DONAHUE: PERCEPTUAL SALIENCE IN TONGUE

1. Overview of the total system

The prototype of a Chinese tone is often described as a post-alveolar affricate with an open back vowel. However, this description is not accurate. Chinese tones are produced by changes in the tongue position and tongue posture, and they are not influenced by the articulatory movements of the lips or the jaw.

2. Tone Sandhi

In Chinese, tones are not independent sounds but are part of a larger system of tone sandhi, which involves the interaction of tones. Tone sandhi occurs when two or more tone-bearing syllables are produced in rapid succession. The resulting tone may be different from the original tones of the individual syllables.


Chan's work on the perception of tones in Chinese has been influential. His research has shown that the perception of tones is not based on the physical characteristics of the sound, but rather on the perceptual salience of the tones.

Table 3. Chan's tone feature assignments

<table>
<thead>
<tr>
<th>Tone</th>
<th>Feature</th>
<th>Value</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H</td>
<td>-</td>
<td>H</td>
</tr>
<tr>
<td>2</td>
<td>L</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>3</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>4</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

4. Donaldson (1992a) shows that the salience of a tone is determined by the perceptual salience of the tone itself, and not by the linguistic context in which it occurs.

5. Other studies have shown that the perception of tones is influenced by factors such as the pitch range of the tone, the duration of the tone, and the context in which the tone is produced.

Table 4. Syllable-to-tone assignments

<table>
<thead>
<tr>
<th>Syllable</th>
<th>Tone 1</th>
<th>Tone 2</th>
<th>Tone 3</th>
<th>Tone 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Syllable-to-tone assignments after Chan

Chan proposes that the perception of tones is influenced by the context in which they are produced. In his model, the context is represented by the tonal pattern of the preceding tones.

1. Final L deletion rule: L H L H
2. Initial L deletion rule: L H L
3. HL deletion rule: H H L
4. Tone lengthening rule: L H L H L

6. Other studies have shown that the perception of tones is influenced by factors such as the pitch range of the tone, the duration of the tone, and the context in which the tone is produced.

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10. Other studies have shown that the perception of tones is influenced by factors such as the pitch range of the tone, the duration of the tone, and the context in which the tone is produced.
5. Sandhi-2: Delay Rule: L→H L → H L
6. LHS: Disambiguation Rule: H L → H H

Then the OCP applies. Then some pitch lowering rules:
- a. H-deleting and lowering: H HLL → H H L
- b. H-lowering: H LLL → H L L
- c. L-deleting: HL → HM

These are all the rules that Chan used in her analysis. In fact, Chan (1985) also gives an account of the tone system of the 5- and 6-syllable expressions. However, I restrict the phenomena discussed in this paper to the epenthetic words. Next I will give an overview of Yip's 1990 proposal for the disyllabic tone sandhi.

2.3. M. Yip (EXPERIMENT)

The data that Yip uses are gathered from other sources, and are nominally different from Chan's data. Yip uses two features to describe the tones and to account for the sandhi changes: Register (Epenthetic) and Tone (Terminated). In Yip's analysis, Register is described as dominating Tones, interacting to define 4 pitch levels (a typologically desirable maximum).

<table>
<thead>
<tr>
<th>Register</th>
<th>Tone</th>
<th>+ upper (H)</th>
<th>+ high (H)</th>
<th>+ lower (L)</th>
<th>+ high (L)</th>
</tr>
</thead>
</table>

Table 4. Interaction of Register and Tone

Another typological consideration that was able to be explained by the use of register was the maximum of two of any given contour.

* Though these generalizations are in fact dispensable to some extent, the difficulty being when (if at all) not can draw the line between phonetics and phonology.

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1. Register Ranking: Register → [+upper]
2. LHL-Disambiguation: LHL → L H L
3. T-Denotation: T → H [+] upper
4. L-Extending: [H] L → H [H] H L
5. H-I deletion: HL → H L
6. L-Disambiguation: [+] upper → [+] closed larynx
7. Convexity Suppression: T → H [+] upper

There is an elegance in the analysis, but there remains the problem of phonetic opacity and unmarked motivation for the types of rules and their orders presented.

2.3. Summary

The two analyses capture the sandhi facts but occasionally must obscure the phonetic facts with their feature assignment, making the motivation for the natural classes and feature assigners either highly unnatural and seemingly arbitrary.

In the next section 1 will present new data for Fuzhou and an account of the tonal phenomena that is phonetically transparent, appealing to perceptual facts for motivation.

