Level/Oblique Opposition and Raoyang Tonology

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Abstract

Phonetic experiments and phonological analysis reveal that Raoyang tone system characterizes level/oblique (LO) opposition, which is hardly captured by a node of contour in tonal geometry. A specific model featuring independent LO feature and pitch feature is then proposed. For cross-linguistic universality of tonal representation, the essay turns to the theory of Contrastive Hierarchy. Related OT constraints are then constructed and ranked for a formal grammar. The paper concludes with a discussion on the theoretical implications of this analysis.

Index Terms: Raoyang, level/oblique opposition, tone sandhi, contrastive hierarchy, Optimality Theory

1. Introduction

Tonal structure is the base for tonal analysis. This paper aims both for a proper tonal structure of Raoyang and for a formal analysis on this dialect. We reflect on the limitation for the tonal geometry proposed in Bao (1990) [1] to represent level/oblique (LO) opposition displayed in Raoyang, and turns to the theory of the Contrastive Hierarchy [2, 3]. The second section briefs the phonetic experiments on Raoyang tones and a rudimentary phonological analysis in support of the claimed LO opposition. The third argues for the inappropriateness to use the node of contour to represent LO opposition. The fourth constructs a contrastive hierarchy involving only an LO feature and a pitch feature, leaving all others as redundant. The fifth is an OT-theoretic account, employing OT constraints built around the two features to unravel the mechanism of Raoyang tonal sandhi. The last section concludes the study and reflects on the theoretical implications of the adopted approach, pointing out its inherent consistence with the underspecification theory and the conflict with the Universal Grammar Hypothesis.

2. Phonetics and phonology on Raoyang tones

Raoyang County lies in the central part of Hebei Province, and in terms of language, Raoyang dialect belongs to Shiji cluster of Jilu Mandarin [4]. According to the Map B2 “Second in Mandarin” in the Language Atlas of China [5], Jilu Mandarin comprises three clusters, namely Shiji, Baotang and Canghui, and Raoyang is right in their intersecting area. According to Liu’s survey of the tone system in Hengshui prefecture, the four northern counties of Raoyang, Shenzhou, Wuqiang, and Anping share a basically identical tone system, which is distinctive from other counties in the Perfect [6]. Therefore, the tone patterns described in this paper can be regarded as common features across the above four counties.

To conduct a survey on the Raoyang tone systems, the paper chose 71 Chinese characters, each of which carries a single syllable and therefore 71 syllables, from the Fangyan Diaocha Zibiao [7], and tailored 126 disyllabic sequences, all without neutral tones. These materials were read by a native male speakers (from Guanting Township), and the recorded data are analyzed with PRAAT for F0 patterns. The data are, in turn, processed with the T-value Formula [8]. Data regression yields four distinctive citation tones as indicated in the Five-point scale in Table 1. Results of disyllabic sequences are shown in Table 2. Refer to the endnote for a pattern of citation tones and for F0 curves of some typical disyllabic sequences.

Table 1: Raoyang citation tones

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>F0</td>
<td>33</td>
<td>452</td>
<td>324</td>
<td>41</td>
</tr>
</tbody>
</table>

Table 2: Results of disyllabic sequences

<table>
<thead>
<tr>
<th></th>
<th>T1 (33)</th>
<th>T2 (452)</th>
<th>T3 (324)</th>
<th>T4 (41)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 (33)</td>
<td>44.22</td>
<td>33.452</td>
<td>33.323</td>
<td>45.51</td>
</tr>
<tr>
<td>T2 (452)</td>
<td>44.32</td>
<td>54.452</td>
<td>54.313</td>
<td>45.52</td>
</tr>
<tr>
<td>T3 (324)</td>
<td>35.33</td>
<td>32.453</td>
<td>42.123</td>
<td>34.52</td>
</tr>
<tr>
<td>T4 (41)</td>
<td>42.44</td>
<td>42.453</td>
<td>43.324</td>
<td>43.42</td>
</tr>
</tbody>
</table>

Disregarding such factors as stochastic errors and sampling errors, and taking into considerations phonetic coarticulation, we notice the following interim facts about disyllabic tones. (1) The second tone basically remains unchanged. (2) T1 as the first tone bisects into low level and high level in different contexts. (3) T2 as the first tone simplifies itself by dropping the end of the complex tone. (4) T3 as the first tone also simplifies itself, but, different from T2, the remaining curve bisects into rise and fall in different contexts. (5) T4 as the first tone keeps being a fall.

