A CROSS-LANGUAGE STUDY OF VOICING CONTRASTS OF STOPS

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ABSTRACT

The present study is concerned with cross-language phonetic differences of voicing contrasts of stops in six Asian languages. Such features as voice onset time (VOT), fundamental frequency (Fo) and the contour, spectral analysis, and the onset F1 frequency were examined, and their cross-language comparisons were made. The results of acoustic analysis showed that each language uses several acoustic dimensions in different ways for distinction of voicing categories and "same" sounds in these languages show some language-specific properties as well as features which are common to many languages.

1. INTRODUCTION

The present study is concerned with cross-language phonetic differences of voicing contrasts of stops in six Asian languages, and to explore the ways to describe some cross-language characteristics of stops. The languages investigated are Japanese, Mandarin Chinese, Korean, Burmese, Thai, and Hindi. The examination is mainly based on the acoustic analysis of initial stops in these languages, several numbers of subjects in each language took part in the experiments for recording linguistic materials. The main issues of investigation is to clarify the phonetic characteristics of voicing contrasts of stops in these languages, to examine the language-specific properties and to make cross-language comparisons on these features.

2. ACOUSTIC ANALYSIS

2.1. Voice Onset Time

Voice onset time (VOT) is usually defined as the time interval between the onset of voicing and articulatory release of the stop consonants, and is a timing dimension of the onset of voicing to articulatory oral release [1]. Based on the acoustic analysis in the present experiment, it has become clear that VOT functions for distinguishing voicing categories of initial stop consonants if they are based on the timing event of glottal and supralaryngeal movements. However, as has been noted in previous studies [2], VOT is not sufficient for distinguishing the categories of stops in such languages as Korean and Hindi which use such laryngeal features as glottal tensing or glottal stricture. In these languages, VOT is unable to distinguish tense stops from lax stops, and voiced stops from breathy voiced stops. This means that VOT is not sufficient if laryngeal features other than glottal timing are involved in the voicing distinction.

Among the three major voicing categories of voiced, voiceless unaspirated and voiceless aspirated stops, it was found that the VOT values of voiceless unaspirated stops show a wide range of variability, while those of voiceless aspirated stops show little variability in these six languages. This implies that voiceless unaspirated stops are articulated with language-particular characteristics and have some flexibility in choosing the articulatory timing region in the VOT continuum. The reason that voiceless aspirated stops show little variability is that aspiration requires a carefully adjusted timing event of glottal width and articulatory release; i.e., the timing when glottal width reaches its maximum opening must be adjusted with articulatory release.

2.2. Fundamental Frequency (Fo) and its contour

As to Fo and its curve, it was demonstrated in the present study that voiced and voiceless distinctions have a different effect on the Fo perturbations of the following vowels, and voiceless stops are generally associated with a higher Fo, while voiced stops are associated with a lower Fo. In Korean, all stops are phonemically voiceless, and the distinction between tense and lax stops affects the Fo perturbations, so that voiceless lax stops show the lowest Fo values compared to voiceless tense stops and voiceless aspirated stops. In Chinese, there was no marked difference between the voiceless unaspirated and voiceless aspirated stops, but in Burmese and Thai there were significant differences between these categories, and the magnitude of differences in Fo values were not different from those of non-tonal languages such as Korean.

It was also demonstrated that there is a difference in the Fo curve from the onset to steady-state portion. Voiceless stops tend to show a lowering pattern, and voiced stops a rising one. In Japanese, the effect of voiceless stops is not apparent, and a level pattern was observed. In Korean, a clear-cut distinction between voiceless tense stops and voiceless lax ones is observed, and the tense stops show an abrupt falling Fo curve. Furthermore, in Hindi, Fo curves of the breathy voiced stops show the lowest values and demonstrated a characteristic Fo pattern of fall - rise.

2.3. Spectral Analysis

The examination of power spectra in each language reveals some differences in intensity level and spectral characteristics. The spectral characteristics can be examined in the regularity of peak energy distribution, level of intensity, bandwidths and the spectral shape. Although the degree of regularity is difficult to measure, it can be said as a general trend that voiced stops show more regularly distributed energy peaks, while voiceless aspirated stops tend to show less regularly distributed energy peaks. Furthermore, although it is generally known that voiceless stops show a greater articulatory force; i.e., higher rate of airflow, than voiced stops, this trend was not consistently observed, and some languages such as Japanese did not show any marked differences.

2.4. The Onset Frequency of the First Formant

As to the onset frequency of the first formant, it was found that there is a difference in F1 onset frequency between voiced and voiceless stops; the onset frequency is in most cases higher in voiceless stops than it is in voiced stops. Differences in the onset frequency reflect differences in the speech production of these types of stops. It was also found that the difference in F1 onset frequency is affected by the ones of following vowels, and stops followed by low vowels show greater changes than those followed by high vowels.

3. SUMMARY

The languages in the present study use several acoustic dimensions for voicing categories in different ways, and the "same" voicing categories which are represented by the same phonetic symbols have a language-specific variability, as well as features which are common to many languages. VOT functions for the distinction if the voicing categories are based on the laryngeal timing in relation to the oral release. If other laryngeal features are involved, other dimensions are needed for distinction. Among the major voicing categories, voiceless unaspirated stops show a wide range of variability in the glottal and supralaryngeal timing events, while voiceless aspirated stops do not. The Fc at the vowel onset represents the initial state of the glottal adjustments and is significant for characterizing the voicing categories which involve a change of initial glottal gestures as found in Hindi breathy stops. Spectral analysis such as intensity level and spectral shape does not appear to provide a useful cue for distinguishing major vicing categories. Finally, the F1 onset frequency is useful for distinguishing the voicing categories of stop consonants.

4. REFERENCES

[2]Han, M.S. and Weitman, R.S.(1970) "Acoustic features of Korean /P, T, K/, /p, t, k/ and /p^h, t^h, k^h/" *Phonetica*, 22, 112-128.

[1]Lisker, L. and Abramson, A.S. (1964), "A cross-language study of voicing in initial stops: Acoustical measurements." *Word*, 20, 384-422.