

MEASUREMENTS OF THE RHYTHM OF MALAY

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ABSTRACT

Acoustic measurements of the rhythm of Malay were made using a version the North Wind and the Sun passage translated into Malay, and these are compared with similar measurements for Standard Southern British English.

The results suggest that Malay has more syllable-based rhythm than British English. However, caution is advisable in drawing this conclusion, as many of the decisions about syllabification and also some of the measurements of vowel duration are rather subjective, and furthermore it is possible that the PVI results are affected by speaking tempo.

Keywords: rhythm, Pairwise Variability Index (PVI), acoustic measurements, Malay

1. INTRODUCTION

Most researchers no longer believe the assertion by Abercrombie [1] that all languages can be neatly categorized as stress-timed or syllable-timed. Furthermore, Roach [15] has raised fundamental doubts about the acoustic measurement of rhythm. Nevertheless, acoustic measurements have recently been successfully made to compare the rhythm of various languages, including Latvian [5], German and Spanish [11], Czech [8], and Chinese [3].

Zuraidah, Knowles and Yong [18] have noted that the rhythm of Malay is sometimes claimed to be syllable-timed, but few attempts seem to have been made to investigate this in depth. Grabe and Low [9] measured a single speaker of Malay among their investigation of 18 different languages, but their results for Malay were inconclusive.

The current study compares measurements of the rhythm of the data from six speakers of Standard Malay (as spoken in Brunei) with similar measurements of the data from six speakers of Standard Southern British English.

In this paper, we will discuss rhythm as being stress/syllable-'based' (rather than 'timed'), as many scholars (e.g [7]), have shown that rhythm involves more than just timing.

2. SPEAKERS

All of the Malay speakers were Bruneians, and they will be referred to as M1 to M6. M1 was a Malay language tutor aged 26, M2, M3, M4, and M5 were university undergraduates aged 34, 23, 23, and 22 respectively, and M6 was a Masters student aged 24.

The British speakers were all lecturers or English language tutors working at a university in Singapore. They were aged between 35 and 52. They will be referred to as B1 to B6.

3. DATA

The North Wind and the Sun Passage was translated into Malay (see [6]), as follows:

Ketika Angin Utara dan Matahari sedang bertengkar mengenai siapa yang lebih kuat, datang seorang pengembara yang memakai jubah. Keduanya bersetuju bahawa siapa yang berjaya menyebabkan pengembara tersebut menanggalkan jubahnya akan dianggap lebih kuat. Lalu Angin Utara pun meniup sekuatnya, namun semakin kuat angin bertiup semakin rapat pula pengembara tersebut memeluk jubahnya sehingga akhirnya Angin Utara pun mengalah. Kemudian Matahari memancarkan sinarnya dan dengan segera pengembara tersebut menanggalkan jubahnya. Akhirnya Angin Utara terpaksa mengaku bahawa Matahari lebih kuat daripadanya.

The passage is 78 words long, which is fewer words than the 113 words in the English passage ([10], p. 33). However, the Malay version has considerably more syllables (217 vs. 143), because there are so few monosyllabic words in the Malay text, and also because many of the words are four syllables as a result of compounding (*Matahari* 'sun' = *mata* 'eye' + *hari* 'day') or affixation (e.g. *pengembara* 'traveller', *bersetuju* 'to agree', *menyebabkan* 'to cause', *menanggalkan* 'to take off'), and one word is even five syllables long (*daripadanya* 'than him'). Nevertheless, it is hoped that the two texts are comparable.

The time taken to read the text is shown in Table 1. On average, the Malay speakers took 38.3 seconds to read it, while the British speakers took

34.8 seconds. Although the Malays seem to take a bit longer, there is in fact no statistical difference between the average durations ($t=1.33$, $df=10$, $p=0.21$, ns).

Table 1: Time (sec) taken to read the text, and tempo (syllables per second).

speaker	time	tempo	speaker	time	tempo
M1	46.6	4.65	B1	35.5	4.02
M2	33.5	6.48	B2	36.4	3.93
M3	33.9	6.41	B3	29.5	4.85
M4	35.7	6.07	B4	37.3	3.83
M5	36.2	6.00	B5	37.9	3.78
M6	43.6	4.97	B6	31.9	4.48
average	38.3	5.76	average	34.8	4.15

However, the greater number of syllables in the Malay text means that it was read at a faster tempo in terms of syllables per second, with an average of 5.76 syllables per second for the Malay data compared with 4.15 syllables per second for the British data, a difference that is highly significant ($t=4.51$, $df=10$, $p=0.001$), and this may have a substantial effect on the results.

