Targeted and Targetless Neutral Tones in Taiwanese Southern Min

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Abstract

This article is an acoustic study on the two types of neutral tone in Taiwanese Southern Min (TSM). Recording materials included a set of verb-clitic constructions with different preceding tones and clitics. Pitch contours in different conditions were compared using Smoothing Spline ANOVA. Our results confirmed that Type 1 neutral tone (NT1) has a low pitch target and that Type 2 neutral tone (NT2) is contextually dependent. Whether NT1 or NT2 is chosen has been treated as the lexical idiosyncrasy of the clitics in question, with idiolectal and dialectal variations. However, we found in this study that the onsets have a bearing on determining the type of neutral tone: the more sonorous the onset, the more possible it is for the clitic to be in NT2. In sum, the two distinct types of neutral tones in TSM not only are unusual among the neutral tones in Sinitic languages, but they also offer novel data for the consonant-tone interaction.

Index Terms: neutral tone, pitch target, tone spreading, the consonant-tone interaction, Taiwanese Southern Min

1. Introduction

There are distinct types of pitch realizations on the neutral tone syllables in Sinitic languages. By *neutral tone* we mean the post-tonic syllables which are toneless or tonally neutralized. Neutral tone syllables may be phonologically unspecified, without any pitch target, and the surface pitch is contextually determined via tone spreading/extension, such as those found in Beijing Mandarin [1] and Wenzhou Chinese [2]. It may also be assigned a default tone, phonetically realized with a fixed pitch target, such as the "weak" mid pitch target for Standard Chinese [2], the mid-low target for Taiwanese Mandarin [4], [5], and the mid-low short tone for Xiamen Chinese [6]. In general, while most Sinitic languages have only one of the patterns above for the neutral tone, it has been reported that Malaysian Mandarin has more than one type of neutral tone, although the determining factors remain unknown [7]. Thus, the starting point of the present study is to investigate the acoustic properties of the neutral tones in Taiwanese Southern Min (henceforth TSM).

TSM is a variety of Southern Min spoken in Taiwan. It has almost the same tonal inventory (see Table 1) and tone sandhi system as Xiamen Chinese [2], [6], [8]. TSM has a right-dominant tone sandhi system, in which phrase-final syllables remain in their base tones, while all non-final syllables are turned into sandhi tones. For example, the first syllable in the verb phrase *khui¹ mmg⁵* [kʰui33.mŋ13] 'open door' is pronounced with a different tone when in isolation (compare: *khui¹* [kʰui44] 'open' and *mng⁵* [mŋ13] 'door').

Some function words/particles in syntactic phrase-final positions are excluded from the tone sandhi domain. In such a case, those "weak" morphemes are said to be neutral-toned, and the base tone falls on the last syllable excluding all these function words in the phrase. For instance, in *khui¹=tioʔ⁸* [kʰui44.tio(ʔ)21] 'open (achievement)' the two morphemes are respectively read in the base tone and the neutral tone, rather than a sandhi tone followed by a base tone (*[kʰui33.tio(ʔ)53]). The neutral-toned morpheme generally has an identical prosodic status as an *enclitic* to the preceding phonological/prosodic phrase, despite their broad occurrences across various syntactic structures including most particles, several suffixes, and some specific non-emphatic pronouns and quantifiers.

Neutral tone in Xiamen is transcribed as a mid-low short tone [6]; however, it has been noted that TSM has two ways in realizing its neutral tone [9]. Type 1 neutral tone (NT1), similar with the one in Xiamen, is constantly realized with a low-falling pitch (e.g. *khui¹=kue³* [kʰui44.kue21] 'open (experiential)'; *tse⁷=kue³* [t͡se33.kue21] 'sit (experiential)'), while the pitch of Type 2 neutral tone (NT2) is contextually dependent and can be regarded as an extension of the preceding tone (e.g. *khui¹=aʔ⁴* [kʰui44.aʔ44] 'open (perfect)'; *tse⁷=aʔ⁴* [t͡se33.aʔ33] 'sit (perfect)'). Whether NT1 or NT2 is chosen is, to the best of our knowledge, mostly morpheme-specific and is subject to inter-speaker and dialectal variations [10]. To this end, therefore, the aim of this study is two-fold. Firstly, we would like to investigate if the previous impressionistic transcriptions can be instrumentally confirmed. In other words, is it really the case that there are two distinct types of neutral tone in TSM, at least, acoustically speaking? Secondly, if yes, what is the actual distribution of the two types of neutral tone? Is there any possible conditioning factor? If no, is there any reason why these neutral tones are misperceived as different tones?

