

The tone contrast of Magey Matbat

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In this paper I present a descriptive account of the tone system of Magey Matbat. I have attempted to give an overview of the ways in which tone interacts with a range of other phenomena in the language system. While this approach is legitimate as a descriptive strategy in its own right, it is all the more worthwhile because Magey Matbat is an endangered language, on which no previous linguistic studies are available. That is why I have been eager to include information on phenomena other than lexical tone, to the extent that they interact with the lexical tone contrast.

The structure of the paper is as follows. Section 1 provides some background information on Magey Matbat, the language or language variant under consideration. The discussion of the Matbat tone begins in section 2, with a basic phonological description of the system of lexical tone contrasts. Section 3 presents the results of a phonetic analysis of the lexical tone system. This analysis covers the interaction between tone and the factors syllable composition and phrasal structure. Also considered in this section is the influence of tonal co-articulation and discourse prominence. The next two sections relate to the role of tone in the grammar. Section 4 introduces three morphological processes that make reference to tone: noun classes, inalienable possession, and the derivation of words with related meanings. Section 5 deals with the marking of questions. Particular attention goes to a tonal morpheme specific to the marking of certain types of questions. In the discussion, in section 6, I will compare the Matbat tone system with that of Ma'ya, a closely related language that also has lexical tone, and I will discuss the origin of the Matbat tone system.

1. Magey Matbat

Magey Matbat has around 500 native speakers, spread over four villages along the coast of the island Misol. The names of these villages are Magey, Kapacol, Aduwey, and Salafen (see Figure 1). Misol lies approximately halfway between the western tip of New Guinea and the Moluccan island of Seram. Two or three other languages are used on the island: Tomolol Matbat, Ma'ya and Biga. Tomolol Matbat is closely related with Magey Matbat, and the two may or may not constitute dialects of a single language.¹ More detailed work on Tomolol Matbat is required to settle this question.

The term Matbat is a self-referring term, meaning 'people of the land', and distinguishes the language communities of Magey Matbat and Tomolol Matbat jointly

¹ In Remijsen (2001a) I followed the judgments of native speakers in classifying Tomolol Matbat and Magey Matbat as dialects of a single language. In the course of subsequent fieldwork, I collected a wordlist and notes on morphology of Tomolol Matbat. These data revealed non-trivial differences between Tomolol Matbat and Magey Matbat, in the lexicon, the sound system, and the grammar. Anecdotally, a native speaker of Tomolol Matbat married to a native speaker of Magey Matbat reported that they used Malay when they were recently married. This suggests that mutual intelligibility between Magey Matbat and Tomolol Matbat is limited.

from the Ma'ya – or Matlow ‘people of the sea’, as they are called in Matbat villages. In other words, on Misol the term Matbat refers to an ethnic group, encompassing both the Magey Matbat and the Tomolol Matbat dialect or language communities. For the sake of brevity, I will hereafter use the term Matbat to refer specifically to the Magey Matbat language or dialect, and I will only use the term Magey Matbat in contexts where ambiguity might arise otherwise.

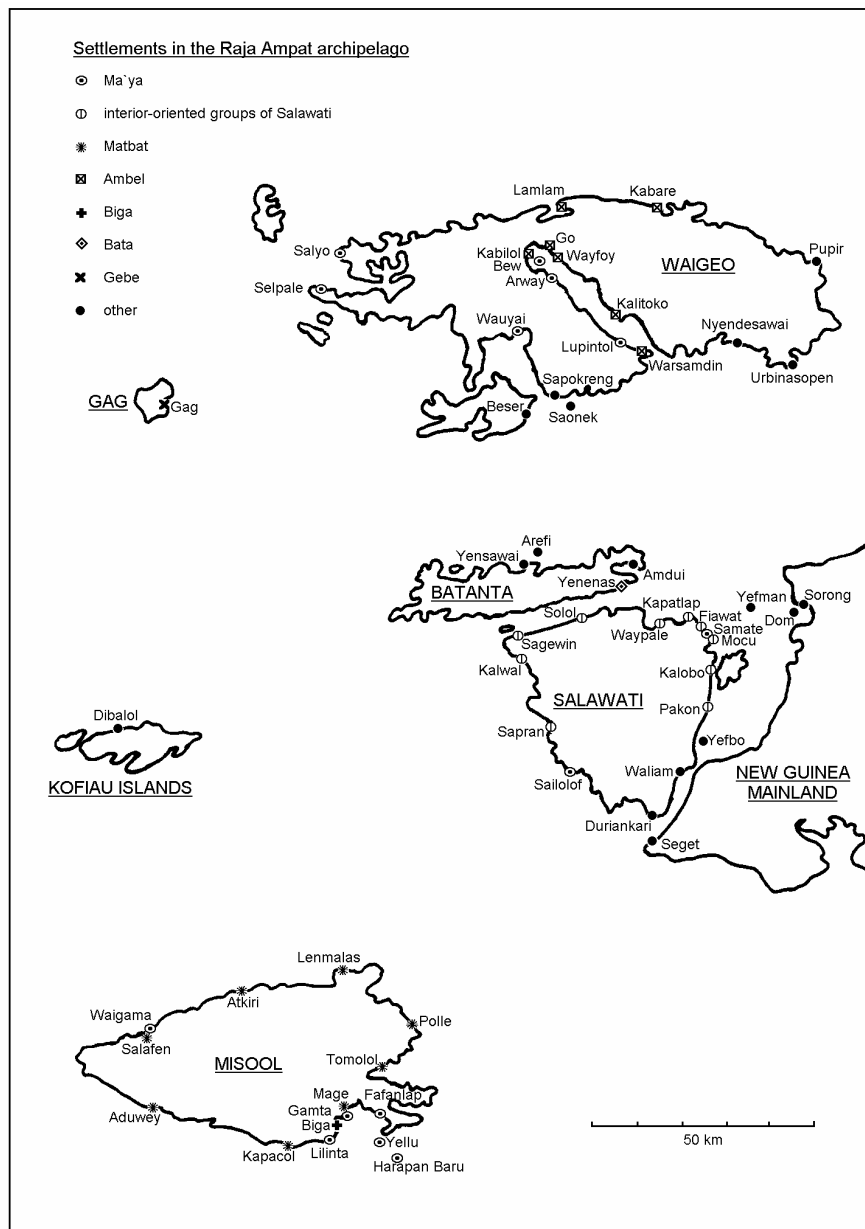


Figure 1: The Raja Ampat islands, with the location of villages. From Remijsen (2001a).

The only data on Magey Matbat and Tomolol Matbat are a small number of wordlists of varying length and quality. All other languages of the Raja Ampat archipelago are similarly underdocumented, with the exception of Ma'ya (van der Leeden 1983, 1993,

1995, 1997, ms. 1, ms. 2; Remijsen 2001a, 2001b, 2002). For Magey Matbat, there is wordlist number 50 in Wallace (1869) and an extended Swadesh list in Remijsen (2001a).² In addition, Smits & Voorhoeve (1992) includes three lists on Tomolol Matbat.

On the basis of list no. 50 in Wallace (1869), Blust (1978) has classified Magey Matbat as a member of the South Halmahera-West New Guinea (SHWNG) subgroup of Austronesian. The limited amount of data available to Blust (1978) implies that this hypothesis can only be tentative. Upon closer scrutiny of the language system as a whole, it becomes clear that there are a number of typically Papuan characteristics, in particular its relatively complex tone system, a noun class system, and inalienable possession. These characteristics are not consistent with the Austronesian prototype (Foley 1998), but they are found in Papuan languages (Foley 1988, 1998). In addition, a considerable proportion of the Matbat lexical items are not of Austronesian origin. However, there are also some typically Austronesian characteristics. In particular, the pronouns are similar in form to those of (other) SHWNG languages, and the pronoun system includes a distinction between exclusive and inclusive in the first plural. Austronesian influence is also evident in the lexicon. A careful study of the lexical, phonological and morphosyntactic evidence in favor of an Austronesian classification is required in this context. This work falls beyond the scope of this article, and I will assume the Austronesian classification of Magey Matbat in Blust (1978) to be correct in this paper.

2. A phonological description of lexical tone in Magey Matbat

Matbat has six lexically contrastive tones or tonemes. These are the Extra High Fall, the High Level, the Low Rise, the Low Level, the Rise-Fall, and the Low Fall.³ Following the convention established in Remijsen (2001a), the Matbat tones are transcribed in this paper by representing the pitch range of the native speaker on the scale from 1 (low) to 4 (extra high). Within this range, level tones are represented by single digits, and contour tones by multiple digits. In this way, the Extra High Fall is transcribed /⁴¹/, the High Level as /³/, the Rise as /¹²/, the Low Level as /¹/, the Rise-Fall as /¹²¹/, and the Low Fall as /²¹/.

This transcription faithfully reflects the prototypical phonetic form of the tonemes, and their position in the tonal space relative to one another. The (near-)minimal set examples in (1) illustrate the tonal contrast and provide phonological support for the distinction.⁴ Additional minimal sets for tone are included in the tables in the Appendix. In general, there are many lexical contrasts solely distinguished by lexical tone.

Extra High Fall	ba ⁴¹	‘to hit’	t-ε ⁴¹ l	‘1p.-go down’	(1)
High Level	ba ³	‘grandfather’			
Low Rise	ba ¹² p	‘father’	te ¹² l	‘to cut’	
Low Level	ba ¹	‘to remain’			

² Evidence for the hypothesis that wordlist 50 in Wallace (1869) documents Magey Matbat is discussed in Remijsen (2001a).

³ In Remijsen (2001a), I analyzed the Low Fall and the Rise Fall as variants of a single toneme. I have now revised my analysis, because of minimal pair evidence discovered in the course of subsequent fieldwork. See minimal sets in (1).

⁴ Tonemes are transcribed after the vowel of syllable with which they are associated. The transcription of segments is phonemic, and follows the IPA convention, with one exception: in Matbat transcriptions in this paper, the character ‘y’ corresponds with IPA [j]. Matbat transcriptions are in bold in the body of the text, and in regular type in tables.

Rise-Fall	ba ¹²¹ ‘stiff’	te ¹²¹ ‘fill’
Low Fall	ba ²¹ ‘to flow’	te ²¹ ‘testicle’

Almost all syllabic morphemes have at least one lexical tone. Those syllabic morphemes that do not have a lexical tone constitute a small and restricted set of syllabic affixes. The noun classifier prefix /**ha-**/ on the numeral in **wa**³**ŋ ha-te**³**m** [canoe CLS-1] ‘one canoe’ is an example. A word is defined as a free (i.e., non-bound) morpheme that may or may not be combined with one or more affixes. It follows that all words – both content and function words – have at least one lexical tone. Monosyllabic words probably make up the majority of the original Matbat lexicon, but disyllabic words are frequent as well. In my collection of over 800 lexical items, I have not encountered any monomorphemic words with more than three syllables.

While at least one syllable in per word is marked for tone, polysyllabic words more often than not include toneless syllables. The position of syllables (not) marked for tone in polysyllabic words is not predictable. Still there is tendency for toneless syllables to be light (CV rather than CVC). These characteristics of the distribution of tone are illustrated by the examples in (2) and (3).

kam ¹² w ‘star’	wu ³ yte ‘sea shore’	gan ge ¹² ŋ ‘illness’	(2)
sapu ⁴¹ lu ¹² y ‘round’	bi ³ mb ¹²¹ mpu ‘butterfly’		(3)

The syllable is the unit with which the Matbat tonemes are associated. In other words, Matbat has syllable tone rather than word tone. The latter hypothesis would predict that the number of tonal patterns for polysyllabic words would be the same as for monosyllabic words. The polysyllabic words in (3) show that this is not the case: more than one syllable may have a toneme. Impressionistically, the lexical tones give rise to a difference in prominence between the syllables of polysyllabic words. In particular, in polysyllabic words with only one lexical tone, the syllable with the toneme stands out from among the neighboring toneless syllables. There is, however, no evidence for lexical stress as a distinct phonological property of words.

