

WORD-FINAL STOPS IN THAI

Arthur S. Abramson

University of Connecticut and Haskins Laboratories

As far as I can tell from the literature, agreement over the phonetic nature of word-final stop consonants in Standard Thai has not been reached. Indeed, non-Thai observers with little training and experience in auditory phonetics often have trouble in just detecting the presence of these normally unreleased stops, especially the velar stop after long /uu/. It is perhaps not surprising then that linguists have failed to be very precise in their application of vaguely defined impressionistic terms to these speech sounds.

The question must be examined against the background of the full system of Thai occlusive consonants.¹ Except possibly for my omission of the glottal stop, the phonemes² displayed in Table 1 will probably cause little argument. Establishing underlying forms for a generative phonology in Thai grammar is not likely to be relevant to the present phonetic analysis. Rather, it can be argued that it is necessary to have proper phonetic descriptions of utterances *before* positing underlying forms from which to derive them by rule.

TABLE 1
Thai Initial Occlusives

	Labial	Dental	Alveolo-Palatal	Velar
Voiced	b	d		
Voiceless Unasp.	p	t	c	k
Asp.	p'	t'	c'	k'

The only serious disagreement in the literature with the intersecting phonetic features of Table 1 is with regard to the roles of voicing and aspiration. Richard B. Noss (1964: 10-13) describes /b d/ as unaspirated lenis stops, /p t c k/ as fortis stops, and /p' t' k'/ as aspirated lenis stops. These appear to be his choices of paramount features,

1. These consonants as a set are called occlusives rather than stops only because it seems desirable to include among them the affricates /c c'/ which share the feature of aspiration with the simple stops.

2. I shall restrict myself in this article to considerations of surface phonology.

although, of course, he adds information about voicing and other aspects of production. Marvin J. Brown (1965 : 39), in line with his model for Thai diachronic phonology, posits glottal closure for /p t c k/. That is, he believes that there is a simultaneous glottal closure which is not released later than the oral closure.

Claims about tensivity as an independently controllable parameter of speech production are tenuous (Abramson and Lisker, 1970) when one seeks experimental validation. The story on voicing and aspiration seem to be quite different. Some several years ago, Leigh Lisker and I (Lisker and Abramson, 1964) showed clearly through acoustic measurements that Thai initial stops are differentiated into three classes on the basis of voice onset time measurements. For the "voiced" stops, spectrograms show high-amplitude laryngeal pulsing during the stop occlusion; that is, the pulsing starts well before the release of the stop; for the "voiceless unaspirated" stops, voicing starts upon release of the stop or shortly thereafter; for the "voiceless aspirated" stops, voicing onset lags considerably behind stop release. The original body of data underlying these conclusions is reproduced in Table 2 (Lisker and Abramson, 1964: 396).³

TABLE 2

Thai Initial Stops : Voice Onset Time in Milliseconds
(3 speakers)

	Labials		
	b	p	p'
Average	-97	6	64
Range	-165 : -40	0 : 20	25 : 100
Number	31	32	33
	Dentals		
	d	t	t'
Average	-78	9	65
Range	-165 : -40	0 : 25	21 : 125
Number	33	33	33
	Velars		
	k	k'	
Average	25	100	
Range	0 : 40	50 : 155	
Number	32	38	

3. In the 1964 cross-language study, we restricted our observations to stops; therefore Table 2 contains no data on the affricates. Since then, however, I have seen not only enough additional spectrograms to confirm our old analysis of the Thai stops but also to validate aligning the two affricates with the voiceless unaspirated and aspirated stops respectively.

The use of negative numbers for /b d/ is simply a convention to indicate voice onset before our reference point, the release of the stop. Aspiration, then, is the acoustic consequence of exciting the vocal tract resonances by means of a noise source, turbulent air coming through the open glottis during the lag between the release of the stop and the onset of voicing. During this voicing lag, the articulator is moving away from its place of articulation, and the vocal tract is assuming a configuration for the syllabic vowel; thus, aspiration is a property of the initial portion of the vowel as well as the stop release. This turbulence is in fact also present in the short voicing lags of the voiceless unaspirated stops but has too short a duration to be very audible.⁴ The voicing lead of /b d/ is typically quite audible. The perceptual relevance of voice onset time has been confirmed for Thai through experiments with synthetic speech (Abramson and Lisker, 1965; Lisker and Abramson, 1970).

