

The Segmental Sound Patterns of Maori*

The description provided by Bauer (1993) is highly detailed, but contains information about a wide variety of dialects. This makes it somewhat difficult to wade through the description to make sure that different grammars are not being conflated. I have done my best to provide data that seems consistent across dialects. That said, errors may have been introduced.

(1) Phonetic description of 17 surface consonants (approximately)

	Labial			Dento-alveolar			Palatal			Velar			Glottal
	+voi	-voi	+asp	+voi	-voi	+asp	+voi	-voi	+asp	+voi	-voi	+asp	-voi
Stop		[p]	[p ^h]		[t]	[t ^h]					[k]	[k ^h]	
Fric	[β]	[f]						[ç]			[x]		[h]
Nas	[m]			[n]						[ŋ]			
Tap				[ɾ]									
Glide	[w]	[ʌ]											

(2) Phonetic description of 10 contrastive consonants showing variation

	Bilabial	Dento-alveolar	Velar	Glottal
Stop	[p]~[p ^h]	[t]~[t ^h]	[k]~[k ^h]~[x]~[ç]	
Fric	[f]~[β]~[ʌ]			[h]
Nas	[m]	[n]	[ŋ]	
Tap		[ɾ]		
Glide	[w]			

(3) Phonetic description of 17 surface vowels (approx.), ignoring length

	Front		Central		Back
High		[y]	[ɨ]	⚭	[u]
	[ɪ]	[ʏ]			[ʊ]
Mid	[e]			⚭	
	[ɛ]		[ɜ]	⚭	[ɔ]
Low			[ɐ]		
				[ɑ]	⚭

Note: shaded cells indicate lip rounding, and I use slightly different IPA symbols minimizing the use of diacritics.

(4) Phonetic description of 5 contrastive vowels showing variation, ignoring length

	Front	Central	Back
High		[ɨ]~[ɪ]	⚭~[ʊ]~[u]~[ʏ]~[y]
Mid	[ɛ]~[e]		[ɔ]~[⚭]
Low		[ɑ]~[ɜ]~[ɐ]~[ɒ]	

Note: shaded cells indicate lip rounding

* Based on the description of Bauer (1993). Maori is an Eastern Malayo-Polynesian language spoken in New Zealand.

(5) Phonetic description of 5 contrastive vowels canonical form, ignoring length

	Front	Central		Back
High		[i]	[ʉ]	
Mid	[ɛ]			[ɔ]
Low		[ɑ]		

Note: shaded cells indicate lip rounding

Bauer (1993) says that there is considerable overlap in the tongue positions of the high central vowels and that they seem to contrast only in terms of lip rounding. The mid back and low vowels also often differ only with respect to rounding, however, when rounded allophones are found in syllables with /w/ (and sometimes /f/) onsets, they are described as lower than the mid vowel.

Syllable structure

The language has a very simple syllable structure, with no codas or clusters = CV, CVV

Vowel distribution

The vowels show significant phonetic variation. And the only co-occurrence restriction seems to be that the round vowels /ʉ/ and /ɔ/ cannot follow /w/ (and /f/ in some dialects).

All sequences of two vowels are found. The following charts provide the distribution and common phonetic realization of vowels in vowel-vowel sequences as discussed by Bauer (1993) - again, slightly different transcription is used here.

(6) VV sequences

	/i/	/ʉ/	/ɛ/	/ɔ/	/ɑ/
/i/	[iɪ]	[iʏ]	[iɛ]	[iɜ]	[iɜ]
/ʉ/	[iʏ]	[ʉʉ]	[ʉɛ]	[ʉɔ]	[ʉɐ]
/ɛ/	[ɛi]	[ɛy]	[ɛɛ]	[ɛɔ]	[ɛɐ]
/ɔ/	[ɜi]	[ɜʉ]	[ɜɛ]	[ɜɔ]	[ɜɐ]
/ɑ/	[ɜi]	[ɐʉ]	[ɜɛ]	[ɑɔ]	[ɑɑ]

Variation in VV sequences:

- /i/ shows little variation. It lowers slightly adjacent to [ʏ, ɜ, ɐ] (i.e. non-low).
- /ɛ/ shows little variation. It raises slightly adjacent to [i, ʉ, y] (i.e. high).
- /ɔ/ shows little variation. It fronts slightly adjacent to [i, ɛ, ɐ] (i.e. non-round).
- /ɑ/ shows considerable variation. It fronts adjacent to [ʉ, ɛ, ɜ] (i.e. non-back), and it raises and fronts adjacent to [i, ɛ] (i.e. fronter, non-low).
- /ʉ/ shows the widest range of variation. It fronts adjacent to [i, ɛ] (i.e. front), it backs if it is followed immediately by [ɛ, ɔ] (i.e. mid).