The Low Fall (/²¹/) appears to be the unmarked toneme. The proportion of words that have this toneme as their only lexical tone is greater among function words than among content words. Examples include **ya**²¹**ka** ‘I’, **po**²¹**w** ‘not’ and **la**²¹ ‘when’; Still, there are a number of exceptions, such as **po**¹²¹**re** ‘not yet’ and **hafa**¹² ‘they’. The Low Fall is also the toneme most frequently involved in derivational processes (see section 4.3). Words with the Low Fall toneme on the final syllable can optionally take a paragoge /-o/ in phrase-final context.

3. The phonetic realization of tone in Magey Matbat

The above phonological description of the Matbat tone system is supported by a quantitative analysis of acoustic data, originally reported in Remijsen (2001a). This study is summarized in sections 3.1 and 3.2 below. In addition, tonal co-articulation and the influence of discourse prominence on tonal realization are discussed in section 3.3.

3.1. The phonetic form of the six tonemes

Minimal set evidence of the tonemes was recorded from eight native speakers (four female, four male). The materials consisted of 48 monosyllabic words, including nine three-way minimal sets. The dataset included both open closed monosyllabic words. In addition, all 48 items were recorded both in phrase-final and in phrase-medial position, using an invariant frame. The preceding and following tonal context of the target word in the frame was kept constant (Low Fall). Figure 2 shows the trajectories of fundamental frequency (hereafter f_0) on each of the six tonemes, averaged over the whole dataset. In Figure 2 and in some of the following graphs, f_0 tracks are represented on a normalized time axis. This means that f_0 was measured at fixed equidistant proportions of the total duration of the voiced part of the rhyme. Between-token variation in duration is lost by this procedure. The advantage of this approach is that, by averaging over values, tonal realization can be compared and plotted across tokens, minimal sets, and speakers.

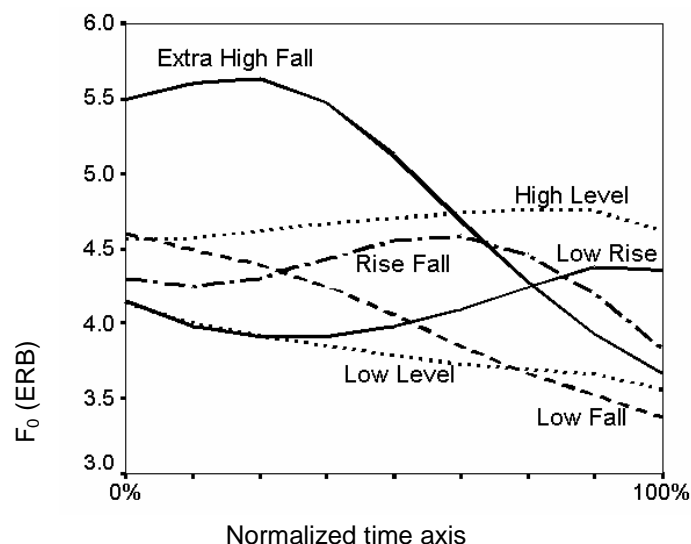


Figure 2: F_0 tracks of the 6 tones on the voiced part of the rhyme (vowel plus voiced coda, if any) of monosyllabic words, averaged over syllable structure, sentence contexts, and speakers. The tracks are represented on a normalized time axis, and plotted against f_0 . From Remijsen (2001a).

A range of measurements related to f_0 were made to find out in which way the tonal patterns differ from one another, and to determine the relative importance of these measures. All f_0 measures were expressed in terms of the psycho-acoustic 'Equivalent Rectangular Bandwidth' scale (ERB), which represents perceived pitch better than the purely physical Hertz scale (Greenwood 1961, Hermes & van Gestel 1991). Two statistical methods were used in the analyses of the results: within-subjects analysis of variance (ANOVA) and Linear Discriminant Analysis (LDA). LDA is a statistical procedure that can show to what extent one or more quantitative variables distinguish between the levels of a nominal variable, in this case lexical tone. Applied to the dataset described above, LDA revealed that 67.7 percent of the tokens could be correctly classified for their toneme on the basis of a measure of the f_0 slope over the voiced part of

the rhyme.⁵ Given that the factor tone has six levels, this result is to be interpreted relative to 16.6 percent chance-level baseline. When both f_0 slope and the mean f_0 over the voiced part of the rhyme were used together in an LDA, 85.6 percent of the tokens could be correctly classified. Both the f_0 slope and the f_0 mean measures were highly significant in the within-subjects ANOVA [f_0 slope: $F(5,35) = 516.9$; f_0 mean: $F(5,35) = 222.1$]. All 6 of the tonemes proved to be significantly different from one another in post-hoc Bonferroni analyses. Correct classification result in the LDA and significance in the post-hoc test were both lowest for the Rise-Fall, probably because this toneme, more than any other toneme, shares characteristics in its tonal realization with other tonemes. See Remijsen (2001a) for a more extensive discussion of the results.

3.2. The influence of syllable structure and phrasal prosody on tonal realization

The structure of the syllable with which a toneme is associated has little influence on the realization of that toneme. This is illustrated in Figure 3, which shows the realization of the Matbat tonemes in syllables with and without a voiced coda.

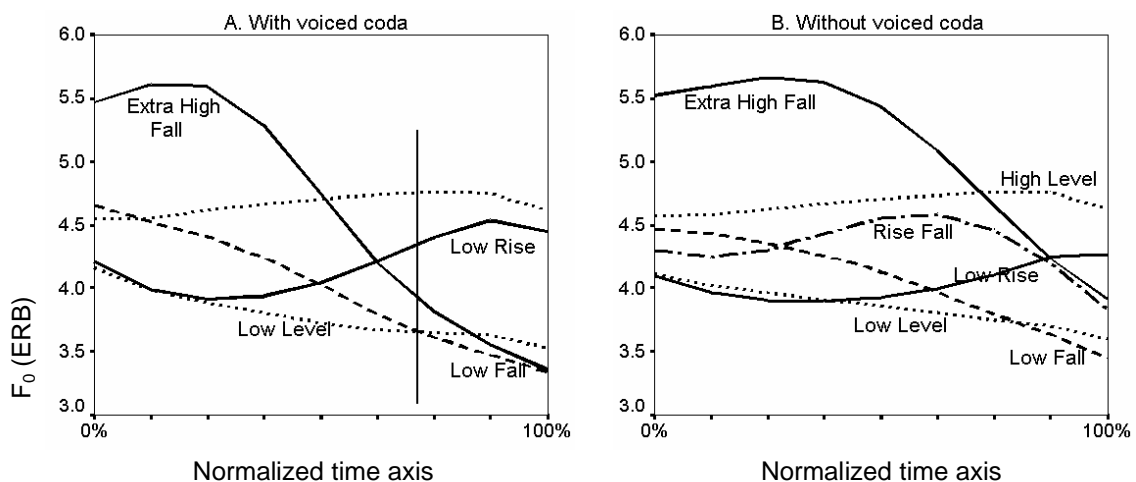


Figure 3: F_0 tracks of the six tonemes on monosyllabic words with (A), and without (B) voiced coda, both over sentence contexts and speakers. The vertical line in 3A marks the average location of the coda onset. The tracks are represented on a normalized time axis, and plotted against f_0 . From Remijsen (2001a).

The graphs in Figure 3 reveal that the tonal realization is not greatly affected by the presence vs. absence of a voiced coda. One small but consistent difference is that contour tones reach more extreme values on syllables that have a voiced coda, as compared to syllables that do not. In other words, falling tones fall to a lower f_0 value and rising tones rise higher when the syllable with which they are associated has a voiced coda. This

⁵ The f_0 slope measure was computed by measuring mean f_0 (expressed in ERB) from the beginning of the voiced part of the rhyme up to its temporal mid-point (part1), and from the mid-point up to the end of the voiced part of the rhyme (part2). The ERB value for part2 is subtracted from the ERB value for part1. The slope value is higher than 0 if f_0 falls throughout the syllable, and it is lower than 0 if f_0 rises through the syllable. It is close to 0 if f_0 is level, or if the domain measurement shows an equal-size mirrored change in f_0 in both parts of the vowel.

phenomenon does not come as a surprise. A syllable with a voiced coda provides more segmental material on which the tonal patterns can be realized. In other words, a voiced coda constitutes an extension of the segmental domain, which allows for the extreme end values of the prototypical realization of contour tones to be realized.

The effect of an utterance boundary is similar. When the words were in sentence-final position, the contour tones reached more extreme f_0 values than when they were embedded in the middle of the carrier sentence. To understand why, we need to consider the fact that in many languages, the final syllable of a word located at the end of an intonational phrase has a relatively longer duration (Vaissière 1983, Maddieson 1985, Cambier-Langeveld 2000). Final lengthening does occur in Matbat: while average vowel duration in sentence-final position stands at 233 milliseconds (ms), it is only 145 ms sentence-medially.⁶ Similar to the effect of a voiced coda, utterance-final lengthening results in more segmental material on which the tonal patterns can be realized. This difference is reflected in Figure 4, which shows the f_0 tracks of the Matbat tonemes in sentence-final and sentence-medial position.

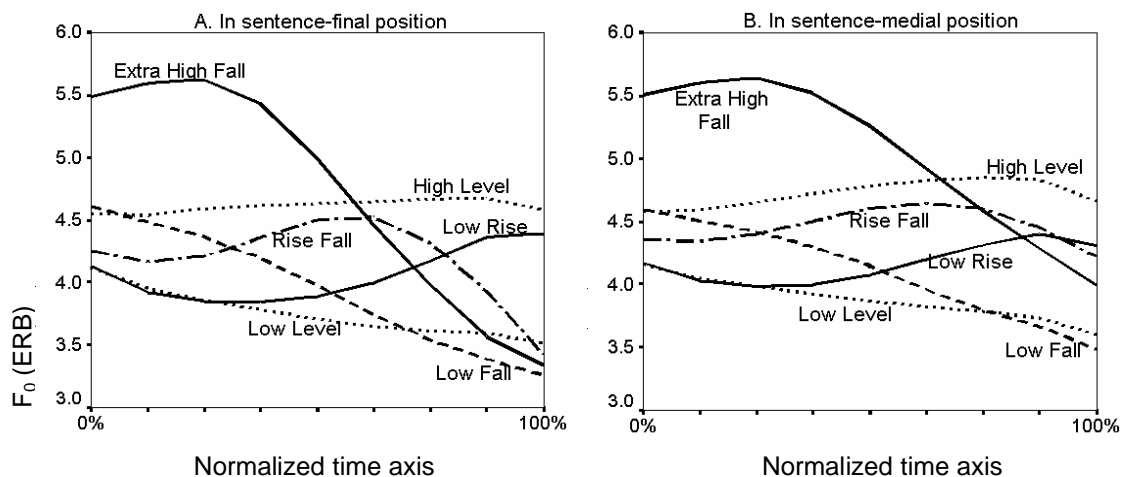


Figure 4: F_0 tracks of the six tonemes on the voiced part of the rhyme of monosyllabic words. Target words in sentence-final (A) and sentence-medial (B) position, both averaged over syllable structure and speakers. The tracks are represented on a normalized time axis, and plotted against f_0 . From Remijsen (2001a).