Table 1: *Tonal inventory of TSM. (Pitch realizations of the tones are transcribed numerically in Chao's scale;* **q** *denotes a checked tone.)*

Label	Tone class	Pitch realization	
		Base tone	Sandhi tone
1	*yin-ping*	[**44**]	[**33**]
2	*(yin-)shang*[1]	[**52**]	[**44**]
3	*yin-qu*	[**21**]	[**52**]
5	*yang-ping*	[**13**]	[**33**]
7	*yang-qu*	[**33**]	[**21**]
A/4ptk	*yin-ru (p/t/k-ending)*	[**32q**]	[**53q**]
B/8ptk	*yang-ru (p/t/k-ending)*	[**53q**][2]	[**21q**]
C/4ʔ	*yin-ru (ʔ-ending)*	[**32q**]	[**52q**]
D/8ʔ	*yang-ru (ʔ-ending)*	[**52q**][2]	[**21q**]

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[1] Tone 6 (*yang-shang*) is absent in TSM because of a merger into other tones (mainly Tones 2 and 7) in earlier developments.

[2] Tone 8 has speaker variations in its base tone realizations, such as [**33q**] and [**32q**], due to dialectal differences [11].

Table 2: *Clitics used in the experiment.*

Type	Clitic	Gloss
NT2	$a\text{ʔ}^4$	perfect aspect marker
NT2	e^5	relativization/nominalization marker
Varied	$le\text{ʔ}^4$	stative durative aspect marker
NT1	khi^3	deictic phase marker (lit. 'thither')
NT1	kue^3	experiential aspect marker (lit. 'pass')
NT1	$tio\text{ʔ}^8$	achievement phase marker (lit. 'attain')

2. Experiment

The present study is primarily concerned with the phonetic realizations of neutral tones in TSM. Six (6) literate TSM-Mandarin bilinguals between 24 and 60 (at the time of recording), consisting of three males and three females, took part in the acoustic experiment. All of them are native to TSM and have no reported history of speech or hearing disorders.

The recording materials are comprised of 162 tokens. Three (3) monosyllabic verbs from each of the nine (9) tonal categories (five non-checked and four checked tones, as listed in Table 1) are paired up with six (6) monosyllabic clitics that bear a neutral tone (as listed in Table 2). Among the six clitics, $a\text{ʔ}^4$ and e^5 are documented as typical NT2 clitics, $le\text{ʔ}^4$ have variations between NT1 and NT2, and the other three clitics carry NT1 in most varieties [10]. The verb-clitic combinations are judged to be natural or acceptable by the participants.

The participants were asked to read a randomized list of the tokens from a computer screen at a normal speech rate, in a sound-proof recording booth at the Phonetics Lab of National Tsing Hua University. The tokens were embedded in the carrier phrase kio^3-si^7 X ____ =$kong^2$. '(I) mistakenly believe that ____.', where X is a high-toned word, and $kong^2$ (lit. 'say') is an evidentiality-denoting sentence-final particle that carries a high-level tone. Four repetitions were collected. The acoustic data were recorded in the wav format, using a Beyerdynamic TG-X21 microphone and a TASCAM DR-100 MK II digital recorder with 16-bit quantization at a sampling rate of 44,100 Hz. In this study, time-normalized F0 data were extracted with Praat [12] and Xu's ProsodyPro script [13]. Individual speakers' F0 values were transformed into semitone values relative to 50 Hz, and cross-speaker F0 values were speaker-intrinsically normalized with the logarithmic z-score transformation [14]. We follow Chuang et al. [15] in comparing pitch contours with Smoothing Spline ANOVA (SS ANOVA). The *gss* package [16] was used for SS ANOVA modelling under R 3.6.0 [17], and the models were visualized using *ggplot2* [18]. Pitch contours of two consecutive syllables were modelled separately. Each pitch contour was plotted with a dotted line representing the predicted mean values and a ribbon showing double standard errors (a 95% confidence interval) across the normalized time.

