Tonal chain shifts in Taiwanese: A comparative markedness approach*

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This paper discusses tonal chain shifts in Taiwanese from the perspective of comparative markedness. The tone circle in this language considers old tone markedness violations more serious than new tone markedness violations. This is referred to as "anti-grandfathering effects," which motivate the circular chain shifts. This paper also argues for local conjunction to work with comparative markedness; new tone markedness constraints are locally conjoined with tone feature faithfulness constraints. The WOW (worst-of-the-worst) effects provide a direction for the tone circle. The employment of comparative markedness offers a fresh angle from which to examine tone sandhi across Chinese dialects, and makes antifaithfulness and contrast preservation dispensable.

Keywords: tone sandhi, chain shift, comparative markedness, Taiwanese, local conjunction, Optimality Theory

1. Introduction

This paper discusses tonal chain shifts in Taiwanese, which are opaque in two ways. First, the output of a tone shift is often identical to another input, and thus the mappings of tones cannot be described by markedness. Second, some of the tone shifts change the register but retain the contour, while others alter the contour but preserve the register.[1]

The present research takes its perspective from comparative markedness (McCarthy 2003), and engages in the pursuit of three

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[1] Many Taiwanese youngsters have lost their native intuition due to the close contact between Taiwanese and Mandarin for over sixty years. In particular, those living in Northern and Central Taiwan often lack intuition of Taiwanese tone sandhi. Such speakers could be the reason why J. Zhang et al (2001) suggests that Taiwanese tone sandhi is not productive. It should be noted that the majority of Taiwanese (including the author) commonly perform the tone sandhi, especially those aged 40 or older and those from Southern Taiwan.

questions. What motivates tonal chain shifts? What is the grammar that predicts specific tone shifts? And what governs tone retention?

The rest of this paper is organized as follows. Section 2 introduces the tonal basics and the tone circle. Section 3 proposes a comparative markedness analysis in relation to local conjunction. Section 4 comments on two alternative analyses, antifaithfulness and contrast preservation. Section 5 offers the conclusion.

2. The Tone Circle

The representation of tone has been probed widely (Yip, 1980, 1989, 2002; Inkelas 1987; Snider 1990; Duanmu, 1990, 1994a; Hyman 1993; Bao, 1990, 1999, among others). Most studies agree that a tone consists of two proportions, *register* and *contour*. For the purpose of discussion, I adopt a tone structure like (1) and assume a contour tone unit (other geometric representations of tone will work for the following discussions as well).

(1)   Representation of Tone

T	Tone Root
|	
r	Register
t₁ t₂	Contour (Tone Melodies)
| |	
μ μ	Mora
σ	Syllable
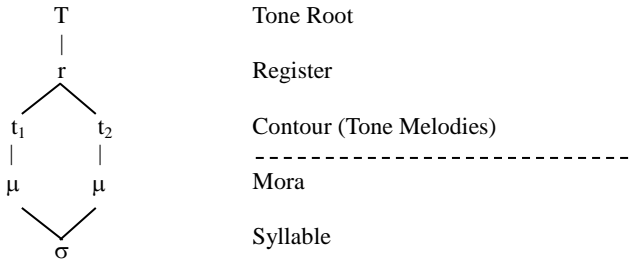
Several notations are used to represent tones in this paper; Hr stands for high register, and Lr⁻ for low register; h stands for a high tone melody, and l for a low tone melody. There are five smooth tones in this language, where each base tone corresponds to a specific sandhi tone, as listed in (2). [2]

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[2] A smooth tone, or a long tone, is a tone carried by an open syllable or a syllable that ends in a sonorant. A checked tone, or a short tone, is a tone carried by a closed syllable which ends in a voiceless stop, such as [p], [t], [k], and [ʔ]. Several works, such as Xu et al (1981), Qian (1992), Hsieh (2005), H. Lin (2011) and others, have observed in Chinese dialects that there is some kind of allophonic relationship between a checked tone and a certain smooth tone. Namely, the smooth tone is borne by a smooth syllable, while its checked counterpart

(2) Smooth tones in Taiwanese[3]

Tone Categories	Base Tones	Sandhi Tones	Examples of Tone Sandhi	Gloss
Yin Ping	H[Hr, h]	M[Lr, h]	a. *kim*[Hr, h]→ [Lr, h] *tseng*[Hr, h]	'gold brick'
Yang Ping	LM[Lr, lh]	M[Lr, h]	b. *thao*[Lr, lh]→ [Lr, h] *nao*[Lr, lh]	'brain'
Shang	HM[Hr, hl]	H[Hr, h]	c. *tsao*[Hr, hl]→ [Hr, h] *lo*[Lr, h]	'to flee'
Yin Qu	ML[Lr, hl]	HM[Hr, hl]	d. *ai*[Lr, hl]→ [Hr, h] *khun*[Lr, hl]	'sleepy'
Yang Qu	M[Lr, h]	ML[Lr, hl]	e. *bin*[Lr, h]→ [Lr, hl] *phue*[Lr, lh]	'face skin'

In a disyllabic string, the left syllable surfaces with a sandhi tone while the right syllable retains its base tone. In other words, the left tone is the sandhi position, where tone shifts occur. The right tone is subject to domain-final retention, which will be addressed in section 6. Some examples of the tone shifts are shown in (2a-e), where the data are presented in italic Romanization with a few modifications: *ph*, *th* and *kh* respectively stand for the aspirated stops [pʰ], [tʰ] and [kʰ], and *ng* for the velar nasal [ŋ].

The mid tone in this language has been treated differently in the literature: either as the high end of the low register, [Lr, h], or as the low end of the high register, [Hr, l]. There are four analyses of the mid tone. First, Bao (1999) suggests that the underlying mid tone is of low register, but the derived surface mid tone is high-registered. According to Bao, the derivation of [Hr, l] offers the advantage of rule economy, as shown in (3).