3. My data: citation tones

Douchet (1974a) presents quantified data for the citation tones (appropriately controlled for possibly influential sociolinguistic and phonetic variables: 4-speakers 2 men and 2 women were chosen). All speakers had been in Australia where the recordings were made about 2 years at the time, there were mostly the same socio-economic background, and had Fuzhou as their mother tongue and the language spoken at home while growing up. Tokens were phonetically controlled to all begin with a velar unaspirated consonant and included each of [H] [L] and [L] for each tone. About 20 repetitions (per speaker per token) were measured at significantly frequent percentage point intervals of absolute duration). These were then normalized across speakers in factor out between-speaker differences, and, factoring out on- and off-set perturbations we see left with:

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This is objective data representative of Fuzhou (or at least the variety spoken by these four speakers) as a whole.

2.3. Tone sandhi: a description

Below is a summary of the disyllabic tone sandhi data that I obtained, "translated" into the Chan tone letters.

<table>
<thead>
<tr>
<th>Syllable</th>
<th>Tone 1</th>
<th>Tone 2</th>
<th>Tone 3</th>
<th>Tone 4</th>
<th>Tone 5</th>
<th>Tone 6</th>
<th>Tone 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>[H] [H]</td>
<td>[H] [H]</td>
<td>[H] [H]</td>
<td>[H] [H]</td>
<td>[H] [H]</td>
<td>[H] [H]</td>
<td>[H] [H]</td>
<td>[H] [H]</td>
</tr>
<tr>
<td>[H] [L]</td>
<td>[H] [L]</td>
<td>[H] [L]</td>
<td>[H] [L]</td>
<td>[H] [L]</td>
<td>[H] [L]</td>
<td>[H] [L]</td>
<td>[H] [L]</td>
</tr>
<tr>
<td>[L] [H]</td>
<td>[L] [H]</td>
<td>[L] [H]</td>
<td>[L] [H]</td>
<td>[L] [H]</td>
<td>[L] [H]</td>
<td>[L] [H]</td>
<td>[L] [H]</td>
</tr>
<tr>
<td>[L] [L]</td>
<td>[L] [L]</td>
<td>[L] [L]</td>
<td>[L] [L]</td>
<td>[L] [L]</td>
<td>[L] [L]</td>
<td>[L] [L]</td>
<td>[L] [L]</td>
</tr>
</tbody>
</table>

Figure 10: Mean Normalized FO for Fuzhou citation tones
Table 8. Futhok tone sandhi forms

<table>
<thead>
<tr>
<th>Tone 4</th>
<th>Tone 2</th>
<th>Tone 3</th>
<th>Tone 2</th>
<th>Tone 3</th>
<th>Tone 4</th>
<th>Tone 2</th>
<th>Tone 3</th>
<th>Tone 2</th>
<th>Tone 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>21</td>
<td>44</td>
<td>44</td>
<td>21</td>
<td>33</td>
<td>25</td>
<td>21</td>
<td>35</td>
<td>23</td>
</tr>
<tr>
<td>21</td>
<td>44</td>
<td>44</td>
<td>21</td>
<td>35</td>
<td>23</td>
<td>21</td>
<td>35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.3. Total feature assignment

I will use Register (upper) and Tone (flattened) or (HL) features to represent these tones. I will however remain completely agnostic about their (highly controversial) phonetic relationship at this stage (as it does not make a difference to the results of this paper).

I define Register here according to the onset of the tone, with Tone 2 then defining the actual mid-range point. I have chosen to describe tone 2 as [upper] H (though it could actually have been [lower] L).

Figure 1b. The definition of Register in Futhok.

The [upper] register tones also have a creakybreathy phonation associated with them (notably not before reported in the literature). Not surprisingly this is stronger with the L onset tone, but is optically produced with the H onset tone. The creaky voice is probably also part of the reason why the [upper] register tones fall slightly.

Table 9. Total feature assignment

<table>
<thead>
<tr>
<th>Tone 4</th>
<th>Tone 2</th>
<th>Tone 3</th>
<th>Tone 4</th>
<th>Tone 2</th>
<th>Tone 3</th>
<th>Tone 4</th>
<th>Tone 2</th>
<th>Tone 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>21</td>
<td>44</td>
<td>21</td>
<td>44</td>
<td>21</td>
<td>35</td>
<td>23</td>
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</tr>
<tr>
<td>21</td>
<td>44</td>
<td>44</td>
<td>21</td>
<td>35</td>
<td>23</td>
<td>21</td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>

3.3. The Tone 4 alternations explained

For a long time the alternations of Tone 4’s sandhi tones have had mostly diachronic explorations. In my data it is clear. The Tone 4 syllable produced is normal in sandhi, without a glottal stop. Group with Tone 4 and Tones 1 and 3, whereas the others are actually produced with a glottal stop. These group with Tone 2 for their sandhi patterns. I believe that the presence of the glottal stop in sandhi position means that the tone is necessarily different as in sandhi (the glottal stop would have displaced the L tone), and that in a tone level would perceptually group better with Tone 2 as ‘mid’ tone, as they both end with a [upper] H tone.