Simple auditory discrimination has the following corresponding findings, which to a certain extent confirms the acoustic results: (1) T1 neutralizes with T2 before T1 and T4. For example, qing (T1) tian (T1) “blue sky” (the bracketed category is citation tone) and qing (T2)tian (T1) “cloudless sky”, tian (T1) di (T4) “heaven and earth” and tian (T2) di (T4) “farm”, are respectively indistinguishable. (2) T2 neutralizes with T4 before T3. For example, in mai(T3)fang(T2) “buy a house” and mai (T4) fang (T2) “sell a house”, mai (T3) mi (T3) “buy rice” and mai (T4) mi (T3) “sell rice”, mai (T3) “buy” and mai (T4) “sell” are indistinguishable.

The findings are generalized into the following patterns.
Oblique tones

two level tones (T1, T2) and two contour tones (T3, T4) in that is, a rise in nature. Lastly, T3 can only be specified as [-raised, +raised], register, the two levels are contrastive in terms of feature for tone, and T1 as a low level one. Without specification for the simple way is to treat T2 as an underlyingly high level neutralizes into T2 (45) under Pattern (1). To account for this, phonologically important but a phonetic phenomenon; T1 (33) is ambiguous and can well be analyzed to have either [+high] register with [-raised] pitch, or [-high] register with [+raised] pitch; the allotone of T1 is definitely [+high]; T1 and its allotone are also safely [+high]. Table 2 shows that T3 basically surfaces as [+high] at sandhi position. Generally, the specification for [high] feature in every tonal category is basically surfaces as [+high] at sandhi position. Generally, the specification for [high] feature in every tonal category is redundant; its specification is left open in.

Additionally, positing on simple contours underlyingly is adequate to yield a four-tone contrast system, while complex contour approach may result in 2*2*2=8 tones, half of which are non-existent.

tone

register  contour

[±high]  [+raised]  [+raised]

Figure 1: Traditional tonal geometry

To establish the underlying structure of tonemes, we need to consider (1) the contrastiveness of tonemes in the tonal inventory and (2) the sandhi behaviors of tonal categories. Additionally, the first position in a two-tone sequence is recognized as the sandhi position; change is restricted to the first tone in Raoyang, as in many other northern dialects. The second tone, and the citation tone, takes the non-sandhi position. We now take a survey of the four tones in terms of their register. T2, T4 and their allotones are all [+high] register. T1 (33) is ambiguous and can well be analyzed to have either [+high] register with [-raised] pitch, or [-high] register with [+raised] pitch; the allotone of T1 is definitely [+high]; T1 and its allotone are also safely [+high]. Table 2 shows that T3 basically surfaces as [+high] at sandhi position. Generally, the specification for [high] feature in every tonal category is predictable from its position. We so posit that the feature for register is redundant; its specification is left open in underlying representation but specified as [+high] by a default rule at a later stage.

T4 shows a high degree of stability and this high falling tone fits into the model with two adjacent [+raised, -raised] pitch features. T2 (452) unexceptionally loses its ending drop at sandhi position, which implies that the end is not phonologically important but a phonetic phenomenon; T1 (33) neutralizes into T2 (45) under Pattern (1). To account for this, the simple way is to treat T2 as an underlyingly high level tone, and T1 as a low level one. Without specification for register, the two levels are contrastive in terms of feature for pitch. Lastly, T3 can only be specified as [-raised, +raised], that is, a rise in nature.

