Universiteit Leiden
The Netherlands

Effects of word length and substrate language on the temporal organization of words in Indonesian

Zanten-Wervelman, E.A. van; Heuven, V.J.J.P. van; Odé C., Stokhof W.

Citation

Zanten-Wervelman, E. A. van, & Heuven, V. J. J. P. van. (1997). Effects of word length and substrate language on the temporal organization of words in Indonesian. In S. W. Odé C. (Ed.), *Proceedings of the Seventh International Conference on Austronesian Linguistics* (pp. 201-213). Amsterdam/Atlanta GA: Rodopi. Retrieved from https://hdl.handle.net/1887/63068

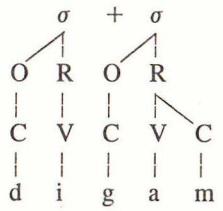
Version: Not Applicable (or Unknown)

License: Leiden University Non-exclusive license

Downloaded from: https://hdl.handle.net/1887/63068

Note: To cite this publication please use the final published version (if applicable).

(b) UNDERLYING AND PHONETIC REPRESENTATION



5 Conclusion

This paper discusses some of the analyses that have been proposed in the literature which attempt to account for the rule of schwa epenthesis in Malay. We have seen that both the linear analysis and the template analysis fail to offer an adequate explanation to the phenomenon. As an alternative solution, we propose an analysis based on the theory of syllable and rule-driven syllabification. This analysis assumes that epenthesis is a repair mechanism triggered by constraints on syllabification. Undoubtedly, the current proposal provides a better explanation of the issue.

REFERENCES

Goldsmith, J.A.
1990 *Autosegmental and Metrical Phonology*. Oxford: Basil Blackwell.
Itô, J.
1986 *Syllable Theory in Prosodic Phonology*. Amherst: University of Massachusetts, Ph.D. Thesis.
Roca, I.
1994 *Generative Phonology*. London: Routledge.
Teoh Boon Seong
1988 *Aspects of Malay Phonology Revisited: A Non-linear Approach*. University of Illinois, Ph.D. Thesis.
Yeoh Chiang Kee
1988 'Kajian Semula Tentang Morfem Dasar Penanda Aktif Dalam Bahasa Melayu', in: Farid M. Onn (ed.) *Bunga Rampai Fonologi Bahasa Melayu*. Petaling Jaya: Fajar Bakti.
Zaharani Ahmad
1993 'Pengimbuhan Awalan MeN Dengan Kata Dasar Bersuku Kata Satu: Masalah dan Penyelesaian', *Dewan Bahasa* 37 (12):1092-1101.

EFFECTS OF WORD LENGTH AND SUBSTRATE LANGUAGE ON THE TEMPORAL ORGANISATION OF WORDS IN INDONESIAN

Ellen van Zanten & Vincent J. van Heuven

1 Introduction

Timing is an important aspect of speech. Languages possess durational rules which are linguistically relevant, as is shown by research on the temporal organisation of many, mainly Western European, languages. As part of our research on the durational system of the Indonesian language we investigated the effect of word length (in number of syllables) on stressed vowel duration and on total word duration. Indonesian words of one up to seven syllables were spoken by six speakers with different regional backgrounds, viz. two Javanese, two Sundanese and two Toba Batak speakers. The target words were spoken three times in a carrier sentence in four different conditions. For a full report on the research method used we refer to van Zanten (1994).

It is usually said that in Indonesian the penultimate syllable is stressed, unless this syllable contains a schwa (cf. for instance Teeuw 1984:9). For an overview of the literature on stress placement the reader is referred to Odé (1994:39-41). There seems to be a general preference for speakers to stress the prefinal syllable, but free variation of stress position is commonly observed, especially for longer words (van Zanten 1994:161-163). Moreover, listeners appear more or less insensitive to deviant stress placement: they do not judge words with deviating stress realisations unacceptable, nor do they attribute metalinguistic contrastive interpretations to such tokens (cf. Ebing 1991 cited in van Heuven 1994:18; see also Moeliono & Soenjono Dardjowidjojo 1988:73). In the course of our work we — informally — observed one exception to this free variation of stress position: stressing the prefinal syllable is obligatory if it is heavy, i.e. closed by a consonant.

