AMPLITUDE AS A CUE TO WORD-INITIAL CONSONANT LENGTH: PATTANI MALAY

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ABSTRACT

Word-initial Pattani Malay consonants are short or long. The closures of the "long" consonants are longer than those of the "short" ones; this is a sufficient cue for perception, but in voiceless plosives the duration of the silent closure is audible only after a vowel, yet listeners label such isolated words well and so must use other cues. The peak amplitudes for the first syllables of disyllabic words are greater for initial long plosives. In this study, increments of closure duration and amplitude were pitted against each other for original short plosives and decrements for original long plosives. In tests, duration was by far the more powerful cue, although amplitude did affect the category boundary. By itself, however, amplitude is a weak cue. Further work is planned on the possible role of the shaping of the amplitude contour.

1. INTRODUCTION

Many languages are described as having a phonological distinction of length in vowels or consonants, or even both. If the term is taken literally, we would expect to find that the underlying mechanism is control of the relative timing of the articulators. Even so, a single mechanism might have a number of acoustic consequences, each of which could help in perception.

Pattani Malay, spoken by about a million ethnic Malays in southern Thailand, is unusual not only in having a length distinction for consonants in word-initial position but also in having one that is relevant for all phonetic classes of consonants in that position [3]. Here are some minimal pairs of words showing the contrast:

/labɔ/	'to profit'	/ɭabɔ/	'spider'
/make/	'to eat'	/mːake/	'eaten'
/bule/	'moon'	/bːule/	'months'
/katoʔ/	'to strike'	/kːatoʔ/	'frog'

If, indeed, the crucial aspect of the articulatory gesture is the duration of the closure or constriction, for pairs like the first two it would not surprise us to find that the length distinction is quite discernible whether in utterance-initial or intervocalic position. But what about the stop consonants, especially the voiceless unaspirated stops of the language? The voiced stops do have voicing lead, so if you are close enough, you can hear short or longer stretches of glottal pulsing during the occlusion. The occlusions of the voiceless stops, however, are silent.

In earlier work [2], I presented acoustic measurements of closure durations for the language, showing that the putative length categories are well separated by duration. Of course, the voiceless stops could not be measured in utterance-initial position. In another study [1], I demonstrated, by systematically increasing the durations of short closures and decreasing the durations of long closures, that this feature is a sufficient and powerful acoustic cue for the perception of the distinction.

As for the voiceless stops, it was conceivable that the two categories were auditorily distinguishable in medial position only. This turned out not to be so in my control tests with unaltered words. Doing only slightly worse than with the other classes of consonants, native speakers rather accurately identified short and long voiceless stops in isolated words.

Among the various plausible acoustic effects of the mechanism, the most likely for the largely disyllabic words involved, was the peak amplitude of the first syllable relative to the second. Indeed, measurements [2] revealed that this ratio is greater for long plosives, that is, both stops and affricates. Presumably, greater air pressure accumulated behind the occlusion before release accounts for the differences. Although both voiced and voiceless plosives showed a significant difference, the level of significance was higher for the latter. No doubt, this is to be explained by differences in glottal impedance of the airflow. The difference is not significant for the continuants.

2. PROCEDURE

This paper is a progress report of my test of the hypothesis that the peak amplitude of the first syllable relative to the second in disyllabic words is a sufficient cue for the perception of the distinction between short and long voiceless stops in Pattani Malay. For my major experiments, as part of an interest in combinations of phonetic features underlying the same phonemic distinction, I have pitted variants in duration and amplitude against each other to determine their relative power.

2.1. Control tests

Although the identifiability of initial short and long consonants had been demonstrated [1], it seemed desirable also to do control tests for the recordings of my new speaker for this study. For each of seven minimal pairs of words I prepared a test containing 20 tokens of each of the two words, yielding 40 randomized stimuli. There were two such randomizations for each word pair. The nasal, lateral, fricative, and plosive categories were represented. The plosives included voiced and voiceless stops and voiceless affricates. (Unfortunately, my only pair of voiced affricates included a word, as I learned later, that would have embarrassed the women among the subjects, so I could not use that test.) The subjects were 30 undergraduate students, all native speakers of Pattani Malay, at the Prince of Songkhla University, Pattani, Thailand.

2.2. Amplitude vs. duration

To test for the relative power of amplitude and duration, three pairs of words with velar, dental, and labial short and long stops respectively were used. All of them were recorded at the end of the carrier sentence /dio katɔ/ 'he said.' By means of the Haskins Laboratories Waveform Editing and Display System (WENDY), the stop closure of the short member of each pair was lengthened in 20-ms steps until it reached or exceeded the duration of its long counterpart. The closure of the long member was shortened in the same way. The first syllable of each variant of the original short stop was increased in amplitude in five 2-dB steps. Likewise, the first syllable of each variant of the original long stop was *decreased* in amplitude in five 2-Db steps. Two test orders were recorded from randomizations of two tokens each of all the resulting stimuli and played to 30 native speakers for identification of the key words.