A comparison of the graphs in Figure 4 reveals that no intonational low boundary tone is added to the tonal configuration in utterance-final position. This is clearest for the Low Rise, which actually rises higher in utterance-final position than in utterance-medial position. The way around, we can also conclude that the low end targets of the Extra High Fall, the Rise Fall, and Low Fall are part of the lexical tone specification, and not due to intonation, since these low targets are present in utterance-medial context as well (Figure 4B).

⁶ The effect of utterance context (medial vs. final position) on vowel duration is significant in a within-subjects ANOVA [$F(1,7) = 198.0, p < 0.01$].

3.3. The influence of tonal co-articulation and focus on tonal realization

In the elicitation of the materials presented in sections 3.1 and 3.2, the speakers were aware that it was their pronunciation of the target word that I was trying to collect. As a result, the graphs in Figures 2,3,4 show the Matbat tonemes articulated most carefully. In addition, because all tonemes were recorded in the same tonal context, the f_0 trajectories of the lexical tones do not show the interaction between lexical tone and potentially confounding factors. In normal language use, however, the realization of the tones is frequently distorted. The most important factor in this respect is tonal co-articulation. When two adjacent syllables both have a lexical tone, then the edge targets on the boundary between the syllables may not match, depending on the identity of the neighboring tones. If there is a mismatch, then one or both of the lexical tones will be realized in an incomplete manner. This phenomenon is illustrated in Figure 5, which shows the f_0 trajectories of two utterances from spontaneous speech.

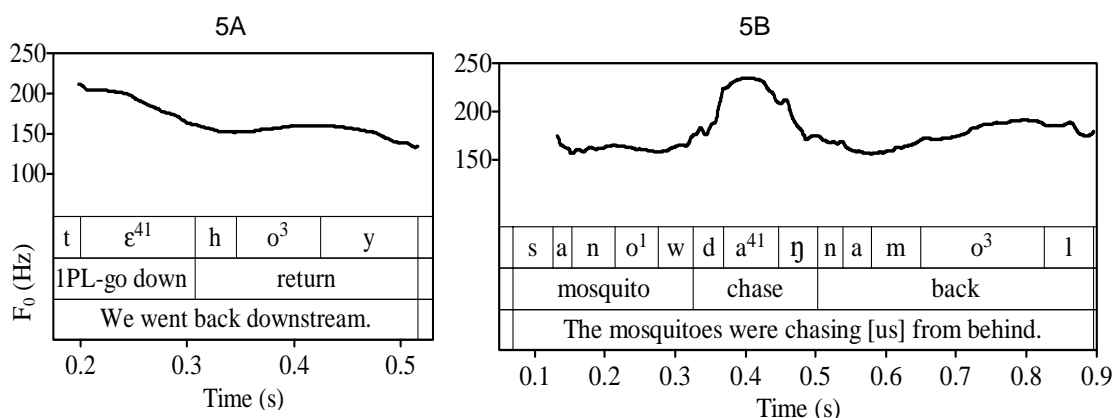


Figure 5: Segmented f_0 tracks of two sentences from a narrative (spontaneous speech), uttered by the same male speaker (AK).

Figure 5A shows a sequence of the Extra High Fall ($/^{41}/$) followed by the High Level ($/^3/$). The low end target of the Extra High Fall differs from the high onset target of the High Level toneme. In this case, the realization of both tonemes is affected: the Extra High Fall does not fall to the bottom of the speaker's range, and the High does not reach its prototypical maximum. Figure 5B shows the same sequence – Extra High Fall followed by High – now separated by a toneless syllable, which accommodates the transition between the distant targets. Now the Extra High Fall has a greater excursion size, as compared with its realization in Figure 5A. Also, the High Level is realized with higher f_0 . Figure 5B also shows a mismatch between the end target of the Low Level ($/^1/$) and a following Extra High Fall ($/^{41}/$). As a result, the Low Level toneme rises slightly in the semivowel coda of the syllable with which the Low Level toneme is associated, towards the onset of the Extra High Fall. It is still unclear to me which factors govern the way mismatches between adjacent tonal targets are handled in Matbat. For example, it could be that low f_0 targets lose out relative to high f_0 targets rather than the way around, as in the sequence **sano¹w da⁴¹ η** in Figure 5B. Or it could be that discourse prominence plays a crucial role.

Tonal realization is also affected by information structure. The utterance in Figure 6, also from spontaneous speech, but from a different speaker, contains a number of examples of this. This sentence is situated at the end of a narrative, which is the story of a running contest between the tick and the pig, in which the tick defeats the pig through deceit. The previous sentence stated that the pig died of exhaustion. Then the focus turns to the tick, who invites his fellow parasites to feast on the dead pig. The focused status of **kayɔ¹²w** ‘tick’ is evident from the unusual duration of this word. In addition, the Low Rise on the final syllable reaches an unusually high value, and the trajectory is unusual. Prototypically, the Low Rise only starts rising in the second half of the rhyme, as on **le¹²y** ‘really’, the last word of the utterance. In the middle of the utterance, **de¹²l** ‘friend’ shows an underarticulated realization of the Low Rise. F₀ goes up abruptly in this word, rather than rising gradually in the second half of the rhyme. The qualitative evidence presented above suggests that the realization of lexical tones may vary considerably in function of the level of discourse prominence of the word with which they are associated. Greater discourse prominence correlates with greater range, while lexical tones associated with little prominent words are prone to be underarticulated.

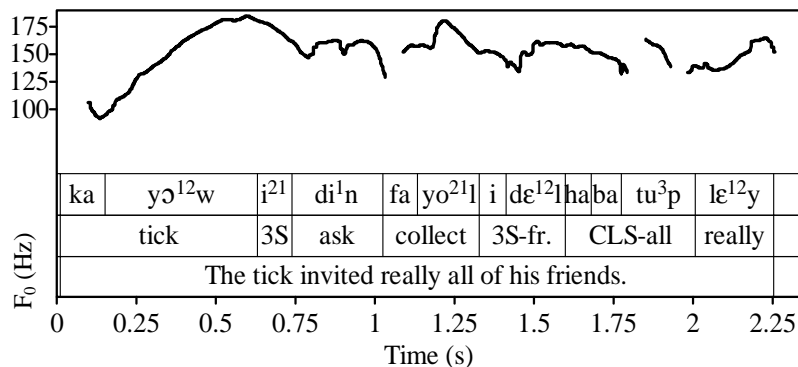


Figure 6: Segmented f₀ track of a sentence from a narrative (spontaneous speech), uttered by a male speaker (TH).

4. The role of tone in morphology

The main function of the Matbat tonal system is to distinguish lexical items from one another. In addition, the tonal system also plays a more limited role in morphosyntax, in three different processes. These are discussed in the following subsections.

4.1. Noun classes

Matbat has a noun class system. That is, each noun is a member of one of six classes, and the definition of these classes is primarily based on the semantic characteristics of the noun. The various classes are listed in Table 1. Some classes – ‘Animate’, ‘Long / Sharp’ and ‘Round / Fruit’ make sense from a general cognitive or analytic perspective. Two other classes – ‘Boat&House’ and ‘Sagocake’ – seem arbitrary in analytic terms, and only make sense if the socio-economic importance of the concepts is taken into account.

For example, the ‘Sagocake’ class has only one member: **ni**¹² ‘sagocake’. This is the only traditional food that can be preserved for longer periods, a crucial quality in a tropical climate without either freezers or much of a money economy. Finally, there is a rest category for all concepts that do not fit in any of the other classes.

Table 1: The affixes marking noun classes on numerals, illustrated by 1, 2, 6, and 10.

	Animate	Boat&House	Long	Round	Sagocake	Rest
1	nun-tɛ ³ m nu ³ n-ha	ha-tɛ ³ m ha ²¹ -ha	di-tɛ ³ m di ⁴¹ -ha	pa-tɛ ³ m pa-di ⁴¹ -ha	ta-tɛ ³ m ta-di ⁴¹ -ha	i-tɛ ³ m di ⁴¹ -ha
2	(ha-)lu ¹²	ha-lu ³	di-lu ³	pa-lu ³	ta-lu ³	i-lu ³
6	(ha-)unɔ ¹²¹ m	ha-unɔ ¹² m	di-nɔ ¹² m	pa-unɔ ¹² m	ta-unɔ ¹² m	i-nɔ ¹² m
10	(ha-)ya ⁴¹	ha-ya ⁴¹	di-ya ⁴¹	pa-ya ⁴¹	ta-ya ⁴¹	i-ya ⁴¹

The noun classes are morphologically marked mainly by means of prefixes on the numeral. I.e., the morphological marking of the class system does not affix to the noun itself, and as a consequence noun class membership is only evident when a numeral is involved. The head noun and its numeral modifier can be separated from one another by one or more other modifiers. Because the morphological marking of the noun class system is affixed to the numeral rather than to the noun itself, it can be interpreted as a kind of agreement marking. The phenomenon is illustrated by the (elicited) examples in (4), and by the paradigms in Table 1.

bɛ³m pa-fi³t (4)
plate CLS-seven
seven plates

ya²¹k k-ɛ³ŋ wa³ŋ li¹w ha-lu³
1s 1s-see canoe big CLS-two.
I see two big canoes

The various noun classes are mainly marked by means of a prefix. However, for one of the classes (Animate), there is marking on the noun itself as well, and this marking is of a tonal nature. For example, **wa³ŋ ha-wa³l** ‘eight canoes’ and **bɛ¹²m pa-wa³l** ‘eight plates’, but **ye¹²m ha-wa¹²l** ‘eight dogs’. In general, the High Level is replaced by the Low Rise on numerals associated with animate nouns, the Low Rise toneme by the Rise-Fall toneme, and other tonemes remain unchanged (cf. Table 1).

4.2. Inalienable possession

In Matbat, most words referring to body parts and kinship terms are inalienably possessed. This means that these words never appear without an inflectional marking of a possessor. In addition, the morphological marking of inalienable possession is different from that of regular possession. These characteristics of inalienable possession are illustrated by the constructed example in (5), which contrasts regular – i.e., alienable – possession (5a) with inalienable possession (5b).

i²¹ n-ε³ŋ ak-wa³ŋ / aw-wa³ŋ / i-wa³ŋ / wa³ŋ (5a)

3s 3-see 1s-canoe / 2s-canoe / 3s-canoe / canoe
He sees my / your / his / a dugout canoe.

i²¹ n-ε³ŋ ak-fa³ŋ / aw-fa³m / i-fa²¹ / (*fa²¹) (5b)

3s 3-see 1s-husband / 2s-husband / 3s-husband / husband
He sees my / your / his / (*a) husband.

While the word for ‘dugout canoe’ in (5a) can be used without specification of a possessor, i.e., in an abstract, general sense, the word for ‘husband’ cannot (5b). In addition, the word for ‘husband’ shows inflectional marking for possessor that is unique to inalienable body parts and kinship terms. Regular possession only involves a prefix (cf. 5a). The morphological marking specific to inalienable possession, on the other hand, is made up of a combination of a tonal suprafix and either an infix or a suffix. The paradigms of five inalienably possessed nouns are listed in Table 2. As these examples illustrate, the third person form of inalienable constitutes the unmarked base form, to which the inflection marking the other forms are added. Not all combinations of number and person are distinguished; the levels are the following: first singular; first plural; second singular and plural + first plural exclusive; third singular and plural. The same levels are distinguished in the inflectional marking of the subject on the verb. Foley (1986:66ff) writes that it is common in Papuan languages for only some combinations of person and number to be distinguished in inflections. The fact that finer distinctions are marked for the first person than for second and third person also corresponds to a tendency observed in the Papuan languages (Foley 1986).

