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Jean Ann
Kyoko Yoshimura

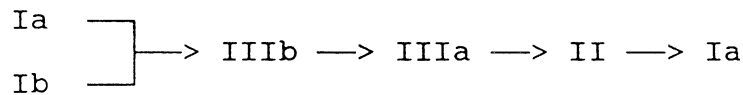# Tone Alternation in Taiwanese[*]

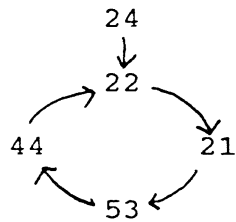Jane S. Tsay

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1. Introduction

This paper deals with tone alternation in Taiwanese, an Amoy dialect of the South Min family of Chinese spoken in Taiwan. The tone alternation (or tone sandhi) in Taiwanese forms a circle, known as the South Min Tone Circle, which is given by Bodman (1955) as in (1a) and by Chen (1987) as in (1b).

(1) South Min Tone Circle

    a. Bodman (1955)[1]

$$\left.\begin{array}{l} \text{Ia} \\ \text{Ib} \end{array}\right\} \longrightarrow \text{IIIb} \longrightarrow \text{IIIa} \longrightarrow \text{II} \longrightarrow \text{Ia}$$

    b. Chen (1987)

Previous studies have tried to formalize this alternation but have failed to propose an elegant solution. For example, Wang (1967) proposes the rule in (2).

(2) Tone Sandhi Rule for Amoy (Wang 1967)

$$\begin{bmatrix} \alpha \text{ HIGH} \\ \beta \text{ FALLING} \end{bmatrix} \longrightarrow \begin{bmatrix} \beta \text{ HIGH} \\ -\alpha \text{ FALLING} \end{bmatrix}$$

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[1] Bodman labels the five tones as Ia, Ib, II, IIIa, and IIIb for historical reasons.

This rule is unnatural and not explanatory.

Likewise, Yip (1980) proposes three rules for this single process. The problems with her rules will be discussed in detail later.

In this paper, I propose a new solution to the problem of the South Min Tone Circle. Two theoretical issues are relevant: the abstractness of the underlying representation and the role of principles and constraints. I claim that by leaving most of the work to the underlying representation and universal and language-specific principles and constraints, the rule for tone alternation in Taiwanese can be greatly simplified.

2. The phenomenon of Taiwanese tone alternation

Many works have discussed the alternation in Taiwanese, for example, Wang (1967), Cheng (1968, 1973), Yip (1980), Hashimoto (1982), Wright (1983), Shih (1986), Tsay (1989), Bao (1990), and Duanmu (1990), among others.

The phenomenon of tone alternation in Taiwanese is that every morpheme (mostly monosyllabic) has two alternating tones: one shows up in context environments, while the other shows up in prejuncture environments (including in citation). The definition for the prejuncture position involves syntactic and/or rhythmic factors which are not at issue here. See for example Chen (1987) and Hsiao (1990) for detailed discussions.

This alternation can be schematized as in (3), where T stands for the prejuncture tone, t for the context tone, and # for the juncture.

(3) Prejuncture/context tone alternation in Taiwanese

$$t \quad t \quad t \quad T \quad \# \quad t \quad t \quad t \quad t \quad T \quad \# \quad ...$$

There are seven surface tones in Taiwanese. Five of them are long, and two of them are short and can only appear with syllables ending in obstruents. Tsay (1989) argues that the two short tones are derived from the long tones; hence they are not discussed here.[2]

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[2] The phonetic values of these tones vary among studies and subdialects (see Weingartner 1970 for an overview). For example, some report Tone I as 55, while some report it as 44. (The digit numbers follow Chao (1930) where 5 denotes the highest pitch and 1 the lowest.) However, from the phonological point of view, it is quite consistent as being a High tone in the language. Another example is the rising tone which is reported as 12 (Lo 1930), 14/24 (Tung 1958), 14 (Tung et al. 1967), 24 (Ting 1970), 34 (Weingartner 1970). Since there is only one rising tone in this language and the tone alternation is not sensitive to the value of the neighboring tones, it seems reasonable to assume that the rising tone is underlyingly a LH contour. The same argument applies to the falling tone, which should be analyzed phonologically as HL.