(3) a.   [Hr, lh] → [Hr, l]   high rising to mid
     b. [Hr, h] → [Hr, lh] → [Hr, l]   high to mid

High rising tone, [Hr, lh], shifts to [Hr, l], as in (3a), and high tone, [Hr, h], also shifts to [Hr, l] via [Hr, lh], as in (3b). Bao indicates that the derivation of [Lr, h] is not preferred because it would entail extra rules. While Bao's proposal requires fewer rules, it encounters a problem with the high register specification of the rising tone, which in Taiwanese (or Xiamen) is usually known as low rising, [Lr, lh] (Yip 1980; Ang 1985; Horwood 2000, among others).[4] A second analysis is to allow the mid

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by a checked syllable. The checked tones are thus omitted here.

  [3] In terms of Chao's (1930) numerical tone notation, 5 represents the highest pitch and 1 represents the lowest. In this paper, H represents a high level tone, 55; HM a high falling tone, 53; M a mid level tone, 33; ML a low falling tone, 21, and LM a low rising tone, 13.

  [4] High rising clusters, MH-H, are generated only on the leftmost syllable in trisyllabic reduplication, which forms a higher tonal contour and longer duration (Ou 1996; Hsiao 1999).

tone to be phonologically unspecified, as Yip (2001) suggests; in this spirit, the mid tone does not possess a phonological target and its phonetic pitch should be variable in different contexts. However, the tone height of the mid tone in Taiwanese is constantly midway between high and low, a fact indicating that the mid tone has a phonological target. Third, Hsieh (2005) considers the mid tone to be a high register tone, which enables him to maintain that high register specification is preserved in the chain shifts. In that case, the tone shifts would change features inconsistently; some would change both register and contour while others change only one of them. Finally, based on a survey of folk verses, names and trisyllabic reduplications, H. Hsu (2008) argues that the mid tone is a low register tone, which occurs in the final, prominent position far less often than the high register tones. This paper also posits the mid tone in Taiwanese as the high end of low register so that the tone mappings change either register or contour but not both. The chain shifts exhibit a **tone circle**, as in (4).

(4)   Taiwanese tone circle
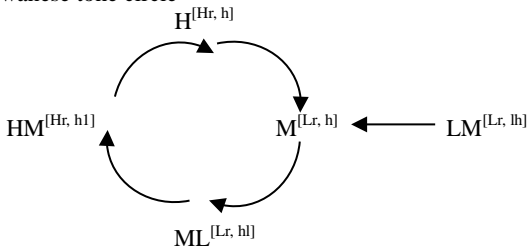
Taiwanese sanctions no LM in sandhi position. The avoidance of LM forces this tone to enter the tone circle. The spinning of the tone circle indicates two patterns. First, it changes exactly one feature, register or contour, but not both. Second, a base tone, regardless of its tonal value, is banned in sandhi position, but the same tonal value can appear as a sandhi output of another tone. I will show in the following section that this asymmetry is keyed to comparative markedness.

3. A Comparative Markedness Approach

McCarthy (2003) proposes a theory of comparative markedness to account for opacity. This theory distinguishes two kinds of markedness violations: old markedness violations, which are shared with the fully faithful candidate (FFC), and new markedness violations, which are not

shared with the FFC. Comparative markedness is rooted in two notions, violation locus and t-correspondence. The violation locus refers to the spot in an output candidate where a markedness constraint is violated. The t-correspondence relates two output candidates through a transitivized correspondence by way of a shared input. This section will look into the tonal chain shifts in Taiwanese from the perspective of comparative markedness, and probe into cross-linguistic evidence.

3.1 Anti-grandfathering Effects

As McCarthy (2003) suggests, a language may tolerate marked structures that are inherited from the input, but ban the same structures that are invented in the output. This is referred to as **grandfathering effects**. On the other hand, a reversal of grandfathering effects, hereafter **anti-grandfathering effects**, is also feasible: a language may prohibit marked structures that are inherited from the input but sanction the same structures that are newly created. Grandfathering effects are derived environment blocking of the otherwise applicable rules, while anti-grandfathering effects may serve as non-derived environment blocking. Comparative markedness essentially captures these issues of derived/non-derived environmental asymmetries. I observe in Taiwanese that anti-grandfathering effects block the emergence of non-derived tones; particularly, the sandhi position (i.e., the non-final position) forbids a base tone but allows a sandhi tone of the same value. Consider (2c) and (2d). The left syllable *tsao* in (2c) cannot carry an output HM, which is fully faithful to its input, but the left syllable *ai* in (2d) has no problem surfacing with an HM, which is mapped from ML. In terms of comparative markedness, I posit two versions of the markedness constraint *T (No-Tone), $*_O T_i$ and $*_N T_i$, whose locus functions are given in (5-6), where the subscripted $_O$ stands for old, and the subscripted $_N$ for new.

(5) $*_O T_i$ (CAND, FFC, $\Re_t$): Let $\text{LOC}_i(\text{CAND}) = \{c_1, c_2, c_3, ...\}$ and let $\text{LOC}_i(\text{FFC}) = \{f_1, f_2, f_3, ...\}$. For each T_m that has a t-correspondent among f_n, assign one violation mark.

(6) $*_N T_i$ (CAND, FFC, $\Re_t$): Let $\text{LOC}_i(\text{CAND}) = \{c_1, c_2, c_3, ...\}$ and let $\text{LOC}_i(\text{FFC}) = \{f_1, f_2, f_3, ...\}$. For each T_m that lacks a t-correspondent among f_n, assign one violation mark.