It is, of course, not straightforward to make cross-language comparisons of speaking rate (see [16]), so it is hard to determine whether the Malay was really spoken at a faster rate than the English or not. The structure of Malay syllables is rather simpler than English ones, as Malay syllables involve no consonant clusters, so it is hardly surprising that the Malay data was spoken with more syllables per second. But does this really mean the Malay data was spoken at a faster rate than the British data? Maybe estimates of speaking rate should instead depend on phonemes per second.

Here, consideration of the effect of speaking rate we will be based on syllables per second, as the measurement of rhythm that is adopted depends on syllables, but we should acknowledge that this decision is open to question.

4. MEASUREMENTS

Acoustic measurements of rhythm were made using Praat [4] by comparing the duration of successive vowels using the Pairwise Variability Index (PVI) proposed by Low, Grabe and Nolan [12] with two small modifications:

- The minimum duration of each vowel was set at 30 msec.
- Measurement of the final syllable in each phrase was omitted.

The first of these modifications was adopted to ensure that the results are not affected by small changes in the measurement of very short vowels. For example, if one vowel is measured as 10 msec and the next as 20 msec, this would give a large value for the PVI even though both syllables in fact have similar duration.

The second modification was adopted because Malay is known to have substantial phrase-final syllable lengthening (see [18]), so an utterance may have perfect syllable-based rhythm and then be terminated with one elongated syllable.

The formula for the PVI calculations adopted here is therefore:

$$(1) \quad PVI = 100 \times \left[\sum_{k=1}^{m-2} \frac{|d_k - d_{k+1}|}{(d_k + d_{k+1})/2} \right] / (m-2)$$

where d is the duration of the vowel in the k th syllable or 0.030 sec, whichever is larger, and m is the number of syllables in the utterance.

One major issue in doing the measurements concerns identification of syllables. Specifically, how many syllables are there in words such as *kuat* ('strong'), *siapa* ('who'), *meniup* ('to blow') and *kemudian* ('then')? For example, in fast speech, *kuat* seems to be pronounced as a single syllable [kwat]; but this would violate the underlying CVC structure of Malay syllables (see [6]), which suggests that the word should be regarded as [ku.at]. Similarly, *siapa* and *meniup* might be either two or three syllables, and *kemudian* might be three or four syllables.

To help resolve this issue, four of the Malay speakers were asked to fill in a brief questionnaire to indicate how many syllables they felt there are in words such as *kuat*, *siapa*, *meniup* and *kemudian*, and they unanimously answered 2, 3, 3, and 4, so these words were treated as [ku.at], [si.a.pa], [mə.ni.up] and [kə.mu.di.an] respectively. For consistency, *traveller* in the English version was treated as three syllables [træ.və.lə] (as indeed it was pronounced by most of the speakers) rather than the alternative [træv.lə] which Wells [16, p. 838] suggests is the more common pronunciation in English.

One other syllabification issue involves *mengenai* ('about') and *memakai* ('to wear'), and the respondents unanimously indicated that *mengenai* has four syllables while *memakai* has three. (The difference arises because the final *-i* is a suffix in *mengenai*, for which the root is *kena*, but not in *memakai*, for which the root is *pakai*.)

5. RESULTS

The results for the measurements of PVI for the twelve speakers are shown in Table 2.

Table 2: PVI results.

speaker	PVI	speaker	PVI
M1	46.04	B1	57.39
M2	40.74	B2	64.09
M3	37.08	B3	55.51
M4	35.19	B4	63.74
M5	41.99	B5	62.18
M6	44.39	B6	56.20
average	40.91	average	59.85

Clearly, the Malay speech has lower PVI values than the British speech, which suggests that the Malay may indeed have more syllable-based rhythm. The difference between the average value for the Malay data, 40.91, and that for the British data, 59.85, is highly significant ($t=8.11$, $df=10$, $p<0.0001$).

