Phonetic Realization of Suffix vs. Non-suffix Morphemes in Taiwanese

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Abstract

We investigated how Taiwanese diminutive suffix -a is phonetically realized in both juncture and context positions. As a grammatical morpheme, suffix -a is similar to Mandarin diminutive suffix -zi as in *yi-zi* "chair". While Mandarin suffix -zi always has a neutral tone or belongs to an unstressed syllable, Taiwanese -a is widely accepted as having a full tone. However, due to the same functional use of the grammatical morpheme as Mandarin one, we expect to find similar patterns in Taiwanese. Therefore, we compared F_0 contours, mean F_0, and duration of Taiwanese suffix -a with a lexical morpheme of the same tone *tsa* "early" in both juncture position and in the middle position of tri-syllabic words. Different speaking rates were also manipulated, since we expect to see some reductions of the weak element in faster speech rate. Our results show that Taiwanese diminutive suffix -a behaves exactly like other full-tone content words and also undergoes tone sandhi as other lexical morphemes do. Even in the middle of tri-syllabic words, there is no reduction in mean F_0 and duration.

Index Terms: Taiwanese, diminutive suffix, F_0, duration

1. Introduction

Grammatical morphemes in Mandarin such as particles, aspect markers and suffixes are widely regarded as having neutral tones [3, 4, 5, 9, 10, 14], which are generally believed to be relatively short and easily influenced by the preceding ones. For example, the verb suffix -zhe in *kan-zhe* "looking" and the nominal suffix -tou in *she-tou* "tongue" are unstressed and thus with a shorter vowel and lower pitch.

Both being in the Chinese language family, Mandarin and Taiwanese share many morphological and syntactic features such as the lack of inflections and having the same word order. The issue of prosodic manifestation of grammatical morphemes in these two languages is especially interesting in the case of suffix. In terms of function [13], Taiwanese diminutive suffix -a is very similar to its Mandarin counterpart suffix -zi as in *yi-zi* "chair" and *zhuo-zi* "table". Similar characteristics of the diminutive suffix -a were specified in [17, 19]: (i) it denotes no extra meanings, and (ii) it marked diminutive. Although Taiwanese -a has a tonal target widely accepted as a full tone, its actual phonetic realization may not necessarily be the same as content words of the same tone, since it plays a rather minor role in conveying the meanings of a word. It is possible that Taiwanese suffix -a has a similar prosodic pattern like strong-weak contrast as Mandarin suffix, but still has a full tone.

Most studies examined -a from the perspectives of phonology [6, 7] or morphology [12]; yet relatively few studies, if any, explored the phonetic behaviors of the suffix -a. The present study attempts to investigate the suffix -a from a phonetic point of view, in particular, its F_0 realization and syllable duration. The production experiment is designed to address two issues: (i) Does grammatical morpheme -a have the same pitch contour as the content word *tsa* "early" in both juncture and context positions? (ii) Does suffix -a become a weaker element than the content word *tsa* and more susceptible to the surrounding environment in a tri-syllabic context when spoken in a fast rate?

Taiwanese has seven lexical tones as shown in TABLE 1 and each tone has two alternative forms depending on the position: tones occurring in the juncture position and those occurring in the context position. These tones are classified into two groups: one is checked tone ending with unreleased voiceless stops and the other group is non-checked tone. Checked and non-checked tones have different tone sandhi patterns and differ in duration; only the five non-checked tones are discussed in this study.

TABLE 1. *Taiwanese Tone Inventories*

Underlined tones are checked tones. The two numbers indicate the tone values on a 5-point scale.

Tone category	Tone Value		Example
	Juncture	Context	
1.Ying Ping	55	33	/si/ 'poem'
2.Ying Shang	53	55	/si/ 'death'
3.Yin Qu	11	53	/si/ 'four'
4.Yin Ru	3	53	/sik/ 'color'
5.Yang Ping	13	33	/si/ 'time'
6.Yangshang			
7.YangQu	33	11	/si/ 'temple'
8.Yang Ru	5	1	/sik/ 'ripe'

Although researchers haven't reached any agreement on whether Mandarin has word stress or not, there is a consensus that almost all the suffixes in Mandarin bear a neutral tone, Taiwanese diminutive suffix -a, on the other hand, is usually regarded as a full tone able to undergo tone sandhi. In the present study, only the suffix -a attached to a noun in the phrase-final position was examined. It is realized as a regular Tone 2: a high falling tone ($-a^{53}$) in the juncture position and a high level tone ($-a^{55}$) in the context position.