The base tone of *tsao*, HM, in (2c) violates $*_O T$, whereas the sandhi tone of *ai*, HM, in (2d) violates $*_N T$. The fact that only the new HM in (2d),

but not the old HM in (3c), is sanctioned in the output requires $*_O T$ to be ranked above $*_N T$, while the faithfulness constraints in (7-8) should be ranked in between.

(7) IDENT-REGISTER (ID-R)
    Assign a violation mark for every register specification in the input that
    is changed in the output.

(8) IDENT-CONTOUR (ID-C)
    Assign a violation mark for every contour specification in the input that
    is changed in the output.

    I propose the partial constraint ranking in (9).

(9) $*_O T \gg$ ID-R, ID-C $\gg *_N T$

This constraint ranking correctly predicts that an output HM emerges in (11) but not in (10); HM fatally violates the top-ranked $*_O T$ in (10), but violates only the lower-ranked ID-R and $*_N T$ in (11).

(10) Input: $HM^{[Hr, hl]}$-T   Output: $H^{[Hr, h]}$-T   = (2c)

	$*_O T$	ID-R	ID-C	$*_N T$
a. $HM^{[Hr, hl]}$	*!			
☞b. $H^{[Hr, h]}$			*	*

(11) Input: $ML^{[Lr, hl]}$-T   Output: $HM^{[Hr, hl]}$-T   = (2d)

	$*_O T$	ID-R	ID-C	$*_N T$
☞a. $HM^{[Hr, hl]}$		*		*
b. $ML^{[Lr, hl]}$	*!			

The point is that the non-derived, base tone candidates are blocked by $*_O T$, while the derived, sandhi tone candidates emerge due to the suspension (bottom-ranking) of $*_N T$. Four of the five Taiwanese tones, as listed in (2), are subject to the distinction between $*_O T$ and $*_N T$, including H, M, ML and HM. The other tone, LM, whether old or new, is completely absent in the tone shifts. This pattern can be governed by the constraint in (12).

(12) *RISE
    Assign a violation mark for every rising tone in the output.

The constraint *RISE is ranked higher than other tone markedness constraints, such as *Fall and *Level, so that no rising tone is created in

the tone circle.

Under the effect of $*_OT$, an input tone must surface as a different tone (a sandhi tone). The avoidance of base tones activates the spinning of the tone circle. The question is then how to ensure that the tone circle spins in the desired direction, or more precisely, how to predict that an input tone maps to a specific output and thus avoid one-to-many mappings. In the following section, I will argue for an approach that incorporates collaboration between comparative markedness and local conjunction.

3.2 WOW Effects

Local conjunction combines two constraints into one in the constraint set (CON) of the grammar, as proposed by Green (1993) and Smolensky (1993, 1995), and variously elaborated in work by Kirchner (1996), Crowhurst and Hewitt (1997), Itô and Mester (1996, 1998), Padgett (2001), Moreton and Smolensky (2002), Morris (2002), and Łubowicz (2002, 2005), among others. A formal statement of this notion is given in (13).

(13) Local conjunction (Smolensky 1995: 10)
 The local conjunction of C_1 and C_2 in domain D, C_1 & C_2, is violated when there is some domain of type D in which C_1 and C_2 are both violated.

The purpose of local conjunction is to prohibit the "worst of the worst," known as **WOW effects**. A conjoined constraint is violated only when both of its members are violated, and the combined effects add up to a single constraint that dominates the unconjoined members individually. Namely, local conjuncts amount to more than the total of their non-local parts. Previous studies on local conjunction have placed restrictions on the types of constraints that are allowed to be locally conjoined. Itô & Mester (1996, 1998) contend that markedness constraints can only be conjoined with markedness constraints, and faithfulness constraints can only be conjoined with faithfulness constraints. Local conjunction of two markedness constraints bans the worst of the worst marked structure, while that of two faithfulness constraints bans the worst of the worst violations of input structures, namely, the output that differs most from the input. Morris (2002) and Łubowicz (2002, 2005) argue for the necessary conjunction of markedness and faithfulness constraints. The idea is that the markedness member of a conjunct, which is inactive or suspended individually, is activated when the faithfulness member is violated. To account for the complex tonal chain shifts in Taiwanese, I propose that

both faithfulness-faithfulness and markedness-faithfulness conjuncts are required in the grammar. A faithfulness-faithfulness conjunct, as posited by Wee (2002), is rephrased in (14).

(14) ID-R&ID-C
   Assign a violation mark for every output tone that violates both ID-R and ID-C.

ID-R&ID-C prevents a tone from mapping itself to one that changes both the register and the contour features. Consider again the tone circle in (4). The five legal tone shifts in the tone circle are listed in (15a). As expected, ID-R&ID-C eliminates the eight illegal tone shifts in (15b), where the sandhi tones differ from the base tones in both register and contour. However, the seven illegal tone shifts in (15c) do not violate ID-R&ID-C, as the sandhi tones merely change either register or contour, but not both.