For the current research, we selected four target words which consisted of CV syllables, with the final syllable closed, viz. *kak, katak, katak-katak* and *kekanak-kanakan*. To get more information on stress placement, we selected three target words with a closed penultimate syllable followed by a consonant in the final syllable, viz. *kataknya, katak-kataknya* and (possibly) *kekanak-kanakannya*. As control words of the former two, target words containing the same stem morpheme but with the suffix *-ku* were selected: *katakku* and *katak-katakku*. We expected these to be pronounced as [kataku] and [katakataku], respectively, (at least by some of the speakers) with open (phonetic) prefinal syllables.

These nine target words spoken in [+final, +focus] condition were analysed. [+focus] words are expected to be accented, with a pitch movement on the stressed syllable; the [+final, +focus] condition was selected because in this condition all sentences were read correctly by all speakers.

2 *Effect of word length on stressed (penultimate) vowel*

Generally speaking, speech sounds are pronounced shorter in longer utterances than in short stretches of speech. As regards Western languages, much research has been carried out on the effect of word length on the duration of the stressed vowel. In Swedish, for instance, the stressed vowel is found to be shortened as the number of syllables following it increases ('anticipatory shortening'). Moreover, increasing the number of syllables before the stressed vowel ('backward compensation') has a smaller but still appreciable effect in Swedish (Lindblom et al. 1981:20-24). Nooteboom (1972) found that, in Dutch, increasing the number of syllables following the stressed vowel has a shortening effect on its duration. Increasing the number of syllables preceding the stressed vowel, however, had only a small effect if the stressed vowel occurred in the final syllable. The duration of the stressed vowel in a non-final syllable was not shortened by increasing the number of preceding syllables; it rather had a tendency to increase slightly. Also, shortening effects proved smaller for phonologically short vowels than for long vowels (Nooteboom 1972:66-68).

Assuming that the penultimate vowel of our Indonesian target words is stressed, we may expect an anticipatory shortening effect for the stressed vowel in bisyllabic as compared to monosyllabic words. For longer Indonesian words, the stress would still be on the penultimate vowel, and adding syllables before the stressed vowel is expected to have little or no effect on the duration of the stressed vowel.

To study the effect of word length on the duration of the stressed penultimate vowel, durations of the penultimate vowels in the nine target words were measured and examined as a function of the number of syllables in the words. Results are visualised in figures 1a-f.

2.1 *Stressed /a/ in monosyllables vs. bisyllables*

Results indicate that 5 out of the 6 speakers pronounce stressed /a/ shorter in bisyllabic words than in monosyllables (anticipatory shortening). The only exception is the Javanese speaker J1 (figure 1a): J1's stressed /a/ is longer in bisyllabic words than in monosyllables. The shortening effect is the smallest for the other Javanese speaker, J2 (figure 1b), i.e. 12 %. The shortening effect is strongest for the Sundanese speakers S1 (figure 1c) and S2 (figure

1d); it amounts to approximately 50 %. The Toba Batak speakers (figures 1e-f) take an intermediate position; 37 and 21 % shortening, respectively.

2.2 *Stressed /a/ in words of 2 to 7 syllables*[1]

For each of the speakers except S1 (no durational effect), regression analysis revealed a slight increase in stressed vowel duration as more syllables are added to the word. The increases in duration are, however, not significant. For all speakers taken together, the correlation of number of syllables and duration of stressed penultimate /a/ revealed an average increment of 2 ms per added syllable. This is not significantly different from 0 increment, and would play no role in speech perception: Nooteboom & Doodeman (1980:281) found just-noticeable differences of 2-7 ms for Dutch short /a/ (mean durations 50-70 ms).

We conclude that the word length effect in our data is restricted to anticipatory shortening: adding one syllable after the stressed syllable causes considerable shortening of the stressed vowel. Increasing the number of syllables before the stressed syllable seems to have no effect in Indonesian.