(4) Tone inventory in Taiwanese[3]

	I	II	III	IV	V
Prejuncture form	H	LH	HL	L	M
Context form	M	M	H	HL	L
Example	ts'ia	lai	man	se	min
Gloss	car	come	pluck	small	face

Examples are given in (5), where the prejuncture (specifically, in these examples, citation) forms are given in the left-hand column and the same words in compounds/phrases (i.e. in context) are given in the right-hand column.

(5) Examples

           Prejuncture   Context

a.   ts'ia^H ts'ia^M – len^{HL}
     "car"   "wheel"

b.   lai^{LH} lai^M – tse^M
     "come"   "come sit"

c.   man^{HL} man^H – hue^H
     "pluck"   "pluck flowers"

d.   se^L se^{HL} – tsaŋ^{LH}
     "small"   "small plant"

e.   min^M min^L – pɔ^L
     "face"   "towel"

---

[3] Consonant Inventory of Taiwanese

	-aspirated	+aspirated		
Labial	p	p'		m
Dental	t	t'		n
Alveo-palatal	ts	ts'	s	
Velar	k	k'		ŋ
Glottal	?		h	

The obstruents in Taiwanese are redundantly voiceless. The only voiced consonants are sonorants: m, n, and ŋ. /m/, /n/, and /ŋ/ are denasalized before non-nasal vowels and surface as [b], [l]/[dz], and [g], respectively. They are [m], [n], [ŋ] before a nasalized vowel or in coda position (see Tung 1958, Ting 1970, Zhang 1983). /ts/, /ts'/, /s/ are palatalized before the high front vowel /i/.

There are six oral vowels /i, e, a, ɔ, o, u/ and four nasal vowels /ĩ, ẽ, ã, ɔ̃/.

3. Two detours

There are two issues that need to be discussed before we formalize the tone alternation rule. The first one is the correlation between tone and voicing and the second one is the direction of the tone alternation.

3.1. Tone and voicing correlation

The distribution of tone shows sensitivity to the voicing (or laryngeal properties) of the onset consonant. That is, Tone I and Tone IV only appear with voiceless onsets, while other tones can appear with both voiceless and voiced onsets. (Note that in this language all obstruents are voiceless, and all sonorants are voiced, as mentioned in Footnote 3 above.)

(6) The distribution of tones with respect to onset voicing[4]
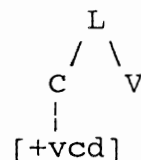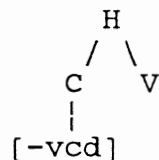   (The blanks stand for the nonexistence of such cases.)

Tone	I	II	III	IV	V
-voiced onset (obstruents)	X	X	X	X	X
+voiced onset (sonorants)	☐	X	X	☐	X

This distribution suggests that tone is sensitive to voicing. As has been proposed in many studies, there is a correlation of vowel pitch and the voicing properties of the preceding consonant (see, for example, Halle & Stevens 1971, Hyman 1973, Hombert 1978, Laughren 1981). Specifically, the pitch of the vowel is higher when the preceding consonant is voiceless than when the preceding consonant is voiced. Following the studies mentioned above, we assume that the laryngeal features responsible for voicing affect the following vowel and result in a higher or lower pitch, depending on whether the consonant is voiceless or voiced. This is shown in (7).