Table 2: Some paradigms for inalienable possession.

	body	jaw	shoulder	Husband	mother-/daughter-in-law
1 st sg.	ni ³ ŋsu	gala ³ ŋ	ba ¹² ŋ	fa ³ ŋ	imo ¹² ŋu ³
2 nd sg.	ni ³ msu	gala ³ m	ba ¹² m	fa ³ m	imo ¹² mu ³
3 rd sg.	ni ²¹ su	ga ²¹ l	ba ²¹ m	fa ²¹	imoyu ³
1 st pl. inc.	ni ³ nsu	gala ³ n	ba ¹² n	fa ³ n	imo ¹² nu ³
1 st pl. exc.	ni ³ msu	gala ³ m	ba ¹² m	fa ³ m	imo ¹² mu ³
2 nd pl.	ni ³ msu	gala ³ m	ba ¹² m	fa ³ m	imo ¹² mu ³
3 rd pl.	ni ²¹ su	ga ²¹ l	ba ²¹ m	fa ²¹	imoyu ³

The tonal suprafix marking the non-third person levels is most often the High Level toneme, but in certain cases it is the Low Rise – for example in the words for ‘shoulder’ and ‘mother / daughter-in-law’ in Table 2.

Inalienable possession is pervasive in the Matbat grammar, in the sense that its marking is not strictly limited to nouns. Various verbs with a meaning related to a physical or emotional state take the inflections of inalienable possession as subject markers on the verb. This is illustrated by the constructed example in (6), where the verb **-ani¹²¹m** ‘to drink’ has the regular subject-marking prefixes, and **lo²¹** ‘to want’ shows the inflections characteristic of inalienable possession.

ya²¹k lɔ³ŋ te k-ani¹²¹m / a²¹w lɔ³m te m-ani¹²¹m / i²¹ lo²¹ te n-ani¹²¹m (6)

1s 1s-want RL 1s-drink / 2s 2-want RL 2-drink / 3s 3-want RL 3-drink

I want to drink / you want to drink / he wants to drink.

4.3. Tone and derivation

Lexical tone plays a prominent role in derivation. That is, both the derivation of new words and word formation through compounding tend to be marked by tonal rather than by segmental changes. Among predicates, intransitive verbs or adjectives⁷ become transitive verbs by means of a tonal change to the Low Fall toneme (7a). There is also derivation of verbs without a change in syntactic argument structure. Most often such derivations are also marked by a replacement of the original tone by Low Fall toneme, as in the examples in (7b). However, there are exceptions to this tendency. A case in point is **do**¹²¹**l** ‘to go under water’ vs. **do**¹²¹**l** ‘to fall’ vs. **do**³**l** ‘to fall (rain)’.

hu ³ ŋ ‘to enter (intransitive)’	>	hu ²¹ ŋ ‘to put in (transitive)’	(7a)
pi ³ n ‘hidden’	>	pi ²¹ n ‘to hide (transitive)’	
pla ¹² ‘hot’	>	pla ²¹ ‘to heat’	
da ⁴¹ ŋ ‘to chase after’	>	da ²¹ ŋ ‘to look for’	(7b)
ba ⁴¹ ‘to blow (re wind)’	>	ba ²¹ ‘to stream, to flow (re water)’	
-anɔ ⁴¹ k ‘to suck out (milk)’	>	-anɔ ²¹ k ‘to breathe’	
di ¹ n ‘to call’	>	di ²¹ n ‘to ask’	

Among nouns, there are also numerous cases of words being derived by a replacement by the Low Fall toneme (8a,b,c). Tone replacement may mark the derivation of a verb from a noun, as in (8b). The derived form most often has the Low Fall (8a,b), but just as in the case of verbs there are cases in which the derivation is marked by another tone, as in the examples in (8c). In such cases it may be unclear which is the source form and which is the derived form.

yɔ ¹ k ‘bag, uterus’	>	yɔ ²¹ k ‘bay’	(8a)
ya ³ p ‘fire’	>	ya ²¹ p ‘to oven cook’	(8b)
ni ¹²¹ n ‘shadow’	<?>	ni ³ n ‘mirror’	(8c)
tɛ ¹²¹ n ‘dry’	<?>	tɛ ¹² n ‘low tide’	

Replacement of marked tones by the Low Fall also plays a important role in derivation through compounding. For example, **yi**⁴¹ ‘water’ gets the Low Fall in compounds such as **na**³**w yi**²¹ ‘palm wine (palm+water)’ and **pata**²¹ **yi**²¹ ‘saliva (mouth+water)’.

5. The tonal marking of questions

Apart from the six lexical tones, there is an additional tonal pattern, which shows similarities with lexical, morphological, and intonational tone. This tonal pattern is associated with some question-marking particles that only appear in sentence-final

⁷ I have not found any criterion to distinguish verbs from adjectives so far. Further research is required to determine whether this distinction is at all relevant in Matbat grammar.

position. In this section, I will first introduce the various ways questions are formed in Matbat, and then focus on the question-marking tone pattern.

5.1. Question formation in Matbat

Yes/no questions are encoded by means of the utterance-final morpheme / ϵ^{31} /, as in example (9a). A yes/no question may express that the speaker expects a negative answer, as in (9b). The utterance final form / $p\text{-}\epsilon^{31}$ /, which is used for this purpose, is a contraction of / $\text{-}\epsilon^{31}$ / with the negation marker / $po^{21}(w)$ /, which itself is also restricted to sentence-final position.

ya²¹w ma¹²y do²¹ ϵ^{31} (9a)

2s brother_in_law EXST YNQ

Is your brother-in-law present? / Do you have a brother?

ya²¹w m-an²¹k p- ϵ^{31} (9b)

2s 2-inhale NEG-YNQ

You don't (want to) smoke, do you?

Just as the yes/no question marker / $\text{-}\epsilon^{31}$ /, most question-word question markers are bound to the right edge of the clause. The only exception is **ma²¹n** 'who'. The default argument structure in Matbat in SVO, and when an animate subject is queried, then **ma²¹n** appears in the original subject position. However, **ma²¹n** is then invariably complemented by either **ina¹²** or **ip³¹**, both utterance-final question markers – cf. example (10). The question markers **ina¹²** or **ip³¹** never mark question-word questions by themselves – they always complement the question words **ma²¹n** 'who' or **pane³¹n** 'what'.

ma²¹n ta b³t ina¹² / ip³¹ (10)

WHO RL come WHQ / WHQ

Who is coming?

There are three more dedicated question-word markers: **pah¹²** 'what, how', **la²¹** 'whereto', and **-fi³¹na** 'how many', which takes a noun class marker prefix. The question marker **pah¹²** can usually be translated to English as 'what', just as above-mentioned **pane³¹n**. However, they are not synonyms: whereas **pane³¹n** is used to query concrete, tangible objects (as in 11a), **pah¹²** relates to more abstract concepts (as in 11b,c). In combination with **ha²¹** 'like, similar to' it can be contracted to **hap¹²**.

a²¹w t¹² pane³¹n (ina¹²) (11a)

2s chop WHAT WHQ

What are you chopping up?

ni¹² ha²¹-pah¹² (11b)

sago LIKE-WHAT

What does sago taste like?

ya²¹w na²¹n pah¹² (11c)

2s name WHAT

What is your name?

Other types of question-word questions are derived from the corresponding prepositions. For example, spatial origin is expressed by means of the preposition **po**²¹, as in (12a). A question on spatial origin is expressed using the related form **pɔ**³¹, as in (12b). The same goes for the expression of time and location. These functions are marked by the prepositions **ba**²¹ and **do**²¹, respectively. When used as a question word, however, these morphemes are realized as **ba**³¹ and **do**³¹, without a complement.

i²¹ **bɔ**³¹ **t** **po**²¹ **fa**¹² **n** **paye**³ (12a)

3S come FROM log side

He is coming from Fafanlap (name of village).

a²¹ **w** **bɔ**³¹ **t** **ho**³ **y** **pɔ**³¹ (12b)

2S arrive return FROM-WHQ

Where are you coming back from?

The question markers **pɔ**³¹, **ba**³¹ and **do**³¹, are all derived from a preposition by means of a change in tone. Something similar happens in questions with the marking of politeness. Declaratives are made more polite by means of the utterance-final morpheme **ho**²¹ – see (13a). In question, politeness is expressed by means of **ho**¹², as illustrated in (13b). The morpheme **ho**¹² only differs from the declarative politeness marker in terms of its tone. Just like **pɔ**³¹, **ba**³¹ and **do**³¹, then, the politeness marker in questions **ho**¹² is derived by a change in tone.

ya²¹ **k** **k-o**²¹ **ho**²¹ (13a)

1S 1S-go POLITE

I am going (with your permission / if you don't mind).

ya²¹ **w** **bo**²¹ **la**²¹ **ho**¹² (13b)

2s go WHERE TO POLITE

Where are you going?

In summary, Matbat questions are formed by means of two different morphosyntactic processes. First, yes/no-questions and a number of question-word questions are formed by dedicated question-marking morphemes. Second, there are some types of question-word questions which do not involve a dedicated question-word. Such questions are formed using a morpheme derived by means of a change in tone.

5.2. Function and form of the High Fall tone (/³¹/)

Interestingly, some of the question-marking morphemes have a tonal pattern that is not found on content words. In section 5.1, I have referred to it as High Fall, and transcribed it as /³¹/. Impressionistically, its pitch pattern lies somewhere between that of the Low Fall (/²¹/), and the Extra High Fall (/⁴¹/) lexical tonemes. The set of question types that have this tone includes some of the dedicated question words (**ɛ**³¹, **pane**³¹ **n**, **-fi**³¹ **na**, **ipɔ**³¹) and all of the question markers that are derived from prepositions (**pɔ**³¹, **ba**³¹, **do**³¹).

To gain insight into the realization of the High Fall, I measured f_0 in four morphemes that have this tonal pattern: ϵ^{31} , ‘YNQ’, $p-\epsilon^{31}$ ‘NEG-YNQ’, $p\sigma^{31}$ ‘FROM-WHQ’, and ba^{31} ‘TIME-WHQ’. So as to be able to consider the realization of the High Fall in relation to the lexical tones, I also collected the near-minimal set /ba(p)/, introduced in example (1), and also la^{21} ‘whereto’. Data were collected from 8 native speakers (4 male, 4 female), in sentence-final position in a variable frame. The descriptive results are presented in terms of normalized f_0 tracks in Figure 7. Figure 7A shows the f_0 tracks of the six lexical tones of Matbat on the near-minimal set /ba(p)/, plus the f_0 track of ba^{31} ‘when’.