Given the rather compelling efficacy of voice onset time in implementing the three-way contrast, any as yet unsubstantiated claims concerning tensity or fortisness seem gratuitous at this time. On the other hand, Brown's assertions as to glottal closure are not necessarily inconsistent with our observations on voice timing. One way to suppress phonation in speech is to swing the anterior portions of the arytenoid cartilages apart and open the glottal aperture beyond the point at which audible vocal-fold vibration can occur; another way is to close the glottis tightly. We hope soon to be able to settle such questions through the use of our flexible fiberoptic endoscope.⁵ In the meantime, recent findings (Kim, 1970), for Korean at least, indicate that stops heard as voiceless inaspirates are likely to be produced not with tight closure but with a small opening of the glottis, while larger glottal apertures are required for greater amounts of aspiration.

In word-final position the phonological picture is somewhat simplified. The two affricates do not appear, and the three-way laryngeal opposition among the stops is not relevant. For each place of articulation there is just one stop phoneme: a labial, a dental and a velar. What is the phonetic nature of this single manner category? From the point of view of the language structure, it may not matter too much; there is neutralization of the distinctive features involved. From the point of view of speech production, it does matter very much. After all, a good description of the language must include rules for pronunciation. If we suppose that these final stops are to be aligned with one of the three initial categories, let us consider the phonetic possibilities in the light of the voice timing dimension which is diagnostic for initial position. Long voicing lag or aspiration is ruled

4. If short voicing lag is effected in part by means of a small glottal aperture (Kim, 1970), we might expect the turbulence to be low in intensity. Low intensity and short duration would combine then to yield less loud aspiration than for the aspirates.

5. See Cooper et al. (1971) and references therein.

out by the fact that the final stops are not normally released, nor, for that matter, is pre-aspiration observed in Thai. We are left then with the mirror images of the laryngeal states of the voiced and voiceless unaspirated categories: (1) voice pulsing continues well into the stop occlusion or (2) voice pulsing ceases by the time of achievement of oral closure.

As suggested at the outset of this article, observers using purely auditory criteria have not presented very convincing pronunciation rules for the use of analysts and students of the language. One Thai writer (Panninee, 1965) writes the final stops as voiceless unreleased /p t k/ in the belief that they are voiceless. Another Thai scholar (Foongfuang, 1960: 50) labels these final consonants as /p t k/ but describes them as "...varying from their allophones in initial position in not being released and in being less tense or fortis." Brown (1965) writes all Modern Central Thai examples with final /p t k/, but for purposes of his historical treatment he is not necessarily matching them with initial /p t k/.

Two recent major reference works that must be taken into account in any present-day linguistic description of Thai see these final stops in a different light. For R. B. Noss (1964: 10-13), the final stops share the "unaspirated lenis" feature of his initial /b d/; therefore, this necessitates positing an additional phoneme /g/, which appears only in final position. Now in his fuller phonetic specification of these consonants, Noss does say that they are fully voiced in initial position--the two that occur there--but that they are normally voiceless in final position and occasionally voiced, especially after a long high vowel. We must recall here that for Noss the primary distinction between the sets /b d g/ and /p t c k/ is based on the fortis/lenis feature rather than voicing. In the table of consonants in her dictionary Mary R. Haas (1964:xi) also posits a phoneme /g/ which occurs together with /b d/ in word-final position in her illustrative examples and in the dictionary entries. No phonetic comment is made, so one is led to believe that these stops are voiced in both positions.⁶ My own experience with the Thai language has never led me to any conviction that I can hear laryngeal pulsing during the occlusions of final stops, so in my own phonemic or morphophonemic transcriptions I have always written them as /p t k/; nevertheless, in an early non-instrumental assessment of the consonants (Abramson, 1962:4), probably under the influence of Haas, I was reluctant to take a firm position and wrote in a Praguian fashion, "...the view taken here is that there is a neutralization of the manner features at the end of a syllable with the archiphonemes written as /p t k/, occurring as [p t k] or [b d g]."

6. This is consistent with her position in textbooks and other publications dating from 1945 too numerous to be cited here.

In the light of the foregoing, it seemed to me that it would be best at this time to approach the problem by examining the final stops acoustically in terms of the voice timing dimension that had proven so efficacious in initial position. Having on hand extensive samples of speech recorded by six educated native speakers of Central Thai, I went through all these tape recordings looking for words with final stops.⁷ The speakers were university students, four men and two women, recorded between 1964 and 1971. In these recordings, made for a variety of purposes but not specifically the present one, I found a total of 140 word-final stops as displayed in Table 3.

TABLE 3

Final Stops Examined (6 speakers: 4 men and 2 women)		
	N	% of Total
/p/	18	13
/t/	45	32
/k/	77	55
Total	140	100

For each stop the number of tokens examined is given together with its percentage of the total. Indeed, not only is the numerical representation of types uneven as shown in Table 3, but also the array of environments in which the stops were found. That is, I simply looked for word-final stops wherever I could find them in the recordings: isolated words, citation forms of short expressions and sentences, and passages of running speech. Of course, it would have been possible to have a few informants record all the vowels of the language followed by the three consonants to form a complete paradigm⁸. My own feeling was that such an approach would achieve statistical symmetry at the price of a certain artificiality. I agree that this kind of artificiality may sometimes be necessary in linguistic investigations and even desirable, but since sufficient recordings were available to provide, as it turned out, a rather stable set of data, it seemed preferable not to call an informant's close attention to my interest in the final stops.