3. Results

3.1. Inter-speaker variation

Based on the impressionistic transcriptions of non-low neutral tone realizations, we found three major varieties of neutral tone types among the six participants, as summarized in Table 3. Variety 1 read $a\text{ʔ}^4$, e^5, and $le\text{ʔ}^4$ in NT2 but the others in NT1. Variety 2 read only $a\text{ʔ}^4$ and e^5 in NT2 but the others in NT1. Variety 3 read all six clitics in NT1, with only sporadic NT2 occurrences. Results of the impressionistic transcriptions, which filtered out the exceptions (about 7%) in the original data, were fed into the statistical models presented below.

Table 3: *Speaker varieties attested in the experiment.*

Variety	Speakers	$a\text{ʔ}^4$, e^5	$le\text{ʔ}^4$	khi^3, kue^3, $tio\text{ʔ}^8$
1	F1, M1, M3	NT2	NT2	NT1
2	M2	NT2	NT1	NT1
3	F2, F3	NT1	NT1	NT1
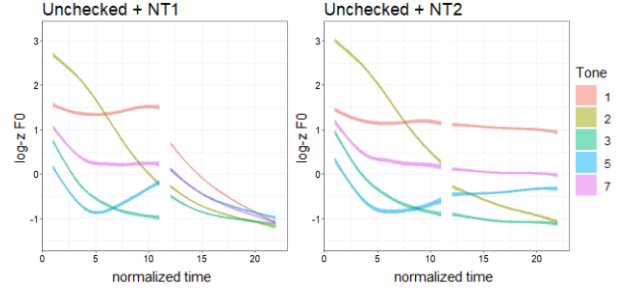
Figure 1: *Pitch contours of NT1 (left) and NT2 (right) and the preceding non-checked tones.*
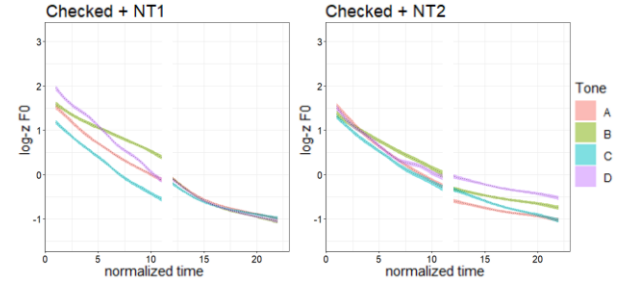
Figure 2: *Pitch contours of NT1 (left) and NT2 (right) and the preceding checked tones.*

3.2. Contextual dependency of NT1 and NT2

Figure 1 illustrates a comparison between NT1 and NT2 after different non-checked tones. First, pitch contours of NT1 syllables were mostly low-falling and all end at a low pitch region. It can therefore be inferred that for NT1 there is a low pitch target that is achieved within a syllable span. Second, pitch onsets of NT1 after different tones had statistically significant differences, showing that the carryover effect from the preceding tone still affects the following syllable, but just to a smaller extent. As for NT2, tone extension lasts throughout the whole neutral tone syllable, differing starkly from the low-toned NT1 when following a tone having a non-low pitch offset (i.e. Tones 1, 5, 7). After high-level and mid-level tones, the pitch contours of NT2 are simply a continuation of the preceding level tones. After the low-rising tone (Tone 5), both the base tone and the neutral tone syllables serve as the domain for realizing the rising pitch contour, as can be seen in the flattened pitch contour compared to that before NT1.