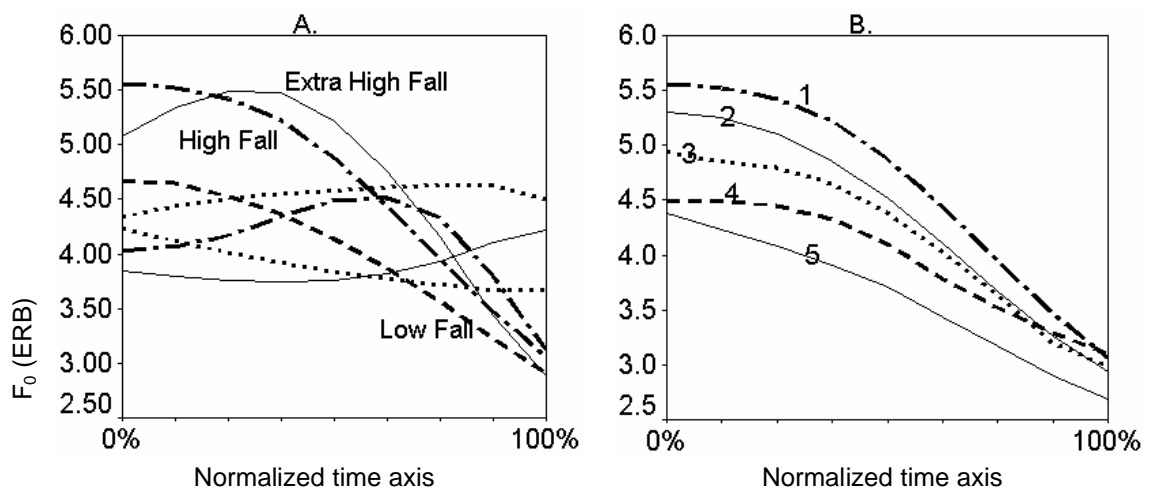


Figure 7: A – f_0 tracks of the question-word ba^{31} plus the near-minimal set /ba(p)/. B – f_0 tracks for the question markers ba^{31} , $-\epsilon^{31}$, $p-\epsilon^{31}$, $p\sigma^{31}$ (1-4), plus the f_0 track of la^{21} (5). The tracks are based on the voiced part of the rhyme. The tracks are represented on a normalized time axis, and plotted against f_0 .

What distinguishes the High Fall from the Extra High Fall is that the latter rises towards an f_0 maximum in the first half of the voiced part of the rhyme. The High Fall, on the other, has level f_0 at the very beginning of the vowel rather than a rise. In addition, the average f_0 in the first half of the vowel is lower for the High Fall than for the Extra High Fall, although there is considerable variation between items in this respect (see Figure 7B). Compared with the Low Fall, on the other hand, the High Fall sets in higher up in the tonal space, and f_0 begins to fall a slightly later. In summary, the High Fall ($^{31}/$) shares similarities both with the Low Fall ($^{21}/$) and with the Extra High Fall ($^{41}/$).

The High Fall ($^{31}/$) is different from the lexical tones in a number of ways. First, as mentioned above, the High Fall only occurs on function words. Second, its function is more morphosyntactic than lexical. That is, several of the function words that take the High Fall in questions can also be used in declaratives, but then they have another tone. Finally, the distribution of the High Fall is restricted to the right edge of the syntactic clause, a unit that tends to correspond to the intonational phrase. In this respect the High Fall is similar to an intonational boundary tone. However, the High Fall can be followed by another tone in some contexts, such as (11a). Similar to the lexical tones, however, the High Fall can be involved in minimal contrasts, as illustrated in example (14).

i²¹ ka¹n ba⁴¹ (14a)
 3S shoot hit
 He shot on target

i²¹ ka¹n ba³¹ (14b)
 3S shoot WHEN
 When did he shoot?

6. Tone and the vowel system

Matbat has seven vowel phonemes: /i,e,ɛ,a,ɔ,o,u/.⁸ Such a four-way distinction in phonemic vowel height (high, high-mid, mid-low, low) is unusual for an Austronesian language. Instead, the SHWNG and Oceanic subgroups of Austronesian typically have a five-vowel system with three levels of height: /i,e,a,o,u/ (Tryon 1995:34, Blust 1978).⁹

The distribution of the Matbat vowels is to some extent predictable on the basis of syllable structure and lexical tone. The influence of these constraining factors is discussed in section 6.1. However, there are several exceptions to these constraints, so that analyses with fewer than seven phonological vowel categories would not be adequate. Section 6.2 presents the results of an acoustic analysis of the Matbat vowels, aimed at testing whether the four levels of vowel height are indeed phonetically distinct. In section 6.3 I briefly discuss the diachronic processes that are likely to have given rise to the seven-vowel system. Particular attention goes to the way tone may have come to constrain vowel quality.

6.1. Phonology

The most important factor constraining the distribution of the vowels is syllable structure. The effect of this factor is illustrated in Table 3. Syllables that are open or that have a semivowel coda can have a high (/i,u/) or a high-mid (/e,o/) vowel, but not a mid-low vowel (/ɛ,ɔ/). Syllables that have a non-semivowel coda that is not /l/ can have a high or a mid-low vowel, but not a high-mid vowel. Finally, syllables ending in /l/ never have a high vowel, but they can have a high-mid or mid-low vowel. In accordance with the interaction outlined in Table 3, we find minimal pairs between e.g. /i/ and /e/ with open syllables, such as **di⁴¹** ‘noise’ vs. **de⁴¹** ‘to throw’, between /e/ and /ɛ/ for syllables ending in /l/, such as **de^{12l}** ‘thread’ vs. **de^{12l}** ‘friend’, and between /i/ and /ɛ/ for other closed syllables – e.g. **ni³ⁿ** ‘mirror’ vs. **ne³ⁿ** ‘mother’. The tables in the Appendix illustrate the interaction between vowel height, lexical tone and syllable structure, for the front and for the back vowels. The vowel /a/ is not included in these tables – it is not constrained at all,

⁸ In Remijsen (2001a), I hypothesized a five-vowel inventory consisting of /i,e,a,o,u/. At that time, I had noticed the difference in vowel quality between [e] and [ɛ], but I had no idea of the factors determining the distribution, I had no knowledge of the minimal pairs, and I was not aware of the contrast between [o] and [ɔ].

⁹ Ma'ya, a sister language of Matbat within SHWNG, and the only Raja Ampat language that has been studied in detail, has this kind of five-vowel system (van der Leeden 1993). Outside the Raja Ampat archipelago, but also a member of the SHWNG subgroup, Sawai has a seven-vowel system, and the phonemes are /i,e,ɛ,a,ɔ,o,u/, just as in Matbat (Whisler 1992, Whisler & Whisler 1995).

as it occurs with any of the three syllable structures distinguished here, and with any of the lexical tones. As a consequence, /a/ is the vowel for which the most complete tonal minimal set has been found – listed in (1).

Table 3: The effect of syllable structure on the distribution of vowels, ignoring words that have the Low Rise. C* stands for a non-semivowel consonant other than /l/. Attested combinations are marked by X.

	/i,u/	/e,o/	/ɛ,ɔ/	/a/
CV(w,y)	X	X		X
CVC*	X		X	X
CVI		X	X	X

The second constraint on the vowel system has to do with the lexical tone system. Open syllables that have the Low Rise tone never have the high-mid vowels, but they do occur with the mid-low level vowels. That is, whereas words with pattern CV(w,y) has the vowels /e,o/ with tones other than the Low Rise (cf. Table 3), they have the vowels /ɛ,ɔ/ instead with the Low Rise. The tables in the Appendix illustrate this interaction.

If there were no exceptions to the constraints between vowel quality on the one hand and syllable structure and tone on the other, then there would be four different phonetic levels of vowel height, but only three would be distinctive for any given combination of syllable structure and lexical tone. We could then do with three – more abstract – phonemic levels of height, and derive the four empirically observed levels by means of a rule- or constraint-based analysis. However, there are a number of exceptions to the above-mentioned generalizations. First, there are a small number of monosyllabic words ending in a consonant other than /l/ that have the a high-mid vowel: **ke¹s** ‘resin’; **tare¹k** ‘corn’; **me²¹s** ‘to lift up’; **po¹s** ‘paddle’; and **tabo¹k** ‘dull’. These are all the words found to have such a pattern. It is interesting that most of them have the Low Level toneme. Second, whereas open syllables only have high or high-mid vowels, open-syllable function words that have the question-marking High Fall tend to have mid-low vowels: **ɛ³¹**, ‘YNQ’, **pɛ³¹** ‘NEG-YNQ’, **pɔ³¹** ‘FROM-WHQ’.

The analysis of the Matbat vowel system and its interaction with syllable structure and lexical tone presented here is based on a dataset of over 800 lexical items, collected in the course of on-going descriptive research on the language. The analysis is supported by the fact that precisely the same interactions are observed among the front vowels and the back vowels. This agreement makes it less likely that the observed constraints are due to chance gaps in the dataset.

6.2. The phonetic realization of vowel quality in Matbat

In my impressionistic auditive analysis, the difference between the mid-high and the mid-low vowels is greater than that between the mid-high vowels and the high vowels. For example, /ɛ/ is produced in a range between [ɛ] and [æ]. As an illustration, the pronunciation of the word /mɛ¹²m/ ‘evening’ reminds of American English *ma’m*. The mid-low and the low vowels, on the other hand, are closer together, to the extent that it is

sometimes hard to determine whether a vowel has /u/ or /o/, or /i/ or /e/.¹⁰ To some extent, this confusion between the high and the high-mid on my part may be due to the fact that the lowering vowel shift is actually an on-going process, and reflect variation in lowering between speakers and words (cf. Labov 1981). In summary, the phonetic distinction between the high and the high-mid vowels is salient in most words, but the difference is smaller than that between the mid-low and the mid-high vowels.

In addition to the auditive analysis, I carried out an acoustic study of the Matbat vowels. The goal was to test the hypothesis that Matbat has seven vowel phonemes, and to gain insight in the way vowel quality interacts with syllable structure. Between 41 and 43 target items were collected from eight native speakers (4 female, 4 male) of Magey Matbat. These items included the near-minimal set /ba[p]/, and cases of sentence-final particles carrying the question-marking High Fall tone ($/^{31}/$). The results relating to these items are presented in section 5.2. Most words on this list, however, were included in relation to the study of the vowel contrasts. The number of items differed considerably from vowel to vowel. About eight cases were included for each of the front vowels, but only two for each of the back vowels.¹¹ F1 and F2 were measured at the temporal midpoint of the vowel, using the default formant measurement algorithm implemented in Praat (Boersma & Weenink 1996). These measurements were produced automatically, but checked individually for errors in the output of the formant detection algorithm. The measurements were z-transformed per speaker to allow for generalization across speakers. The descriptive results are presented in Figure 8A.

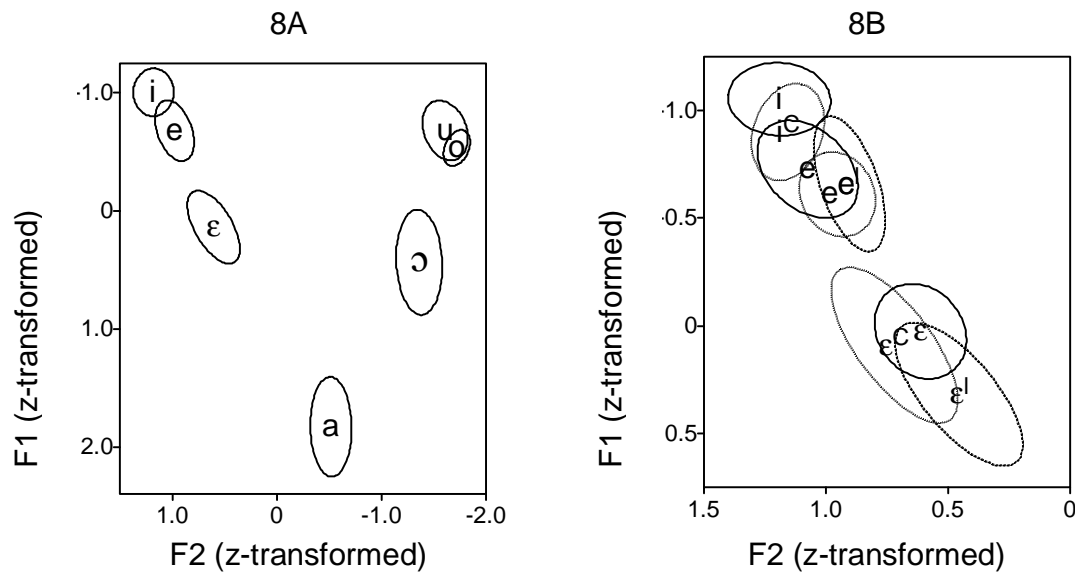


Figure 8: Mean F1 by F2 values and ellipses (encircling one st. dev.) for the seven vowels. Panel A: the seven vowels. Panel B: (front vowels only) separate values in function of syllable structure: no coda (V), coda /l/ (V^l), and non-/l/ coda (V^C).