2.3. Amplitude in isolated words

The perceptual efficacy of amplitude without help from closure duration was tested by taking all the amplitude variants from the original short and long forms of one of the word pairs in section 2.2. Two test orders were recorded from randomizations of four tokens of each stimulus and played to 30 native speakers.

3. RESULTS

3.1. Control tests

The previously demonstrated identifiability of the utterance-initial consonants [1] was reaffirmed. The major difference is that the voiceless long affricates in this sample were labeled correctly 96% of the time, whereas in the last study it was just above chance at 55%.

3.2. Amplitude vs. duration

Because of the limitation on space, the results of only two of the experiments are given here. Figure 1 gives the responses of 30 native speakers to nine durations in 20-msec steps of the [k]-closure in /kameŋ/ 'goat' combined with six amplitude levels in 2-dB steps. The vertical axis

shows the percentage identification as short /k/. The earlier crossover of the higher-amplitude curves at the 50% point to the long-/kː/ category, giving judgments of /kaməŋ/ 'goatlike,' is highly significant [F (40, 1160)=9.0, p < .001]; nevertheless, the values of duration at the short end are very little affected. The opposite procedure, shortening original long /kː/ and lowering the amplitude, yielded similar results, as shown in Figure 2. The results are essentially the same for the other two places of articulation.

3.3. Amplitude in isolated words

In Figure 3 both the short and long responses are plotted for increments of amplitude on original /pagi/ 'morning.' While the two curves converge, they never cross each other. Figure 4 shows rather similar effects for decrements of amplitude combined with isolated tokens of /pːagi/ 'early morning.'

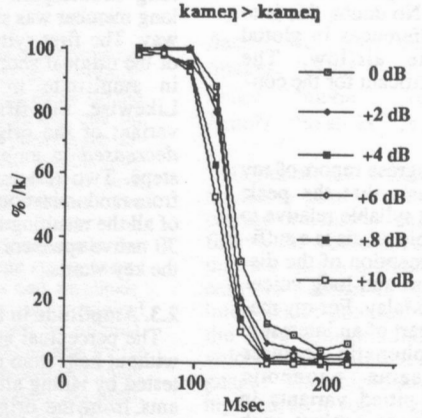

Fig. 1. Responses to /kamen/ 'goat' and its variants with increased closure duration and first-syllable amplitude.

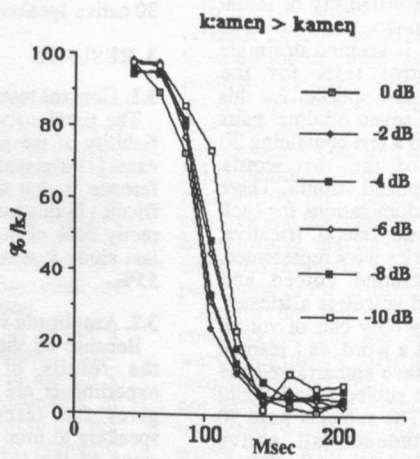

Fig. 2. Responses to /kːamen/ 'goatlike' and its variants with decreased closure duration and first-syllable amplitude.

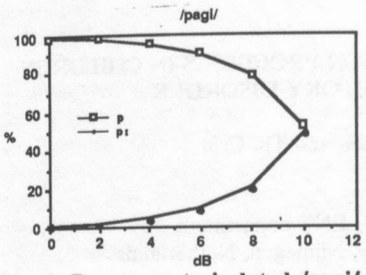

Fig. 3. Responses to isolated /pagi/ 'morning' and its variants with increased first-syllable amplitude.

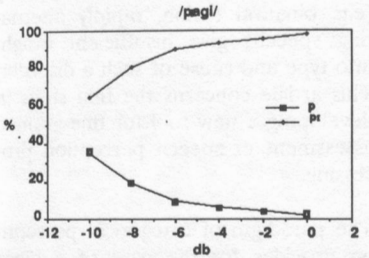

Fig. 4. Responses to isolated /pːagi/ 'early morning' and its variants with decreased first-syllable amplitude.

4. CONCLUSION

It is clear that when both features are present, duration is dominant; nevertheless, the boundary between the two perceptual categories is significantly affected by relative amplitude. In utterance-initial position, however, relative amplitude is only a weak cue, apparently secondary to something else.

To understand how the length distinction is perceived in uitterance-initial voiceless plosives, perhaps further work should be done on the possible role of the shaping of the amplitude contour. That is, maybe a finer analysis of utterances and a more complicated making of stimuli will show, for example, that the rise-time of the amplitude carries more weight than the peak value, or that the two work together. Indeed, a very preliminary look at this time suggests that the rise time is shorter in the production of the long stops. Also, it is possible that the major amplitude difference is confined to the region of the release burst. Other features that have not seemed promising so far, such as fundamental frequency and rate of formant transitions, may have to be examined more closely too.

5. ACKNOWLEDGMENTS

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6. REFERENCES

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