3 *Effect of consonantal context*

Figures 1a-f show considerable variation in the duration of /a/ in the penultimate syllable of the target words which may not be explained by word length, but rather by the consonant which followed it. This was not the same in all target words: in six cases it was /k/ (*kak, katakku, kataknya, katak-katakku, katak-kataknya, kekanak-kanakan*), in two cases /t/ (*katak, katak-katak*) and in one target word /n/ (*kekanak-kanakannya*). It is known from the literature that the following consonant can have a large effect on the duration of the preceding vowel. For instance, vowels were found to be shorter before /k/ than before /t/. It is also said that the influence of the manner of articulation of a consonant upon the duration of a preceding vowel is language specific (Lehiste 1970:19-27).

For both *Javanese* speakers (figures 1a-b), /a/ is shorter before /k/ than before /t/ or /n/. Upon closer examination, the shortening effect depends on the exact realisation of /k/: when realised as a glottal stop (ex.: [kataʔku]), the shortening effect on the preceding /a/ is considerable, viz. at least 20 ms. This

[1] The data for the 6-syllable target word *kekanak-kanakan* should probably be disregarded as stress was often not on the penultimate syllable here (cf. 1. Introduction).

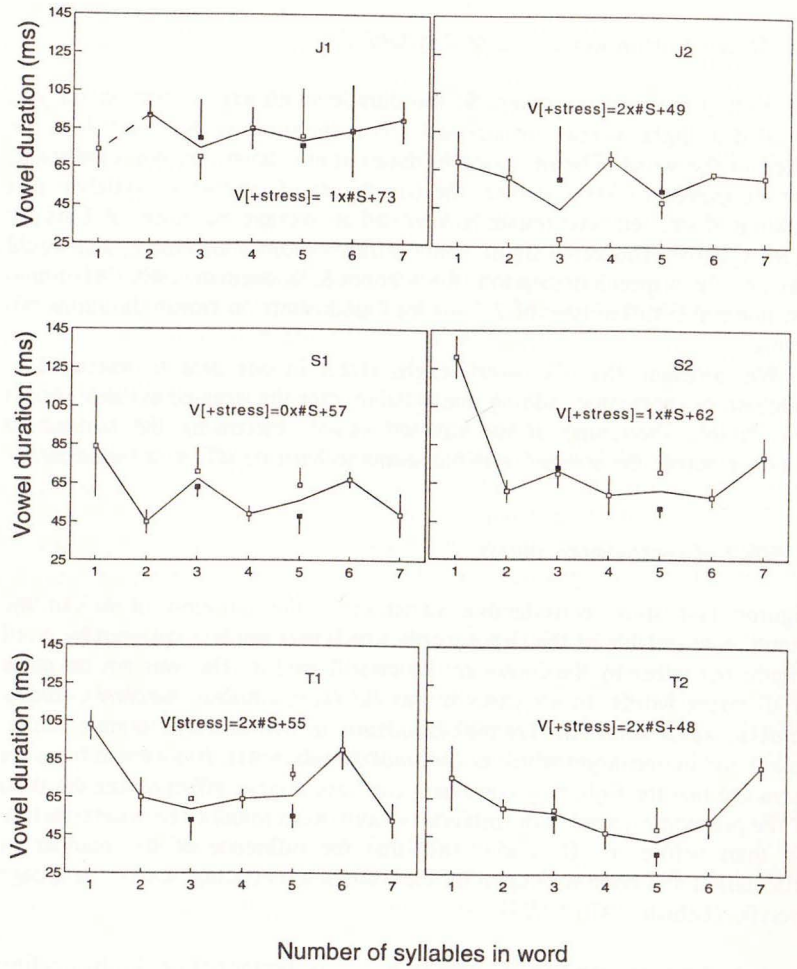


Figure 1: Duration of penultimate vowel related to the number of syllables in the word; the means of three-syllable *katakku* (open circles) and *kataknya* (closed circles) are averaged in the graph; similarly five-syllabic *katak-katakku* (open circles) and *katak-kataknya* (closed syllables).

effect is not as pronounced or even absent when /k/ is realised in a different way (as [k] or [g]) by the same speakers, or when it is absent. Speaker J1 pronounces the target word *katak-katakku* three times with glottal stop [kataʔkataʔku] (duration penultimate /a/ 68 ms), and once without [kataʔkataku] (penultimate /a/ 118 ms); we assume that the glottal stop has a shortening effect of some 50 ms on the preceding vowel /a/. The shortening effect of the glottal stop is related to an abrupt ending of the preceding vowel (Newman & van Heuven 1981:7).