6. DISCUSSION

Although the results seem to indicate that Malay has more syllable-based rhythm than English, some caution is appropriate. Ong, Deterding and Low [14] have shown that many of the measurements involved in deriving the PVI values can be quite subjective. And Nolan and Asu [13] recommend that some aspects of the PVI implementation should be re-evaluated, particularly how much we should be depending on a comparison of the duration of successive vowels, and they suggest that, for the rhythm of Estonian, measurements of feet as well as syllables are important.

One issue that needs to be considered further is syllabification, for example whether *kuat* has one or two syllables. The word might phonologically be two syllables but phonetically it is often a single syllable, and in that case, which should we be using? Furthermore, it is almost always impossible to make a principled judgment about the syllable boundary in the middle of the tokens of *kuat*, so the mid-point is generally used; but this results in two syllables of equal duration, which inevitably results in a low value for the PVI. In contrast, in the English data, treating *traveller* as three syllables rather than two results in a higher PVI value, as the [ə] in the second syllable is always very short (or non-existent) while the other two vowels are generally longer.

The influence of this syllabification can be evaluated by regarding *kuat*, *siapa*, *menilup* and *kemudian* as consisting of the smaller number of

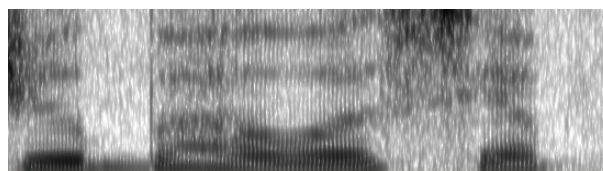
syllables, specifically 1, 2, 2, and 3 syllables respectively, and also treating *traveller* as bisyllabic. The PVI results under these conditions are shown in Table 3. The average values for the PVI are now 44.37 for the Malay speakers and 58.82 for the British. Although these averages for the Malay and British data are still significantly different ($t=5.73$, $df=10$, $p=0.0002$), the difference is rather less than before.

Table 3: PVI results (with fewer syllables).

speaker	PVI	speaker	PVI
M1	49.66	B1	55.54
M2	44.44	B2	63.92
M3	39.99	B3	55.22
M4	38.33	B4	62.79
M5	45.10	B5	60.90
M6	48.69	B6	54.55
average	44.37	average	58.82

One other concern is the arbitrary nature of many of the measurements. For example, *bahawa* ('that') has a medial [h] and then a medial [w], and it is hard to make a principled decision about the start and end of the vowels before and after each of these consonants. Figure 1 shows a spectrogram (derived from Praat [4]) of about 0.7 seconds of the speech of M3 saying *bahawa*.

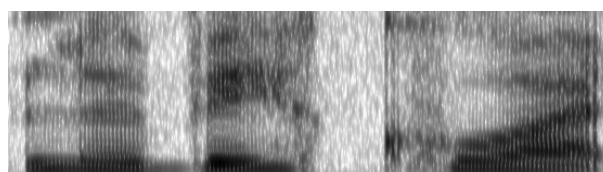
Figure 1: *bahawa* as spoken by M3.



b a h a w a

In fact, medial and final [h] is rather common in the Malay text, e.g. *Matahari* ('sun'), *lebih* ('more'), *jubah* ('cloak'), and in such cases, it is nearly always impossible to identify the end of the vowel before the start of the [h] with any confidence. Figure 2 shows the spectrogram (about 0.7 seconds) of M6 saying *lebih kuat*, and it is not at all certain where to mark the end of the second vowel in *lebih*. (In this example, one might note also the difficulty in identifying the end of the first syllable in *kuat* if it is regarded as bisyllabic.)

Figure 2: *lebih kuat* as spoken by M6.



l ə b i h k u a t

If we draw conclusions about rhythm on the basis of these measurements, we need always to remember how subjective many of them are.