(15) Legal and illegal tone shifts

Legal tone shifts (a)	Illegal tone shifts	
	(b) ID-R&ID-C violated	(c) ID-R&ID-C not violated
$LM^{[Lr, lh]} \rightarrow M^{[Lr, h]}$	$LM^{[Lr, lh]} \rightarrow HM^{[Hr, hl]}$ $LM^{[Lr, lh]} \rightarrow H^{[Hr, h]}$	$LM^{[Lr, lh]} \rightarrow ML^{[Lr, hl]}$
$M^{[Lr, h]} \rightarrow ML^{[Lr, hl]}$	$M^{[Lr, h]} \rightarrow HM^{[Hr, hl]}$	$M^{[Lr, h]} \rightarrow H^{[Hr, h]}$ $M^{[Lr, h]} \rightarrow LM^{[Lr, lh]}$
$ML^{[Lr, hl]} \rightarrow HM^{[Hr, hl]}$	$ML^{[Lr, hl]} \rightarrow H^{[Hr, h]}$	$ML^{[Lr, hl]} \rightarrow M^{[Lr, h]}$ $ML^{[Lr, hl]} \rightarrow LM^{[Lr, lh]}$
$HM^{[Hr, hl]} \rightarrow H^{[Hr, h]}$	$HM^{[Hr, hl]} \rightarrow M^{[Lr, h]}$ $HM^{[Hr, hl]} \rightarrow LM^{[Lr, lh]}$	$HM^{[Hr, hl]} \rightarrow ML^{[Lr, hl]}$
$H^{[Hr, h]} \rightarrow M^{[Lr, h]}$	$H^{[Hr, h]} \rightarrow ML^{[Lr, hl]}$ $H^{[Hr, h]} \rightarrow LM^{[Lr, lh]}$	$H^{[Hr, h]} \rightarrow HM^{[Hr, hl]}$

Two of the seven illegal tone shifts in (15c) result in LM, which can be eliminated by *RISE. The LM → ML mapping can be eliminated by LINEARITY, as defined in (16).

(16) LINEARITY
   Let $xy \in$ input, $x'y' \in$ output,
   x precedes y, x corresponds to x', y corresponds to y'
   Assign a violation mark for every sequence of $y'x'$ in the output.

LINEARITY prevents a rising tone to map to a falling tone, as shown in

(17), where the parenthesized "!" indicates that either of the violations is fatal, and the discontinuous tableau indicates the lack of interaction between the two rankings.

(17) Input: $LM^{[Lr, lh]}$-T   Output: $M^{[Lr, h]}$-T   = (2b)

	$*_O$T	ID-R	ID-C	$*_N$T		*RISE	ID-R&ID-C	LINEARITY
a. $LM^{[Lr, lh]}$	*(!)					*(!)		
☞b. $M^{[Lr, h]}$			*	*				
c. $ML^{[Lr, hl]}$			*	*				*!
d. $HM^{[Hr, hl]}$		*	*	*			*!	
e. $H^{[Hr, h]}$		*	*	*			*!	

In (17), LM in candidate (a) is ruled out by either $*_O$T or *RISE, and ML in candidate (c) by LINEARITY. Both HM in candidate (d) and H in candidate (e) violate ID-R&ID-C, since the mappings $LM^{[Lr, lh]} \rightarrow HM^{[Hr, hl]}$ and $LM^{[Lr, lh]} \rightarrow H^{[Hr, h]}$ change both register and contour. Eventually, M in candidate (b) emerges, in suspension of the lowest-ranked $*_N$T.

The other four illegal tone shifts in (15c) cannot be excluded, including $M^{[Lr, h]} \rightarrow H^{[Hr, h]}$, $ML^{[Lr, hl]} \rightarrow M^{[Lr, h]}$, $HM^{[Hr, hl]} \rightarrow ML^{[Lr, hl]}$, and $H^{[Hr, h]} \rightarrow HM^{[Hr, hl]}$. In order to exclude these four illegal tone shifts, I put forward four conjuncts of new tone markedness constraints and tone feature faithfulness constraints, as in (18).

(18) Comparative markedness and local conjunction
    a. *[Hr, h]&ID-R
        Assign a violation mark for every output tone that violates both *H
        and ID-R.
    b. *[Lr, h]&ID-C
        Assign a violation mark for every output tone that violates both
        *M and ID-C.
    c. *[Lr, hl]&ID-R
        Assign a violation mark for every output tone that violates both
        *ML and ID-R.
    d. *[Hr, hl]&ID-C
        Assign a violation mark for every output tone that violates both
        *HM and ID-C.

An individual new tone markedness constraint is bottom-ranked in Taiwanese so that an input can map to a new tone. The conjuncts are ranked above the individual new tone markedness constraints and tone feature faithfulness constraints. There is no crucial ranking between the conjuncts. The constraint *[Hr, h]&ID-R prohibits the $M^{[Lr, h]} \rightarrow H^{[Hr, h]}$

mapping, *[Lr, h]&ID-C forbids the ML$^{[Lr, hl]}$ → M$^{[Lr, h]}$ mapping, *[Lr, hl]&ID-R disallows the HM$^{[Hr, hl]}$ → ML$^{[Lr, hl]}$ mapping, and *[Hr, hl]&ID-C bans the H$^{[Hr, h]}$ → HM$^{[Hr, hl]}$ mapping, as shown in (19-22).

(19) Input: M$^{[Lr, h]}$-T   Output: ML$^{[Lr, hl]}$-T   = (2e)

	*$_O$T	ID-R	ID-C	*$_N$T	*RISE	ID-R & ID-C	*[Hr, h] & ID-R	*[Lr, hl] & ID-R
a. LM$^{[Lr, lh]}$			*	*	*!			
b. M$^{[Lr, h]}$	*!							
☞c. ML$^{[Lr, hl]}$			*	*				
d. HM$^{[Hr, hl]}$		*	*	*			*!	
e. H$^{[Hr, h]}$		*		*				*!

(20) Input: ML$^{[Lr, hl]}$-T   Output: HM$^{[Hr, hl]}$-T   = (2d)

	*$_O$T	ID-R	ID-C	*$_N$T	*RISE	ID-R & ID-C	*[Lr, h] & ID-C	*[Hr, hl] & ID-C
a. LM$^{[Lr, lh]}$			*	*	*!			
b. M$^{[Lr, h]}$			*	*			*!	
c. ML$^{[Lr, hl]}$	*!							
☞ d. HM$^{[Hr, hl]}$		*		*				
e. H$^{[Hr, h]}$		*	*	*		*!		