(7) Consonant and Vowel Correlation

    a. [-vcd] C -> high pitch   b. [+vcd] C -> low pitch

```
         H                        L
        / \                      / \
       C   V                    C   V
       |                        |
     [-vcd]                   [+vcd]
```

---

[4] There are exceptions to this distribution, for example, mī[H] "grasp with all five fingers". However, these exceptions generally do not have Chinese characters, implying that they are borrowings (cf. Norman and Mei 1976).

Presumably, this is true for all languages (see, for example, Nearey 1989). However, in non-tone languages, the pitch/vowel correlation would not have any phonological effect, whereas in the case of tone languages, since vowels carry distinctive tones themselves, the pitch/vowel correlation will have a phonological effect. For example, if the vowel carries a lexical high tone, the syllable with a voiced onset might end up having a Low-High tone, that is, a rising contour tone. This is shown in (8a). However, as shown in (8b), if the vowel carries a lexical low tone, there would be no effect. That is, either the two L's merge or the spreading of L is ruled out by the Obligatory Contour Principle (McCarthy 1986, Yip 1988, among others).

(8) The phonological effect of the voiced onset

    a. on a high-toned vowel   b. on a low-toned vowel

```
        L H                    L L
       / \ |                  / \ |
      C   V                  C   V
      |                      |
   [+vcd]                  [+vcd]
```

Assuming Radical Underspecification (Kiparsky 1982, Archangeli 1984, Archangeli and Pulleyblank 1989), only one value of voice ([+voiced] in this case) is present underlyingly. Hence, in the case of a voiceless onset, there will also be no effect of the voicing property, as shown in (9).

(9) No phonological effect of the voiceless onset

    a. on a high-toned vowel   b. on a low-toned vowel

```
        H                         L
        |                         |
    C   V                     C   V
```

This seems to be the case in Taiwanese. In prejuncture form, only Tone II can appear with sonorant initials, which are the only voiced consonants in this language. If we assume that the obstruent initials which appear with Tone II are underlyingly voiced and are devoiced later[5], Tone II can only appear with a voiced onset, while Tone I only appears with a voiceless onset. These two tones are in complementary distribution, hence can be collapsed into one. In other words, Tones I and II are underlyingly one tone, namely the High tone. Due to the effect of the onset voicing on the following vowel, as demonstrated in (8) and (9), syllables with a voiceless onset would show up as High (i.e. Tone I) and syllables with a voiced onset show up as Low-High (i.e. Tone II).

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[5]   This suggestion actually goes with the diachronic tendency of devoicing in this language.

Another piece of evidence that supports this hypothesis is
that both Tones I and II have the same context form (i.e. M).
Therefore, we conclude that Tones I and II are actually one tone
and name it Tone I&II.

(10) Tone I&II

```
                  Tone I&II
   Context           M
   Prejuncture       H
```

The prejuncture form of this tone then surfaces as two
variants, H and LH, depending on the underlying voicing of the
onset consonant.

(11)   Tone I&II in prejuncture form (UR for underlying
        representation and SR for surface representation)[6]

Tone I&II			
	-vcd onset (obstruent)	+vcd onset (obstruent)	+vcd onset (sonorant)
UR	H	H	H
SR	H (Tone I)	LH (Tone II)	LH

The voiced obstruents can never surface as voiced due to the
feature cooccurrence constraint in (12), and are neutralized with
voiceless obstruents.

(12) Feature Cooccurrence Constraint

    *[-sonorant, +voiced]

The tone-voicing correlation does not affect Tone III because
it is a contour tone which already has two tonemes underlyingly.
As for Tone IV, which is a low tone, there would be no effect, as
shown in (8b) and (9b), and it shows up as low no matter if the
initial consonant is underlyingly voiced or voiceless. Tone V has
the default tone M and is toneless underlyingly. Hence it would
not be affected either.
    To sum up, in this section I have argued that Tones I and II
are underlyingly one tone. Morphemes appearing with Tone II have
underlying voiced onsets. However, obstruents never surface as
[+voiced] due to the feature cooccurrence constraint in (12).