The above discussion shows that underlyingly there are two level tones (T1, T2) and two contour tones (T3, T4) in Raoyang; Two level tones are neutralizable in Pattern (1) and two contour tones are neutralizable in Pattern (2). For reasons to be discussed in the next section, we here use the traditional tone in the poética meters in Middle Chinese, oblique tones, for contour tones, simply to avoid confusions with the traditional connotation of the latter. There is no neutralization between level tones and oblique tones, as shown below in Table 3, which may be called level/oblique (LO) opposition.

<table>
<thead>
<tr>
<th>Tones</th>
<th>1</th>
<th>h</th>
<th>lh</th>
<th>hl</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1(i)</td>
<td>h.l</td>
<td>l.h</td>
<td>l.h.l</td>
<td>h.hl</td>
</tr>
<tr>
<td>T2(h)</td>
<td>h.l</td>
<td>h.h</td>
<td>h.hl</td>
<td>h.hl</td>
</tr>
<tr>
<td>T3(lh)</td>
<td>lh.l</td>
<td>lh.h</td>
<td>hl.hl</td>
<td>lh.hl</td>
</tr>
<tr>
<td>T4(rl)</td>
<td>rl.l</td>
<td>rl.h</td>
<td>rl.hl</td>
<td>rl.hl</td>
</tr>
</tbody>
</table>

Rule 1: T1→T2/_{T1,T4}
Rule 1: T3→T4/_{T2,T3}

3. The phonological representation for LO opposition

In the tonal model given in Bao [1], contour constitutes an intermediate tier between tone root and pitch features. We now argue that contour in this model cannot capture the LO opposition displayed in Raoyang. The arguments also disfavor the proposal that contour is a unary feature [8].

In terms of opposition, contour, as a node in the model, can express binary opposition by the existence and non-existence of the node. It does not seem to be inappropriate to use the node of contour, as far as binarity is concerned.

However, a node in feature geometry is only capable of indicating a privative opposition. The existence of a node means the existence of the indicated phonological constituent, which, possibly though not necessarily, undergoes phonological activity. Lacking this node means the non-existence of the indicated constituent, which cannot be referred to in phonology. Furthermore, the model has the pitch features attached to the node of contour. The dependence of pitch features on the node of contour means pitch features will not be there if contour is not. Suppose a contour node is used in Raoyang, it would be T3 and T4 who bear it; T1 and T2 would lack it, in accordance with the definition of a privative opposition, leaving register feature alone in the structure. Recall that we have earlier argued that register is underspecified underlyingly. The question then is how T1 and
T2 are contrastive in the inventory. On this account, positing to represent the LO opposition through the existence and non-existence of the contour node would necessarily place us in an awkward situation of deprived means of representation.

There is another drawback. If we suppose that Rule 1 and Rule 2 in Raoyang involve specifying successively opposite values to pitch 1 feature and pitch 2 feature, we need to explain what reasons are there to call for double application instead of a single one. Constraints of such sort are often arbitrary and unconvincing.

Interestingly, the inadequacy in using a contour node to represent contrast dissimilation is witnessed in Tianjin, where the sandhi patterns of the four tones T1 (11), T2 (55), T3 (13), T4 (53) are shown in the first two columns of Table 6 [9].

Table 6: Tianjin tone sandhi pattern

<table>
<thead>
<tr>
<th>Sandhi patterns</th>
<th>Five-point values</th>
<th>LO conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1+T1 → T3,T1</td>
<td>11+11 → 13.11</td>
<td>L → O</td>
</tr>
<tr>
<td>T3+T3 → T2,T3</td>
<td>13+13 → 55.13</td>
<td>O → L</td>
</tr>
<tr>
<td>T4+T4 → T1,T4</td>
<td>53+53 → 11.53</td>
<td>O → L</td>
</tr>
<tr>
<td>T4+T1 → T2,T1</td>
<td>53+11 → 55.11</td>
<td>L → O</td>
</tr>
</tbody>
</table>

The effect of tonal dissimilation has long been noticed. Indeed dissimilation can act as the trigger of tone sandhi, accounting for three out of four sandhi patterns. What has often been overlooked is the targets of the sound change, i.e., all four patterns are conversions between level tones and oblique tones (see the third column), which is quite the opposite situation of Raoyang. It is difficult, if not impossible, to capture this LO conversion with a contour node. Current analysis is often seen to retreat from tonal geometry and adopt a more out-of-focus approach, representing four tones roughly as high, low, rise and fall.

