.1. Test materials

The 3rd tones examined here occurred in two sets of clauses extracted from the ASCCD discourse corpus, where they were read aloud by two male and two female speakers.

Set1:..... 可以用极简单的事例加以说明
(.....it can be illuminated by using quite simple instance)

Set2: 现代经济学是这样表述的: 制度至关重要, 制度是人选择的, 是交易的结果

(It is described in such a way in modern economics: institution is most crucial, institution is chosen by people, is the result of bargaining)

The material in set1 is a clause within the sentence of 世间的问题, 原来极复杂的, 可以用极简单的事例加以说明. There are a total of four 3rd tone syllables in the clause, namely, 可/ke/, 以/yi/ (hereafter yi-a), 简/jian/ and another 以/yi/ (hereafter yi-b), but the 可/ke/ has become a 2nd tone by application of the tone sandhi rule, so only three 3rd tones (as marked with italics) will be examined here. Perceptually, /jian/ is accented, /yi-a/ and /yi-b/ are unaccented in this clause.

The material in set2 is a compound sentence that consists of 4 clauses, which includes a total of four 3rd tones, i.e., 表/biao/, 紧/jin/, 选/xuan/ and 果/guo/. They are all located in a broad focal area of each clause respectively. Their relative degree of accent could be shown by the following order: /xuan/ > /jin/ > /biao/ > /guo/ according to their grammatical position in the clause. This grading was verified by perceptual impression.

2.2. Method of examination

Prosodic prominence is relative compared to that of non-prominent parts within a certain domain on the one hand, but it must also be influenced by other prosodic factors on the other hand. In order to examine the pitch manifestation at any position on the phrasal level, we have to set up some scale, in order to normalize the measured F0 as the equivalent of perceived pitch measurements, including the high point (hereafter H-point), low point (hereafter L-point) and pitch level in each domain (here within a clause). The following equation defines a reference scale, which is designed to eliminate the influence of pitch declination due to physiological mechanisms:

$$F0r = f0h.b - (f0h.b - f0h.e) / (\text{syll}.n - 1) * (\text{ta}.n - 1)$$

Where $F0r$ represents the value (Hz) of the reference scale corresponding to a given position of the test tone, $f0h.b$ is the value at the beginning of the syllable and $f0h.e$ is that of the final syllable in that clause, $\text{syll}.n$ is the number of total syllables in the clause and $\text{ta}.n$ is the ordinal number of the tone being analyzed. Then, both the direction and magnitude of the pitch deviation for each test tone can be obtained by calculating the difference between the measured value and the reference value. If the calculated deviation is negative, it means that the pitch of the test tone is lower than the reference scale; on the contrary, if the result is a positive value, it means that the pitch of the test tone is higher than reference scale.

3. Results and Discussion

3.1. Result from test 1

The data obtained from test 1 is summarized in Figure 1 and Table 1. First, from Figure 1 we can see that the deviation on the H-point (shown as the red column) of accented /jian/ is not much higher than that of unaccented /yi-a/, and it is even lower than that of unaccented /yi-b/. On the other hand, however, its L-point (shown as the blue column) is significantly lower than /yi-a/ and /yi-b/. And such a regular phenomenon is observed identically in all of the 4 speakers' utterances.

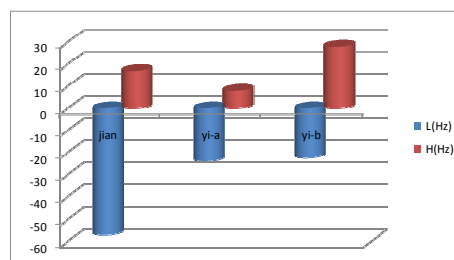


Figure 1: Illustration of the H- and L-point (Hz) as deviations from the reference scale in accented and unaccented 3rd tones

Secondly, from the data listed in Table1, we can see that the pitch level of the 3rd tones in the clause are driven down generally, and that here exists an obvious difference between accented /jian/ and unaccented /yi-a/ and /yi-b/ tones, though the magnitude of deviation for male speakers is smaller than that for female speakers, and the data for male speakers is even higher than the reference scale in the case of unaccented /yi-a/. All these differences indicate that a pronounced pitch lowering is the key point for the prominence of the 3rd tone in an utterance.

Table 1: Pitch register (Hz) deviated from reference scale in accented and unaccented 3rd tones

	f	m
jian	-30.55	-14.065
Yi-a	-15.95	10.34
Yi-b	-1.525	-0.65

The values reported here were raw F0 values in Hz. but it would not change the results obtained, if applying the same formula to values on a log scale by transforming the F0 values into semitone values as listed in Table1-1.

