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Laryngeal Control in the Plosives of Standard Thai

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Abstract

Much work has been done on the relevance of the timing of glottal pulsing relative to the occurrence of consonantal closure for phonemic distinctions between homorganic stops. In this paper, I have assembled old and new work on the plosives of Standard Thai, including the addition of data on the palatal affricates. In word-initial position, in both production and perception, the traditionally labeled voiced, voiceless unaspirated, and voiceless aspirated stop consonants are well separated by voice onset time (VOT). The two palatal affricates are likewise so distinguished in production, although perceptual experiments have not yet been run for them. In word-final position, where there are no contrasts of voicing and aspiration, the only plosives that occur are the stops; they show no voicing in their closures. A limited sampling of running speech indicates that, with some reduction of range, the distinguishing mechanism is quite robust. Temporal control of the laryngeal source, then, is sufficient to account for the three-way voicing distinction of Standard Thai.

Background

In common with other languages of the Thai family, Standard Thai has a system of plosive consonants that is interesting for two reasons: (1) its three-way voicing contrast and (2) its paradigmatic gaps. This can be seen in the intersecting rows and columns of Table 1. With some minor disagreements, this table reflects the organization given or implied by various scholars (e.g., Abramson. 1962; Noss, 1964; Harris, 1972). The two bottom rows are usually said to be distinguished by the feature of aspiration, even though the traditional phonetic meaning of the term is not properly applicable to affricates, as in the case of the palatal plosives of Thai. That is, the term is used here in an abstract phonological sense; nevertheless, as will be shown later, the palatals agree with the simple oral stops in that we can separate them by a measure of the relative timing of the voice source. Finally, both the palatals and the velars have "holes in the pattern" in the voiced series.

Table 1 Paradigmatic array of the oral plosives of Standard Thai

	Bilabial	Dental	Palatal[a]	Velar
Voiced	b	d		
Voiceless unaspirated	p	t	c	k
Voiceless aspirated	ph	th	ch	kh

[a]The 1989 revision of the chart of the International Phonetic Alphabet has eliminated the old separate palato-alveolar column.

The palatals appear only in syllable-initial position; furthermore, the three-way contrast of the three rows of the table is relevant only in that position. Most linguists working on Thai take the simple oral stops in final position to be /p t k/.

Some years ago, Leigh Lisker and I wondered whether a single laryngeal mechanism might underlie distinctions between homorganic consonants commonly described, for so many languages, as depending upon such features as voicing, aspiration, tensity, and perhaps others. Such a mechanism posited by us was one of laryngeal timing. That is, we asked whether a "simple" difference in the timing of the turning on and off of the laryngeal voice-source relative to the moment of consonantal occlusion or constriction would serve to differentiate the phonemes in question. We limited ourselves in that study (Lisker & Abramson, 1964) to stop consonants and to word-initial position to take advantage of what seemed to be the maximum number of such contrasts in a wide variety of languages.

Limited thus to initial position, our measurement of laryngeal timing became one of voice onset time (VOT), which was defined as the time between the onset of voicing and the release of the stop. With zero time assigned to the moment of release, voicing onset before the release was stated as a negative value and onset after the release as a positive value. Using sound spectrograms, we obtained data from a number of languages with a two-way contrast, such as English, a three-way contrast, such as Thai, and a four-way contrast, such as Hindi. By and large, our VOT values did a good job of separating the categories of the 11 languages examined.[1] Experiments with synthetic speech confirmed the perceptual efficacy of VOT for a representative sampling of languages (Abramson & Lisker, 1965, 1970; Lisker & Abramson, 1970). All this led to our arguing for the relevance of voice timing to questions concerning the validity of distinctive features in phonology (Lisker & Abramson, 1971).

Among the languages successfully handled by the concept of VOT is Standard Thai. As a token of my great respect and admiration for my old friend Mayuri Sukwiwat, I have pulled together old data on the plosives of the language from various publications and combined them with new data, including measurements of the previously unanalyzed palatals.