The other natural classes consist of the ‘falls’ and what I will call ‘tens’, though the latter are also captured by ‘extreme’. I will return to this here.

Table 10 presents an impressionistic pattern of what is going on with Futhok tone sandhi.

Table 10. Impressionistic description of Futhok tone sandhi

<table>
<thead>
<tr>
<th>Second</th>
<th>TS</th>
<th>TF</th>
<th>T6, T8</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>49</td>
<td>M</td>
<td>L</td>
<td>N</td>
<td>H</td>
<td>M</td>
<td>L</td>
</tr>
</tbody>
</table>

3.4. Tones sandhi: perceptual salience

I was able to shed light on the natural classes relevant for Futhok tone sandhi by exploring the literature on the perception of tone. Conover (and others) in various of his papers finds the following to be perceptually salient aspects of linguistic tone in contour tone languages:

- height: average pitch
- direction: from A towards B (rise vs. fall)
- contour: basically (slow) or (fast)
- slope: magnitude of slope

Scholars have used various of these concepts, though without actually making the connection to the perceptual literature. Zhang (1997) makes use of the magnitude of the slope, and the use of fall could date back to much earlier works on tonal features (eg Wang 1967), but as far as I know no-one has made use of ‘average pitch height’.

I will explore direction (specifically fall) and height with the new Futhok data and show that they are relevant for the natural classes involved in tone sandhi. Specifically, for height I will be looking at the mid range average pitch.

Table 11. Perceptual description of Futhok tone sandhi

Note that for ease of exposition I have relabelled the features as follows:

- [upper]: L
- [lower]: H
- [mixed]: I

Table 11. Perceptual description of Futhok tone sandhi

In features, this translates to:

- [upper]: L
- [lower]: H
- [mixed]: I
3.7. Summary

A summary of my tone sandhi data is as follows:
1. Full enhancement: any tone \rightarrow non-local before fall
2. Dissimilation: mid tones \rightarrow dissimilation in Regime OR Tone
3. Tonal boundaries: [il] preferred for non-prosodic; Extreme tones become H.
4. Box as fall in non-prosodic syllables (tone features and assimilate)

Assimilation:
Unless you’re dissimilating, assimilate to the next of falling tone.

4. Conclusion

I believe that tone sandhi is driven by perceptual salience and that is best understood the principles involved in dissimilating the phonemes, we should first understand the targets that the speakers perceive, and thus must try to produce.

In this paper I have used Fuzhou tone data as a case to illustrate this point. Through a discussion of Fuzhou tone sandhi data, I have shown how data about perceptual salience of linguistic tone has shed some light on understanding the natural classes relevant for understanding the tone sandhi alternations in Fuzhou. Several sandhi changes which were previously harder to explain may be seen as natural perceptual enhancements. Finally, these perceptually oriented natural classes and future work would help themselves well to an Optimality Theoretic account of the tone sandhi phenomena.

References:


DONALDSON, CATHRYN. An OT account of Fuzhou tone sandhi. ms. Stanford University.

Theoretical Implications of Huaqia Rime Change

Yen-Huai Liu
Michigan State University

The Huaqia dialect of Hua in China (Hua 1982a, 1982b) exhibits numerous tones, and it’s rime structure in these morphophonemic elements is known to be complex, with both free and bound rimes. In this paper we focus on the implications of Huaqia rime change. We argue that Huaqia rime change is driven by Optimality Theory (OT), specifically the principles are (1) Optimality Theory and (2) Optimality Theory. The implications of Huaqia rime change are (1) Optimality Theory and (2) Optimality Theory.

1. Introduction

In this paper I discuss some issues that arise when Optimality Theory (OT) is adopted to analyze alternations among Huaqia affixations. The points of OT are summarized in (1).

(1) Optimality Theory

a. OT provides a set of constraints that are universal and universally present in all grammars.

b. Constraints are viable; but violation is minimal.

c. The constraints are ranked on a language-particular basis. A grammar is a ranking of the constraints.

d. The constraint hierarchy evaluates a set of candidate analyses that are admitted by a very general consideration of structural well-formedness.

e. Non-attitudes of the constraint hierarchy are compared over the whole relative frequency and the whole candidate set. There is no serial deviation.

f. The universal constraints that OT admits include (1) Optimality Theory and (2) Optimality Theory constraints that require identity between input and output, between a subpattern and its base, and among morphologically related words. (2) The markedness/faithfulness constraints on the output, and (3) the alignments constraints that match the edges of phonological and morphological categories. These constraints are minimally violated and ranked on a language-particular basis. These output features are then selected through evaluation of a set of ranked universal constraints. The output in (3) illustrates how an output is selected through constraint evaluation. Given the constraint ranking A > B > C, and input k = C, the optimal output is because it violates the lowest ranked constraint.

I would like to thank the audience at LACL/INACL-15 for their comments and suggestions.