The shortening effect of the glottal stop on the preceding vowel also offers an explanation for speaker J1's comparatively short /a/ in the monosyllabic target word. This word was indeed always pronounced as [kaʔ] by J1. If we assume that speaker J1's short /a/ in the monosyllable *kak* is due to the glottal stop, we may also suppose that, in a different consonantal context, /a/ would have been considerably longer, thus conforming to the pattern of the other five Indonesian speakers.

The patterns are different for the *Sundanese* speakers (figures 1c-d); for both speakers the penultimate stressed /a/'s tend to be longer before /k/ than before /t/. For speaker S2, the differences are very small with much overlap, but for S1, /a/ is appreciably longer before /k/ than before /t/. We do not have an explanation for this unexpected pattern. For the Toba Batak speakers (figures 1e-f) no particular pattern can be observed that can be attributed to consonantal context. The effect of the following consonant on the stressed /a/ is considerable, especially for the Javanese speakers. The effect is different for our three groups of speakers and can be seen as an effect of the substrate language.

We conclude our discussion of the duration of the stressed vowel by stating that, as in Western languages, adding a syllable after the stressed vowel of a monosyllabic word causes drastic shortening of this vowel. Increasing the number of syllables before the stressed syllable (words of two to seven syllables) has no significant effect for our Indonesian speakers. If indeed the duration of the stressed vowel is approximately the same in all polysyllabic words in Indonesian, when spoken by the same speaker, it may make sense to take this duration as the basic vowel duration. Vowel durations in monosyllables, which are less common in Indonesian, could then be seen as (compensatorily) lengthened.

4 *Effect of word length on word duration; the issue of stress-timing versus syllable-timing*

4.1 *Effect of word length on word duration*

In the present section we are interested in the effect of word length (in syllables) on total word duration. Durations of all segments of the nine

selected target words were measured. Target words were occasionally preceded by a hesitation pause. It is impossible to determine a boundary between a pause and the closure time of a voiceless plosive which follows it. Whenever the silent interval before the explosion of a word initial consonant was longer than 200 ms it was considered to include a hesitation pause. In such cases initial consonant duration was put at 200 ms. (Durations of word initial /k/'s which were not preceded by a hesitation pause were around 100-150 ms or even less in our data.) Word final /k/ was often unreleased and for that reason not measurable. As a consequence, all final consonants were excluded from the analysis. Results of the measurements are visualised in figure 2. Figure 2 shows an increase in word duration for most words and most speakers.

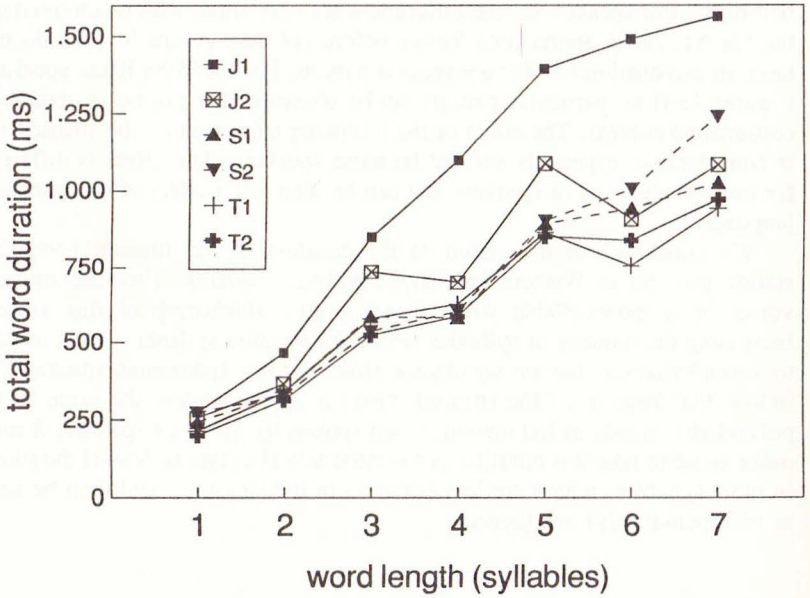


Figure 2: Total durations (ms) of target words related to number of syllables in the word; initial consonant max. 200 ms; final consonant excluded.

