Types of Dipping Tones

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Abstract

This paper classifies dipping tones in the framework of the Multi-Register and Four-Level tonal model. There are six types of dipping tones, four in Register M and two in Register L. The former includes (1) low dipping /323/, (2) back dipping /523/, (3) front dipping /324/, and (4) double circumflex /3232/, and the latter includes (5) creaky dipping /202/ and (6) slack dipping /213/. After the establishment of a dipping typology, a set of distinctive features is proposed to specify these contours, and an evolutionary map is depicted to trace the changing routes of dipping tones.

Index Terms: tone, typology, contrastive tonal types, dipping, double circumflex, multi registers, four levels

1. Introduction

The dipping tone has a falling-rising pitch curve with a turning point at the lowest part of the speaker’s pitch range. It includes six contrastive types, and the first type is the familiar low dipping tone. The remaining five have all only recently been found and conceptualized. Three of these - a falling-like back dipping, a rising-like front dipping, and the double circumflex tone (DCT) - are produced in common clear voice. The remaining two, the creaky and slack dipping tones, are produced with special voice qualities.

The low dipping is commonly used in tone languages. The Beijing Tone 2 or shangsheng, in terms of historical categories, is a low dipping. Although dipping tones occur in hundreds of Chinese geographic varieties, up until now we know little about its distinctive features and contrastive types. This paper purports to establish a typology for dipping tones.

Before that, however, we need to introduce a new theoretical framework, the Multi-Register and Four-Level model (RLM) (cf. Zhu, 2012a for details), for transcribing and representing dipping tones and beyond. The RLM is developed from the FPS. It is refined, in terms of register, yet simplified, in terms of pitch level. Basically, it is suggested that (a) a language may have more than one type of phonation which defines up to three tonological registers; (b) each register should have its own pitch range, which is divided into four levels; and (c) each register will be one notch lower or higher in pitch than the adjacent ones. The following diagram shows a total of three registers and six pitch levels:

![Figure 1: The Multi-Register and Four-Level tonal model](image1)

2. Low dipping and its variants

2.1. Low dipping tone

The most frequent dipping contour in tone languages is the low dipping in Rg M. A typical example is T2 or shangsheng in Beijing Mandarin, transcribed as [214] in FPS, {323, 324, 322, 303} in RLM; see the sample contour in figure below. The turning point of a low dipping tone occurs about 40% into the production of the tone as a whole (Zhu, 1999).
As the section title suggests, the low dipping tone can be considered as a representative variant of the /pure low tone/ (PLT); it also has a creaky variant.

### 2.2. As a variant of the PLT

The PLT, /pure low tone 22/, has four phonetic realizations with the low dipping being one of them. We will not discuss it in detail here; the interested reader is referred to Zhu (2012b) and Zhu and Yi (2011). In a word, long and unchecked, i.e. shushing tones in Rg M are divided as PLT and non-PLT. PLT can be realized as various LOW pitch contours, like {323, 324, 32, 22, 23}, which do not contrast one another but can be distinguished from each other with respect to the feature [±CONTOURISITY]. PLT does not employ pitch contourisity as distinctive features; it is perceived as ‘LOW’ as a whole.

Let us come back to the typical PLT, Beijing T2, which is transcribed as [214] in FPS. However, Chao (1933) put forward a concept of ‘half shang’ 半上 and took it as low falling [21] or low leveling [11] in FPS. Wang Li (1979) also regarded it as a low leveling [22]. And furthermore, many Beijing natives pronounce it with creaky voice (see §2.3). Thereby, contours [214, 21, 11] ([324, 32, 22] in RLM accordingly) are variants to one another, and they are all phonetic realization forms of the same tone type of PLT. Tone 1a in Gurao 谷饶, a variety of Southern Min, was also described as low falling [21] (Jin & Shi, 2010). It actually has different pitch contours for different speakers (Zhu, Hong, & Lam, forthcoming) including low falling (speaker M4), low-level falling (M1, M2) and low dipping (M3, W1), as exemplified in figure below. There are four words bearing the same tone 1a produced by two speakers. The first word in the upper panel looks like a low dipping, but the second a low falling. Both words in the lower panel sound like a low leveling, but with a dropping head.

