
Tone Sandhi as Evidence for Segmentation in Taiwanese

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1 Introduction

A major question in the study of language acquisition concerns how children learn to segment fluent speech into linguistic constituents such as words and syntactic phrases. In this paper, we show how production data can be used as indirect evidence for children's segmentation of fluent speech. Specifically, this paper examines how developmental changes in segmentation are reflected in Taiwanese tone sandhi (TTS).¹

TTS describes a pattern of tone alternations that are sensitive to the boundaries of prosodic phrases built on syntactic constituents such as NP and VP (see Chen 1987, Lin 1994). Infants and young children just beginning to talk may be able to use TTS alternations in adult speech to learn where the constituent boundaries are (see Tsay, in press). Moreover, the errors that children make in producing tone sandhi alternations provide important evidence about how they are segmenting speech into constituents. TTS is thus an as-yet unexplored tool for researchers to learn more about the development of segmentation in production.

Evidence about the units used in child language production came from the tone errors of two children (2;1-2;9) acquiring Taiwanese. We found that young children sometimes use smaller units than adults (e.g. splitting

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the two constituents of a compound word) and sometimes combine units that would be separate for adults. Moreover, segmentation was sensitive to grammatical factors such as semantic transparency and morphosyntactic structure.

2 Background

In this section, we first introduce the pattern of TTS, with special focus on the interface between the tone alternation domain (tone group) and syntactic structure. We then explain the relevance of TTS to the study of children's segmentation.

2.1 Taiwanese Tone Sandhi

Taiwanese is a dialect of Southern Min Chinese spoken in Taiwan. Except for some function words, each syllable (also a morpheme in most cases) carries one of the seven lexical tones. Moreover, each tone category has two tone values: one occurs in juncture position and the other in context position (to be explained further below). Tone inventory and tone values of the variety we examined (Chia-yi County) are given in Table 1 below, where H, M, and L stand for high, mid, and low pitches, respectively.²

Tone category	Tone value	
	Juncture	Context
1	H	M
2	LM	M
3	HL	H
4	L	HL
5	M	L

Table 1 Tone inventory in Taiwanese

For example, as shown in Table 2 below, a Tone 4 morpheme *si* meaning "four" has a juncture tone (L) when it appears in the compound "ten-four; fourteen", and a context tone (HL) when it appears in the compound "four-ten; forty".

² Tone 6 and Tone 7 only appear in syllables ending with an unreleased -p, -t, -k, or -ʔ. It has been proposed that these two tones can be treated as variants of two of the other five tones (Cheng 1968, Tsay 1989). Furthermore, the acquisition of these tones is confounded by the syllable structure (Tsay and Huang 1998) and thus should be analyzed separately. Therefore, these two tones are not discussed in this paper.

	Correct	TTS errors	Misc. errors
Target in juncture tsap ^L si ^L "fourteen"	si ^L	*Context form si ^{HL}	*Other tones si ^H , si ^M , si ^{LH} ...
Target in context si ^{HL} tsap ^H "forty"	si ^{HL}	*Juncture form si ^L	*Other tones si ^H , si ^M , si ^{LH} ...

Table 3 Classification of tone errors

4 Results and Discussion

Our findings are as follows.

First of all, the overall error rate was low (7-14% for Jun, 8-14% for Lin), as shown in Tables 4 and 5 below. This is consistent with previous studies of tone languages which found that children have good mastery of tone categories by the age of 2;0 (e.g. Li and Thompson 1978, King 1980, Hsu 1989).

Child: Jun	Juncture				Context			
Period	1	2	3	<i>I-3</i>	1	2	3	<i>I-3</i>
Total errors	98	20	114	232	148	23	143	314
Total tokens	1238	556	1679	3473	759	323	1098	2180
Error %	8%	4%	7%	7%	19%	7%	13%	14%

Table 4 Overall error rate for Jun

Child: Lin	Juncture				Context			
Period	1	2	3	<i>I-3</i>	1	2	3	<i>I-3</i>
Total errors	87	80	177	344	101	125	205	431
Total tokens	947	1052	2142	4141	664	770	1692	3126
Error %	9%	8%	8%	8%	15%	16%	12%	14%

Table 5 Overall error rate for Lin

Secondly, for both children the error rate was about twice as high in context position as in juncture position. This may seem to indicate that children were segmenting utterances into smaller units than adults. One such example is given below where a compound word (NP) was split into two constituents and as indicated by the use of juncture tone M on the first constituent rather than context tone L.

- (2) Target: *ten*^L ue^M]_{NP} ia^L
 Lin: *tji*əŋ^M] ue^M]_{NP} ia^L (2;3.26)

electricity speech (particle)
"telephone"

However, if we examine the error types shown in Tables 6 and 7, Jun showed no difference in the proportion of TTS errors in juncture position (35%) vs. context position (36%), while Lin showed a difference opposite to that expected, having more TTS errors in juncture position (72%) than in context position (45%).

Child: Jun	Juncture				Context			
Period	1	2	3	<i>I-3</i>	1	2	3	<i>I-3</i>
TTS errors	32	9	40	81	28	4	82	114
Misc. errors	66	11	74	151	122	19	61	200
Total errors	98	20	114	232	148	23	143	314
TTS error %	33%	45%	35%	35%	19%	17%	57%	36%

Table 6 TTS error rate for Jun

Child: Lin	Juncture				Context			
Period	1	2	3	<i>I-3</i>	1	2	3	<i>I-3</i>
TTS errors	53	61	132	246	43	59	91	193
Misc. errors	34	19	45	98	58	66	114	238
Total errors	87	80	177	344	101	125	205	431
TTS error %	61%	76%	75%	72%	43%	47%	44%	45%

Table 7 TTS error rate for Lin

These observations imply that children do not start with a default parameter setting of "X^{lex}". However, the children did sometimes split up words as the above example in (2) shows. Moreover, using the same data discussed in this paper, Chen (1999) found effects of semantic transparency and morphosyntax on the rate of TTS errors in context position. Semantically transparent disyllabic compounds were more likely to have TTS errors in context position than semantically opaque words. The children also made more TTS errors in context position in verb phrases than in nominal compounds.

Errors made in juncture position also provide information about mis-segmentation. For example, the following error is a TTS error occurring in juncture position, indicating that the child was combining two tone groups into one.

- (3) Target: t'i^M tiŋ^{HL}]_{NP} pue^H]_{VP}, t'i^M tiŋ^M]_{NP}
 Lin: te^M tʃiəŋ^H pe^H], la^M tʃiəŋ^{HL}] (2;3.12)
 sky top fly sky top