The Javanese speaker J1 exhibits a noticeable flattening of the curve for words consisting of six and seven syllables. Five speakers have relatively long durations for the three-syllable words *katakku* and *kataknya* and for five-syllable *katak-katakku* and *katak-kataknya*. We have no out-of-hand explanations for this, except, possibly, that these words are less common and therefore pronounced slightly more slowly. Speaker J1's three- and five-syllable words do not have these relatively long durations; this speaker pronounced all target words rather slowly. Secondly, the three- as well as the five-syllable words end in a vowel; all other target words end in a consonant (which was, as indicated above, not included in the measurements).

In table 1, the goodness of fit of the linear relationship between number of syllables and total word duration is expressed as Pearson's r. For a perfect relationship, r should equal 1. Moreover, if the word duration is exactly proportional to the number of syllables, there should be a zero intercept. Obviously, the relationships in our data are not perfectly linear and word duration is not exactly proportional to the number of syllables. Nevertheless, there is a strong correlation between number of syllables and word duration for all speakers, as indicated by r: 0.87 - 0.96. The intercept, which probably represents the extra durational increment for accented syllables (Fletcher 1991:199) ranges from 39 to 191 ms.

Table 1: Relation between word length in syllables and word duration: word duration = c(onstant) + number of syllables x increase per syllable.

Speaker	N	r	c (ms) intercept	durational increase per syllable (ms)
J1	31	0.96	128	227
J2	26	0.87	191	147
S1	27	0.96	119	139
S2	27	0.93	39	166
T1	27	0.93	157	120
T2	27	0.93	96	133

4.2 The stress-timing versus syllable-timing discussion

High values for r are reported in the literature for so-called syllable-timed languages (Fletcher 1991). According to Moeliono & Dardjowidjojo (1988:73), Indonesian is a syllable-timed language; its rhythm is based on the number of syllables: the larger the number of syllables in an utterance, the more time it takes to pronounce it. In a strictly syllable-timed language all

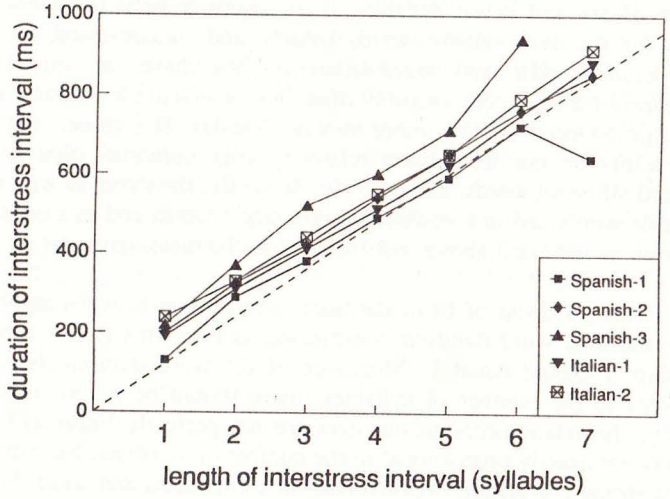


Figure 3a: Mean interstress interval durations of a so-called syllable-timed language, Spanish, and an 'unclassified' language, Italian, as a function of number of syllables in the interstress interval (after Dauer); the relationship of a hypothetical strictly syllable-timed language is indicated with a dashed line.