Figure 2 depicts the pitch contours between NT1 and NT2 after checked tones. While NT1 does not show any difference after the four checked tones, an NT2 following Tone 8 (labeled as B and D) is realized at a higher pitch. In fact, the six speakers exhibit differences regarding this sequence. Only speaker F1 (Figure 3) realizes Tone 8 with a mid-level tone [**33q**] and shows tone spreading onto the following NT2 (but not NT1) syllable. The other speakers realize Tone 8 either with a high-falling [**53q**]/[**52q**] or a mid-falling [**32q**] variant (which can be attributed to the regional variations [11]), the NT2 realizations after which are hardly distinguishable from the low-toned NT1.
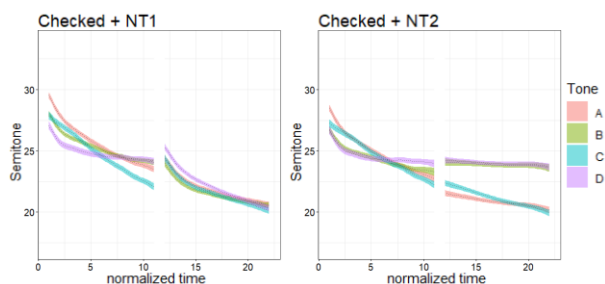
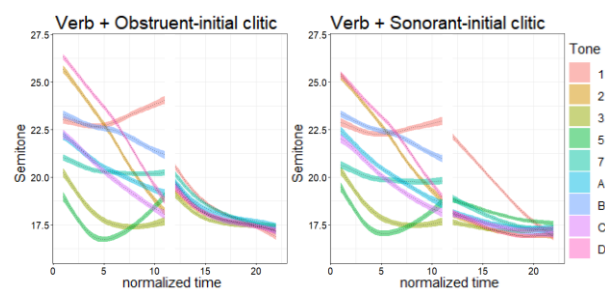Figure 3: *Speaker F1's pitch contours of NT1 (left) and NT2 (right) and the preceding checked tones.*

Figure 4: *Speaker F3's pitch contours of obstruent- (left) and sonorant-initial (right) clitics and the preceding full tones.*

3.3. Tonal carryover and onset sonority

According to inter-speaker variations generalized in §3.1, we found that the two onsetless clitics induced the most NT2 occurrences and that the lateral-initial clitic *leʔ⁴* can also be produced with NT2 for some speakers. In contrast, the clitics with a voiceless obstruent onset are mostly rendered as NT1. It is tempting to posit that whether tone extension happens (NT2) or not (NT1) may hinge on the sonority profile of the interluding onset of the clitics. Given the fact that NT2 is in free variation with NT1 for some speakers, we hypothesize that NT2 is a derived pattern from the variety with NT1 only (such as Variety 3 in Table 3 and Xiamen) since a sonorant interluding onset may facilitate the carryover effect, in sharp contrast to a voiceless obstruent onset that interrupts F0 contours.

We further found that in Variety 3, where the clitics were produced with NT1, clitics that differ in onset sonority also have different magnitudes of the carryover effect. The pitch contours of speaker F3 are plotted in Figure 4 for a better understanding. Pitch offsets of neutral tone syllable for speaker F3 were equally low for all the six clitics in our study; that is, they were all pronounced as NT1. Yet the preceding tone made a significant difference in the neutral tone's pitch onset only when that neutral tone syllable is sonorant-initial (onsetless or lateral-initial, including the clitics *aʔ⁴*, *e⁵*, and *leʔ⁴*). Obstruent-initial neutral tone syllables do not have such differences in pitch contour no matter which tone in the stem precedes it. The present asymmetry may be easily explained via the fact that F0 contours will be broken on an obstruent, but not on a sonorant.

4. Discussion

4.1. Research findings

Acoustic data in the experiment indicated that NT1 should have a low pitch target. Although the carryover effect is still significant (albeit in a slight fashion) in the onset of NT1, the pitch offsets are not significantly different across most preceding tone conditions. So our results confirm Chang's [9] and Du's [19] transcription [21] for NT1.

In contrast, NT2 does not have a default low pitch target; the surface pitch contour on an NT2 syllable is dependent on the preceding tone. Thus, tone extensions of this sort make NT2 significantly different from NT1 after tones with a non-low offset (Tones 1, 5, and 7; 8 for some speakers). Among these tones, the only contour tone (Tone 5) does not exhibit the typical tone spreading (/13.0/ → [**13.33**]) nor tone split (/13.0/ → [**11.33**]). The low-rising pitch on a disyllable /13.0/ → [**12.23**] (vs. [**13.21**] in NT1) is neither fully realized within its own syllable and then spread onto the following toneless syllable, nor splits into the "low-mid" sequence on the respective syllables (i.e. [**11.33**]); rather, it is obvious that the two pitch targets in the stem are re-aligned with the edges of a disyllable and the flanking pitch contour is determined via interpolation.