A fall in pitch does not necessarily guarantee a falling tone phonologically. Acoustically there has never been a genuine low leveling F0 <22> (here the angle brackets are used to represent F0 contour); instead, a dropping onset happens all the time, like <’22>. The high head <’> is not a linguistic target but only due to a physiological function -- acoustic properties do not the phonological categories one-to-one match. It is unavoidable for a low leveling or a low rising tone to have a dropping onset in pitch contour, as we are unable to reach the lowest pitch at the very beginning of speech. Generally we begin from the point of {3} in RLM, which is called a default configuration, then fall to the lowest point, resulting in a low falling contour {32}; if the length lasts longer, a low leveling tone {22} will come into being, or the pitch might come back to the default configuration, there will be a up tail—that is the low dipping {323/324}; if the turning point happens a little forward, there will be a low rising tone {123}. All the pitch changes involved are in a continuum and they all indicate a ‘low’ tone. In order to achieve the target of ‘lowness’, phonation is sometimes employed, like creaky voice (Zhu and Yang, 2010) or slack tail (Zhu, Lam, and Hong, forthcoming).

### 2.3. Stiff dipping as a variant of low dipping

Variants of the low dipping here mean its various phonetic realizations: {323, 324} and those with Stiff Voice {32, 323}. Stiff Voice consists of three sub-types: Glottal Muffle, Creaky Voice and Weak Stiff. The latter two are mainly applied to dipping tones. The coexistence of a normal low dipping and its Stiff variants is very common in Mandarin. For example, a Zhonggyan Mandarin variety of Weixian, Henan province has four citation tones: 1a {34}, 1b {52}, T2 {55}, and T3 {303}. Most words in T3 take creaky voice. The word 肉 [fa303] ‘meat’ sounds with obvious creaky voice, whose pitch at the first half of the contour is broken and cannot be measured. There are some words in T3 where the pitch contour remains unbroken as the intensity is decreased. This is what we called Weak Stiff as illustrated by 煉 [xaj32] ‘harm’ on the left of figure below. Phonetically the two contours in the figure are transcribed as {323} and {303}, and are both phonetic variants of the same low dipping tone {323}.

![Sample PLT 1a words in Gurao Min](image1)

![Sample words from Weixian Mandarin](image2)
3. Dipping tones in Rg L: slack dipping and creaky dipping

Two dipping tones can contrast with each other not only in pitch contour but also in voice quality: clear voice versus slack voice; creaky dipping versus low dipping. Section 2 showed that, in Beijing Mandarin for example, a creaky tone can be a phonetic variant of a low dipping. This section will show the phonological contrast between two low dipping tones in different registers: (323) in Rg M vs. creaky dipping (202/303) in Rg L. The creaky dipping here becomes a distinctive type. Figure below contains a sample pair of a low dipping and a creaky dipping from a Jianghuai Mandarin variety, used in Shouxian, Anhui Province (a male speaker). His T2 {323} and 1a {303} are both dipping tones. Their onsets are very close, with T2 109 Hz and 1a 108 Hz, and their offset pitches and duration are almost the same. The only difference between the two lies in the phonation types: the former is in ordinary phonation and the latter creaky voice. The creaky dipping (303) in Rg L is typologically represented as [202]. Its phonetic realization might be [202, 203, 302, 303] or higher [304]. The contrastive type [202] is thus represented in order to differentiate from another type: the low dipping [323] in Rg M, and its creaky variant [303]. Furthermore, the [202] is one of the phonetic realizations of the /PLT 11/ in Rg L, and [323] a phonetic realization of the /PLT 22/ in Rg M.

Another pair of sample words is from a Wu dialect, used in Kunshan, Jiangsu province. Yang tones in Wu are usually produced with slack voice in Rg L. Tone 3b in Wu is a dipping tone with slack voice and tone 3a is in Rg M, produced with normal clear voice.

4. Back dipping

4.1. Contrast with low dipping

A new dipping type in Rg M has recently been discovered: the back dipping. Its turning point occurs about mid-way along its pitch contour, further back than that of the low dipping. It sounds like a falling pitch with a pause at the later part before bouncing back, and is characterized with a higher head and a lower tail, in full contrast to the front dipping which usually has a lower head and a higher tail. Back dipping may contrast with low dipping in the same Rg M of a language and thus form a minimal pair. The two dipping tones in the upper panel of figure 8 are from a Northern Min dialect used in Dutou village, Shihi-zhen, Pucheng county, Fujian province (the high rising tone is given here as a reference for the speaker’s pitch range). The pitch curves in the figure are Log Z-score normalized mean F0 ones (cf. Zhu, 1999 for details). Tone 4a (a falling tone) in Dutou Min is softened into a low dipping contour, and tone 4a is a back dipping.