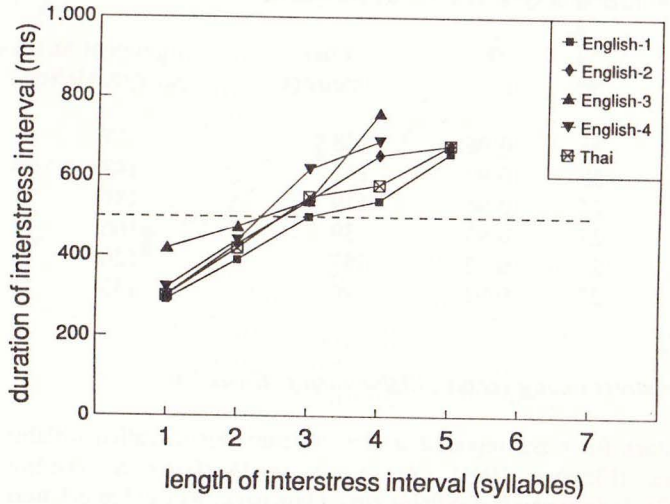


Figure 3b: Mean interstress interval durations of two so-called stress-timed languages, English and Thai, as a function of the number of syllables in the interstress interval (after Dauer); the relationship of a hypothetical strictly stress-timed language is indicated with a dashed line.

syllables would have equal duration, regardless of such factors as stress. The regression curve should have a zero intercept, and the correlation between length in syllables and duration in time should equal 1; cf. figure 3a (dashed line). In so-called stress-timed languages, such as English, on the other hand, the time interval between successive stressed syllables is supposed to be constant, regardless of the number of syllables which occur between the stresses. Consequently, in stress-timed languages, syllable durations shorten as the number of syllables increases (cf. figure 3b, dashed line).

Our data are based on durations of words and not on interstress interval durations. The target words were, however, all incorporated into identical carrier sentences which had an identical stress pattern. It seems legitimate, then, to compare our data with data on the relation between interstress interval length in syllables and in real time, thus touching upon the distinction between syllable-timed languages and stress-timed languages.

Fletcher (1991:199) related prosodic word durations (i.e. units consisting of an accented syllable plus all preceding unaccented syllables) and prosodic word length in syllables in spontaneously spoken French, a language which is usually described as syllable-timed. She found high correlation values, r ranging from 0.79 to 0.94, but she considers the strict syllable-timing principle as ruled out by the fact that all speakers' data show intercept values of over 100 ms (Fletcher 1991:199). Other researchers found high positive correlations for the so-called stress-timed languages Swedish (around 0.92; Fant & Kruckenberg 1989) and British English (between 0.94 and 0.96; Williams & Hiller 1989). Fletcher concludes that languages cannot be distinguished on the basis of timing of interstress intervals or syllable durations (Fletcher 1991:195).

Dauer (1983) compared data from the stress-timed languages English and Thai (cf. figure 3b), a syllable-timed language (Spanish) and the 'unclassified' languages Italian and Greek (cf. figure 3a). She found that the mean duration of interstress intervals was proportional to the number of syllables in the interval for all the languages analysed, including English and Thai. Dauer concludes that the difference between stress-timed and syllable-timed languages has nothing to do with the durations of interstress intervals, and proposes that the rhythmic differences which are perceived between stress-timed and syllable-timed languages are a result of differences in language structure.

In our view there is, however, an appreciable difference between Dauer's examples of stress-timed languages on the one hand, and her syllable-timed languages on the other, although neither strict syllable-timing nor strict stress-timing occurs. Notably, the intercepts are larger for the stress-timed languages (figure 3b) than for the syllable-timed languages (figure 3a). Our Indonesian data (figure 2) seem to fit in quite well with the so-called syllable-timed languages.

Dauer attributes the following characteristics to languages which are called syllable-timed. They usually do not have lexical stress, nor do they have vowel length contrast. The prevailing syllable structure is CV; there are no complex consonant clusters. Vowels are not reduced in unstressed position. Stress-timed languages, on the other hand, usually have lexical stress and a vowel length contrast. In languages like English, syllables can be much more complex and consequently longer than in Spanish or French, and these 'heavy' syllables tend to be stressed; unstressed vowels are often reduced to schwa (Dauer 1983).