(21) Input: HM$^{[Hr, hl]}$-T   Output: H$^{[Hr, h]}$-T   = (2c)

	*$_O$T	ID-R	ID-C	*$_N$T	*RISE	ID-R & ID-C	*[Hr, h] & ID-R	*[Lr, hl] & ID-R
a. LM$^{[Lr, lh]}$		*	*	*	*(!)	*(!)		
b. M$^{[Lr, h]}$		*	*	*		*!		
c. ML$^{[Lr, hl]}$		*		*				*!
d. HM$^{[Hr, hl]}$	*!							
☞e. H$^{[Hr, h]}$		*		*				

(22) Input: H$^{[Hr, h]}$-T   Output: M$^{[Lr, h]}$-T   = (2a)[5]

	*$_O$T	ID-R	ID-C	*$_N$T	*RISE	ID-R & ID-C	*[Lr, h] & ID-C	*[Hr, hl] & ID-C

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[5] A constraint, *[Lr, l]&ID-R, is omitted here. This constraint must be undominated in Taiwanese to avoid the H$^{[Hr, h]}$ → L$^{[Lr, l]}$ mapping. See also tableau (28) in section 3.3.

a. LM$^{[Lr, lh]}$		*	*	*	*(!)	*(!)		
☞b. M$^{[Lr, h]}$		*		*				
c. ML$^{[Lr, hl]}$		*		*		*!		
d. HM$^{[Hr, hl]}$			*	*				*!
e. H$^{[Hr, h]}$	*!			*				

It should be noted that $*_N$[Lr, h]&ID-C is dominated by LINEARITY, in spite of the fact that the conjuncts do not interact with each other, as shown in (23).

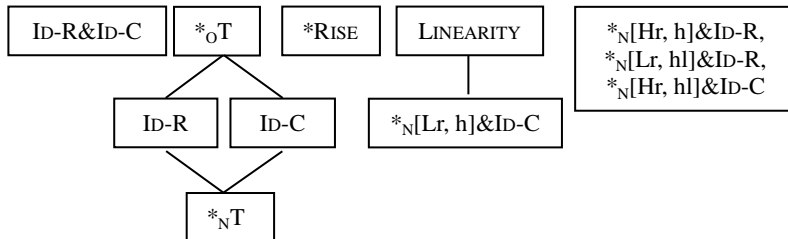(23) Input: LM$^{[Lr, lh]}$-T   Output: M$^{[Lr, h]}$-T   = (2b)

	$*_O$T	ID-R	ID-C	$*_N$T	*RISE	ID-R & ID-C	LINEARITY	$*_N$[Lr, h]&ID-C
a. LM$^{[Lr, lh]}$	*(!)				*(!)			
☞b. M$^{[Lr, h]}$			*	*				*
c. ML$^{[Lr, hl]}$			*	*			*!	
d. HM$^{[Hr, hl]}$		*	*	*		*!		
e. H$^{[Hr, h]}$		*	*	*		*!		

An anonymous reviewer has suggested that the goal of achieving the WOW effect is lost if a markedness constraint is combined with a faithfulness constraint for the simple reason that the pro-change markedness constraints are inherently in conflict with the anti-change faithfulness constraints. It is not clear what candidate is not allowed by local conjunction of a markedness constraint with a faithfulness constraint. In fact, as Łubowicz (2002: 248) has pointed out, when a low-ranked markedness constraint is conjoined with a faithfulness constraint, "a violation of the faithfulness constraint activates the low-ranked markedness constraint." In the case of Taiwanese tonal chain shifts, $*_N$T, a constraint family consisting of $*_N$[Hr, h], $*_N$[Hr, hl], $*_N$[Lr, h], $*_N$[Lr, lh] and $*_N$[Lr, hl], is bottom-ranked; however, when the primitive members of the family are conjoined with faithfulness constraints, the conjuncts are undominated or high-ranked. Specifically, $*_N$[Hr, h]&ID-R bars the M$^{[Lr, h]}$ → H$^{[Hr, h]}$ shift, $*_N$[Lr, h]&ID-C bars the ML$^{[Lr, hl]}$ → M$^{[Lr, h]}$ shift, $*_N$[Lr, hl]&ID-R bars the HM$^{[Hr, hl]}$ → ML$^{[Lr, hl]}$ shift, and $*_N$[Hr, hl]&ID-C bars the H$^{[Hr, h]}$ → HM$^{[Hr, hl]}$ shift.

In brief, the markedness constraint, *RISE, prevents the emergence of any rising tone, and the faithfulness constraint, LINEARITY, bans tonal metathesis. The faithfulness-faithfulness conjunct, ID-R&ID-C, blocks the mappings that change both register and contour. The

markedness-faithfulness conjuncts, as in (18a-d), spin the tone circle in the correct direction, as in (4), and avoid a reverse, incorrect spin which would render erroneous predictions. The constraint rankings of the tonal chain shifts are summarized in (24).

(24) Summarized constraint rankings

ID-R&ID-C	$*_O T$	*RISE	LINEARITY	$*_N[\text{Hr, h}]\&\text{ID-R}$, $*_N[\text{Lr, hl}]\&\text{ID-R}$, $*_N[\text{Hr, hl}]\&\text{ID-C}$
	ID-R ID-C		$*_N[\text{Lr, h}]\&\text{ID-C}$	
	$*_N T$			

3.3 Cross-linguistic Evidence

Comparative markedness also offers a universal basis that facilitates analyses of other Chinese dialects that manifest tone shifts. In Jincheng, a Southern Min dialect spoken in Jinmen, LM[Lr, lh] shifts to ML[Lr, hl] but not to M[Lr, h] (H. Shih 1997). In that case, $*_N[\text{Lr, h}]\&\text{ID-C}$ dominates LINEARITY, as in (25).