The three speaker varieties of the neutral tone types found in the experiment may be conditioned by the factor of onset sonority. The distribution of NT1 and NT2 in the clitics is, to a great extent, attributable to the clitics' onset sonority. The onsetless clitics are the most compatible ones with NT2, and the lateral-initial clitic is the second best candidate; the other three clitics with voiceless obstruent onsets are simply incompatible with NT2. Such an idiosyncrasy could be explained by the fact that tonal carryover is more evident on sonorant-initial (and onsetless) clitics than on obstruent-initial clitics. The difference in tonal carryover could then be phonologized into the lexically divergent patterns of neutral tone in terms of tone spreading.

4.2. The co-existing neutral tones

The two neutral tones in TSM make it a unique case in the typology of neutral tones across Sinitic languages. Most Sinitic languages have, if any, only a uniform pattern for their neutral tone. In Beijing Mandarin, Lee and Zee's experimental study has shown that lexical morphemes with different underlying tones and the two suffixes (-*zi* and -*de*) have basically the same neutral tone realization [1]. Taiwanese Mandarin also has a consistent mid-low target for the neutral tone [4], aside from sporadic exceptions that resemble their unreduced forms.

One may wonder if the two neutral tones in TSM can be accounted for by the morphosyntactic differences of the clitics. That is, it may be owing to a difference between functional and lexical categories (or something alike). In the present study, *aʔ⁴*, *leʔ⁴*, and *kue³* are all aspect markers in general, but they belong to three respective groups in terms of the neutral tone types. In another consequent experiment with a similar design, we further confirmed that the other deictic phase marker *lai⁵* 'hither' patterns together with the durative marker *leʔ⁴*, but not with its antonymous counterpart *khi³* 'thither'. Ang did not support the correlation between neutral tone types and syntax either in his comprehensive survey on the TSM clitics [10]. That is, a lexical–functional division cannot draw a clear-cut border that separates the two neutral tones. Therefore, the choice between the two neutral tones has often been described as merely lexical idiosyncrasies of these morphemes in previous works.

On the basis of a tonal system like that of Xiamen, TSM has another type of neutral tone that is only found in some specific clitics. The two neutral tones in TSM differ in whether tone extension is applied and, consequently, whether a default low tone is assigned. In the literature, it has been reported that the

morpheme-specific neutral tone realizations in TSM are more or less similar to those in Malaysian Mandarin [7]. In Malaysian Mandarin, the lexical neutral tone is very limited, exhibiting fossilized idiosyncrasies of the lexemes. As for the other neutral-toned morphemes, kinship reduplications and the suffix *-zi* pattern together (mid-level after tone 3; low-falling elsewhere), while the other suffix *-de* is always realized with a mid-level tone. Yet different from TSM, the co-existing neutral tone patterns in Malaysian Mandarin have their respective pitch targets, which could be a result of language contact since the variety of Malaysian Mandarin is spoken in Penang, where the majority of the local Chinese Malaysians also speak Penang Hokkien, another variety of Southern Min.

4.3. Tone extension conditioned by onset sonority

The two types of neutral tone in TSM, however, are better explained as an ongoing "lexical diffusion" that may be based on "phonetic naturalness." In the present study, we propose that onset sonority is the main factor that determines whether a neutral-toned clitic belongs to NT1 or NT2. An onsetless clitic tends to allow the preceding tone to spread onto it, and a sonorant-initial clitic is the second most possible for tone spreading. An obstruent-initial clitic, especially the one with a voiceless obstruent onset, is incompatible with tone spreading, due to the lack of vocal fold vibration, and thus no F0 contours.

As suggested by the data illustrated in §3.3, the more sonorous the onset, the more possible it is for the neutral-toned clitic to allow tonal carryover, which is then phonologized as tone extension (NT2). The phonologization process is lexically speaking gradual; we speculate that it happened firstly in the most likely environment (i.e., onsetless clitics) and then in a less likely environment (sonorant-initial clitics), as is reflected in Varieties 1 and 2 in Table 3.