The structural properties which Dauer attributes to syllable-timed languages as opposed to stress-timed languages fit Indonesian quite well. Indonesian has no lexical stress and no vowel length contrast. Also, open syllables are very common, consonant clusters tend to be avoided, and there does not seem to be much reduction of vowels in unstressed position. As a final characteristic, Dauer mentions the fact that in syllable-timed languages, stress has less effect on the duration of syllables than in stress-timed languages. Stressed syllables in (syllable-timed) Spanish are, on average, 1.3 times longer than unstressed syllables; whereas, in (stress-timed) English, they are 1.5 times longer (Dauer 1983:58).

4.3 The effect of stress on the duration of syllables

To get some idea about the effect of stress on the duration of syllables in Indonesian, we compared the mean durations of the stressed syllables with the mean durations of the unstressed syllables in the target words. Only target words with accented penultimate syllable were taken into account. Results show that in our limited Indonesian data, stressed syllables are, on average, 1.3 times longer than unstressed syllables (cf. table 2). In syllable-timed Spanish, stressed syllables were also found to be 1.3 times longer than unstressed syllables. Thus, Indonesian seems to comply with this characteristic of syllable-timed languages as well.

The Toba Batak language has lexical stress (van der Tuuk 1971:19-22; Nababan 1981:21-29). Nababan (1981:27, 135) states that vowels in stressed syllables are longer than unstressed vowels in Toba Batak. Therefore, we expected the stress effect to be stronger for the Toba Batak speakers than for the Javanese and Sundanese speakers, who do not have lexical stress in their substrate language. The effect of stress is indeed stronger for our Toba Batak speakers than for the other speakers (1.4 and 1.25, respectively). Our data are, however, too limited to draw any firm conclusions as regards the influence of the substrate language in this respect.

Table 2: Mean duration (ms) of stressed and unstressed syllables in 9 target words; only words with a stressed penultimate syllable are included.

speaker	mean duration of stressed syllable	mean duration of all unstressed syllables	ratio
J1	300	243	1.2
J2	225	169	1.3
S1	208	161	1.3
S2	213	187	1.1
T1	182	135	1.4
T2	200	147	1.4
all speakers			1.3

5 Concluding remarks

In the present study, the effect of word length on the temporal organisation of Indonesian words was investigated. We found that the effect of word length on the stressed penultimate vowel is restricted to anticipatory shortening: adding one syllable after the stressed syllable causes considerable shortening of the stressed vowel. Increasing the number of syllables before the stressed syllable has no effect on the duration of the stressed vowel.

The difference in duration between stressed and unstressed syllables is smaller in Indonesian than in so-called stress-timed languages. This small effect of stress on the duration of syllables reflects observations by Teeuw (1984:9) and other linguists, that stress is weaker in Indonesian than in Dutch. If the durational differences between stressed and unstressed syllables are but small, we may also argue that, at least in [-focus] position, the exact position of the stress in the word is not easily detected, nor would it functionally be as important as in so-called stress-timed languages.

We found two ways in which the substrate language influences the temporal organisation of Indonesian words: firstly, the effect of stress on the duration of syllables is stronger for the Toba Batak speakers than for the Sundanese and Javanese speakers; secondly, for the Javanese speakers, but not for the Sundanese and Toba Batak speakers, (stressed) /a/ is considerably shortened when followed by /k/, especially when this consonant is realised as a glottal stop.

Although strict syllable-timing or strict stress-timing do not exist, it seems that languages can be grouped according to their rhythmic behaviour into less strict categories with either a tendency toward syllable-timing or toward stress-

timing. Our Indonesian speakers would then belong to the group that tends to syllable-timing.

REFERENCES

Dauer, R.M.
1983 'Stress-timing and syllable-timing reanalysed', *Journal of Phonetics* 11:51-62.

Ebing, E.F.
1991 'A preliminary description of pitch accents in Bahasa Indonesia', *Proceedings of the XIIth International Congress of Phonetic Sciences* 3. Aix-en-Provence, 258-261.

Fant, G. & A. Kruckenberg
1989 'Preliminaries to the study of Swedish prose reading and reading style', *Speech Transmission Laboratory, Quarterly Progress and Status Report*. Stockholm: Royal Institute of Technology (KTH) 2:1-80.