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[6]   Since the prejuncture form is in the postlexical level, the UR here is
actually the input to that level, and SR the output.

The tone inventory now appears as in (13).

(13) Tone Inventory (replace M with $\varnothing$, assuming M is the
      default tone)

	Tone I&II	Tone III	Tone IV	Tone V
Context	$\varnothing$	H	HL	L
Prejuncture	H	HL	L	$\varnothing$

3.2. The direction of alternation

The second apparent detour is about the direction of
alternation.   That is, is the context form basic and the
prejuncture form derived or the other way around? It seems to be
more plausible to assume that the context form is basic and the
prejuncture form is derived from the context form for the following
reason.

The context tone is not sensitive to the value of the
neighboring tones, as shown in (14). The word for "bowl" has a HL
tone in citation (i.e. in prejuncture position), as in (14a). It
shows up as a H tone in context (14b-d) no matter what the values
of the neighboring tones are.

(14) a. $u\bar{a}^{HL}$ #   "bowl"

      b. $tua^{L} - u\bar{a}^{H} - ko\eta^{H}$ #   "big bowl"
           (big - bowl - grand)

      c. $se^{H} - u\bar{a}^{H} - ti^{M}$ #   "do the dishes"
           (wash - bowl - chopsticks)

      d. $k'i\eta^{M} - u\bar{a}^{H} - te^{HL}$ #   "eat up the food"
           (to clean - bowl - bottom)

If we were to assume that the context form is derived from the
prejuncture form, we would have trouble defining the conditioning
environment.

However, if we assume that the prejuncture form is derived
from the context form, we may propose the juncture as the
conditioning environment. Hence we conclude that the direction of
alternation is from context form to prejuncture form.[7]

(15)   The direction of alternation (T_{con} for context tone, T_{pre}
       for prejuncture tone, # for juncture)

       $T_{con} \quad \text{-->} \quad T_{pre} \quad / \underline{\quad} \#$

---

[7]   Ting (1982), Hashimoto (1982), and Ho (1984) have made the same proposal
for independent reasons.

The tone alternation is given in (16).

(16) Context tone (basic) --> prejuncture tone (derived)

	T_{con}		T_{pre}
Tone I&II	$\emptyset$	-->	H
Tone III	H	-->	HL
Tone IV	HL	-->	L
Tone V	L	-->	$\emptyset$

The South Min Tone Circle now appears as in (17).

(17) The South Min Tone Circle

```
∅ ------> H
↑         |
|         |
|         v
L <------ HL
```
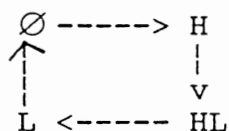
4. The new explanation of the South Min Tone Circle

At least three generalizations can be drawn from the circle in (17). These generalizations are given in (18).

(18) Generalizations

   a. The set of context tones is the same as the set of prejuncture tones. That is, no new tone is created through tone alternation.[8]
   b. Only one toneme is deleted or inserted at one time. For example, $\emptyset$ -> HL is not allowed.
   c. There is no exchange of tones. That is, $\emptyset$ -> H and H -> $\emptyset$ cannot both apply.

Interestingly, there are independently motivated principles and constraints that account for the generalizations in (18).

(19) **Contrast Preservation Principle**[9]: Tone contrast in the language must be preserved. Hence no new tone is created through tone alternation. (cf. Structure Preservation (Kiparsky 1985))

(20) **Rule Argument Constraint:** Feature changing is prohibited. Phonological rules can only manipulate one argument per rule (implicitly assumed in Goldsmith 1976, Clements 1985, Sagey 1986, Archangeli and Pulleyblank (to appear)).

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[8] As pointed out by Doug Pulleyblank (pc), the triple reduplication in Taiwanese creates a rising tone which is slightly higher than the lexical rising tone. However, this does not happen in the context/prejuncture tone alternation.

[9] Thanks to Alan Prince for suggesting this term.