The LO opposition in Raoyang and the LO conversion in Tianjin both point to the inadequacy of the tonal model, specifically the node of contour. To capture the pattern like this, we advocate using contour as a feature which is capable of expressing equipollent opposition, instead of a node which expresses a privative opposition.

4. The contrastive hierarchy of Raoyang tones

We have complicated the picture of tonal structure by adding a new member, the feature for LO. However, previous studies have also clearly shown the role of contour node in some tonal systems [10, 11]. If we admit the soundness of arguments for and against the representation of contour, we wonder how these claims are compatible. The theory of contrastive hierarchy offers such a solution [2, 3].

As a development of the underspecification theory, the theory of contrastive hierarchy holds that the featural content of a segment is determined by contrastiveness. Only those features that are needed to contrast segments are present in the representation; others are not specified. This view is not new, as discussed and refuted in Archangeli [12]. What makes viable this version of contrastive specification lies in the claim that specifications of features are not made at one stroke, but in a certain order. Features in a certain order constitute a hierarchy; those at upper level of the hierarchy have a bigger scope and their re-specification may affect more phonemes. Hierarchies differ across languages and may be decided on case-by-case basis. Successive Division Algorithm offers the steps to determine a contrastive hierarchy.

We now apply the contrastive hierarchy in Raoyang tonology. We only need to extract two features that are enough to render the 4 underlying tones contrastive, the LO feature and pitch feature. Other features such as register, contour, and even the end of a complex tone can be regarded as non-present at the underlying level. In the traditional sense, two pitch features are needed to decide a contour. But in our case, only the left pitch is needed, as the specification for LO can predict the value of the right pitch feature. For example, [-oblique] means a level tone, requiring the right pitch feature to have the same value as the left pitch feature; [+oblique] means an oblique tone, deciding the right pitch feature to have the opposite value of the left one. The specification of the right pitch feature is done at a later stage, whether before coming out of phonology or in the phonetics. The proposed geometry is shown in Figure 2.

As to the hierarchy, we don’t have good reasons to organize the LO and pitch features into orders. Either of the features evenly cuts the tone inventory into two equal parts, and they have virtually the same scope, making us unable to decide which cut is made first. But taking a diachronic look, we do prefer to place LO before pitch. In so doing, we regard LO to be more fundamental than pitch, which is therefore more volatile, and neutralizable, as displayed in the formulated sandhi patterns. Thus the contrastive hierarchy in Raoyang is posited as in Table 7.

Table 7: Contrastive hierarchy in Raoyang tonology

<table>
<thead>
<tr>
<th></th>
<th>T1 (33)</th>
<th>T2 (452)</th>
<th>T3 (324)</th>
<th>T4 (41)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Pitch</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

Apparently, with the introduction of LO feature, we find that the sandhi patterns all have one thing in common. The LO feature remains constant while the pitch feature is variable. Tone mapping shows great regularity: it is restricted within the pitch tier. LO does not undergo change, but may act as partial trigger, contributing to the context of the sound change.