Fletcher, J.
1991 'Rhythm and final lengthening in French', *Journal of Phonetics* 19:193-212.

Heuven, V.J. van
1994 'Introducing prosodic phonetics', in: C. Odé & V.J. van Heuven (eds.) *Experimental studies of Indonesian prosody*. Semaian 9. Leiden: Vakgroep Talen en Culturen van Zuidoost-Azië en Oceanië, Rijksuniversiteit te Leiden, 1-26.

Lehiste, I.
1970 *Suprasegmentals*. Cambridge, Mass. and London: MIT Press.

Lindblom, B., B. Lyberg & K. Holmgren
1981 'Durational patterns of Swedish phonology: do they reflect short-term motor memory processes?'. Bloomington, unpublished paper distributed by the Linguistics Club Indiana University.

Moeliono, A.M. & Soenjono Dardjowidjojo (eds.)
1988 *Tata Bahasa Baku Bahasa Indonesia*. Jakarta: Balai Pustaka.

Nababan, P.W.J.
1981 *A grammar of Toba Batak*. Materials in languages of Indonesia 6. Pacific Linguistics D 37.

Newman, R.M. & V.J. van Heuven
1981 'An acoustic and phonological study of pre-pausal vowel length in Hausa', *Journal of African Languages and Linguistics* 3:1-18.

Nooteboom, S.G.
1972 *Production and Perception of Vowel Duration; a Study of Durational Properties of Vowels in Dutch*. Utrecht University, Ph.D. Thesis.

Nooteboom, S.G. & G.J.N. Doodeman
1980 'Production and perception of vowel length in spoken sentences', *Journal of the Acoustical Society of America* 67:276-287.

Odé, C.
1994 'On the perception of prominence in Indonesian', in: C. Odé & V.J. van Heuven (eds.) *Experimental studies of Indonesian prosody*. Semaian 9. Leiden: Vakgroep Talen en Culturen van Zuidoost-Azië en Oceanië, Rijksuniversiteit te Leiden, 27-107.

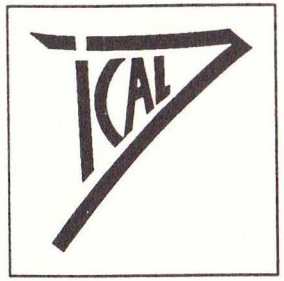
Teeuw, A.
1984[4] *Leerboek Bahasa Indonesia*. Groningen: Wolters-Noordhoff.

Tuuk, H.N. van der
1971 *A Grammar of Toba Batak*. Den Haag: M. Nijhoff. (Translation of *Tobasche Spraakkunst, Eerste Stuk (Klankstelsel)* 1864).

Williams, B. & S. Hiller
1989 'Investigating randomness in foot timing patterns in English', *Journal of the Acoustical Society of America* 85, Suppl. 1, p. S59.

Zanten, E. van
1994 'The effect of sentence position and accent on the duration of Indonesian words: a pilot study', in: C. Odé & V.J. van Heuven (eds.) *Experimental studies of Indonesian prosody*. Semaian 9. Leiden: Vakgroep Talen en Culturen van Zuidoost-Azië en Oceanië, Rijksuniversiteit te Leiden, 140-180.

Proceedings of the Seventh International Conference on *Austronesian Linguistics*

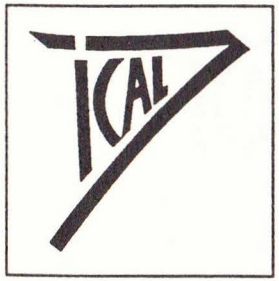


Leiden
22-27 August 1994

Cecilia Odé & Wim Stokhof
Editors
with the assistance of Connie Baak

Leiden University
Department of Languages and Cultures of
South East Asia and Oceania,
Projects Division

Proceedings of the Seventh International Conference on *Austronesian Linguistics*



Leiden
22-27 August 1994

Cecilia Odé & Wim Stokhof
Editors

Amsterdam - Atlanta, GA 1997