Ann. Bull. RILP, No. 15, 45 - 54 (1981)

LARYNGEAL ADJUSTMENTS FOR SYLLABLE-FINAL STOPS IN CANTONESE

Ray Iwata*, Masayuki Sawashima and Hajime Hirose

1. Introduction

As is well known, Cantonese is a language spoken in the southern part of China.[1)] In Cantonese two types of stops and affricates are distinguished in the syllable-initial position: voiceless inaspirates and aspirates, whereas in the final position there is only one type of stops -p,-t,-k as well as the nasal stops -m,-n,-ŋ. .Final -p,-t,-k can only be found in so-called "entering tone" syllables, which are characterized by the shorter duration and a sudden stop of glottal vibration by the oral closure for -p,-t,-k. Cantonese is commonly said to have nine kinds of lexical tones and three of them are called "entering tones" which are represented here as Tones 7, 8, 9.[2)]

As is also the case with many other languages in southern China, final stops in Cantonese are pronounced without oral release and the perceptual cue for identifying the place of articulation should lie in the formant transition of the onglide (W.S-Y Wang, 1959).

In the preceding paper (Iwata et al. 1979), we examined the laryngeal control for the final stops of Fukienese (Taiwan dialect of Min-Nan dialects group) based on fiberoptic observation and reported that a closed glottis without glottal vibration accompanied by glottalization was observed, at least when they were uttered in the isolated form. As for the laryngeal condition for final stops in Cantonese, Fok (1974) noted, "They are usually accompanied by the glottalization" (p. 8) and referred to the entering tones as "glottalized tones". The aim of the present paper is to further clarify the laryngeal gestures for Cantonese final stops in various phonetic environments, based on fiberoptic observation.

* Dept. of Chinese Literature, Kumamoto University.

2. Subjects and Test utterances

2-1 Subject

The subject in our experiment is a male native speaker of Cantonese. He was born and brought up in Hong Kong, and is currently a student of Tokyo University, Linguistics Department.

2-2 Test utterances

Test utterances are divided into six sets.

Set 1. This set was introduced for the purpose of examining:

1) the laryngeal gestures for -p,-t,-k in isolated syllables
2) the laryngeal gestures for vowels with different kinds of Non-entering tones (i.e. without final -p,-t,-k)

The following morpheme words written in Chinese characters were uttered in isolation.[3)]

1) $t\acute{i}p^{8}$, $t\int ip^{9}$, pit^{8}, $t\acute{i}k^{9}$, $t\int\theta k^{7}$
2) i^{1}, i^{2}, i^{3}, i^{4}, i^{5}, i^{6}

(The number to the right of the phonetic alphabet represents the tonal category, see Note 2) below)

Set 2. The following words were uttered in the carrier sentence:
$[ŋo^{5}\ iu^{3}$ _____ $]$ "I need _____ "
for the purpose of examining:

1) the laryngeal gestures for syllable initial stops
2) the laryngeal gestures for -p,-t,-k in the sentence final position

1) pin^{1}, $p\acute{i}n^{1}$, tin^{1}, $t\acute{i}n^{1}$
2) the same words as represented in Set 1-1)

Set 3. The following words were uttered in the carrier sentence:
$[k\ œy^{6}\ sek^{9}$ _____ ma?$]$ "Does he eat _____ ?"
to examine the laryngeal gestures for -k in $[sek^{9}]$ followed by various kinds of sounds:
y^{4}, $t\int y^{1}$, $t\int\acute{i}^{5}$, lei^{5}, $\int yt^{8}$, hou^{4}

Set 4. The following predicative phrases preceded by noun phrase:
$[nei^{5}\ t\int ek^{8}\ pit^{8}$ _____ ?$]$ "Is this turtle _____ ?"
were uttered to examine the laryngeal gestures for -t in $[pit^{8}]$ followed by various kinds of sounds:
fu^{2} m fu^{2}, yn^{5} m yn^{5}, $heŋ^{1}$ m $heŋ^{1}$,
$p\acute{e}ŋ^{4}$ m $peŋ^{4}$, $t\int\acute{i}^{4}$ m $t\int\acute{i}^{4}$, lei^{6} m lei^{6}

Set 5. The following two syllable words were uttered to examine the laryngeal gestures for -p,-t,-k in the medial position of the two syllable words:

$t^{\prime}it^{8}$ $k^{\prime}iu^{4}$ kik^{9} tyn^{1} hip^{9} lik^{9} $t\int it^{8}$ $i\text{ɐ}t^{9}$ œ
lik^{9} $\int i^{2}$ $t\int\theta k^{9}$ hei^{3} $tsek^{7}$ y^{4} $t\int yt^{8}$ $t\text{œ}y^{3}$
$k^{\prime}yt^{8}$ $te\eta^{6}$ $t^{\prime}yt^{8}$ lei^{4} uk^{7} $k^{\prime}ei^{2}$

Set 6. The following sentences were uttered at normal conversational speed to examine the laryngeal gestures for -p,-t,-k in natural speech.

1) [nei^{5} sek^{9} $ts^{\prime}an^{1}$ m sek^{9} a ?] "Do you take a meal?"
2) [nei^{5} ke^{3} $sa\eta^{1}$ i^{3} hou^{2} m hou^{2} $i\text{ɐ}p^{9}$ sek^{7} a ?]
"Does your business have good income?"
3) [ηo^{6} tei sek^{9} tso^{2} fan^{6} lo] "We have eaten a meal"

3. Fiberoptic Observation of Laryngeal Gestures

A flexible fiberscope was inserted through the nose of the subject and 16 mm films of the larynx were taken at a rate of 50 frames/sec during the articulation of the test utterances. The speech signals and timing marks were recorded simultaneously on magnetic tape in order to relate each film frame to the corresponding acoustic events. A magnified view of the larynx can be examined frame by frame using a film analyzer. The measurements were made on the distance between the vocal processes of the arytenoid cartilages when the glottis is open.

4. Results

Set 1.

1) -p,-t,-k in isolated syllables

As shown in Figure 1, the glottis is closed throughout the entire period of the phonation. Furthermore, it can be observed that the false vocal folds slowly start to be adducted prior to the articulatory implosion for final stop and are rapidly adducted almost immediately after the implosion. The same findings can be confirmed also in other samples. We regard such laryngeal activity as a characteristic feature of glottalization (Fujimura and Sawashima 1971, Iwata et al. 1979).

2) Vowels not followed by -p,-t,-k

In four samples out of six, a rapid adduction of false vocal folds took place just before the voice off-set of the vowel.[4] The glottalized gesture observed here, however, did not last so long as that found in syllables with final stops.

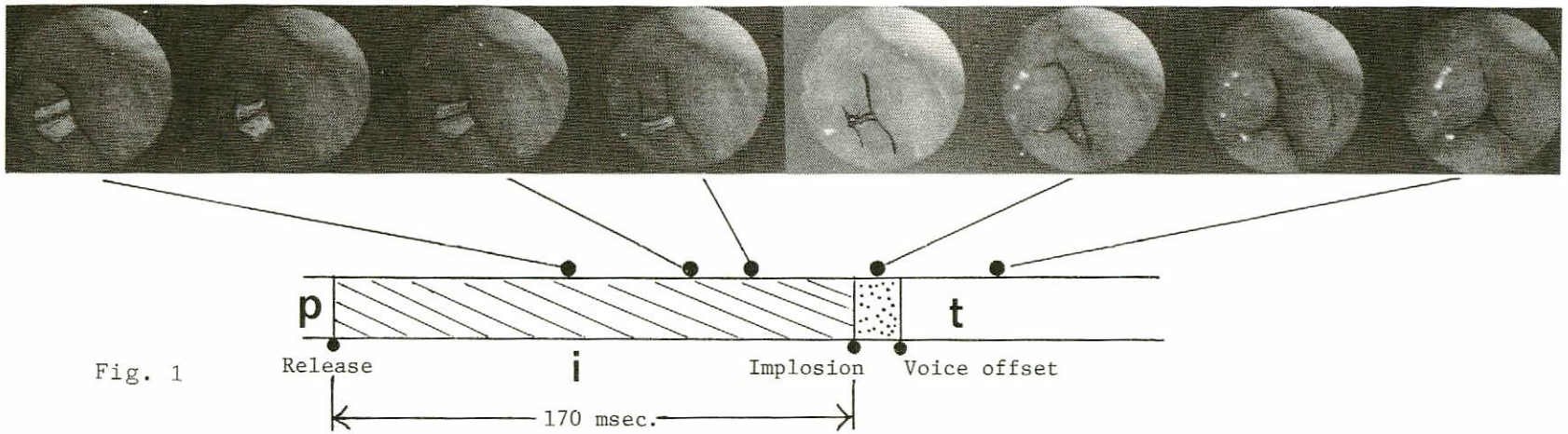
p
t
Release
i
Implosion
Voice offset
170 msec.

Fig. 1

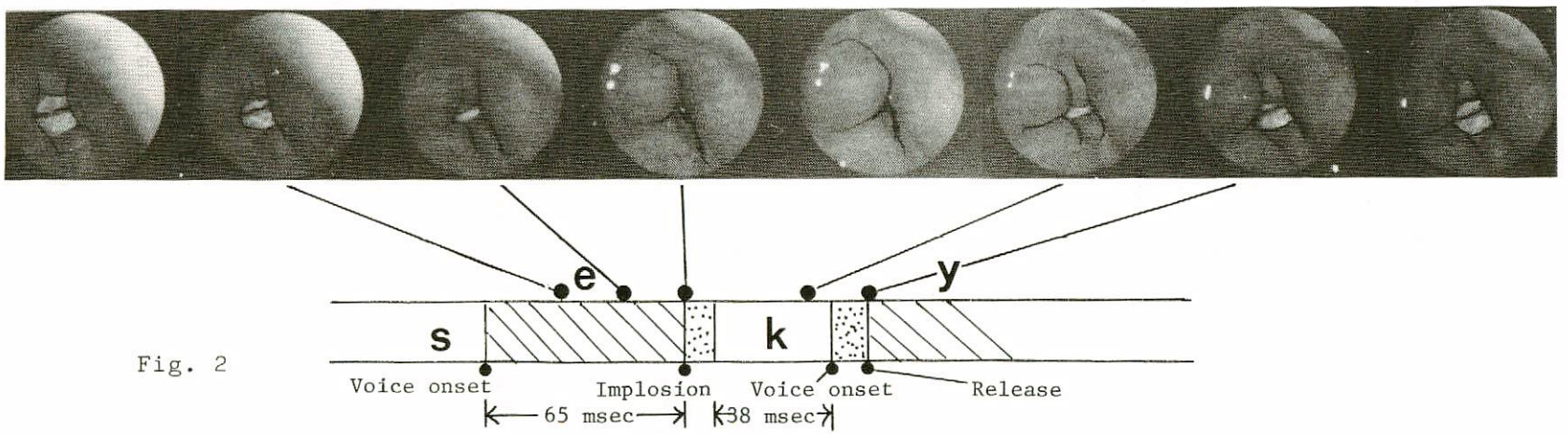
e
y
s
k
Voice onset
Implosion
Voice onset
Release
65 msec
38 msec

Fig. 2

Set 2.

1) Initial stops

Similar findings can be confirmed in Cantonese as in the other languages in China (see Iwata and Hirose 1976, Iwata et al. 1979).

In the voiceless inaspirates, closed vocal processes with a spindle-shaped gap in the membranous portion of the glottis could be observed.

In the voiceless aspirates, the glottis was wide open and maximum opening was achieved immediately before or after articulatory release. In the present subject, voice onset time for voiceless aspirates was relatively short, and glottal vibration sometimes started even when the glottal opening was considerably maintained.

2) -p,-t,-k in the sentence final position

Almost the same findings could be confirmed as those found in -p,-t,-k uttered in isolated syllables (see Set 1-1)). But the adduction of the false vocal folds generally starts earlier than in isolated syllables.

Set 3, 4. Final stops in the medial position of carrier sentences

Similar findings were observed in both Sets 3 and 4. The laryngeal gestures for final stops are variable depending on the following sounds.

1) -t,-k followed by vowel [y] (the number of samples is three)

Figure 2 shows selected frames of the laryngeal views for the sequence [sek^{9}+ y-].

Glottalized gesture can be observed to start prior to the formation of articulatory closure and maintained even at the beginning of the following vowel.

2) -t,-k followed by voiced lateral [l] (the number of samples is four)

Glottalized gesture could be observed to start prior to the articulatory closure and maintained even after the formation of the closure for the following [l].

3) -t,-k followed by voiceless inaspirates [tʃ] (the number of samples is two)

Figure 3 shows selected frames of the laryngeal views for the sequence [sek^{9}+ tʃ-].

The glottalized gesture mentioned above can not be recognized,

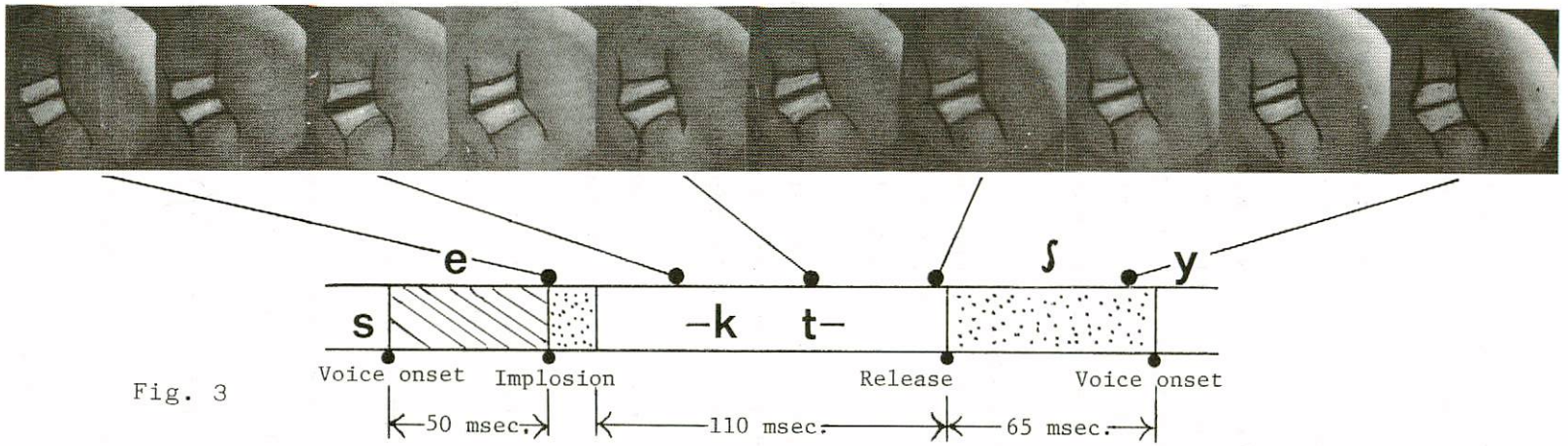
e
ʃ
y
s
-k
t-
Voice onset
Implosion
Release
Voice onset
50 msec.
110 msec.
65 msec.

Fig. 3

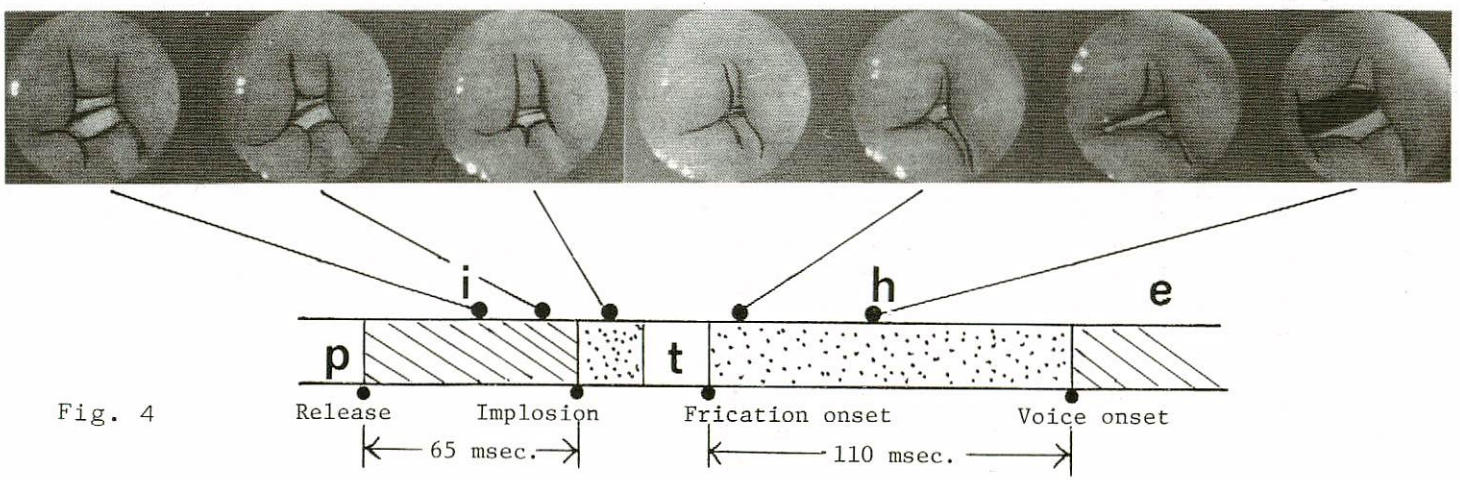
i
h
e
p
t
Release
Implosion
Frication onset
Voice onset
65 msec.
110 msec.

Fig. 4

and the glottis starts to open around the voice off-set time of the preceding vowel reaching its maximum before the explosion of the following affricate, although the degree of opening is small.[5)]

4) -t,-k followed by voiceless aspirates [p^{ϵ}, $t\int^{\epsilon}$] (the number of samples is six)

In five samples out of six, the glottis was wide open and glottalization could not be found at all. In one sample, however, where the closure duration was quite longer than in the other samples, glottalized gesture could be found to start prior to the implosion, lasting for a few periods, while the glottis started to open after the disappearance of the glottalized gesture.

5) -t,-k followed by fricative [h][6)] (the number of samples is two)

Figure 4 shows selected frames of the laryngeal views for the sequence [pit^{8}+ h-].

The glottalized gesture can be observed to start prior to the implosion of final stops, and maintained to the time around the frication onset of the following fricative. After the frication onset, glottis starts to open. The maximum glottal width can be matched with that for voiceless aspirates.

6) -t,-k followed by fricative [$\int$, f] (the number of samples is four)

In three samples out of four, the glottis was observed to open, though the maximum glottal width was not so wide as that found in voiceless aspirates. On the other hand, in one sample where -t was followed by fricative [f], slight adduction of the false vocal folds was observed just for a few periods prior to the implosion for final stops -t. Even in that case, however, glottis starts to open after the frication onset of the following fricative.

Set 5. Final stops in the medial position of two-syllable words (the number of samples is ten)

The findings here are almost the same as those seen in Sets 3 and 4.

When final stops are followed by vowels, lateral [l], and [h], the glottalized gesture is observed in every sample.

When final stops are followed by voiceless unaspirated stops, a closed glottis with a spindle-shaped gap in the membranous portion of the glottis can be observed in every sample.

When final stops are followed by voiceless aspirates and fricative [ʃ], the glottis is wide open.

Set 6. Final stops in natural speech

In this set, the laryngeal gesture for four kinds of sequences: -k+ a, -k+ ts-, -k+ ts'-, -p+ s- were examined. In the sequence -k+ a, [a] represents a sentence final particle usually pronounced without a tone of its own (commonly referred to as "neutral tone"). Even in this sequence, the glottalized gesture was retained in spite of the fact that the final stop -k was voiced. As for the other sequences, findings similar to those mentioned above were confirmed. Slight opening of the glottis for a sequence -k+ ts-, wide opening of the glottis for sequences -k+ ts' and -p+ s-.

5. Remarks

In the present investigation, the syllable final stops of Cantonese were explored in various types of sentences or words, changing the following sounds.

First of all we should point out that what is characteristic in the laryngeal control for syllable final stops in Cantonese is the glottalized gesture, which is manifested by the adduction of the false vocal folds or the supraglottic laryngeal constriction. It is also true that even in syllables without final stops, the glottalized gesture could sometimes be observed at the end of the vowel (see Set 1-2)), but the glottalized gesture was maintained for longer periods and realized without exception in the production of syllables with final stops. This kind of laryngeal feature is in good conformity with that reported for Fukienese final stops (Iwata et al. 1979).