The preceding syllable of the suffix -a generally undergoes regular sandhi rules.[1] For example, when the word kam^{55} "tangerine" occurs in isolation, its output form is the same as its underlying tone: a high level tone kam^{55} **(TABLE 2.a)**. However, when kam^{55} precedes the suffix -a, it changes to the context tone kam^{33} **(TABLE 2.b)**. Similarly, in the case when kam^{55}-a^{53} precedes another noun $giap^{53}$ "juice", the high falling a^{53} turns to high level a^{55}**(TABLE 2.c).**.

[1] There are also other special rules regarding the pre-a position tone sandhi [8].

TABLE 2. *Tone sandhi of kam^{55} and suffix -a^{53}*

UNDERLYING FORM	OUTPUT FORM	GLOSS
a. kam^{55}	kam^{55}	tangerine
b. kam^{55}–a^{53}	Kam$^{\mathbf{33}}$–**a$^{\mathbf{53}}$**	tangerine
c. kam^{55}–a^{53}–tɕiap^{53}	Kam^{33}–**a$^{\mathbf{55}}$**–tɕiap^{53}	tangerine juice

2. Method

2.1. Materials

The design of the test material was guided by two factors. First, tonal context was varied. Only two lexical tones occurring in the preceding syllable were included; that is, the high level and the mid level tones, since non-level tones and low tone never occur before the suffix -a. However, five lexical tones were included in the following position: high, mid, low, falling and rising tones. Secondly, two speaking rates, fast and normal were manipulated because duration may influence the phonetic realization of a grammatical morpheme.

Three types of wordlists were included in the study: (i) disyllabic words consisting of a word and a suffix -a, and disyllabic words consisting of a word and a non-suffix *tsa*, as illustrated in **TABLE 3**. (ii) tri-syllabic words with suffix -a in the middle; (iii) tri-syllabic word with *tsa* in the middle as shown in **TABLE 4.**

TABLE 3. Disyllabic wordlist

Noun + suffix -a

UNDERLYING FOM	OUTPUT FORM	GLOSS
tɕiau^{55}–a^{53}	tɕiau^{33}–a^{53}	bird
tɕim^{55}–a^{53}	tɕim^{33}–a^{53}	crab
kɔ^{55}–tsa^{53}	kɔ^{33}–tsa^{53}	ancient

In the disyllabic wordlist, the tonal combinations are High level tone (55) + Falling tone (53) and Mid level tone (33) + Falling tone (53). In the tri-syllabic wordlists, -a occurs in the middle, preceded by a high and a mid level tone and followed by High level tone (55), Mid level tone (33), Low tone (11), Low rising tone (13) and falling tone (53), as listed in **TABLE 4a.** The same five tonal combinations with high level tone in the first syllable as shown in **TABLE 4b.,** which enables us to compare the tonal realization of -a in the middle of a tri-syllabic with other words of the same tone. However, we could not find any real words with surface mid tone occurring before *tsa*.

TABLE 4. Tri-syllabic wordlist

a. Noun+ suffix -a + Noun

UNDERLYING FOM	OUTPUT FORM	GLOSS
tɕiau^{53}–**a$^{\mathbf{53}}$**–k^{h}a^{55}	tɕiau^{55}–**a$^{\mathbf{55}}$**–k^{h}a^{55}	bird's leg
tɕiau^{53}–**a$^{\mathbf{53}}$**–bi^{33}	tɕiau^{55}–**a$^{\mathbf{55}}$**–bi^{33}	bird's smell
tɕiau^{53}–**a$^{\mathbf{53}}$**–tiam^{11}	tɕiau^{55}–**a$^{\mathbf{55}}$**–tiam^{11}	bird store
tɕiau^{53}–**a$^{\mathbf{53}}$**–p^{h}ue^{13}	tɕiau^{55}–**a$^{\mathbf{55}}$**–p^{h}ue^{13}	bird skin
tɕiau^{53}–**a$^{\mathbf{53}}$**–tɕiu^{53}	tɕiau^{55}–**a$^{\mathbf{55}}$**–tɕiu^{53}	bird wine
ɕim^{13}–**a$^{\mathbf{53}}$**–k^{h}a^{55}	ɕim^{33}–**a$^{\mathbf{55}}$**–k^{h}a^{55}	crab's leg
ɕim^{13}–**a$^{\mathbf{53}}$**–bi^{33}	ɕim^{33}–**a$^{\mathbf{55}}$**–bi^{33}	crab's smell
ɕim^{13}–**a$^{\mathbf{53}}$**–tiam^{11}	ɕim^{33}–**a$^{\mathbf{55}}$**–tiam^{11}	crab store
ɕim^{13}–**a$^{\mathbf{53}}$**–p^{h}ue^{13}	ɕim^{33}–**a$^{\mathbf{55}}$**–p^{h}ue^{13}	crab skin
ɕim^{13}–**a$^{\mathbf{53}}$**–tɕiu^{53}	ɕim^{33}–**a$^{\mathbf{55}}$**–tɕiu^{53}	crab wine