A final concern involves the relationship between speech tempo and the measurement of rhythm. Barry and Russo [2] have shown that there is some influence from speech tempo on the PVI values, with German, Naples Italian and Pisa Italian all showing a small but consistent reduction in PVI values with increasing speech rate. In the current study, the Malay speech was produced at a higher tempo than the British speech in terms of syllables per second, though given the reduced syllable complexity of Malay, it is not clear if this really means that the Malay was spoken faster. Of further concern is the fact that the two Malay speakers with who spoke most slowly (M1 and M6) have the highest PVI values, and similarly the three British speakers who spoke most slowly (B2, B4 and B5) have the highest PVI values among the British speakers. In fact there is a high correlation between the duration of the reading and the PVI results for both sets of data (Malay: $r=0.79$; British: $r=0.85$). It seems that syllable rate indeed has a substantial effect on the PVI results, and it is possible that all the measurements have actually shown is that the Malay data was spoken with more syllables per second.

7. CONCLUSION

The results tentatively indicate that Malay has more syllable-based rhythm than British English. However, there remain substantial concerns about the implementation of the PVI, especially regarding syllabification, subjectivity in determining the start and end of vowels, and the influence of speaking tempo on the results. These are all issues that should be investigated further.

8. REFERENCES

- [1] Abercrombie, D. 1967. *Elements of General Phonetics*. Edinburgh: Edinburgh University Press.
- [2] Barry, W.J., Russo, M. 2003. Measuring rhythm: Is it separable from speech rate? In Mettouchi, A., Ferré G. (eds), *Proc. IP2003* Nantes, France, 15-20.
- [3] Benton, M., Dockendorf, L., Jin, W., Liu, Y., Edmondson, J.A. 2007. The continuum of speech rhythm: Computational testing of speech rhythm of large corpora from natural Chinese and English speech. *Proc. 16th ICPhS* Saarbrücken, 1269-1272.
- [4] Boersma, P., Weenink, D. Praat: doing phonetics by computer. <http://www.fon.hum.uva.nl/praat/>
- [5] Bond, Z.S., Markus, D., Stockmal, V. 2003. Prosodic and rhythmic patterns produced by native and non-native speakers of a quantity-sensitive language. *Proc. 15th ICPhS* Barcelona, 526-530.
- [6] Clynes, A., Deterding, D. 2011. Standard Malay (Brunei). *JIPA* 21(3).
- [7] Cummins, F., Port, R. 1998. Rhythmic constraints on stress timing in English. *Journal of Phonetics* 24, 145-171.
- [8] Dankovičová J., Dellwo, V. 2007. Czech speech rhythm and the rhythm class hypothesis. *Proc. 16th ICPhS* Saarbrücken, 1241-1244.
- [9] Grabe, E., Low, E.L. 2002. Durational variability in speech and the rhythm class hypothesis. In Gussenhoven, C., Warner, N. (eds.), *Laboratory Phonology 7*, 515-546.
- [10] IPA 1999. *Handbook of the International Phonetic Association*. Cambridge: Cambridge University Press.
- [11] Lleó C., Rakow, M., Kehoe, M. 2007. Acquiring rhythmically different languages in a bilingual context. *Proc. 16th ICPhS* Saarbrücken, 1545-1548.
- [12] Low, E.L., Grabe, E., Nolan, F. 2000. Quantitative characterizations of speech rhythm: syllable-timing in Singapore English. *Journal of Phonetics* 29, 217-230.
- [13] Nolan, F., Asu, E.L. 2009. The pairwise variability index and coexisting rhythms in language. *Phonetica* 66, 64-77.
- [14] Ong, P.K.F., Deterding, D., Low, E.L. 2005. Rhythm in Singapore English: A comparison of indexes. In Deterding, D., Brown, A., Low, E.L. (eds.), *English in Singapore: Phonetic Research on a Corpus*. Singapore: McGraw-Hill, 74-85
- [15] Roach, P. 1982. On the distinction between 'stress-timed' and 'syllable-timed' languages. In Crystal, D. (ed.), *Linguistic Controversies*. London: Edward Arnold, 73-79.
- [16] Roach, P. 1998. Myth 18: Some languages are spoken more quickly than others. In Bauer, L., Trudgill, P. (eds.), *Language Myths*. London: Penguin, 150-158.
- [17] Wells, J.C. 2008. *Longman Pronunciation Dictionary*. Harlow, UK: Pearson.
- [18] Zuraidah M.D., Knowles, G., Yong, J. 2008. How words can be misleading: A study of syllable timing and "stress" in Malay. *The Linguistics Journal* 3(2). http://www.linguistics-journal.com/August_2008_zmd.php