Variation in CV sequences:

- /i/ tends to be higher following stops and lower following [f] and [r] (i.e. oral non-stops).
- /a/ tends to be rounded following [w] and [f] (i.e. labial non-stops) and fronted following [n] and [r] (i.e. coronal non-stops).
- /ɔ/ tends to be fronted following non-velar oral consonants.
- /ʊ/ tends to be fronted following [t], [n] and [r] (i.e. coronals).

All of these variations are consistent with co-articulation effects, are variable by speaker and speech rate, and do not create categorical changes. Therefore, I assume that no phonological feature changes take place.

Vowel behavior in syllabification

The syllabification of vowel sequences is complicated, but the claim is that it (and stress assignment) is predictable.

The basic claim about syllabification of vowels is that:

- Every morpheme boundary corresponds to a syllable boundary.
- Mono-morphemic sequences of identical vowels form a single syllable.
- Mono-morphemic sequences of non-identical vowels form binary syllables starting from the left.

However, stress assignment in this language suggests that things are slightly more complicated. In monomorphemic forms, main stress is weight sensitive and is assigned to the leftmost heaviest syllable, where there is a hierarchy of preference: $(C)V_iV_i > (C)V_iV_k > (C)V$. If we assume that both $(C)V_iV_i$ and $(C)V_iV_k$ are bimoraic syllables in all cases as predicted by the above syllabification rules, then we must explain the preference for stressing sequences of identical vowels over sequences of non-identical vowels. Such an account would require either a difference in moraicity of these two syllable types, perhaps having recursive moraic tiers *a la* Hayes (1995), or would require a prominence-sensitivity (my interpretation of Gordon 1999) rather than a quantity-sensitivity approach.

Another option is to say that identical vowels in monomorphemes are always syllabified together, but non-identical vowels are only syllabified together if they would form a heavy stressed syllable. This is the approach taken to Kashmiri $CVV > CVC > CV$ in Morén (2000), where long vowels and diphthongs are always bimoraic syllables, but CVC is only bimoraic if stressed. I will assume this approach.

Vowel epenthesis

Because of the strict syllable structure requirements of the language, native morphemes never contain underlying consonant clusters and clusters never arise from morpheme concatenation. Therefore, there is never a need for vowel epenthesis within the native vocabulary. However, vowels are epenthesized to break up some consonant clusters in borrowings (other clusters undergo simplification by deletion). Bauer claims that there is a tendency for the epenthetic vowel to be identical in nature to an adjacent vowel, but that other vowels are often inserted

and there is no clear generalization to be made about their quality. I leave this to future research and will not use vowel epenthesis to make claims about vowel feature specification.

Vowel behavior discussed thus far leads to the following hypothesis:

- /ɯ/ and /ɔ/ are labial since they cannot co-occur with /w/ (and /f/, dialectally)

Given the distribution of the vocalic segments, their phonetic characteristics and the tenets of the Parallel Structures Model, there are a number of likely interpretations of Maori vowels (particularly the mid vowels). Two likely interpretations are given in (7) and (8). Note that there are segments composed of only a single feature and because there is no difference in place behavior between consonants and vowels (e.g. no vowel place harmony), only C-place features are necessary.

In (7), there are three phonologically high vowels distinguished by place, there is one phonologically mid vowel, which is labial, and there is one phonologically low vowel.

(7) PSM feature chart for Maori vowels (option 1)

		C-place [lab]	C-place [cor]	V-manner [closed]	V-manner [open]
High	/i/			✓	
	/ɯ/	✓		✓	
	/ɛ/		✓	✓	
Mid	/ɔ/	✓		✓	✓
Low	/a/				✓

Option 2 in (8) differs from (7) in that there is no phonological mid vowel and there are two low vowels differentiated via place.

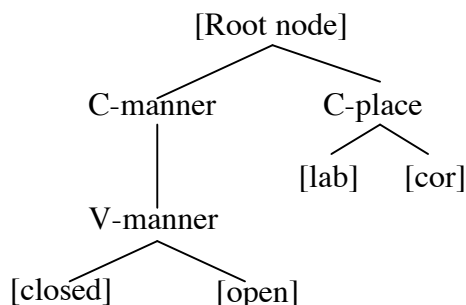
(8) PSM feature chart for Maori vowels (option 2)

		C-place [lab]	C-place [cor]	V-manner [closed]	V-manner [open]
High	/i/			✓	
	/ɯ/	✓		✓	
	/ɛ/		✓	✓	
Low	/a/				✓
	/ɔ/	✓			✓

Both of these options capture the facts, but I will choose the feature specifications in (8) because the representation of the mid back vowel is simpler.

The fully specified representation compatible with both (7) and (8) is given in (9).