b. *Noun + non-suffix -tsa + Noun*

UNDERLYING FOM	OUTPUT FORM	GLOSS
kɔ^{53}–**tsa$^{\mathbf{53}}$**–biŋ^{55}	kɔ^{55}–**tsa$^{\mathbf{55}}$**–biŋ^{55}	ancient ice
kɔ^{53}–**tsa$^{\mathbf{53}}$**–bi^{33}	kɔ^{55}–**tsa$^{\mathbf{55}}$**–bi^{33}	ancient flavor
kɔ^{53}–**tsa$^{\mathbf{53}}$**–tiam^{11}	kɔ^{55}–**tsa$^{\mathbf{55}}$**–tiam^{11}	ancient store
kɔ^{53}–**tsa$^{\mathbf{53}}$**–laŋ^{13}	kɔ^{55}–**tsa$^{\mathbf{55}}$**–laŋ^{13}	ancient people
kɔ^{53}–**tsa$^{\mathbf{53}}$**–tɕiu^{53}	kɔ^{55}–**tsa$^{\mathbf{55}}$**–tɕiu^{53}	ancient wine

Our materials include 18 target words and 18 fillers. DMDX [11] was used to present the target words in the wordlists.

2.2. Subjects

Eight Taiwanese speakers, four male and four females, were recruited as subjects. Their average age was 49.5, ranging from 43 to 57. To guarantee minimal dialectal variances in Taiwanese, only native Taiwanese speakers in Chia-yi area participated in this experiment and none of them reported having any speech disorders.

2.3. Elicitation procedure

Subjects sat in front of a computer with 17-in. monitor in a sound-treated room in the Phonetics Lab of the Institute of Linguistics at National Chung Cheng University, Taiwan. There were five sessions in the production experiment, with a short break in between. The first session was a practice trial, used to familiarize subjects with the words that would appear later in the production task. During the break, the experimenter would check if they had any problems with the procedure. In each session, the thirty-six words were randomized and presented on the screen to elicit subjects' production. The target words were shown on the computer screen one by one after an affixation cross. When the subjects saw a target word on the screen, they were asked to read out the word twice, first with their normal speaking rate and second with a speaking rate they regarded as the fastest.

2.4. Recording

DMDX was used to elicit the production and to record the data, which were directly digitized into the computer. A technical microphone (Audio-Technica ATR20) was placed about 5 inches in front of the subject's lips. The first session was regarded as a practice trial, and thus it was excluded from our production data analyses. In total, 288 tokens (36 words* 4 repetitions* 2 types of speed) were recorded for each subject, and only 144 of them were the intended target we used in our data analyses.

2.5. F_0 extraction

The extraction of F_0 contours was done by a procedure using a custom-written Praat [2] script. The script [18] allowed us to generate accurate F_0 tracks by manually rectifying the markings of individual vocal pulses. When the script was run, two windows, one with pulse markings and the other with TextGrid together with the waveform, were displayed. The vocal pulse markings generated by Praat were then manually corrected in the pulse window for errors such as missed or double marked cycles. Labeling was done manually in the TextGrid window and normalized mean F_0 contours, mean F_0 and mean duration were also computed.