Wide-band sound spectrograms of all the utterances were examined for acoustic signs of laryngeal pulsing during the closures of the final stops. If there was some ambiguity as to the presence of vertical striations in the spectrograms at the fundamental frequency of the speaker's voice, especially in the samples embedded in running

7. I included some of these data in my review of the Haas dictionary (Abramson, 1966). This review will appear in the public domain if Volume 22 of *Word* is ever published.

8. Naturally, as in all experimental work, anyone is free to test the generality of my results with a change in experimental design.

speech, narrow-band spectrograms were inspected as well to examine the harmonics of the voice for continuity. For the most part, the wide-band spectrograms were sufficient and preferable because of their better time resolution.

I have divided my observations of the word-final stops into the two broad classes of those occurring at the end of an utterance and those occurring embedded within an utterance. To test for voicing it should really be enough to present data on utterance-final stops since the claims in the literature seem to be intended to apply to "optimum" citation forms. I, however, wished to examine the possibility that these stops might show a definite trend toward the voiced state by progressive assimilation to a following voiced environment, while manifesting themselves as voiceless consonants in utterance-final position and before voiceless phones. Nothing in the data indicated any profit in distinguishing between utterance-final stops in citation forms from those in running speech. In running speech, any clearly marked pause or end of discourse was accepted as a sign of an utterance-final stop. The utterance-medial word-final stops appearing before voiced phones were distinguished from those appearing before voiceless phones. The results of this investigation are presented in Table 4, which shows the number of items examined for each class and the number and percentage of those for which voicing of the stop occlusions appeared in the spectrograms.

TABLE 4
Laryngeal Pulsing in Final Stops

	Number examined	Voicing present
Utterance-final	73	2 (3%)
Utterance-medial		
Before voiced phones	32	5 (16%)
Before voiceless phones	35	1 (3%)
Totals	140	8 (6%)
After long high vowels	28	2 (7%)

The data of Table 4 make it overwhelmingly clear that the only reasonable statement of a phonetic rule for word-final stops in Thai, regardless of the context, is that they be produced without voicing. Note that after the totals in the table I have an extra entry for the stops found after long high vowels. This was done because of Noss's claim that these in particular are likely to be voiced. In fact, the two that were voiced (7% of 28) fall among the five that were voiced before voiced phones. It should be noted that even before voiced phones the tendency to voice the occlusions of the stops is rather weak, only 16 percent. In general, the six percent of the total that showed voicing is characterized by low-amplitude pulsing of the kind that we have previously called "edge

vibration" (Lisker and Abramson, 1964 : 416-18) and would normally expect to be weak continued oscillation of the vocal folds while the glottis is opening; edge vibrations of this kind seem usually to be below auditory threshold (Lisker and Abramson, 1967 : 8-9). Examination of the spectrograms convinces me that this is the situation, but I do not have the precise amplitude measurements that would entitle me to make such a distinction in Table 4. In only two of these instances was the voice pulsing a convincing mirror image of the situation in word-initial voiced stops. Both of these were utterances of the dental stop in the expression /p'ûut dûaj/ in which apparently a real [d] was pronounced throughout the single sustained stop occlusion ending the first word and beginning the second.

Voice pulsing, then, clearly is not characteristic of word-final stops in Thai. The rare instances of unbroken high-amplitude laryngeal pulsing in this body of data were cases of assimilation to following homorganic stop sounds. Otherwise, the several cases observed seem to be nothing more than the weak, inaudible pulsing caused by the failure of the margins of the glottis to cease oscillating completely when the glottal aperture is not large; although normally too weak to be heard in a speech context, these pulses may have sufficient intensity to be detected by instruments. On the basis of *available* phonetic data, it is implausible to align word-final stops in Thai with anything but initial /p t k/.

It is unfortunate that such important reference books as the Haas dictionary and the Noss grammar can mislead students of the language as to one aspect of Thai pronunciation. Admittedly, some of the speculations of Brown as to glottal control and Noss as to the state of the supraglottal articulators should be investigated by instrumental means now at our disposal. With the knowledge of these phenomena in general and Thai phonetics in particular now available, however, I simply wish to assert that there is as yet no basis for denying the primacy of the timing of laryngeal control of voicing--and thus aspiration--for both initial and final stops of Thai.