(25)

Dialects	Rankings	Tone shifts
Jincheng	$*_N[\text{Lr, h}]\&\text{ID-C} \gg \text{LINEARITY}$	LM[Lr, lh] → ML[Lr, hl]
Taiwanese	LINEARITY $\gg *_N[\text{Lr, h}]\&\text{ID-C}$	LM[Lr, lh] → M[Lr, h]

In Hisnchu Raoping, a sub-dialect of Hakka, HM[Hr, hl] shifts to M[Lr, h] but not to H[Hr, h] (K. Hsu 2008; Hsiao 2013), a fact that requires ID-R& ID-C to be ranked below $*_N[\text{Hr, h}]\&\text{ID-C}$, as in (26).

(26)

Dialects	Rankings	Tone shifts
Hisnchu Raoping	$*_N[\text{Hr, h}]\&\text{ID-C} \gg \text{ID-R}\& \text{ID-C}$	HM[Hr, hl] → M[Lr, h]
Taiwanese	ID-R& ID-C $\gg *_N[\text{Hr, h}]\&\text{ID-C}$ (inactive)	HM[Hr, hl] → H[Hr, h]

A clearer resemblance lies in Leling, a Shandong dialect, where tonal chain shifts are found in pre-neutral-tone position (Cao 2007), as shown in (27).

(27) Leling tone circle

$$H^{[Hr, h]}$$

$$HM^{[Hr, h1]} \qquad L^{[Lr, l]}$$

$$ML^{[Lr, hl]}$$
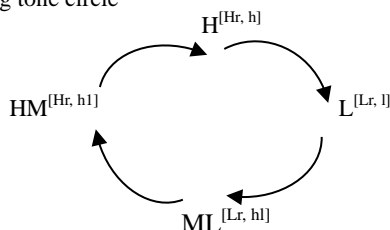
An obvious difference between Taiwanese and Leling tone circles is that in the latter, $H^{[Hr, h]}$ shifts to $L^{[Lr, l]}$ but not to $M^{[Lr, hl]}$. In that event, $*_N[Lr, h]$&ID-R outranks $*_N[Lr, l]$&ID-R in this dialect, as in (28).

(28)	Dialects	Rankings	Tone shifts
	Leling	$*_N[Lr, h]$&ID-R >> $*_N[Lr, l]$&ID-R	$H^{[Hr, h]} \to L^{[Lr, l]}$
	Taiwanese	$*_N[Lr, l]$&ID-R >> $*_N[Lr, h]$&ID-R (inactive)[6]	$H^{[Hr, h]} \to M^{[Lr, h]}$

Tone sandhi in Jincheng, Hsinchu Raoping and Leling has demonstrated a need for the collaboration of comparative markedness and local conjunction. The variations between Taiwanese and the three Chinese dialects arise from different rankings of the relevant constraints. The anti-grandfathering effects and the WOW effects together offer a fresh angle from which to examine tone sandhi cross-linguistically.

3.4 Tone Retention

In Taiwanese, the final syllable usually retains its base tone. The disyllabic strings in (2) have shown that the left syllables are subject to tone shifts but the right syllables are not. For convenience of discussion, I use the right-edge faithfulness constraint in (29) to govern the tone retention in the right syllable, following the ideas developed in Chen (1987, 2000), H. Hsu (1994), and Hsiao (1991, 1995, 2000).[7]

(29) IDENT-T-R (ID-T-R)   (Hsiao 2000)
    Assign a violation mark for the rightmost tone in the output that is not

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[6] The constraint $*_N[Lr, h]$&ID-R is inactive or suspended in Taiwanese such that the mapping from $H^{[Hr, h]}$ to $M^{[Lr, h]}$ is possible. On the other hand, $*_N[Lr, h]$&ID-C is undominated in Taiwanese to prevent $ML^{[Lr, hl]}$ from mapping to $M^{[Lr, h]}$. See also tableaux (20) and (22) in section 3.2.

[7] Those who object to right-edge faithfulness can interpret this as head-faithfulness with the assumption that Taiwanese tonal prosody is right-headed, cf. also Itô et al (1996), Beckman (1998), Lombardi (1999), Yip (2002), and Nelson (2003), among others.

identical to the input.

The constraint ID-T-R must dominate $*_O$T and *RISE to preserve the base tone of the right syllable. The following tableaux support this dominance relation.

(30) Input: T-ML[Lr, hl]   Output: T-ML[Lr, hl]   = (2d)

	ID-T-R	$*_O$T	*RISE
a. HM[Hr, hl]	*!		
☞b. ML[Lr, hl]		*	

(31) Input: T-LM[Lr, lh]   Output: T-LM[Lr, lh]   = (2e)

	ID-T-R	$*_O$T	*RISE
a. M[Lr, h]	*!		
☞b. LM[Lr, lh]		*	*

The question is whether Taiwanese tone sandhi should be treated as a morphological phenomenon, or a phrasal phenomenon, where lexical tones are mutated in larger phrases. Some studies (Hsiao 1990; Tsay and Myers 1996; Zhang et al. 2009) consider it a matter of allomorph selection under Hayes' (1990) precompiled phrasal phonology. Others (Chen 1987, 2000; H. Hsu 1994; J. Lin 1995; Hsiao 1991, 1995, 2000) define the tone sandhi domain at the phrasal level, syntactically or prosodically. In particular, Hsiao (1995) has observed a couple of prosodically-conditioned patterns in (32), where the target tones are boldfaced.