Table 2-1: Pitch register (St.) deviated from reference scale in accented and unaccented 3rd tones

	f	m
jian	-1.485	-1.148
Yi-a	-1.203	1.014
Yi-b	-0.183	-0.187

3.2. Result from test 2

Figure 2 gives an additional comparison on the deviation of H-point and L-point among the 3rd tones, taking into account the different degree of accent in the sentence. From this figure we can see that the L-point of the 3rd tones is each time deviated downward from the reference scale regardless of their accent degree, but the magnitude is regularly depending on the degree of accent. The H-point, however, exhibits a rather irregular behaviour and seems have no clear relation to the degree of accent degree. This may explain why it has sometimes been claimed that the 3rd tone in Mandarin has no clear contribution to prosodic prominence [11, 12], because the attention of majority of the studies concentrated on the behavior of the H-point, and ignore that of the L-point.

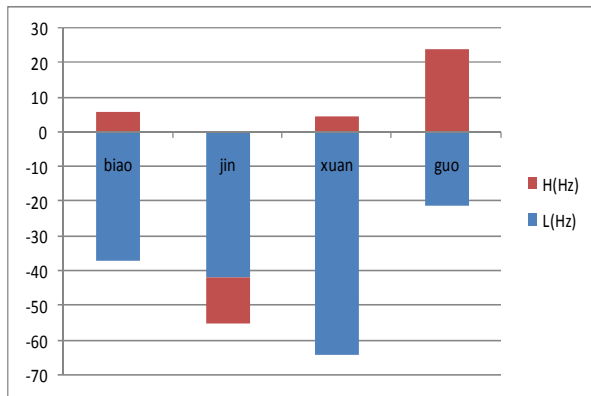


Figure 2: Illustration of the H- and L-point as deviations from the reference scale in 3rd tones with different degrees of accentuation

3.3. Discussion

As can be seen in Figure 1, the H-point of the 3rd tone seems to have no regular correlation with its accent status; whereas its L-point is systematically deviated downward from the reference scale, and the magnitude of deviation is significantly greater in the accentuated case (in /jian/). This tells us that prosodic prominence in the case of the 3rd tone is implemented via pitch adjustment for the tone itself, and not simply relying on the H-point raising of neighbouring tones.

The data obtained here also confirm previous findings on pitch range expansion in focal condition. A much higher onset f0 of the 3rd tone is found in accented cases, which might be the main source causing the pitch range expansion. However, another question might be raised at the same time, that is, how should we view the onset f0 raising in the case of accent? Obviously, it is not an intrinsic feature of 3rd tone itself, because the phonological target of the 3rd tone is originally the lowest among the four tones in Mandarin.

This phenomenon may be explained by in terms of Yi Xu's PA model [13].

First, according to this model, the underlying target for a given tone can be considered as remaining constant, and it is always implemented near the end of the syllable that the tone is attached to. Secondly, pitch movement towards a tonal target starts at the syllable onset and ends at the syllable offset. It must take time to change pitch in order to approach the target. And third, in continuous speech, the onset f0 of a tone is determined by the offset f0 of the preceding tone due to co-articulation. For example, when a 1st tone is followed by a 1st, 2nd, 3rd and 4th tone (represented as High, Rising, Low and Falling) respectively, as shown in the upper part of Figure 3, the f0 at the starting points of the following tones are all very high and close to one another, then they separate from each other as they gradually approach their specific targets. When a 3rd tone is preceded by a 1st, 2nd, 3rd and 4th tone respectively, its onset f0 will be quite discrete as shown in the lower part of Figure 3. Obviously, the onset f0 of the 3rd tone is raised in all cases, and specific height will depend on the underlying target of the preceding tone. Thus, a transition course between neighboring tones will result inevitably in this case.

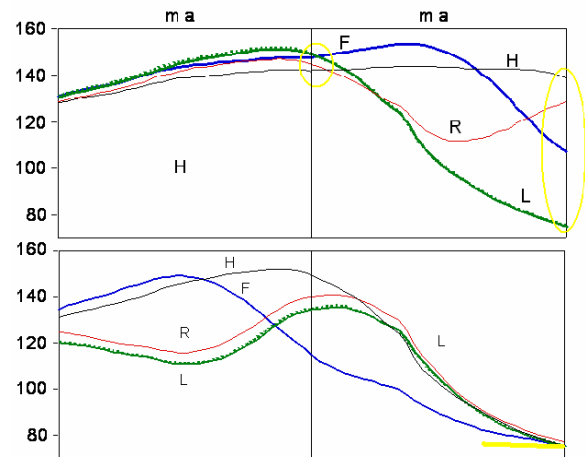


Figure 3: Illustration of pitch alignment and co-articulation (Figure taken from Xu, 1997. The top panel illustrates a High tone followed by High, Rise, Low and Fall. The bottom panel illustrates a final Low tone preceded by High, Rise, Low and Fall. Values are in Hz.)