4.2. Phonetic manifestations of back dipping

A back dipping tone usually looks like the curve of the first word in figure 9, [pu] ‘mend’: its turning point is at the midpoint of the contour or further back, and the falling part of the tone lasts long. The turning point of a back dipping could be a little further forward, like the one of the second word in the figure, [tαn] ‘wait’: It falls faster and the leveling in the later part lasts longer. For some words the falling part is even faster and deeper, which results in creak at the turning point, as exemplified on the last word, [f⁵f] ‘wait’; ‘mend’: its turning point is at the midpoint of the contour or further back, and the falling part of the tone lasts long. The turning point of a back dipping could be a little further forward, like the one of the second word in the figure, [tαn] ‘wait’: It falls faster and the leveling in the later part lasts longer. For some words the falling part is even faster and deeper, which results in creak at the turning point, as exemplified on the last word, [f⁵f] ‘wait’; ‘mend’, in Rg M, [right] tone 4a [324] vs. tone 4a [423] in Dutou Min, Pucheng; [lower] tone 1a [323] vs. T2 [523] from Zhaizishan Mandarin, Linxian.

Figure 7: Low dipping vs. creaky dipping in Wang’ancun Mandarin. [Left] Tone 2 [pʰiːn⁵²] ‘flat’, in Rg M. [right] tone 1a [pʰiːn³⁰³] ‘side’, in Rg L.

Figure 9: Phonetic variants of the back dipping T2 /523/ from Nanliangshui village, Jixixi. [From left] [pu] ‘mend’, [tαn] ‘wait’, [f⁵f] ‘wait’, ‘mend’.

Figure 8: Low dipping vs. back dipping. [upper] tone 4a [324] vs. tone 2a [423] in Dutou Min, Pucheng; [lower] tone 1a [323] vs. T2 [523] from Zhaizishan Mandarin, Linxian.
5. Double circumflex tone

The back dipping presented in the last section sounds and looks a bit weird due to its rare occurrence. It comes from an even weirder and rarer tone type: the double circumflex tone (DCT) (Zhu and Yi, 2011).

5.1. What is ‘double circumflex’?

A DCT has two turning points, with a falling-rising-falling pitch curve. It is also classified as a dipping tone typologically because it lies at the midpoint of a sound change from a low dipping to a back dipping. There are three kinds of DCT, as shown in figure below. Distinctions among these three kinds are made on the basis of the heights of the onset and the peak. Tone 1b {3232} from a Cantonese variety of downtown Deqing, where the onset and peak have the same height, is deemed as the standard DCT (the right upper panel of figure), tone 3a {3242} from a Xiang dialect, used in Qiqingjiang, has a lower head and higher peak (the lower panel of the figure), and tone 2a {4232} from a Qinjin Mandarin variety, used in Yuejiashan village, Nuanquan-zhen, Zhongyang county, Shaanxi province, has a higher head and lower peak (the left upper panel of the figure).

![Figure 10: DCT with different onset and peak heights](image)

**5.2. Mid-point of sound change: from DCT to back dipping, low dipping to DCT**

In general, the three types of DCT with small phonetic deviations discussed in 5.1 are variants to one another, but note that the high-head DCT might be a premonition or a sign of the sound change from DCT to back dipping. It is a transitional type. When the first fall of a DCT takes more time, the concave part will occupy most part of the tonal curve, leaving a tiny falling tail towards the offset, creating a weakened DCT. Furthermore, when the falling tail disappears totally, a back dipping tone will come into being. For example, T2 from a Mianxian dialect of Zhongyuan Mandarin (Qinlong sub-group), Shanxi province, is a front dipping [324], and toneT3, is a creaky dipping [303], as shown in figure below.

![Figure 11: Front dipping [upper] vs. creaky dipping [lower] in Mianxian Mandarin](image)

The two dipping tones can be analyzed phonologically in two different ways. The first analysis depends on the fact that there is no genuine low dipping in Rg M and that few T3 words are produced without creak. This suggests that T3 may phonologically be treated as a /low dipping/ in Rg M with a phonetic variant of creaky dipping, like T2 in Beijing. In this case, there is a phonological contrast between a /low dipping/ and a /front dipping/. The second analysis is to consider the
The table needs some explanations. (1) Typologically distinct tone categories are placed between slashes ‘/’, a notation borrowed from phonemics. Therefore, (2) the two #5’ contours, {323} and {202}, are not contrastive types, at least not at the same level as other types. They are sub-types of /PLT/, represented as /22/ in Rg M or /11/ in Rg L. In other words, the commonest low dipping tone in Rg M is a phonetic variant of the PLT. The low dipping can phonetically be realized as {323, 324, 303, 304, 323, 523}, etc. (3) There are two dipping tones in Rg L (\{#RgM\}): creaky [202] (or [203, 303, 302] phonetically) and slack /213/ (or [313, 312] phonetically). The DCT differs from other types in the feature [LONG] as it does be a bit longer than other contour types phonetically, but not necessarily. This label is used just for the sake of convenience; otherwise, we should employ another label such as [double turning points]. (4) The back dipping is transcribed /523/; phonetically it could be [423]. The underline for the tone value can be removed if no ambiguity is incurred. (5) The back and front dipping are differentiated by the feature [zhigh], the back dipping with a high onset and the front a low onset. (6) All five of the dipping tones have their Stiff variants: Creaky [303, 304, 302, 304] or Weak Stiff [323, 523] at turning point.

7.2. An evolutionary map

Taking DCT and rising into account, we can see an evolutionary route: rising \(\leftrightarrow\) front dipping \(\rightarrow\) low dipping \(\rightarrow\) DCT (variation with high-head DCT) \(\rightarrow\) back dipping \(\rightarrow\) low falling (~low dipping); low dipping \(\rightarrow\) creaky dipping (~Fortis creaky dipping). See the figure for more clarity.

![Figure 13: An evolutionary map of dipping tones (dashed lines denote variants)](image)

It can be seen from the figure that the pivot of all dipping tones is the low dipping, from which the front dipping, the DCT, and the creaky dipping can develop. Low dipping is also a variant of the low falling.

7.3. Tonotype and toneme

As shown in section 6, ‘front dipping’ cannot be determined as a contrastive type decisively. Of the four cases discussed, there are alternative treatments for the front dipping. If the Xinghua speaker W1’s pattern were to prevail in the whole community, that would be a decisive piece of supportive evidence. But even so, it is a possible or potential phonological contrast whose existence is justified in one individual’s system, and it might spread throughout the community.

The ‘tonal type’ or ‘tonotype’ in typology is somewhat similar to the ‘phoneme’, but more strictly defined, in the sense that it is a ‘universal phoneme’ in all tone languages rather than a phoneme that is defined only in one specific language. We may determine a ‘front dipping’ toneme in any of the above four linguistic varieties, but we are still a bit hesitant about deciding its status as a tonotype. If the toneme ‘front dipping’ had been determined unambiguously in a language, the

Front dipping \(\rightarrow\) Low dipping \(\rightarrow\) DCT \(\rightarrow\) Back dipping

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The first choice is preferable for the sake of economy, because one less phonological register (Rg L) is required. And since mono-register tone system exists in hundreds of Mandarin varieties, it is of course more convenient for cross-Mandarin comparisons.

6.3. Contrast against low dipping

If there is a case that clearly demonstrates a contrast between front and low dipping in the same Rg M, that will justify the typological status of the front dipping. Here is a supportive piece of evidence, though not decisive.

The Xinghua dialect of Jiangsu province (Tairu sub-group of Jianghuai Mandarin) has 7 citation tones, with ping, qu and ru all splitting into yin and yang. It has two dipping tones: a low dipping T2 {323} and a front dipping 1a {324}.

It is no doubt that the speaker W1 contrasts the low dipping with the front dipping. However, there exists a contrast between a PLT 2a and a raised shallow dipping 1a from another speaker W2. Since there are large between-speaker variations, the speaker W1's tone pattern might be an idiosyncratic performance, and cannot be a piece of decisive evidence, though not decisive.

Contrast against low dipping

7.1. A typological inventory and distinctive features

This paper classified dipping tones in the theoretical framework of the Multi-Register and Four-Level tonal model. There are six types of dipping tones, four in Rg M and two in Rg L, as shown in the following figure.

![Figure 12: Six dipping tones represented in the RL model (\{505\} is a variant of \{202\})](image)

The six dipping types can be specified with four pairs of Rg L, as shown in the following figure.

