漢語及少數民族語言語音學研討會論文集

The Proceedings of the Conference on Phonetics of the Languages in China

會議于一九九八年五月廿八日至卅日
在香港城市大學舉行

Conference held at
the City University of Hong Kong
May 28 - 30, 1998

徐雲揚 林茂燦 編

Edited by
Eric Zee & Lin Maocan

本次研討會由香港城市大學，中文、翻譯及語言學系的語音實驗室組織。

The Conference on Phonetics of the Languages in China has been organized by the Phonetics Laboratory of the Department of Chinese, Translation and Linguistics at the City University of Hong Kong.

 ISBN 962-442-128-5
Printed by MPU, City University of Hong Kong
83 Tat Chee Avenue, Kowloon
Hong Kong

PHONETIC PARAMETERS IN THE ACQUISITION OF ENTERING TONES IN TAIWANESE

Jane Tsay and Ting-yu Huang
Graduate Institute of Linguistics, National Chung Cheng University

1. INTRODUCTION

This paper reports an acoustic study of the checked syllables, i.e. syllables that appear with Entering tones (Rusheng, 入聲), produced by a child learning Taiwanese as a first language, with a special focus on the duration of the checked syllables as opposed to the duration of open syllables. The goal of the study was to examine the nature of the variation in the acquisition data as being phonemic (categorical) or phonetic (gradient).

Taiwanese, a branch of Southern Min Chinese, has seven lexical tones including two Entering tones and five non-Entering tones. The two Entering tones only occur in checked syllables, i.e. syllables ending with an unreleased stop p, t, k, or ? (glottal stop), while other tones occur in syllables ending with a sonorant (vowel, nasal, glide). It has been observed in the phonological acquisition literature that since children tend to drop the coda stop of the checked syllables, the Entering tones seem to be acquired later than other tones (King 1980, Hsu 1989).

This phenomenon raises a very interesting issue concerning language acquisition. How do we know when the child has acquired the contrast of the different phonological categories (open syllable vs. checked syllable)? That is, when children drop a coda stop, does the dropping take place at the phonemic level (categorical variation) or at the phonetic level (gradient variation)?

Such questions can be addressed by measuring syllable duration. It is well known that open syllables are longer than closed syllables (Lehiste 1970). If coda deletion takes place at the phonemic level, we would expect the duration of the open syllable derived from dropping the coda to be the same as the duration of an underlying open syllable; that is, the phonetic process of compensatory lengthening should behave as if the glottal stop were never present. If, on the other hand, the deletion occurs at the phonetic level, then the duration of the checked syllable should remain distinct from that of a true open syllable. Of these two possibilities, the latter seems more likely, given what is known about variability of motor control in the production of consonants by young children (e.g. Kent and Miolo 1995).

There is an additional interesting complexity in the behavior of checked syllables. In the adult phonology of Taiwanese, glottal stops are deleted in the course of tone sandhi. That is, checked syllables lose the final glottal stop and become open syllables when they appear in so-called context position (e.g. within a word). When they appear in so-called juncture position (e.g. at the end of an utterance), the glottal stop is retained (for clarification of the concepts of context and juncture, see Chen 1987, Tsay 1994, among others). As a rule of the categorical phonology of Taiwanese (Tsay 1994, Tsay and Myers 1996), this glottal stop deletion process should produce open syllables that have the same duration as underlying open syllables. Hence if children know the effects of this rule (not necessarily the rule itself; see Discussion), glottal stop deletion should also be categorical in their speech, but only in context position.

In summary, if the above arguments are correct, we predict the patterns illustrated in the following diagrams, where "=" represents no significant differences in duration, "≠" significant differences in duration, "V" an open syllable, "V?" a checked syllable with a coda glottal stop, "V(?)" a checked syllable with glottal deletion.

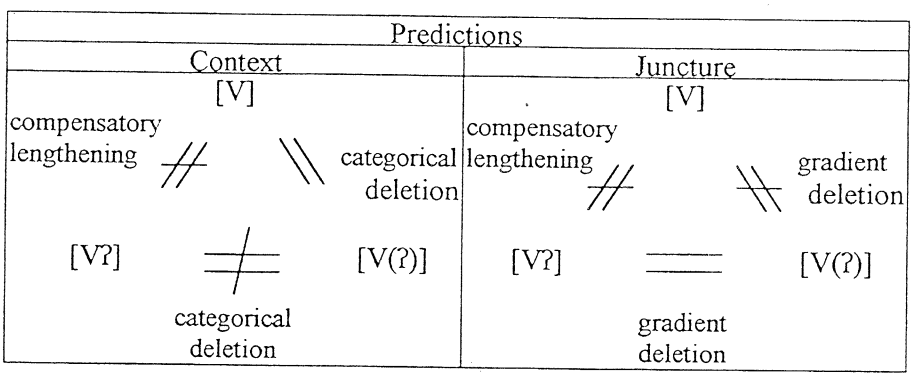

Figure 1 Predictions

2. METHOD

In this experiment, we measured the duration of open syllables and checked syllables in both context and juncture positions. The source of the materials is Tsay (in progress), *A Developmental Study of Taiwanese Tone Acquisition*, which is a three year study of a group of children aged approximately from 1;1 to 4;0 from Taiwanese speaking families in Southern Taiwan. The specific subject described here is one of the boys from this group. Ten 60-minute recordings of spontaneous speech from regular home visit interviews were made while the subject was between the ages of 2;1.17 and 2;5.4. As described in Introduction, the duration contrasts included: [V] vs. [V?], [V] vs [V(?)], and [V?] vs.[V(?)] in both context and juncture positions. In addition, the comparisons between [V] and [VK] were also made. (Almost no tokens of [V(K)] were found in this child's speech.)

In order to avoid intrinsic vowel duration differences, we only measured syllables with the vowels [-a] or [-ia]. There were a total of 257 tokens with the rime [-a] or [-ia], 168 tokens with the rime [-a?] or [-ia?], and 51 tokens with the rime [-ak] or [-iak]. Comparisons were made only within each vowel category and within each tone category for non-checked syllables (e.g. [-a^{33}] with [-ak], [-ia^{55}] with [ia?]). (Superscript digits denote the tone.) Because the materials were from spontaneous speech, tokens that were unintelligible (too weak or noisy) or difficult to segment (e.g. with sonorant onsets) were discarded. All checked syllables were presented auditorily for categorical judgments by two linguists to decide whether the coda stop was present. The judgments were transcribed in IPA to indicate the presence or dropping of the coda stop (e.g. [V(?)] indicates glottal stop deletion in a checked syllable).

The recordings were then digitized and the duration of target syllables were measured using the speech analysis software of the Kay Computerized Speech Lab. Each syllable was measured from the beginning of periodicity to the end of periodicity. Vowel formants and amplitude were used to clarify judgments of the beginning and end points of periodicity, if this was unclear from the waveform alone.

3. RESULTS

The following tables show the descriptive statistics for the durations of different syllable types.

syllable	-a^{33}	-a?^{53}	-a(?)^{53}	-ia^{55}	-ia?^{21}	-ia(?)^{21}	-ak
example	腳，剪	打	打，肉	寫	吃	吃	讀，目
n	38	1	16	3	5	37	16
$\bar{x}$	156.9		184.6	195.3	91.8	164.9	112.1
s.d.	64.0		30.2	29.9	21.9	51.2	25.8

Table 1 Duration in Context Position

syllable	-a^{55}	-a?	-a(?)	-ia^{55}	-ia?	-ia(?)	-ak
example	腳，乾	打	打，肉	車	吃	吃，隻	讀，北
n	31	2	14	25	5	35	18
$\bar{x}$	252.7		230.1	279.96	148.6	203.6	151.1
s.d.	61.9		50.7	85.7	11.9	76.0	40.7

Table 2 Duration in Juncture Position

Two-tailed unpaired t-tests were done for each of syllable type contrasts in this experiment. The size of samples was controlled so that in both samples under comparison there were the same number of observations. For example, there were 16 [-ak] measurements and 38 [-a^{33}] measurements in context position. Therefore, 16 out of 38 measurements in the [-a^{33}] group were chosen at random to match the sample size of the other group.

We first compare the duration of [-a] vs. [-ak] tokens. The difference was significantly different in both context position ($p<.01$) and juncture position ($p<.001$).

The results for other comparisons are shown below. ("=" represents no significant differences in duration, "≠" significant differences in duration.)

syllable types	Prediction	Results	Confirmation of prediction
Context position			
-ia vs. -ia?	≠	$p < .01$	yes
-ia? vs. -ia(?)	≠	$p < .05$	yes
-a vs. -a(?)	=	$p > .7$	yes
-ia vs. -ia(?)	=	$p > .5$	yes
Juncture position			
-ia vs. -ia?	≠	$p < .001$	yes
-ia? vs. -ia(?)	=	$p > .5$	yes
-a vs. -a(?)	≠	$p > .4$	no
-ia vs. -ia(?)	≠	$p < .001$	yes

Table 3 Results in both Context and Juncture Positions

4. DISCUSSION

This study attempted to apply instrumental and quantitative methods to the study of natural speech by children. In spite of the obvious difficulties of this endeavor, we hope to have provided evidence for three main findings.

First, the phenomenon of compensatory lengthening has been found in the speech of children acquiring Taiwanese.

Second, the deletion of final glottal stop in juncture position is gradient, not categorical. The implication of this finding is that children might acquire the checked syllables as phonemic categories, but still have trouble with the fine motor control required for consonant closure (e.g. -ʔ and -k). In other words, they are maintaining the distinctiveness of the Entering tone category by imitating the acoustic property that is simplest for them at their stage of articulatory development, namely syllable duration.

Third, the deletion of final glottal stop in context position is categorical. This suggests that an aspect of the adult pattern of tone sandhi is acquired quite early. Of course, the results do not imply that the children actually apply tone sandhi and glottal-stop deletion as phonological rules (in fact, adults probably do not either; see Tsay and Myers 1996). It seems more likely to us that children at this stage are merely imitating the acoustic targets of the adults' words, and this includes the long open allomorphs of checked syllables in context position.

ACKNOWLEDGEMENTS

This research was partially supported by a grant from the National Science Council, Taiwan. The authors thank James Myers for helpful discussions and comments on this paper. We also thank Xiao-jun Chen and Hui-chuan Liu for helping collect the original data.

REFERENCES

Chen, M. Y. 1987. "The syntax of Xiamen tone sandhi." *Phonology Yearbook* 4.109-149.

Hsu, H.-C. 1989. *Phonological Acquisition of Taiwanese: A Longitudinal Case Study*. MA thesis. National Tsing Hua University.

Kent, R. D and G. Miolo (1995) "Phonetic Abilities in the First Year of Life." In P. Fletcher and B. MacWhinney (eds.) *The Handbook of Child Language*, 303-334.

King, B. 1980. *The Acquisition of Tone in Taiwanese*. MA thesis. Fu Jer Catholic University.

Lehiste, I. 1970. *Suprasegmentals*. MIT Press: Cambridge, MA.

Tsay, J. 1994. *Phonological Pitch*. PhD dissertation. University of Arizona.

Tsay, J. and J. Myers. 1996. "Taiwanese Tone Sandhi as Allomorph Selection." *Proceedings of the Twenty Second Annual Meeting of the Berkeley Linguistic Society*. Berkeley, California. 394-405.

Tsay, J. (in progress) *A Developmental Study of Taiwanese Tone Acquisition*. National Chung Cheng University. Research Project Funded by National Science, Taiwan. (NSC 87-2411-H-194-019)