5. An OT-theoretic account

The last section concludes that LO and pitch are the only two features present in Raoyang tonology. To see the role each feature plays to get the surface forms, we now turn to the Optimality Theory which offers a formal approach for constraints about phonological constituents to be weighed against each other [13]. We observe the following facts which can be translated into OT constraints.
Table 8: OT tableau for T1+T1

<table>
<thead>
<tr>
<th>Input: /-o,-t/+o,-t/</th>
<th>IDENT-IO-T-HEAD</th>
<th>IDENT-IO-LO</th>
<th>IDENT-IO-[+raised]</th>
<th>OCP-T</th>
<th>{<em>[[-raised]/[+raised],</em>[-oblique]/[+oblique]}}ADJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>[-o,-t] [-o,-t]</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>[-o,+r] [-o,-t]</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>[+o,-r] [-o,-t]</td>
<td>*</td>
<td>*</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>[-o,-r] [+o,-r]</td>
<td>!</td>
<td>!</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>[-o,+r] [+o,-r]</td>
<td>!</td>
<td>!</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

(4) The illegitimacy of T1.T1 and T3.T3

OCP-T: Same tones are not adjacent.

*[-raised]: Low pitch is not allowed.

OCP-T is a constraint on the output tonal sequence, found in Tianjin, Xi’an, Chengdu, and Kunming etc [14]. *[-raised] is another markedness constraint which prefers high pitch to low.

(5) The illegitimacy of T1.T4 and T3.T2

*[-raised]/[+raised]: High pitch and low pitch are not adjacent.

*[-oblique]/[+oblique]: Levelness and obliqueness are not adjacent.

According to the Local Conjunction theory, [15] the above two markedness constraints may join into a composite. A form that violates both member constraints violates the composite. It functions to reduce the difficulties in articulation. {*[[-raised]/[+raised],*[-oblique]/[+oblique]}}._

The six constraints are ranked into the following hierarchy.

IDENT-IO-T-HEAD, IDENT-IO-LO, IDENT-IO-[+raised] >> OCP-T, {*[-raised]/[+raised],*[-oblique]/[+oblique]}}._ >> *[-raised]

We are now ready to see that the hierarchy of constraints we have posited is able to produce only those manifested forms. Take the input of T1+T1, and T2+T3 for example. Six out of sixteen possible candidates are listed for space reasons.

6. Conclusions

Phonetic and auditory experiments are conducted on Raoyang tones. Analysis reveals that the tone sandhi patterns display LO opposition. The inadequacy of contour node in traditional tonal geometry is examined. The argument is that LO opposition is best represented as an equipollent feature, rather than a privative node. We propose that a new feature of LO is present in Raoyang tonology; the LO feature and a pitch feature are independent of each other.

To accommodate the compatibility of LO feature and the usually claimed contour node, and possibly other tonological constituents present across languages, we turned to the theory of contrastive hierarchy. The contrastive hierarchy of LO>>pitch is constructed to conform to the observation that it is only the pitch feature that undergoes change and that LO feature remains constant. OT-theoretical account allows us to see more clearly the role each feature plays in determining the output. The fact that the simple tonal structure consisting of LO and pitch features are sufficient to determine the correct output form can be seen as an argument for our proposal of the two features.

About the theory of contrastive hierarchy, a few remarks are called for here. It is inherently consistent with the underspecification theory. The introduction of hierarchy into the contrastive specification approach allows more flexibility in determining an underlying structure. A feature present in the phonology of one language may not be present in another and hence underlying structures may differ significantly from case to case. We assume that in analysis of various Chinese tone systems, LO, even the end of complex tones, in addition to the oft-cited phonological active constituents such as register, contour and pitch, are all possible candidates, to be
picked up by a language and organized into contrastive hierarchies. The first attempt has been made to apply contrastive hierarchy in the tonal analysis of a number of Chinese languages [8]. Investigation across a wide range of dialects to find out the extent to which the theory could be applied remains to be done, and interesting generalizations may emerge.

Finally, we should caution against the conflict between the contrastive hierarchy and the Universal Grammar Hypothesis. While UG in generative grammar posits that features are unlearnable and biologically endowed, contrastive hierarchy claims that features are generalized from observed sound patterns. If features in UG are universal, features in contrastive hierarchy are emergent [16].

7. Note

Citation tone patterns and F0 curves in some disyllabic sequences: