PHYSIOLOGICAL PROPERTIES OF "BREATHY" PHONATION IN A CHINESE DIALECT

Rai Iwata*, Hajime Hirose**, Seiji Niihira***, Satoshi Horiguchi****

Faculty of Humanities, Shizuoka University, Japan
RIH, Faculty of Medicine, University of Tokyo, Japan
Tokyo Metropolitan Neurological Hospital, Japan

ABSTRACT
Physiological features of the difference in phonation types were investigated on Suzhou Chinese by use of fiberoptic endoscopy and electromyography. The findings suggest that "nor- nal" vs. "breathy" opposition in phonation type in Suzhou should be brought about by antagonistic setting in the larynx.

1. INTRODUCTION
It is known that there is an interesting interaction between initial consonants, vowels, and tones in Wu dialects. Recent phonologists often mention the "nor-nal" vs. "breathy" opposition in treating this phenomenon, but the physiological reality of it is still unclear. In Wu dialects, a normal (or "clear") syllable is initiated by so called "normal" initials (usually indicated by a vowel), and a breathy (or "warbled") syllable is initiated by so called "breathy" initials. The vowels are characterized by the adduction of arytenoid (Vocalis, VOC) and sternohyoid (SH) muscles in breathy phonation, whereas normal (or "clear") initials are initiated by a "clear" initial (i.e., voiceless unaspirated stops), followed by a breathy vowel with low pitch initiation; whereas a normal (or clear) syllable is initiated by a "clear" initial (i.e. voiceless unaspirated stops), and followed by a breathy vowel with high pitch initiation.

Experiments were conducted on Suzhou Chinese one of the main dialects in Wu area, to reveal the physiological aspects of the difference between "breathy" and "normal" phonation. Seven lexical tones are discriminated in Suzhou as described below by tone letters. Among seven tones TONE I, II, III, IVa, and IVb, are characterized by shorter duration in their syllables than in other syllables and indicated one numeral (2) or two numerals with an underline (23) [1].

1a ⑤ 1b ⑧ 1Ⅰ 52 1Ⅱ 42 1Ⅰb 23

1.5 PROCEDURE
Laryngeal views were observed by a flexible fibroscope and were recorded on VTR at a rate of 30 frames (60 fields) per second. The intrapharyngeal pressure (Po) was simultaneously measured by introducing a miniature pressure transducer through the nostril to the perinasal region. A laryngeal electromyography(EMG) recording was made on the arytenoid, thyroathyroid vocalis, and arytenoid (SH). The EMG signals were rectified and its duration over a period of 5 ms. and sampled at a rate of 1 kHz.

In the experiments syllables with zero initials and dental stops, [th[t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t][t]
suppressed at the initiation. This evidence is in good conformity with the fiberoptic observation. In the syllables with high or rising pitch VOC activity increases at the syllable final portion showing a reciprocal pattern with CT. This is related with the pitch control of the tones as well as the vocal termination of the syllable[1].

SH, CT. The activity of SH and CT is basically antagonistic at the beginning of the syllables: SH is activated for breathy phonation and CT for normal phonation. Both SH and CT show the early initiation in their activities: in the syllables with dental stops, they start their activities at around the closure point or even earlier. In other words, high and low pitch initiations are preceded by early activation of CT and SH. In pitch rising and falling, however, CT and SH are not antagonistic. CT evidently participates in pitch raising (see EMG for [61231]), but SH does not show any marked activity in pitch falling (see EMG for [152]).

Evidence observed in bisyllabic words

The vocal muscles have been reported to be realized in fully voiced consonants in connected speech. In the experiment a set of bisyllabic words which have normal or muddy initials in the second syllable were also examined. VOT in muddy stops is in most cases negative and the glottis (both cartilaginous and membranous portions) is closed. The closure duration and F0 in muddy stops are significantly shorter/lower than in normal stops.

4. Discussion

It is suggested that the difference in phonation types should be produced by the antagonistic interaction in the larynx. Breathy phonation is characterized by ary-epiglottic constriction[7] with the downward movement of the arytenoids. The activity of SH, and presumably other extrinsic muscles as well, undoubtedly contribute to form the constriction and the downward shift of the larynx. These muscles adjust the free work of the larynx as a whole, then externally or vertically effecting the tension of the vocal folds[4][8]. Note that VOC and CT are suppressed at the initiation of the breathy phonation. Concomitantly increased activity of the extrinsic muscles would shorten and thicken the vocal folds by exerting the forces externally on them. Its adductive tension being increased, the "breathy" quality of the syllable might be brought about by a "slack" state of the vocal folds which would provide a favorable condition for low pitch initiation. And this may also be a reason the vocal folds start vibrating in the intervocalic positions.

The normal phonation, on the other hand, is initiated by the increased activity of VOC in the vocal initiation and that of CT in the consonantal initiation, the former of which is often accompanied by the adductive gesture of the false vocal folds. VOC contributes to increase the adductive tension of the vocal folds by supplying the medial compression[6]. CT is primarily a pitch raiser, but note that its activity is initiated quite early. It is assumed that CT also participates in increasing the adductive tension of the folds[6]. Thus a "slight" state of the vocal folds in normal phonation is unlikely to cause the vibration and would provide a favorable condition for high pitch initiation.

REFERENCES