FIGURE 1.1
F_0 contours of juncture *-a* and juncture *tsa* in the fast condition

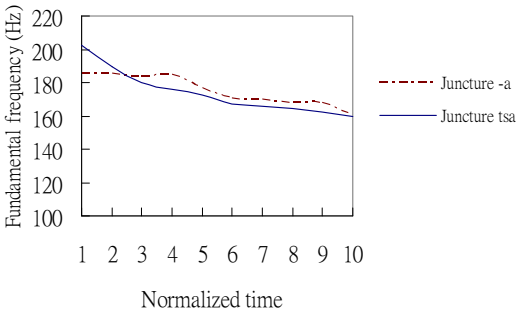


FIGURE 1.2
F_0 contours of context *-a* and context *tsa* in the fast condition

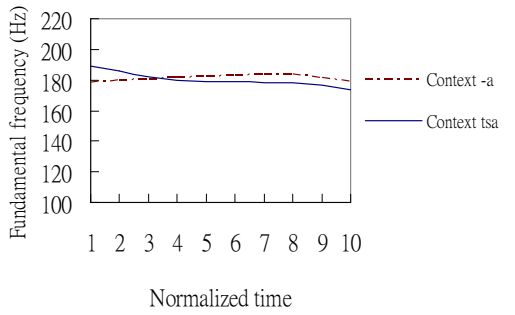


FIGURE 1.3
F_0 contours of juncture *-a* and context *tsa* in the normal condition

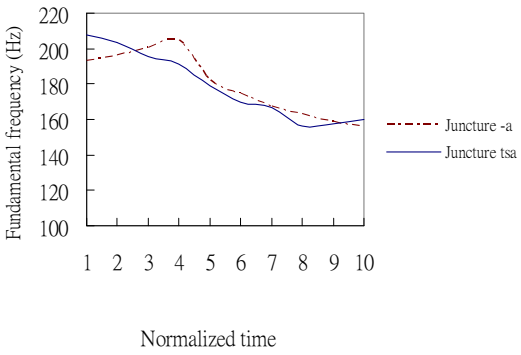
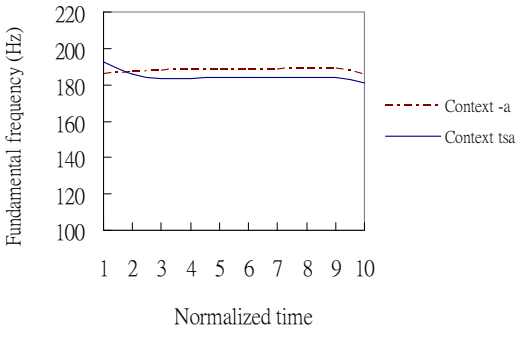


FIGURE 1.4
F_0 contours of context *-a* and context *tsa* in the normal condition



3. Results and data analysis

We measured F_0 contours and the vowel duration -a and *tsa* in both fast and normal speaking rates. **FIGURE 1.1** and **FIGURE 1.2** display the time-normalized F_0 contours -a and *tsa* produced by 8 speakers in a fast speaking rate. In **FIGURE 1.1,** the F_0 contour of juncture -a is an average of 64 tokens (8 speakers* 4 repetition * 2 word) and that of juncture *tsa* is an average of 32 tokens (8 speakers* 4 repetition * 1 word). In **FIGURE 1.2**, the F_0 contour of the context -a is an average of 320 tokens (8 speakers*4 repetition*10 words) while that of *tsa* is an average of 160 tokens (8 speakers * 4 repetition * 5 words).

FIGURE 1.3 and **FIGURE 1.4** illustrate the F_0 contours of -a and *tsa* when they were produced in a normal speaking rate. In general, these four normalized F_0 contours do not show much difference between suffix -a and content word *tsa*. However, there are larger differences in the beginning of the syllable, which may be due to the perturbation of the consonant /tɕ/ and also different preceding tones in -a and *tsa*.

To further explore the difference between these two morphemes, average mean F_0 of the high level tone in -a and *tsa* are also computed as illustrated in **TABLE 5.** Two-way (speaking rate, position) mixed ANOVAs showed significant effect of speaking rate ($F[1,26]=1394.12$, $p<.001$), but no significant effect of position. There was no interaction between speaking rates and position, either.