Thai Data

Citation forms

Not only in the laboratory of the experimental phonetician, but also in linguistic fieldwork, it has been customary and very helpful to build up a data-base with short expressions, common citation forms of words, uttered by native speakers of the language under investigation. Although we know that in everyday speech communication, such words are much more likely to be embedded in running speech that varies in tempo, emphasis, and intonation, we nevertheless find citation forms to afford a convenient point of departure for further work. In any event, one-word sentences do occur from time to time. One might argue that, starting with the first learning of our native language in early childhood, we always have citation forms as one mode of speech. Perhaps they come closest to the underlying abstract lexical entries posited by the phonologist. Of course, a complete phonological account would provide rules for the contextually determined variations of these forms in running speech.

Table 2 Three speakers' voice onset times (in msec) for the oral stops of Thai in isolated words: means, ranges, and numbers of tokens. (From Lisker & Abramson, 1964)

		Labial	
	/b/	/p/	/ph/
M	-97	6	64
R	-165 :-40	0 : 20	25 : 100
N	31	32	33
		Dental	
	/d/	/t/	/th/
M	-78	9	65
R	-165 :-40	0 : 25	25 : 125
N	33	33	33
		Velar	
		/k/	/kh/
M		25	100
R		0 : 40	50 : 155
N		32	38

The data in Table 2 were obtained from wideband spectrograms of the productions of three native speakers of Thai. At that time (Lisker & Abramson, 1964), we rounded off all values to the nearest 5 milliseconds, as an estimate of our precision; this is reflected in the ranges. All tokens of /b/ and /d/ show negative values of VOT starting well before the release. The voiceless inaspirates /p t k/ show short voicing lags after the release, while the voiceless aspirates /ph th kh/ show long lags. That is, the temporal dimension serves well to separate the categories. In spite of the paradigmatic gap where there could be a voiced velar stop, there is no intrusion of /k/ values into that space.

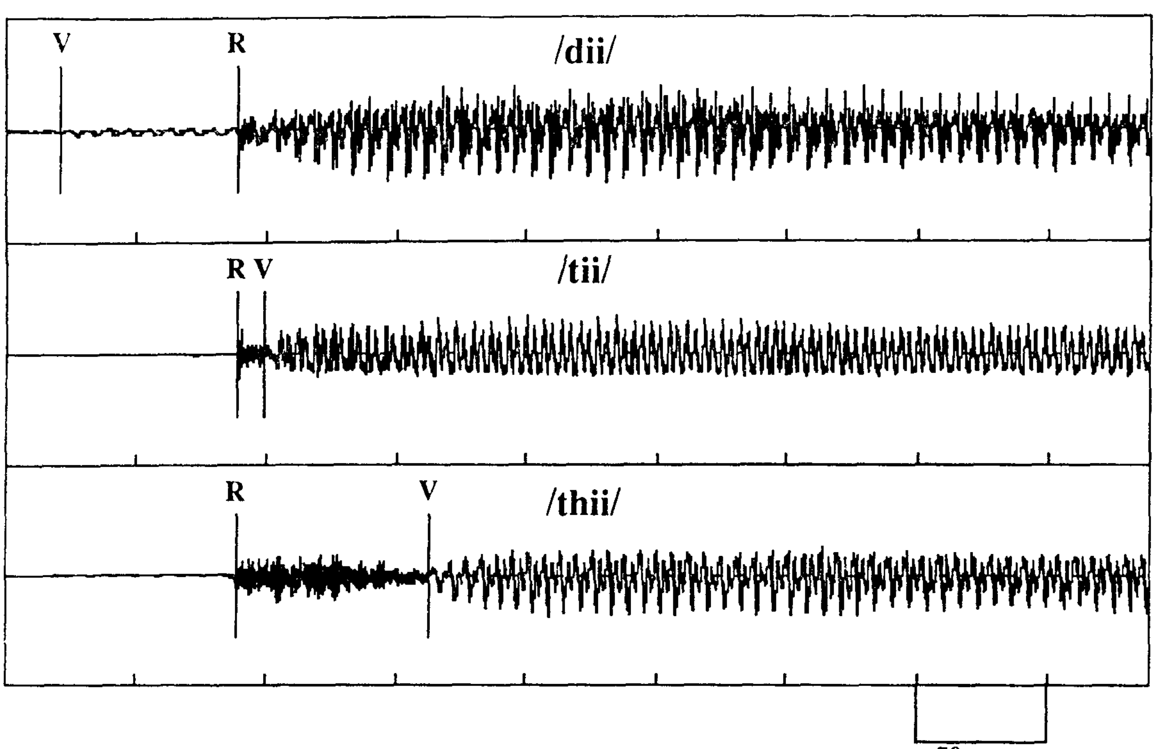

Figure 1 Waveforms showing VOT differences in Thai dental stops. R = release of oral closure. V = onset of voicing (glottal pulsing).