Consequently, if follow this point of view, the onset f0 raising of a 3rd tone should be regarded as a transition state coming naturally from the preceding tones, no matter whether the 3rd tone is accented or not. In fact, this can be observed in real speech, as in the example shown in Figure 4, where the onset f0 is raised not only in accented 简/jian/, but also in unaccented 以/yi-a/ and 以/yi-b/ cases; the main difference between them is that, the f0 contour of 简/jian/ shows a more cragged slope than that of 以/yi-a/ and 以/yi-b/. Apparently, such a difference is caused by following factors: on the one hand, the onset f0 of 简/jian/ is much higher than that of 以/yi-a/ and 以/yi-b/, due to a much higher offset f0 of the preceding 极/ji/, which also located in the focal area. On the other hand, the phonological target of 简/jian/ is manifested more typically than 以/yi-a/ and 以/yi-b/, its L-point is sharply driven down and has obviously broken through the declination trend for the whole utterance. Therefore, a longer distance must be taken for the approximation from the onset to the end of its target, thus, a much more cragged f0 slope is reasonably to be expected.



可以用 极 简单的事例 加以 说明

Fig. 4: The f0 movements in the clause 可以用极简单的事例加以说明

In addition, the present study also presents some new data that relate to the interaction between prosodic prominence and prosodic phrasing in both focal and non-focal conditions. For example, the pitch behaviour of 果/guo/ shown in Figure 2 may imply some important information that we may have ignored before. At first, as mentioned in section 2.2, another purpose of this investigation is try to find the way to integrate the contributions of prosodic prominence and prosodic phrasing. To satisfy this purpose, the second set of material is selected to test how the two aspects interact and integrate each other. Now the situation of 果/guo/ may imply

some answer. Since 果/ɡuo/ is least accented and is located at the end of a clause, which is actually the last clause of this sentence, both the deviations of its H- and L- points are not only higher than its accented partners, but also deviate evenly from the reference scale, so that they may carry phrase terminal information and accent information at the same time. In fact, the example of /yi-b/ in test 1 also implies the same information.

4. Conclusions

According to the results obtained so far from both tests, it can be claimed again that, first, the typical characteristics for prosodic prominence of the 3rd tone in Mandarin is the driving down of its pitch level which is manifested mainly by a sharp lowering of its L-point; this is obviously opposite to the case of other tones, where the prominence is manifested by the driving up of the pitch level and is manifested by a further raising of the H-point. This fact shows clearly that, both directions of pitch deviation from a reference level have their own role in contributing to prosodic prominence. Consequently, we should pay more attention to the L-point of the 3rd tones, because there still some doubts without clear answers.

In addition, the present study has provided some new data on the interaction between prosodic prominence and prosodic phrasing in both accented and unaccented cases. This finding reminds us that the feature of the 3rd tone in Mandarin Chinese might be an appropriate window for the approach to the essence of the “neutral intonation”, as found by Yuan-Ren Chao[14], and to be defined as the base of intonation of a language, but is language-dependent. According to Chao’s theory, perceived intonation is the algebraical sum of the neutral intonation and modal intonation. The “modal intonation” is mainly referred to the expression of speaking mood or speaker’s emotion, its implemented pattern seems to be language universal. Whereas, the “neutral intonation” is the pattern of basic tonal variation when tones being spoken joined, it is just referring to the restriction from phonological rules of certain language or dialect only, but without any particular mood or emotion; so the “neutral intonation” must be language-dependent, namely, “one model for one language or dialect”. For example, tone sandhi and “neutral tone” are the main phonological rules that affect basic tonal variation in Mandarin Chinese; however, the situations in other dialects of Chinese are absolutely distinguished from that of Mandarin. The difference not only concerning with the specifications of tone sandhi, but also with the “neutral tone” patterns, or even without “neutral tone” in some dialects like Cantonese [15]. In particular, it is well-known that tone sandhi in Mandarin are especially concerned to the case of 3rd tone [14], its peculiar F0 variations is the main factor that resulting in a dazzling F0 contour of the whole utterance, as can be seen from the examples described in this study. Consequently, it might be the key in recognizing the structure of Mandarin intonation to discover the special characteristics of the 3rd tone in depth.

5. References

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