¹⁰ I have perceived realizations of **gi**¹² ‘to peel’ in some cases as having the vowel /e/. Similarly, I have perceived **de**³ ‘house’, **mo**³ ‘debt’, **kar**¹²ⁿ **fo**^{4l} ‘k.o. ant’, **napo**^{2l} ‘skin’, and **me**^{12l} ‘hungry/thirsty’ each at least once with a high vowel. In each case, however, checks with several speakers lead to the transcription given in the tables in Appendix.

¹¹ The reason for this imbalance was the consideration to limit the overall length of the data elicitation session. For that reason, I decided to collect detailed information on only one level of advancement, namely front.

The results presented in Figure 8 illustrate that the distributions of /ɛ/, /a/, and /o/ are clearly distinct. The front vowels /i/ and /e/, however, overlap slightly, and for the back vowels /u/ and /o/ the overlap is considerable. The difference between /i/ and /e/, and between /u/ and /o/ is greater if the interaction with syllable structure is taken into account. That is, the vowels of open syllables are higher than those closed syllables, and the collapsing of the values from open and closed syllables for the high vowels /i/ and /u/ lowers their overall average height (i.e., raises the F1), bringing them closer to the average of /e/ and /o/. For the front vowels, this interaction between vowel quality and syllable structure can be observed in Figure 8B. The same kind of interaction is affecting the realization of the back vowels. Also, the small number of cases included for /u/ and /o/ – two cases of each – means that the extensive overlap observed here does not necessarily reflect the population in a faithful manner.

In a within-subjects multivariate ANOVA with the factor vowel phoneme and both F1 and F2 measurements as the dependents, the independent vowel phoneme had a highly significant effect on both of the dependents [F1: $F(6,7) = 693.1$; $p < 0.001$; F2: $F(6,7) = 1437.4$; $p < 0.001$]. In post-hoc Bonferroni analyses on the contrasts between the various vowels, all 7 vowels were significantly different from one another in terms of F2 (all $p < 0.001$, apart from /u/ vs. /o/, which was $p = 0.029$), and all but two were also different in terms of F1. The two exceptions were /u/ vs. /o/ and /u/ vs. /e/. In a Linear Discriminant Analysis with the factor vowel phoneme and both F1 and F2 as the postdictors, 86 % of the vowels was correctly classified for vowel quality. The correct classification scores were the lowest for the high and high-mid vowels – /i/: 83 %; /e/: 75 %; /u/: 65 %; /o/: 75 %. In conclusion, the inferential test results support the hypothesis that Matbat has seven different vowels, at the phonetic level. For the distinction between /u/ and /o/, the size of the effect is small, possibly due to the small number of cases.

6.3. The diachronic origin of the Matbat vowel system

How did Matbat develop a seven-vowel system, and why is the distribution of all vowels but /a/ constrained by syllable structure and lexical tone the way it is? In the search for answers to these questions, I assume, following Blust (1978), that Proto SHWNG, the direct ancestor of Matbat, had a five-vowel contrast (/i,e,a,o,u/). A comparison with cognates and the source form of loan words indicates that the additional level of vowel height is the result of a lowering of high and high-mid vowels, rather than of raising of vowels that have /a/. Some examples are listed in (15).

le¹se³n ‘salt’	vs.	Ma'ya / ¹ lisi ³ n/ (same meaning)	(15)
tare¹k ‘flour’	vs.	Malay /ta ¹ rigu/ ‘corn’	
te²l ‘testicles’	<	Malay /te ¹ lur/ ‘egg’	
-mo³l ‘interior’	vs.	Ma'ya /la ¹ mu ³ l/ (same meaning)	
fago¹²l ‘to shave’	vs.	Ma'ya /fa ¹ gu ³ l/ (same meaning)	
go¹l ‘sugar’	<	Malay / ¹ gula/ (same meaning)	

In each of the examples listed in (15), a low-mid vowel in Matbat corresponds to a mid vowel in Ma'ya or Malay, and a high-mid vowel in Matbat corresponds to a high vowel in

the Ma'ya or Malay. Both Ma'ya and Malay have vowel systems with three height levels. Some of the examples in (15) are likely to have been borrowed in the course of the last five hundred years, such as **go¹** 'sugar'. As such they provide further support for the systematic nature of the constraints mentioned in section 6.1. Since /u/ does not occur before /l/, the vowel of Malay /'gula/ was lowered to /o/. Other words that have a cognate in Ma'ya, are likely to have lowered through internal development. An example is **-mo³** 'interior', cognate with Ma'ya /lamu³l/ (same meaning). Such cognates suggest that the Matbat vowel system underwent a vowel shift in which vowel were lowered.

The lowering vowel shift was obviously conditioned by syllable structure. We find that the shift has developed the furthest for words ending in /l/, and has not (yet) affected words that are open or have a semivowel coda, unless they have the Low Rise (see tables in Appendix). The evidence of lowering is strongest for syllables ending in /l/ – this pattern no longer occurs with high vowels. I therefore hypothesize that the shift started in syllables with a coda /l/. While this hypothesis accounts for the patterns observed in the data, this hypothesis is also adequate in an explanatory sense: /l/ is likely to induce changes in the acoustics and therefore in the perception of adjacent vowels (Ladefoged & Maddieson 1996:193).

A final argument in favor of the hypothesis that the shift started with /l/ is that, synchronically, /l/ has the same effect (lowering and centralizing) on the quality of preceding vowels as hypothesized to account for the onset of the vowel shift. Figure 8B shows the mean values and spreading around the mean for /i/, /e/, and /ɛ/. Separate values are given for forms ending /l/, forms ending in a non-approximant coda, and forms that have no coda. Figure 8B shows for front vowels that syllables ending in /l/ are lower and more centralized than words with the same vowel phoneme that do not have /l/. Both the difference in advancement and the one in height in function of the presence of a coda /l/ are statistically significant. In a within-subjects ANOVA with the z-transformed F1 as a dependent and the fixed factors vowel (/e/ and /ɛ/) and presence of a coda /l/, we found significant main effects for both factors [vowel: $F(1,7) = 175.2$, $p < 0.001$; presence of coda /l/: $F(1,7) = 13.2$, $p = 0.008$]. There also was a significant interaction between vowel type and the presence of a coda /l/, revealing that the effect of /l/ on F1 is greater when the vowel is /ɛ/ than when it is /e/ [vowel: $F(1,7) = 9.25$, $p = 0.019$]. The same analysis, now with z-transformed F2 as the dependent, also yields significant effects for both factors [vowel: $F(1,7) = 86.5$, $p < 0.001$; presence of coda /l/: $F(1,7) = 53.7$, $p < 0.001$]. Here the interaction is not significant [vowel: $F(1,7) = 3.6$, $p = 0.099$ n.s.]. I.e., it appears that, at least for the front vowels, the factor hypothesized to constitute the cause of the vowel shift in the direction of /a/ has the same effect synchronically. The size of the effect is greater for F2 (reflecting advancement) than for F1 (reflecting height). Assuming the shift started in high-mid vowels of syllables ending in /l/, the lowering would then have spread to words ending in other non-semivowel consonants. Between- and within-speaker variation in vowel realization suggest that the vowel-shift is an on-going process, and it would certainly be worthwhile to follow-up these results in a longitudinal way.

Apart from syllable structure, the vowel shift is also influenced by lexical tone. First, the shift from high-mid to mid-low (/e/ to /ɛ/ and /o/ to /ɔ/) is more developed for words that have the Low Rise. Words with this lexical tone have the mid-low rather than the high-mid vowel, even if the syllable is open or ends in a semivowel. Second, some words that have a consonant other than /l/ are lagging, showing the high-mid rather than the

mid-low. All but one of these have the Low Level toneme. In summary, the Low Rise toneme is a progressive factor in the vowel shift, and the Low tone is a conservative factor, although its effect is less systematic than that of the Low Rise.

How can the interaction between vowel quality and lexical tone be explained? The rise in f_0 at the end of the Low Rise implies a corresponding rise in the higher harmonics, which occur at every whole multiple of f_0 . I speculate that this toneme may have induced an increase in F1, as the speakers tuned F1 upwards so as to follow the nearest rising harmonic. This is illustrated in Figure 9. The schematic representation in Figure 9A shows the null hypothesis, under which f_0 rises without affecting F1. The schematic representation in Figure 9B illustrates the way a change in f_0 should affect F1, in order to account for the interaction between tone and vowel quality in Matbat.

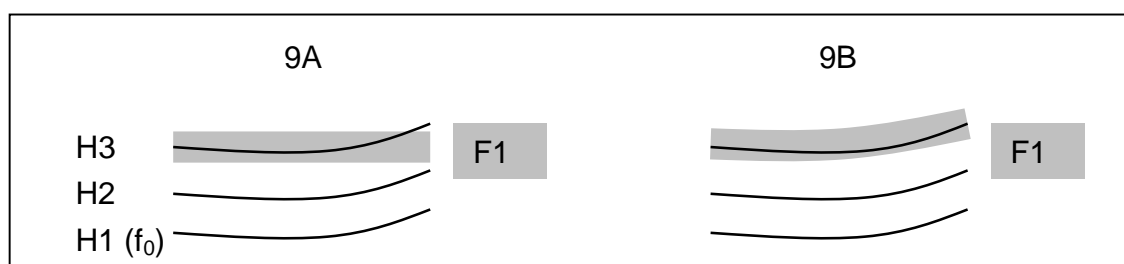


Figure 9: Schematic representations of the absence (A) vs. presence (B) of an interaction between f_0 and F1, mediated by the harmonics.

Interestingly, the kind of interaction between f_0 and F1 (‘formant tuning’) illustrated in Figure 9B is well known from acoustic studies involving professional singers (Rossing 1990:353, Sundberg & Skoog 1997, Joliveau, Smith & Wolfe 2004). Sopranos in particular learn to tune their formants to f_0 , leading to “increase[d] loudness and uniformity of tone, albeit at the expense of comprehensibility” (Joliveau, Smith & Wolfe 2004:116). A perception study by Carlsson & Sundberg (1992) revealed that expert listeners do not appreciate formant tuning. This suggests that formant tuning benefits the speaker rather than the hearer, and therefore may be a mechanical, intrinsic characteristic of producing an f_0 rise. From the perspective of the Matbat vowel change process, a rise of F1 in open syllables with a Low Rise would give these syllables the same kind of transition as induced by a following /l/ in closed syllables. In an inferential test with only two open-syllable minimally contrastive word sets with a high vowel, the difference in F1 at vowel offset between the Low Rise (/¹²/) and the other tonemes tended towards significance [$F(1,7) = 2.19$; $p = .105$ n.s.].¹² I speculate that a controlled comparison with a greater dataset may yield significance, either in Matbat or in a language with a phonetically similar low rising toneme, such as Mandarin Chinese. Pending such quantitative confirmation, the tonal conditioning of Matbat vowel quality suggests that in normal speech, just as in singing, a rise in f_0 may be accompanied by a rise in F1.