New data for the present study were obtained from a recently available speaker, CT, whose production of the three-way contrast is exemplified for the dental stops in the waveforms of Figure 1. I have chosen to take advantage of the greater precision of an elaborate waveform-editing computer program at Haskins Laboratories, rather than use spectrograms again. The moment of release of the stop, marked R, is generally easy to pick out. Voice onset is marked V. Let us look more closely at the waveforms of Figure 1. The releases of the initial stops of the three words have been aligned in time. The final portions of the final long vowels have been trimmed off to make for a symmetrical display. For /dii/, the quasi-periodic pulsing V-R occurs during the closure before the release and so takes a negative VOT value, i.e., a voicing lead of -68 msec. In both /tii/ and /thii,/ the interval R-V at the beginning of the vocalic span is filled with aperiodic energy resulting from a turbulent airflow; that is, they have positive values of VOT. Thus, in these examples, /tii/ has a voicing lag of 10 msec and /thii/, 74 msec. The VOT values in Table 3 are, then, for all the monosyllabic utterances analyzed, the durations of the intervals between R and V. This time, I have given standard deviations rather than ranges. (The raw data from 1964 are no longer available, so I cannot calculate standard deviations for Table 2.) New in this table and, I believe, in the literature, are values for the palatal affricates. The mean values and the small standard deviations show good separation of /c/ and /ch/, with no intrusion into the space for a potential palatal with voicing lead. Some work has been done on the intersection of phonemic tones with the voicing states of Thai plosives (Gandour, 1974) and the involvement of these states with perturbations of fundamental frequency in the historical emergence of tones in the language (e.g., Erickson, 1975).

Table 3 CT's VOT values (in msec) for the plosives of Standard Thai: means, standard deviations, and numbers of tokens.

		Labial	
	/b/	/p/	/ph/
M	-85	10	95
SD	-32	3	13
N	10	10	10
		Dental	
	/d/	/t/	/th/
M	-87	11	85
SD	-18	4	20
N	10	10	10
		Palatal	
		/c/	/ch/
M		38	124
SD		11	31
N		10	10
		Velar	
		/k/	/kh/
M		24	104
SD		8	20
N		10	10

As I intimated at the beginning of this paper, something has to be said to justify the feature aspiration in Table 1 for the palatals. The waveforms in Figure 2 will help. Comparing the latter with the waveforms of the voiceless stops in Figure 1 reveals that for both sets the interval R–V is filled with turbulence; however, the turbulence for the affricates is obviously more intense and of longer duration than that of the stops relative to the following voice-excited remainder of the vowel. This difference arises from the fact that the turbulence of the affricates is local; it is generated, with the glottis open, in the narrow channel of the lingual constriction of the fricative portion of the articulation. Thus, it is not aspiration in the usual sense of the term. Note, by the way, that such an account implies an additional difference between /c/ and /ch/, namely, an articulatory one; to allow through *local turbulence* for a longer voicing lag in /ch/, it is necessary to maintain the frication of this plosive for a longer time. Such an inference, I hasten to add, remains to be verified by direct examination of articulation, perhaps through dynamic palatography. (This means that the language has not exploited another phonetic possibility, aspiration after the relaxation of the palatal constriction.) In the voiceless stops, on the other hand, aside form the transient noise at the moment of release itself, most of the turbulence is caused by an aperiodic source at the open glottis exciting the relatively open, unconstricted supraglottal cavities suitable for the articulation of vowels.[2] This is true aspiration as the term is normally used, even though some small portion of the turbulence is no doubt contributed by friction along the walls of the tract. In any event, the data presented here lend support to the handling of all the Thai plosives in the same way. The abstract phonologist may see some virtue in continuing to use the word "aspiration" for both kinds of voicing lag.

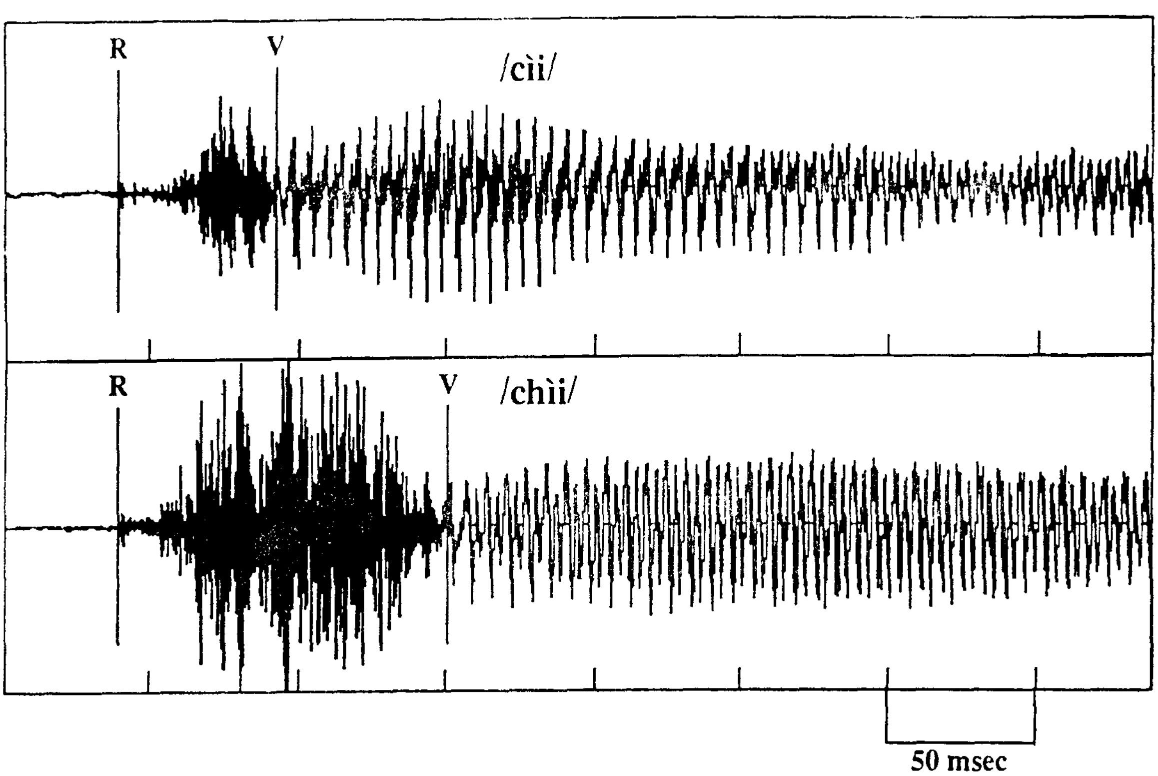

Figure 2 Waveforms showing VOT differences in Thai palatal affricates. R = release of oral closure. V = onset of voicing (glottal pulsing). R–V is also the duration of the frication.

Perceptual validation

Not only our original measurements (Lisker&Abramson, 1964) but also a perceptual study with manipulated and unmanipulated natural English speech with native speakers of a few languages, including Thai (Lotz, Abramson, Gerstman, Ingemann & Nemser, 1960), led us to hypothesize that the complex acoustic consequences of systematic shifts in laryngeal timing are perceptually relevant. Producing small increments of VOT from -150 msec to + 150 msec for labial, dental, and velar stops on a formant synthesizer, we produced synthetic syllables that varied in a number of ways: (1) time of onset of pseudoglottal pulsing and thus in the spectral nature of the voicing, which might start as a low frequency band during oral closure or as periodic excitation of vocalic formants, (2) aspiration noise during voicing lag, and (3) attenuation of the first formant of the vowel during voicing lag. We had native speakers write words in Thai script as labels for all these stimuli. The results stongly supported the hypothesis (Abramson & Lisker, 1965, 1970; Lisker & Abramson, 1970).