TABLE 5 Average of Mean F_0 (Hz) of context *-a* and *tsa* in the middle position of a tri-syllabic word.

	fast condition	normal condition
context -a	182.54Hz	218.38Hz
context -tsa	181.28Hz	216.70Hz

FIGURE 2.1 and FIGURE 2.2 display the mean vowel duration of -a and *tsa* in different positions and in different speaking rates. Linear mixed-effects modeling [1] is used in our data analysis. It includes all the data points rather than an average. LME was run by using the free statistical software R. LME analyses found regression coefficients, β. Significance was tested using t values. The result of duration shows that there is no significant difference between juncture and context position (β =1.39, t=0.30, $p>.05$) and suffix -a and content word *tsa* (β =0.32, t=0.09, $p>.05$).

FIGURE 2.1
Mean vowel duration of *-a* and *tsa* in the juncture position

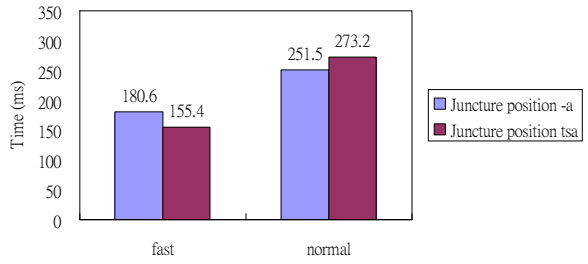
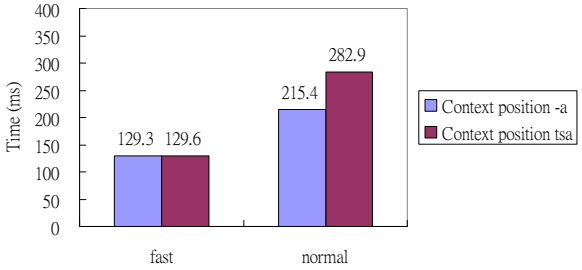


FIGURE 2.2
Mean vowel duration of *-a* and *tsa* in the context position



4. Discussion

The acoustic analysis in our production experiment shows that there is no significant difference between Taiwanese suffix -a and full tone content word *tsa* in their pitch contour and syllable duration. The slight difference in the beginning of the contour is mainly due to influence of the preceding tone, since it is an average of all the tokens. When the -a is preceded by both a high level tone and a mid level tone, *tsa* is only preceded by a high level tone. Therefore, the pitch range of *tsa* is higher in the beginning than that of -a. Another possible reason causing the difference is the consonant perturbation. However, either in juncture position or in context position, suffix -a and non-suffix *tsa* showed similar patterns of pitch contour and vowel duration. Due to the same functional use of the grammatical morpheme, we were surprised to find that even in a faster speech, the suffix -a still behaved the same as other non-suffix full tones. In Mandarin, the neutral tone shortens the duration of a syllable to about 61 % of the regular syllable [5]. However, Taiwanese suffix -a is not only realized a full tone, but also retain similar duration as the content word *tsa*. It is very likely that in Taiwanese, neutral tones only occur in the particles in phrasal-final or sentence-final positions [13], grammatical morphemes such as diminutive suffix -a and classifier -e may be already lexicalized. In this case, another possible explanation of this phenomenon is that at the lexical level, as proposed in Allomorph Selection Hypothesis [15, 16], Taiwanese tone sandhi does not involve on-line change of one tone category to another, but rather the selection of allomorphs appropriate to the environment. That is, Taiwanese native speakers store both allomorphs *-a*^{55} *and -a*^{53} in their mental lexicon, just as they do for *tsa*^{55} and *tsa*^{53}.

5. Conclusion

The present finding shows that Taiwanese diminutive suffix -a behaves like a full tone and undergoes tone sandhi as other lexical morphemes do. Due to the larger amount of data, we didn't examine all the grammatical morphemes in Taiwanese, but at least, this study provides an acoustic evidence to show that a grammatical morpheme in Taiwanese does have a full tone and can resist reduction when occurring in compound words. This may further provide some support for the argument of syllable-timed nature in Taiwanese, since each morpheme is assigned same weight, even in a suffix. Many Chinese languages have a neutral tone on grammatical morphemes such as Mandarin suffixes in nouns and pronouns. Further studies on other grammatical morphemes in Taiwanese are needed to explore if the neutral tone in Taiwanese only occurs at final particles rather than suffixes of different functions. As suggested in [13], only phrase-final or sentence-final particles have neutral tones.

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