¹² The minimal sets were **nu**¹² ‘to kiss’; **nu**³ ‘place’; **nu**¹ ‘coconut (tree)’, and **tu**¹²¹ ‘to peel’; **tu**⁴¹ ‘grass’; **tu**¹²¹ ‘storm’. Target words were embedded in sentence-final position in a carrier. The materials were collected as part of the dataset on lexical tone (Remijsen 2001a), the analysis of which is summarized in sections 3.1 and 3.2.

7. Discussion and conclusion

7.1. Conclusion: Matbat is a tone language with six tonemes

According to the analysis presented here, Matbat has a lexical tone system with six tonemes. This hypothesis is supported by minimal-set evidence and by an acoustic analysis (Remijsen 2001a). The acoustic analysis provides detailed information on the realization of the six tonemes. It also showed that the realization of the tonemes is not greatly affected by the presence of a prosodic boundary, or by the composition of the syllable with which a toneme is associated.

The main function of the Matbat tone contrast is to distinguish lexical items from one another. In addition, tone is involved in the marking of some morphological contrasts, of which derivation is probably the most significant one. In addition to the lexical tones, there is a question-marking tone pattern that is restricted to the right edge of the phrase. Both the question-marking function and the distribution are characteristic of intonational boundary tones. Unlike unambiguously intonational tones, however, this tone pattern is lexically restricted to a heterogeneous subset of the question-marking morphemes.

Tone interacts with vowel quality in an intriguing way, with the Low Rise toneme inducing lowering of mid vowels in open syllables. More research is needed to determine whether this phenomenon can be attributed to formant tuning.

7.2. Comparison with the Ma¹ya tone system

Of the six tonemes of Matbat, three correspond closely to tonemes of the Ma¹ya language, with which Matbat is genetically related. That is, the Matbat High /³/, Low Fall /²¹/, and Low Rise /¹²/ tonemes resemble three tonemes of Ma¹ya, that have the same transcription as their Matbat counterparts, in the numeric convention used in this paper.¹³ Table 4 shows some minimal sets for tone in Ma¹ya.

Table 4: Minimal sets for lexical tone in Ma¹ya (Salawati dialect).¹⁴

High Level	Low Rise	Low Fall
'na ³	'na ¹²	'na ²¹
'sugar palm'	'sky'	'belly'
'ga ³	'ga ¹²	'ga ²¹
'wood'	'place'	'cracked'
'ba ³ n	'ba ¹² n	'ba ²¹ n
'(car) tyre'	'k.o. tree'	'to seek shelter'

¹³ The transcription of the Ma¹ya tonemes was originally proposed by van der Leeden (1983).

¹⁴ In a generative phonological analysis, the Low Fall can be interpreted as underspecified, filled in on syllables that are stressed but that do not have any of the marked tones (Remijsen 2001a).

In Matbat, words with the Low Fall toneme on the final syllable have an optional paragoge /-o/ in phrase-final context. Something very similar is the case for the phonetically similar Fall toneme in Ma'ya. Here the paragoge /-o/ is invariably present in phrase-final position.

Figure 10 shows the tonal space of the Ma'ya tones, in the Salawati and Misol dialects of the language. Misol is the island where Matbat is spoken alongside Ma'ya. The f_0 tracks in Figure 10 result from a methodology very similar to that used in the analysis of Matbat tone. Just as for Matbat, the Ma'ya (near-)minimal sets were collected in medial and final positions in a fixed frame utterance, from 8 native speakers (four female, four male).

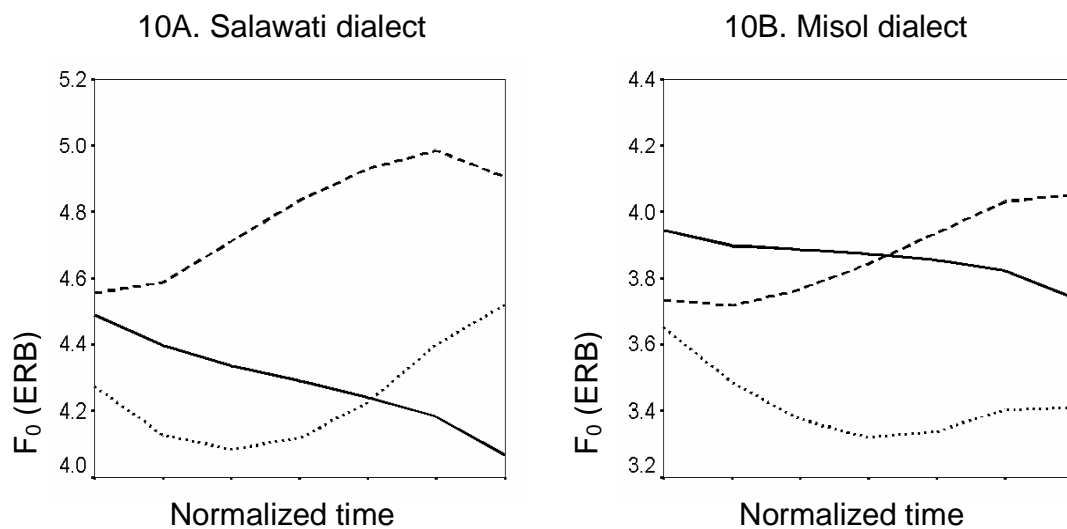


Figure 10: F_0 tracks of the three Ma'ya tonemes as realized on the vowel of monosyllabic near-minimal sets in sentence-final position in a frame sentence – Low Fall: full; High Level: interrupted; Low Rise: dotted. A – Salawati dialect (14 sets), B – Misol dialect (15 sets). The tracks are represented on a normalized time axis, and plotted against f_0 . From Remijsen (2001a).

While the three Ma'ya tonemes each have a phonetically similar counterpart in the Matbat tone system, there are some important differences between the word-prosodic of the two languages. Most obviously, Matbat has three additional tonemes. Also, while the Ma'ya tonemes are restricted to the final syllable of the word, the association of tones with syllables in Matbat is unpredictable, as illustrated by the examples in (2). In other words, the Ma'ya tonal contrast is tighter constrained in a syntagmatic sense. If we consider the variation of tonal system as a continuum between the lexical pitch-accent type and the prototypical tone system (cf. McCawley 1978), then Matbat is closer to the prototypical lexical tone type than Ma'ya is. Finally, Ma'ya has a lexical stress contrast independent of lexical tone (Remijsen 2001a, 2002), in addition to the lexical tone contrast. An example is the minimal pair /'mana³/ 'grease' vs. /ma'na³/ 'light of weight'. This is different from Matbat, which does not have lexical stress.

7.3. The origin of tone in Matbat

Lexical tone is uncommon among Austronesian languages. Out of 1,262 (Grimes 1996) Austronesian languages, no more than 16 (1.3 percent) have been reported to feature lexical tone. Apart from Matbat and Ma'ya, the following 14 Austronesian languages have been reported to feature lexical tone:

- The Chamic languages Eastern Cham (Edmondson & Gregerson 1993) and Utsat (Maddieson & Pang 1993)
- Mor, a SHWNG language from Cendrawasih Bay (Laycock 1978)
- Kara, Barok and Patpatar, all in New Ireland (Hajek 1995)
- The North Huon Gulf languages Yabem and Bukawa (Ross 1993)
- Five languages of New Caledonia (Rivierre 1993)
- Awad Bing (Cahill, 2003)

While most of these languages have a two-tone contrast, three-tone systems have been reported for Eastern Cham and for Cémuhi, one of the New Caledonia languages.¹⁵ A conspicuous exception, however, is Utsat, which has five lexically contrastive tonemes. Utsat is used by a small community of only two villages on Hainan island, surrounded by a population speaking a Chinese tone language (Maddieson & Pang 1993). The comparative anomaly of the Utsat tone system makes sense when we take into account the influence of language contact. Language contact may also have been a factor in the origin of lexical tone in Eastern Cham, Mor, Kara, Barok, and Patpatar. The tone languages of North Huon Gulf and of New Caledonia, on the other hand, have been interpreted as instantiations of spontaneous tonogenesis (Rivierre 1993, Ross 1993, respectively).

I hypothesize that the six-toneme system of Matbat is the result of language contact with a non-Austronesian language. Different from Utsat, however, this non-Austronesian language no longer exists.¹⁶ Various types of tonal phenomena, including complex lexical tone systems, have been reported for the non-Austronesian (Papuan) languages of New Guinea (Donohue 1997 and references there). However, there is currently no Papuan tone language on Misol, or anywhere else in the Raja Ampat archipelago. The closest non-Austronesian language is Moi, which is used on the New Guinea mainland and on the eastern coast of Salawati island – Moi has not been reported to feature lexical tone (Menick 1995). In the absence of evidence of an existing non-Austronesian language with a similarly complex tone system in the area, I hypothesize that the Papuan tone language involved in the contact situation was used on Misol before the arrival of Proto-SHWNG on Misol, probably around 1500 BC (Bellwood 1998:961). Matbat, then, evolved out of this contact situation. Below I will present additional arguments in favor of this hypothesis.

There is strong evidence that the prosodic characteristics of a substrate language may significantly contribute to a language that develops from a contact situation, even when

¹⁵ Inspection of the data on Awad Bing in Cahill (2003) suggests that this language may have word-prosodic contrast similar to the word-accent systems of e.g. Serbo-Croatian and Swedish. There is one prominent syllable in the word, which can have either a high or a falling tone. In the examples in Cahill (2003), the prominent syllable is consistently marked by duration and intensity, which are well known to be correlates of lexical stress.

¹⁶ Unless Matbat would be reclassified as a non-Austronesian language.

the influence of this substrate language elsewhere in the language system and in the vocabulary is fairly limited. In this way, Papiamentu, a creole language of the Caribbean with a predominantly Spanish and/or Portuguese vocabulary, has retained a tonal contrast from its West African heritage (Römer 1991). Similarly, the Scots dialect of the Shetland islands (north of Scotland) has complementary quantity, a phenomenon that is characteristic for its Norse substrate: in stressed closed monosyllabic words, long vowels are followed by a short consonant and short vowels by a long consonant (van Leyden 2002).

Moreover, evidence of the Papuan influence is not limited to the Matbat tone system. It is also apparent from the vocabulary, and from the grammar. My own data on the Matbat lexicon suggest that a considerable proportion of the lexicon of Matbat has not been derived from an Austronesian ancestor. Although all SHWNG languages in the Raja Ampat archipelago have non-Austronesian lexical items, the phenomenon is the most prominent in Matbat and Ambel, another SHWNG language of the Raja Ampat islands. Like its tonal contrast, the considerable proportion of non-Austronesian items in the Matbat lexicon can be accounted for readily by attributing it to the non-Austronesian substrate language. In addition Matbat has inflection for inalienable possession on body parts and kinship terms, and inflection for noun classes on numerals. Both of these characteristics do not reflect the Austronesian prototype (Foley 1998), but they are not uncommon in Papuan languages (Foley 1988, 1998). It is worthwhile to note that the tonal contrast is tied up with these typically Papuan phenomena in the morphosyntax (cf. sections 4.1, 4.2). In summary, the contact situation that would have given rise to the tone system is independently required to account for the presence of other non-Austronesian influences in the Matbat language.