(21) **Exchange Rule Constraint:** Exchange rules are not allowed i.e. * A $\xleftarrow{\text{----}}$ B (Anderson & Browne 1973).[10]

Under the Contrast Preservation Principle (19), no new tone is created through tone alternation. In other words, when tone alternation occurs, each tone can only choose an alternating tone from the already existing tone inventory. This is shown in (22).

(22) Step one: apply (19)

```
Ø   -->   {H, HL,  L}
H   -->   {Ø, HL,  L}
HL  -->   {Ø, H,   L}
L   -->   {Ø, H,  HL}
```

According to the Rule Argument Constraint (20), a rule can only manipulate one argument at a time. Since Ø -> HL and HL -> Ø would require deleting two tonemes, these two are ruled out. H -> L and L -> H are also ruled out because they require a deletion and an insertion (i.e. feature changing).

(23) Step two: apply (20)

```
Ø   -->   {H,   L}
H   -->   {Ø, HL}
HL  -->   {H,   L}
L   -->   {Ø, HL}
```

Now there are two choices left, Ø -> H or Ø -> L. This language chooses Ø -> H. The Tone Alternation Rule is thus as in (24).

(24) Taiwanese Tone Alternation Rule

Ø --> H

This gives the result in (25).

(25) Step three: apply (24)

```
Ø   -->   {H}
H   -->   {Ø, HL}
HL  -->   {H,   L}
L   -->   {Ø, HL}
```

---

[10]   Nick Clements (pc) pointed out to me that Palestine Arabic might be a counterexample.

The Exchange Rule Constraint in (21) would prohibit H from choosing ∅ because it would create an exchange rule ∅ ⇌--> H. Hence H can only choose HL. By the same constraint, HL would have to choose L, and L would choose ∅. This gives the final result, as in (26), which is exactly the South Min Tone Circle.

(26) Step four: apply (21)

```
∅  -->   {H }
H  -->   {HL}
HL -->   {L }
L  -->   {∅ }
```

In summary, I have shown that the tone alternation in Taiwanese follows from one principle and two constraints. The tone alternation rule itself is simply "Insert H".

By contrast, Yip's analysis of Taiwanese tone alternation requires three rules, which are given in (27). Unlike the analysis proposed above, she assumes Tone I and Tone II are underlyingly two distinct tones. Also she assumes that the direction of alternation is from prejuncture tone to context tone. Another difference is that for her the rising tone is LM, instead of LH as in the above analysis. Therefore, she has five long tones: H, LM, HL, L, and M. The alternation is like those in (1): H/LM -> M -> L -> HL -> H. First, the Register Switch Rule (27a) derives H -> M and M -> L. Then, the Recessive Deletion Rule (27b) derives HL -> H and LM -> M. Finally, the Dissimilation Rule (27c) derives L -> HL.

(27) Taiwanese tone sandhi rules (Yip 1980, pp. 324-326)

a. <u>Register Switch</u> (H -> M, M -> L)

$[\alpha$ upper] --> $[-\alpha$ upper] / $\underline{\quad\quad}$
$$\begin{array}{c} /\backslash \\ \beta T \quad \beta T \end{array}$$

b. <u>Recessive Deletion</u> (HL -> H, LM -> M)

$-\alpha$ H ---> ∅ // α H

c. <u>Dissimilation</u> (LL -> HL)

L --> H / $\underline{\quad}$ $\overset{/\backslash}{\quad}$ L

This analysis misses the important point that tone alternation in Taiwanese is one single process.

5. Conclusions

In this paper, I have argued that although obstruents in Taiwanese surface as voiceless, the distribution of tone shows that some obstruents are underlyingly voiced. I have also shown that the seemingly mysterious South Min Tone Circle actually follows from one principle and two constraints. After leaving most of the work to the principle and constraints, the tone alternation rule in Taiwanese is a very simple one -- Insert H.

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