(32) Prosody-conditioned tone sandhi of *bo*HM[Hr, hl] 'wife'
　　a.(*tshua*ML[Lr, hl] *bo***H**[Hr, h] *tsieng*LM[Lr, lh])　　　　'before marrying a wife'
　　b.(*tshua*ML[Lr, hl] *bo***HM**[Hr, hl])(*yi*H *tsieng*LM[Lr, lh]) 'before marrying a wife'

The two clauses in (32) display the same syntactic structure and express the same meaning. The only difference between the two is the number of syllable. In (32a), the clause constitutes a trisyllabic foot, where *bo* is non-final and thus HM[Hr, hl] shifts to H[Hr, h]. The tetrasyllabic clause in (32b) is parsed into two disyllabic feet; *bo* is at the right edge of the left foot and thus retains its base tone, HM[Hr, hl].[8] In this sense, ID-T-R operates within a prosodic domain.

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[8] For further discussions of the principles of syllabic foot formation, see Hsiao (1995: ch. 5).

4. On Alternative Analyses

Antifaithfulness and contrast preservation are two alternative approaches to the tonal chain shifts. However, this section will show that with comparative markedness, there is no need for either approach.

4.1 Antifaithfulness

Alderete (1999, 2001) proposes the idea of **antifaithfulness**, which is implemented within the output-to-output (OO) correspondence.[9] As he suggests, there is a corresponding antifaithfulness constraint for every faithfulness constraint. Two studies, Horwood (2000) and Wee (2002), use this idea to account for the tone circle of Taiwanese. Horwood puts forward a pair of antifaithfulness constraints, ¬ID-R and ¬ID-C, both of which dominate the faithfulness constraints, ID-R and ID-C, to force the chain shifts. These antifaithfulness constraints require that the sandhi tone and its output base not have the same register or contour feature. For example, ¬ID-R forces $H^{[Hr, h]}$ to shift to $M^{[Lr, h]}$, while ¬ID-C pushes $HM^{[Hr, hl]}$ to map to $H^{[Hr, h]}$. However, there is a ranking paradox in Horwood's analysis, as shown in (33a,b).

(33) Ranking paradox
    a. Input/base: $H^{[Hr, h]}$ Sandhi output: $M^{[Lr, h]}$

	¬ID-R	¬ID-C
a. $H^{[Hr, h]}$	*!	*
b. $HM^{[Hr, hl]}$	*!	
☞ c. $M^{[Lr, h]}$		*

    b. Input/base: $HM^{[Hr, hl]}$ Sandhi output: $H^{[Hr, h]}$

	¬ID-C	¬ID-R
☞ a. $H^{[Hr, h]}$		*
b. $HM^{[Hr, hl]}$	*!	*
c. $M^{[Lr, h]}$	*!	

Wee (2002) notices such a paradox and proposes the local conjunction of ID-R and ID-C to resolve this problem. "ID-R&ID-C >> ¬ID-R, ¬ID-C >> ID-R, ID-C" allows an output to change either its register or its contour, but not both. I have discussed in section 3.2 that ID-R&ID-C can eliminate some illegal tone shifts, as in (15b), where the sandhi tones differ from the

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[9] Alderete (2008) proposed the possibility of IO-antifaithfulness in sentence phonology, in particular, the phrasal tone sandhi of Taiwanese. However, he did not discuss further.

base tones in both register and contour, but cannot eliminate other illegal tone shifts, as in (15c), where the sandhi tones change merely register or contour.

Basically, "$*_OT \gg$ FAITH $\gg *_NT$" accomplishes the effects that anti-faithfulness attempts to achieve with "¬FAITH $\gg$ FAITH". Łubowicz (2003b) uses locally conjoined constraints of markedness and antifaithfulness to account for chain shifts, in parallel with comparative markedness. The negation of faithfulness is used to rule out old markedness violations, namely, $_OM = [M\&¬F]$. However, antifaithfulness serves as a trigger for alternation that seems to lack historical or physiological motivation. Comparative markedness, on the other hand, is well-established in diachronic changes that become constant in synchronic grammar. This is what has motivated arguments on (non-)derived environment effects that may (counter)bleed or (counter)feed, yielding among other important devices such things as Bracket Erasure to create invisibility. In other words, comparative markedness is superior to antifaithfulness in terms of generality.

Essentially, "$*_OT \gg$ FAITH $\gg *_NT$" requires that derived markedness be endured while underived markedness demands mutation. Consequently, the tonal chain shifts can be motivated by the anti-grandfathering effects without incorporating antifaithfulness. While Taiwanese exhibits anti-grandfathering effects, Shangsi, a Hakka dialect, instantiates a case of grandfathering effects: an old $H^{[Hr, h]}$ can be followed by an old $HM^{[Hr, hl]}$ but not by a new one (Zeng 2007; Hsiao 2013). This fact entails a ranking where $*_NOCP(h)$ dominates $*_OOCP(h)$. The typological effect of "$*_NT \gg *_OT$" or "$*_OT \gg *_NT$" achieves, respectively, the grandfathering and anti-grandfathering effects as a natural consequence of factorial typology.

4.2 Contrast Preservation

Barrie (2006) considers the tone circle resulting from **contrast preservation**, as proposed by Łubowicz (2003). In his analysis, candidates are scenarios (or minigrammars) that show alternations, but not individual tokens. Two of his candidate scenarios are shown in (36-37).[10] The arrows in the circular scenarios map the input tones to the outputs. A tone that is not linked by any arrow maps to itself.

(34) Full tone circle (Barrie 2006: 138,   (35) Partial tone circle (Barrie 2006:

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[10] Barrie (2006) considers the rising tone to be a high rising tone, which in fact is low-registered, as discussed in section 2 (see also footnote 3).