In the same vein, regarding a more complete array of the TSM neutral-toned clitics, as shown in Table 4 [10], we can say that onset sonority does a good job in determining the neutral tone types, although there are some exceptions. In contemporary TSM, clitics with a voiceless obstruent is still not subject to tone extension, so they still predominantly exhibit NT1. In Table 4 we also list several clitics with a *voiced* obstruent onset (e.g. *gueʔ⁸* and *dzit⁸*). According to our fieldnotes and Ang's documentation [10], these clitics do allow tone extension, albeit limited only to specific morphemes and speakers, suggesting that clitics with a voiced obstruent onset behaves somewhat between the sonorant-initial and the other obstruent-initial clitics, as far as NT1 vs. NT2 is concerned.

Only a few special cases need further remarks. Firstly, complex directional phase markers and bare quantifiers only allow NT1, even if they have sonorant onsets (e.g. *pue¹=loʔ⁸-lai⁵* 'fly down here', *lim¹=nng⁷-ũã²* 'drink some bowls (of broth)'). It is perhaps their disyllabicity that leads to a "sour grapes" effect ([20], [21]) for neither syllable in the constituent to allow tone extension/spreading, since a two-syllable span can be more resistant to the phonologization of tonal carryover. Secondly, most sentence-final particles for mood or question are incompatible with NT2, probably because they are already or they still need to be associated with certain boundary tones in intonation to encode pragmatic information.

The present study also provides another interesting dimension in terms of the consonant-tone interaction. Specifically, in TSM, it is the sonorant/voiced segments that encourage tone spreading, while the voiceless obstruents play a role in blocking tone extension. This pattern is very different

from the more well-known "blocking effect," seen in examples such as the *depressors* of Bantu and Wu languages [22], [23]. Unmarked depressors are (breathy) voiced consonants, so in these languages, high tone spreading is often blocked by the inherently low-toned (breathy) voiced consonant but not by the voiceless (aspirated) ones. The TSM data reveal a reversal of the depressor consonants because the voiceless obstruents in TSM block tone extension in the neutral tone environments, but the voiced onsets tend not to do so.

5. Conclusion

This paper is an acoustic study of the two neutral tones (NT1 vs. NT2) in TSM. With the help of SS ANOVA modelling, our experimental results confirmed the co-existence of two neutral tone patterns: NT1 has a fixed low pitch target, and NT2 is contextually dependent. Taking speaker variation into consideration further reveals a substantially different picture. Importantly, one of the major findings is that onset sonority has a bearing on the choice between NT1 and NT2. Needless to say, the present results are far from conclusive. More acoustic (and perhaps articulatory, such as Electroglottography) data from more speakers with diverse backgrounds are definitely needed for a more comprehensive understanding of the neutral tones in TSM.

6. Acknowledgments

Table 4: *Some neutral-toned clitics in TSM.*

Type	Clitic	Gloss
NT1	*kue³*	experiential aspect marker (lit. 'pass')
	khi³	deictic phase marker (lit. 'thither')
	tioʔ⁸	achievement phase marker (lit. 'attain')
	si²	phase marker (lit. 'die')
	khui¹	phase marker (lit. 'open')
	tiau⁷	phase marker (lit. 'drop')
	tshu³	'homestead'
	ka¹	'clan'
	Sentence-final particles: *a, la, oo, loo*, etc.
	Complex directional phase markers: *tshut⁴-khi³* 'out there', *loʔ⁸-lai⁵* 'down here', etc.
	Bare quantifiers: *tsit⁸-pue¹* 'some cups' (lit. 'a cup'), *nng⁷-ũã²* 'some bowls' (lit. 'two bowls'), etc.
Varied	*leʔ⁴*	stative durative aspect marker
	lai⁵	deictic phase marker (lit. 'hither')
	li²	'inside'
	gueʔ⁸	'month' [*tsĩã¹=gueʔ⁸* 'first month']
	ni⁵	'year' [*tsun⁵=ni⁵* 'the year before last']
	dzit⁸	'day' [*au⁷=dzit⁸* 'the day after tomorrow']
	Pronouns: *gua²* 'I', *gun²* 'we (excl)', *lan²* 'we (incl)', *li²* 'you (sg)', *lin²* 'you (pl)', *i¹* '(s)he', *in¹* 'they', *lang⁵* 'one'
NT2	*aʔ⁴*	perfect aspect marker
	e⁵	relativization/nominalization marker
	a²	hypocoristic/locative/adjectival suffix

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