There is also a negative argument, against the alternative hypothesis, that tone in Matbat is the result of spontaneous tonogenesis. When a language develops tonal contrasts through internal development, it is possible to relate the resulting tonal contrast to segmental contrasts in the ancestor language, such as a voicing contrast in stops leading (Hombert 1978, Ross 1993). I have found no such regular correspondences for Matbat.

It was observed above that all three of the Ma'ya tones are acoustically similar to Matbat tones: both languages have a high level toneme, a low rise, and a low fall. Given this close similarity, I extend the substrate hypothesis so as to account for lexical tone in Ma'ya as well. That is, I hypothesize that the non-Austronesian tone language that contributed lexical tone to the contact situation out of which Matbat developed, or another non-Austronesian closely related to it, was the source of the Ma'ya tonal contrast. For Matbat, the substrate hypothesis is the only plausible scenario for tonogenesis. For tonogenesis in Ma'ya, on the other hand, there is a realistic alternative. There is evidence that the Ma'ya villages of the Raja Ampat archipelago played an important part in the slave trade between west New Guinea and the Moluccas, and that there frequently were slaves in *raja* villages such as Samate, up to the beginning of the 20th century.¹⁷ An important weakness of this alternative hypothesis is that all but one of the Papuan languages of New Guinea that are located nearest to the Raja Ampat islands do not have lexical tone. The only exception is Abun, which has a three-way tone contrast with a low

¹⁷ See Remijsen (2001a) for further discussion and references.

functional load (C. Berry 1998, K. Berry p.c.). Both for Matbat and for Ma'ya, therefore, language contact with a non-Austronesian language within the Raja Ampat islands is the most likely explanation for the origin of tone.

7.4. Further research

Very little is known about Raja Ampat languages other than Ma'ya. Our knowledge on these languages is limited to wordlists, and even those most basic data are not available for Bata. I believe that Matbat (Misol) and Ambel (Waigeo) are the most worthwhile objects of language documentation in this context. These are the two languages that show the least similarity with Ma'ya. Ma'ya is relatively well-documented, if we include those materials by van der Leeden that have not yet been published. Efforts are underway to publish these materials, and to provide a grammar sketch of Magey Matbat.

With respect to the study of lexical tone in Matbat, it would be worthwhile to compare the tonal systems of Magey Matbat with that of Tomolol Matbat. Tomolol Matbat also has lexical tone contrasts, but no further details are available so far.

Acknowledgements

I thank the people of Magey for letting me stay in their village, and for being supportive and helpful towards me, in spite of numerous misunderstandings. Their warm welcome encouraged me to go back and continue the study of Matbat after the first fieldwork trip.

The first fieldwork trip to Magey (7 days on-site in March 2001), and the analysis of the resulting data, was funded by the Royal Netherlands Academy of Arts and Sciences (KNAW). Transport to Misol was provided by the fishing company Pt. Ramoi. The second fieldwork trip (45 days on-site in May and June 2003), and the analysis of the resulting data, was funded by a postdoctoral grant of the Netherlands Organization for Scientific Research (NWO). The second fieldwork trip was made possible by institutional support of the Max Planck Institute for Evolutionary Anthropology (Jakarta field station) and Atma Jaya University. Special thanks are due to Uri Tadmor of the Jakarta field station, for support and hospitality in Jakarta. The pearl farming company Pt. Yellu Mutiara provided transport between Sorong and Misol on the second trip. In particular I thank the manager, Bpk. Taufik Wijaya, for hospitality in Tiga-Lima.

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Appendix

Tables: Examples of the interaction between vowel quality, syllable structure and lexical tone, in monosyllables and in disyllables with a toneless penult. Separate tables by advancement (front / back). CVC*: the final consonant is not a semivowel and not /l/; CV*: the vowel may or may not be followed by a semivowel. Minimal sets for tone and vowel quality (within the same level of advancement) of which at least two members are included in the table are marked.

	/ɛ/	/e/	/i/
/3/	CVC* <u>nɛ</u> ³ n 'mother'; flɛ ³ s 'to cut (weed)'; fɛ ³ n 'sea turtle' CVI hɛ ³ l 'mountain'; kalɛ ³ l 'k.o. parrot'	CVI hɛ ³ l 'to shine (moon)'; be ³ l 'to flash (lightning, camera)' CV* de ³ 'house'; le ³ 'eclipse'; le ³ y 'shore'	CVC* li ³ m '3'; mi ³ n 'mirror'; fi ³ t '7' CV* fi ³ 'good'; si ³ 'excrements'; -si ³ w '9 (inan.)'
/12/	CVC* fɛ ¹² t 'to cut'; kɛ ¹² s 'to write'; ye ¹² m 'dog'; takɛ ¹² k 'chicken' CVI tɛ ¹² l 'to cut'; dɛ ¹² l 'friend' CV* tɛ ¹² 'iron'; pɛ ¹² 'to stab'; le ¹² y 'real'; sɛ ¹² w 'to refuse'	CVI dɛ ¹² l 'thread'	CVC* hi ¹² p 'to wash'; di ¹² ŋ 'to sew' CV* ni ¹² 'sago'; yi ¹² 'to sail'; gi ¹² 'to peel'; -si ¹² w '9 (an.)'
/1/	CVC* -ɛ ¹ n 'to carry'; mɛ ¹ n 'to angle'; fɛ ¹ n 'to breastfeed' CVI laɛ ¹ l 'strait(s)'	CVC* ke ¹ s 'resin'; tare ¹ k 'corn' CVI pe ¹ l 'to open'; tɛ ¹ l 'to push off' CV* fe ¹ 'k.o. shed'; pe ¹ w 'blood'; ige ¹ y 'earthworm'	CVC* yi ¹ n 'fish'; ni ¹ p 'to fly' CV* mi ¹ 'to pee'; li ¹ 'to lie on one's side'
/121/	CVC* lɛ ¹²¹ n 'fishing spear'; tɛ ¹²¹ n 'dry' CVI tɛ ¹²¹ l 'to fill'; tɛ ¹²¹ lo 'head'	CVI me ¹²¹ l 'hungry/thirsty' CV* se ¹²¹ 'drunk'; de ¹²¹ 'ill'; le ¹²¹ y 'to dig'	CVC* -ani ¹²¹ m 'to drink' CV* -awi ¹²¹ 'to steal'; di ¹²¹ 'to build a wall'
/41/	CVC* mɛ ⁴¹ k 'bottle'; lɛ ⁴¹ n 'sago' CVI -ɛ ⁴¹ l 'to go down'	CVI we ⁴¹ l 'fishing rod' CV* de ⁴¹ 'to throw'	CV* di ⁴¹ 'noise (of motor)'; yi ⁴¹ 'water'; wi ⁴¹ 'k.o. tree'
/21/	CVC* flɛ ²¹ m 'to send' CVI pɛ ²¹ l 'to arrive'; gɛ ²¹ l 'fruit'; tɛ ²¹ l 'testicle'	CVC* me ²¹ s 'to lift up' CVI tɛ ²¹ l 'to point out' CV* be ²¹ 'to give'	CVC* gi ²¹ m 'to send'; pi ²¹ n 'hidden'

	/ɔ/	/o/	/u/
/3/	<p>CVC* pɔ³n ‘thing’; mɔ³k ‘cup’; fɔ³n ‘full’; bɔ³t ‘to reach’</p> <p>CVI yɔ³l ‘to shout’; -tɔ³l ‘three’</p>	<p>CVI mo³l ‘debt’; gago³l ‘unripe’</p> <p>CV* aklo³ ‘cassowary’; mo³y ‘sharp’; ho³y ‘to return’; kamo³w ‘deaf’</p>	<p>CVC* du³m ‘to follow’; su³f ‘vegetable’; hu³ŋ ‘to enter’</p> <p>CV* -lu³ ‘two’; nu³ ‘place’; bu³y ‘piece of cloth, sarong’</p>
/12/	<p>CVC* ko¹²k ‘throat’; so¹²m ‘dirty’</p> <p>CVI do¹²l ‘to fall’; -ɔ¹²l ‘to stand up’</p> <p>CV* tɔ¹² ‘to chop’; hafɔ¹² ‘3PL’; mɔ¹²w ‘dry’; ŋɔ¹²y ‘river’</p>	<p>CVI fago¹²l ‘to shave’</p>	<p>CVC* blu¹²n ‘hair (head)’; du¹²t ‘mother’; hu¹²ŋ ‘to search’</p> <p>CV* nu¹² ‘to smell, to kiss’; fu¹²y ‘to sweep’; lu¹²y ‘to dive’</p>
/1/	<p>CVC* ho¹ŋ ‘mango’; do¹k ‘to boil’; yɔ¹k ‘k.o. bag’; mɔ¹n ‘heavy’</p> <p>CVI palɔ¹l ‘aubergine’</p>	<p>CVC* po¹s ‘paddle’; tabo¹k ‘dull’</p> <p>CVI go¹l ‘sugar’; so¹l ‘to dig’</p> <p>CV* so¹ ‘sour’; mo¹ ‘current’; do¹y ‘cough’; sano¹w ‘mosquito’</p>	<p>CVC* lu¹ŋ ‘to burn (intr.)’; payu¹s ‘bait’; nu¹k ‘to stab’</p> <p>CV* yu¹ ‘to raise up’; saku¹y ‘k.o. lizard’; itu¹y ‘k.o. shellfish’</p>
/121/	<p>CVC* tɔ¹²¹m ‘to pick’; salɔ¹²¹n ‘zero’</p> <p>iso¹²¹t ‘k.o. tuber’</p> <p>CVI ho¹²¹l ‘to sit’</p>	<p>CVI do¹²¹l ‘to go down in water’; fo¹²¹l ‘to stroke’</p> <p>CV* ipo¹²¹ ‘bird’; fo¹²¹w ‘to whistle’</p>	<p>CV* bu¹²¹ ‘to embrace’; tu¹²¹ ‘thunder’</p>
/41/	<p>CVC* mɔ⁴¹n ‘areca nut’; nɔ⁴¹ŋ ‘to hear’; nɔ⁴¹n ‘to jump’</p> <p>CVI ho⁴¹l ‘snare’</p> <p>CVC* -ɔ⁴¹p ‘to sell’; yɔ⁴¹k ‘bay’; manɔ⁴¹n ‘eye-3S’</p> <p>CVI tɔ⁴¹l ‘egg’; fɔ⁴¹l ‘to avoid because of a taboo’</p>	<p>CVI karɔ⁴¹n fo⁴¹l ‘k.o. ant’</p> <p>CV* wo⁴¹ ‘wind’; iko⁴¹w ‘lobster’; fo⁴¹y ‘arrow’</p> <p>CVI ho⁴¹l ‘seed in fruit’; napo⁴¹l ‘body hair’; fay o⁴¹l ‘to gather’</p> <p>CV* bo⁴¹l ‘to go (on foot)’; lo⁴¹y ‘heart’</p>	<p>CV* nu⁴¹ ‘room’; ifu⁴¹ ‘k.o. fruit dove’; tu⁴¹ ‘grass, weed’</p> <p>CVC* -u⁴¹n ‘to know’;</p> <p>CV* sadu⁴¹ ‘to push’; nanu⁴¹ ‘scale (of fish)’</p>
/21/			