Tableau 2, Candidate 1)   138, Tableau 2, Candidate 4)
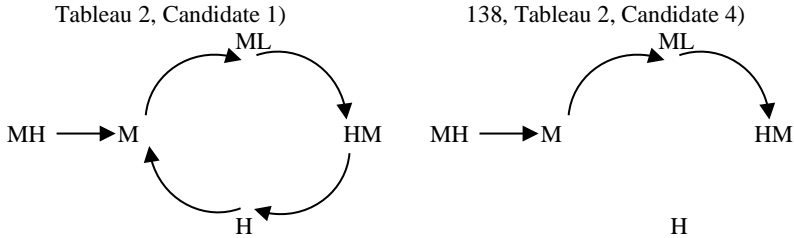
Barrie posits two sets of constraints, PRESERVECONTRAST and tone markedness. The constraints of PRESERVECONTRAST$_{OUTPUT}$ (PC$_{OUT}$), such as PC$_{OUT}$(PITCH) and PC$_{OUT}$(REGISTER), are violated when a scenario loses a contrast for a certain feature in the output. The tone markedness constraints, *RISE, *CONTOUR and *HIGH, are violated by individual tokens. Given the constraint ranking [*RISE, PC$_{OUT}$(REGISTER) >> PC$_{OUT}$(PITCH), *CONTOUR, *HIGH], the circular scenario in (34) is chosen over the one in (35). The tableau in (36) shows how the scenarios are selected.

(36) Tone Circle Selection

| Scenarios	*RISE	PC$_{OUT}$(REGISTER)	PC$_{OUT}$(PITCH)	*CONTOUR	*HIGH
☞ a.= (36)			*	*ML *HM	*H
b.= (37)		*!		*ML **HM	*H

According to Barrie, PC$_{OUT}$(PITCH) is violated by candidate (a), where both MH and H map to M and lose contrast in pitch; candidate (b) then incurs a fatal violation of PC$_{OUT}$(REGISTER), since both ML and HM map to HM and lose a contrast in register. The idea is that contrast preservation would force a circular movement in a scenario where neutralization would occur.

Several problems of Barrie's analysis are observed here. First, if the primary goal of faithfulness is contrast preservation, then fully faithful candidates would be allowed to be chosen when the whole tone sandhi system is juxtaposed. This would predict a system where all the input tones emerge without mutation, as all contrasts are retained. Hence, it is imperative for contrast preservation to be triggered by antifaithfulness. At this point, contrast preservation is simply an explanation for the presence of antifaithfulness (cf. also Hsieh 2005 and Thomas 2008). We have seen in section 3 that the employment of comparative markedness can trigger tonal chain shifts without incorporating antifaithfulness. In this sense,

contrast preservation would still need to be activated by comparative markedness. Conversely, with comparative markedness, Barrie's constraints are dispensable and the relevance of contrast preservation is severely limited.

Second, contrast preservation could wrongly select a reverse tone circle like (39), which would not do worse on the same constraint ranking.

(37) Reverse tone circle
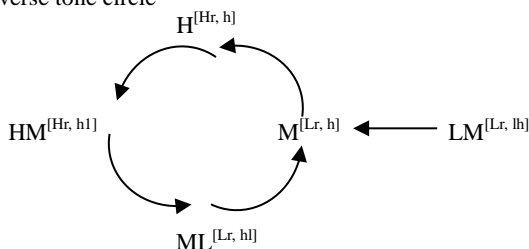
The tableau in (38) shows how an incorrect prediction arises from Barrie's constraints. Both scenarios tie in every way so that the reverse circle in candidate (b) cannot be ruled out. It is thus quite clear that Barrie's proposal is inadequate, for it is unable to provide direction for the tone circle.

(38) Incorrect Prediction

Scenarios	*RISE	PC$_{OUT}$(REGISTER)	PC$_{OUT}$(PITCH)	*CONTOUR	*HIGH
☞ a.= (37)			*	*ML *HM	*H
☞* b.= (39)			*	*ML *HM	*H

Finally, in Barrie's approach, there's a minor role for markedness constraints, but the PC constraints are the main engine that works behind the scenes to motivate the mappings. The PC constraints work on entire linguistic systems, in contrast to the standard approach to processes, which is to work on linguistic forms. The candidates in (36-37) or (39) are whole systems, not forms. This is a serious problem for the PC approach, and as well as for approaches like Padgett's (2003) regarding dispersion effects. Both require a higher-order grammar that works on possible languages rather than on language forms. But all other phonological accounts predict a larger language by predicting the individual mappings a language is made up of. The present comparative markedness analysis, on the other hand, is able to produce the desired mappings without requiring

constraints that work on the entire linguistic system.[11]

5. Conclusion

Circular chain shifts cannot be described simply in terms of markedness. The shifts that map tone 1 to tone 2 and tone 2 to tone 3 entail a markedness scale where tone 3 is more unmarked than tone 2, which in turn is more unmarked than tone 1. When tone 3 also maps to tone 1, the latter does not do better on markedness than the former, and hence a paradox arises. In this sense, the tonal chain shifts in Taiwanese cannot be accounted for in terms of rankings of markedness and faithfulness constraints alone. This paper has proposed a comparative markedness analysis, ranking old tone markedness constraints above new tone markedness constraints. The anti-grandfathering effects trigger the tone circle. Local conjunction works with comparative markedness to offer a direction for the tone circle. This paper has constructed the grammar of the tonal chain shifts from the perspective of comparative markedness, where antifaithfulness and contrast preservation can be dispensed with. Further research can investigate how the tone shifts operate on prosodic structures, and how stress affects the tone shifts.

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