<table>
<thead>
<tr>
<th>front</th>
<th>back</th>
<th>low dipping</th>
<th>high dipping</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PLT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>/323/</td>
<td>/523/</td>
</tr>
</tbody>
</table>

Table 1. Four pitch-length types and six pitch-length-register dipping tone types

<table>
<thead>
<tr>
<th></th>
<th>front</th>
<th>back</th>
<th>low dipping</th>
<th>high dipping</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td>PLT</td>
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<td></td>
<td>/323/</td>
<td>/523/</td>
</tr>
</tbody>
</table>

7. Further discussions

Figure 13: An evolutionary map of dipping tones (dashed lines denote variants)
tonotype ‘front dipping’ could also have been established. If the toneme is only one of the phonological solutions in a language, whether the tonotype can be established depends on additional criteria as follows:

1. By definition that the turning point takes place 30% of the way along the tone curve. This is not a pure acoustic phonetic criterion because low dipping, back dipping, and even rising type are all thus defined.

2. Circular contrasts in more than one language. Front dipping contrasts with back dipping in languages such as Zoucheng Mandarin, back dipping contrasts with low dipping in languages such as Dutom Min of Shipi and Zhaizishan Mandarin of Linxian, and low dipping contrasts with front dipping for one Xinghua speaker.

3. Its role as a transition between dipping and rising in phonological evolution.

4. The last and unexpected reason comes from the phonological consideration of the two Rg L dipping tones. The creaky dipping is no doubt a realization of PLT in Rg L, and the other, slack dipping has to be assigned a position of ‘front’ dipping.

For all these reasons, we might be justified in admitting it as a tonotype.

7.4. Extreme cases of dipping tone patterns

‘Tone pattern’ refers to the distribution or configuration of distinct contours in a tone system. Two examples will be presented to show that some dipping tones are more close to the rising tone and others are closer to the DCT.

The first is the Xinghua Mandarin variety in which there is a contrast among low dipping, front dipping and rising (the upper panel of figure 14), according to three parameters. The first is the position of the turning point in the course of the tone: middle, front, and incipient. The second and the third is the height of the turning point and tail: low, mid, and high. These three might not be independent of one another. The lower the turning point, the earlier it occurs and the lower its offset is. A contrast among these three contours is a little tricky and hard to sustain. As discussed above, the two dipping tones were produced differently by another Xinghua speaker, to maintain the contrast with the high rising 1b. These three contours constitute the most subtle tone pattern ever found. We deduced that the indistinctiveness of this pattern might be an isolated phenomenon and that it will be hard for it to prevail in a community.

Figure 14: Contrast among dipping tones. [upper] contrast of a high rising, a front dipping, and a low dipping in Xinghua Mandarin. [lower] contrast of a low dipping, a back dipping, and a DCT in Chaling Gan. [right].

The other one is a contrast among a low dipping, a back dipping and a DCT in a Gan variety, used in Chaling Township, Hunan province (the lower panel of figure 14). It has five citation tones; three of them are dipping tones: a DCT 1a {3232}, a back dipping 1b {522}, and a low dipping 3b {434}. Chaling has the weirdest tone pattern with three dipping tones and two falling tones but no level tone. The two falling tones are: a (high) short falling /52/ (T2), and a (long) low falling /42/ (3a). The Chaling case might be adopted as a typical model of the complexity of tone patterns. Another thing worth noting is that it is the falling rather than the level tone that is indispensable in a tone language. This should be a universal in tone typology.

8. Summary

There are five major contour types (in terms of pitch contour and length) in tone languages. Four of them - falling, dipping, level, and rising - share the feature [+CONTOURISITY], and the remaining one - PLT - has the feature [-CONTOURISITY]. The falling contour is the most frequent among contour types, with the largest number of varieties, but, surprisingly, these are not the most difficult to classify (Zhu 2012b). The dipping tone has fewer sub-types than the falling one, but is more difficult to deal with. This is partly due to the subtle demarcations internally and externally, and partly due to the fact that the commonest and default type of dipping tone, the low dipping, is eventually a phonetic variant of the PLT.

Dipping tones are all phonologically long, so far as we know, and mainly occur in Rg M and less commonly in Rg L. Out of the six types, /creaky/ and /slack dipping/ occur in Rg L, and the other four, /low, back, front, DCT/, occur in Rg M. There is no typologically distinct dipping tone in Rg H. The other five also have their creaky variants, but in the same register.

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