When uttered in the medial position of sentences or word, the manner of laryngeal control for final stops can roughly be classified into two kinds.

One type can be found when the voiced sounds, including vowels and voiced lateral, and [h] follow final stops. In those sequences, glottalized gesture is invariably retained.

The other type can be found when the voiceless sounds, including voiceless inaspirates, aspirates and fricative (except [h]), follow final stops. In those sequences, the glottalized gesture found in other phonetic environments often disappears and

final stops are assimilated into the following sounds as far as the laryngeal gesture is concerned. Even in these phonetic environments, however, the glottalized gesture is retained when the closure duration is sufficiently long.

It should be noted here that in Cantonese, irrespective of in what type of sentences or words, the manner of laryngeal control for the final stop is maintained almost without changing, provided the same type of segment follows the final stop. For a typical example, see Set 6. In the sequence -k+ a in the natural sentence uttered at normal conversational speed, it was found that the glottalized gesture was still observed in spite of the fact that the glottal vibration had already started.

Notes

1) Genealogically speaking, Cantonese is known to fall under the "Han" language together with the northern dialects in China. In traditional dialectal terms, the language under discussion should be called a Hong Kong dialect of the "Yue" dialects group.
2) Tonal value of nine tones in Cantonese are introduced as follows according to Chao's five level system (Chao 1947).

<u>Tones without final -p,-t,-k</u>

Tone 1 high level (55) or high falling (53)	Tone 4 low falling (21)
Tone 2 high rising (35)	Tone 5 low rising (23)
Tone 3 mid-level (33)	Tone 6 low level (22)

<u>Tones with final -p,-t,-k</u>

Tone 7 high short (5)	Tone 9 low short (2)
Tone 8 mid short (3)	

3) For readers who are familiar with Chinese characters, carrier sentences and test words are introduced in Chinese characters:

Set 1. 1) 貼，褶，蝳，鉄，敆，竹

2) 衣，椅，意，婍，耳，二

Set 2. 我要 ——→

1) 鞭，編，顛，天

2) 貼，褶，蝳，鉄，敆，竹

Set 3. 佢食_____吗？

鱼，猪，柿，李，雪，灺

Set 4. 呢只鐘_____？

苦唔苦，软唔软，轻唔轻

平唔平，遲唔遲，利唔利

Set 5. 鉄桥，极端，协力，节日

历史，竹器，鯽鱼，绝对

決定，脱离，屋企

Set 6. 1) 你食餐唔食啊？

2) 你嘅生意好唔好入息啊？

3) 我哋食咗飯啥

4) Tonal type seems to be irrelevent to the glottalized gesture observed for the utterance ending of the non-entering tone syllables, because it can sometimes be observed also in the other non-entering tone syllables found in the other sets, irrespective of their tonal categories.

5) Although they are all voiceless inaspirates, laryngeal gesture for stops and affricates is slightly different. Vocal processes are slightly open for affricates but closed for stops, although spindle-shaped gap can be observed for voiceless unaspirated stops.

6) It is uncertain whether this sound is glottal fricative or supra-glottal fricative. For the sake of convenience we notate it as [h].

References

Chao, Y.R. (1947); Cantonese primer. Cambridge, Mass. Harvard University Press.

Fok, C.Y-Y (1974); A perceptual study of tones in Cantonese. Center of Asian Studies, Occasional Papers and Monographs, 18, University of Hong Kong.

Fujimura, O. and M. Sawashima (1971); Consonant sequences and laryngeal control. Ann. Bull. RILP, 5, 1-6.

Iwata, R. and H. Hirose (1976); Fiberoptic acoustic studies of Mandarin stops and Affricates. Ann. Bull. RILP, 10, 47-60.

Iwata, R., M. Sawashima, H. Hirose and S. Niimi (1979); Laryngeal adjustments of Fukienese stops - Initial plosives and final applosives -. Ann. Bull. RILP, 13, 61-81.