Running speech

Perhaps the ultimate test of the validity of phonetic features found to underlie phonemic distinctions in citation forms is the power of such features to distinguish phonological categories in casual running speech too. There is, unfortunately, a difficult procedural problem. For a given speaker, it is very hard to gather a large, contextually balanced sampling of measurable tokens of plosives in running speech. If the speech is truly spontaneous and unrehearsed, there is no way to keep the speaker from varying his overall prosody and embedding his plosives in a random assortment of phonetic contexts.

Table 4 CT's VOT values (in msec) for the plosives of Standard Thai in a small sample of running speech.

	Labial	
/b/	/p/	/ph/
-80	10	51
-90	5	74
-80	3	
	Dental	
/d/	/t/	/th/
-27	12	79
-109	9	34
	11	
	13	
	Palatal	
	/c/	/ch/
	25	78
	37	94
		91
	Velar	
	/k/	/kh/
	18	53
	21	69
	29	100
		63
		90
		44

In spite of these problems, I have measured VOT values for a number of plosives from about 10 minutes of a description of Thai holidays recorded for another purpose by CT, the new speaker of this study. The data are given in Table 4. The numbers of utterances for the set of plosives are not only uneven but also small, so I have entered them all rather than give averages. In spite of some compression of ranges, especially for the aspirates, it can be seen that the phonetic distinctions are maintained. The results are very similar to those obtained long ago by Lisker & Abramson (1964) for one other speaker. In both sets of data, I could not measure many additional tokens of /b d/ in which glottal pulsing continued unbroken from a preceding voiced environment. Of course, inseparable as they are for purposes of measurement from preceding segments, these items do, nevertheless, fall into place as standing in clear contrast, through laryngeal timing, with the other two categories. I plan soon to test the robustness of VOT for perception in running speech.

Another aspect of running speech, one that pertains to isolated words as well, is the voicing state of closures of word-final stops. (It will be recalled that the palatals do not occur here). I explored this question in another paper (Abramson, 1972). The overwhelming finding was that, whatever the following environment, the closures of word-final Thai stop consonants are not voiced. A scattering of additional data from the speech of CT of this paper is in complete agreement with that conclusion. Thus, given the suspension of the three-way contrast in this position, it is best to align the word-final oral stops with initial /p t k/.

Conclusion

The efficacy of a feature of laryngeal timing as the phonetic basis of the three-way distinction of voicing and aspiration in the plosives of Standard Thai has been established. With a phonologically required focus on word-initial position, this mechanism is conveniently called voice onset time (VOT). Various experiments have shown the perceptual relevance of this feature for stops but not yet for the palatal affricates. Acoustic underpinning has been provided for the assignment of final stop consonants to the category of voiceless inaspirates. Limited work with running speech suggests the robustness of the mechanism, although perceptual work remains to be done.

Of theoretic interest for Thai and other languages in which laryngeal timing is critical for consonantal distinctions, is the observation that a single physiological mechanism appears to underlie a rather complex acoustic output. That is, a number of acoustic features of this output might separately serve as acoustic cues to the phonemic distinctions, yet all of them seem to be linked under the control of a single mechanism.

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Notes

1. To separate all four categories of Hindi and Marathi on the one hand and all three of Korean on the other, VOT must be supplemented in each case by one more laryngeal feature.

2. Jimmy G. Harris (1972) states that the voiceless inaspirates of Thai are produced with a closed glottis. Of course, one way of cutting off glottal pulsing is through tight adduction of the vocal folds. If he is right, it must nevertheless be the case that the glottal stop occurs during the oral closure, because, as can be seen in the waveforms here or in spectrograms, the glottis must be open during the voicing lag to yield the observed turbulence.

The Author

Arthur Abramson first met Mrs. Mayuri Sukwiwat while he was teaching in Bangkok between 1953 and 1955. Since then he has gone on to teach at Columbia University, New York University, City University of New York and finally the University of Connecticut where he is now a Professor of Linguistics. He has also been on the research staff of Haskins Laboratories since 1959 and a Research Associate since 1965. He specialises in experimental phonetics and is currently a member of the Council of the International Phonetic Association.

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