(9) Fully-specified Maori PSM Vowel Geometry



Consonant allophones, distribution and features

Recall the set of contrastive consonants and their allophonic variation. These are repeated in (10).

(10) Phonetic description of 10 contrastive consonants showing variation

	Bilabial	Dento-alveolar	Velar	Glottal
Stop	[p]~[p ^h]	[t]~[t ^h]	[k]~[k ^h]~[x]~[ç]	
Fric	[f]~[β]~[ɸ]			[h]
Nas	[m]	[n]	[ŋ]	
Tap		[ɾ]		
Glide	[w]			

The allophony is as follows:

- Stop aspiration is extremely variable by speaker and context. Some speakers have almost no aspiration, while others have as much as that found in English. There tends to be more aspiration with increased loudness/stress, and different speakers will have more aspiration on stops at different places of articulation. Aspiration can sometimes be realized as various degrees of affrication - again, depending on speaker and context. Because the range and inconsistency of variation across speakers/within the same speaker, and because no categorical change is found, aspiration and affrication are taken to be phonetic phenomena.
- Velar frication is a dialectal variation found in “isolated tokens” (Bauer 1993: 531) mainly in the Western region of the North Island. It is usually (but not exclusively) found before lower back vowels. Without more data, I will ignore the velar fricative as being atypical at best and most likely another type of phonetic variation.
- The labial fricative has a wide range of variants, the most common of which are shown in (10). According to Bauer, this segment “varies sometimes by dialect, sometimes by speaker, and sometimes varies with a single speaker from one token to another.” Bauer (1993: 531). I take this variation to be of a phonetic, not phonological nature.

Since there seem to be no restrictions on the occurrence of the contrastive segments (within the bounds of the syllable structure of the language), there seem to be only two means by

which to establish the feature specification of each consonant - surface phonetic characteristics, and the principles of the PSM.

[h] is clearly a continuant without an oral place of articulation. Therefore, we might assign it C-manner[open].

(11) PSM feature chart for Maori /h/

	C-manner [open]
/h/	✓

Among the dento-alveolar consonants, [ɾ] has the weakest closure and does not seem to form a series with other segments with similar manner of articulation. Therefore, we might assign it C-place[cor].

(12) PSM feature chart for Maori /ɾ/

	C-place [cor]
/ɾ/	✓

Among the labial consonants, both /f/ and /w/ have fairly weak manner articulation, but /f/ is consistently voiceless, suggesting it is closed enough to suppress spontaneous vocal fold vibration and/or has an active opening gesture (i.e. glottal), so we might assume that [w] is just labial place. In addition, if we assume that both /ʉ/ and /ɔ/ have a C-place[lab] feature, then the cooccurrence restriction against [wʉ] and [wɔ] might be explained via absorption of the mannerless labial into the adjacent labial vowel - more work is obviously needed here.

(13) PSM feature chart for Maori /w/

	C-place [lab]
/w/	✓

This would leave /f/ as a labial fricative. Further evidence suggesting that this is a correct phonological interpretation for the relationship between /w/, /f/ and /h/ (see (11)) comes from the phonetic variation found across dialects. Some dialectal variants /f/ include: [h̠w], [w̠h], and [h^w]. This suggests that /f/ is composed of the /h/ continuant and the [w] labial.

(14) PSM feature chart for Maori /f/

	C-place [lab]	C-manner [open]
/f/	✓	✓

Given the use of both a labial and coronal feature, then we might interpret /p/ and /t/ as labial and coronal stops, respectively.

(15) PSM feature chart for Maori /p/ and /t/

	C-place [lab]	C-place [cor]	C-manner [closed]
/p/	✓		✓
/t/		✓	✓

Given the use of C-manner[closed], there must be a segment composed of only this feature. The only option is /k/.

(16) PSM feature chart for Maori /k/

	C-manner [closed]
/k/	✓

The specification for Maori non-nasal consonants is summarized in (17).

(17) PSM feature chart for Maori non-nasal consonants

		C-place		C-laryn	C-manner	
		[lab]	[cor]	[closed]	[closed]	[open]
Mannerless	/w/	✓				
	/r/		✓			
Stop	/k/				✓	
	/p/	✓			✓	
	/t/		✓		✓	
Continuant	/h/					✓
	/f/	✓				

We are left with having to specify the nasal consonants with features. There are at least two possibilities. First, we might simply assume that nasality necessarily implies mapping to a nasal manner feature. This option is given in (18).

(18) PSM feature chart for Maori nasal consonants (option 1)

	C-place [lab]	C-place [cor]	C-manner [nasal]
/ŋ/			✓
/m/	✓		✓
/n/		✓	✓

This has the disadvantage of introducing another feature. Another option is to consider other aspects about the articulation of these segments and to “reuse” features used elsewhere in the system. Note that nasal stops involve both stopping the flow of air and having continuous flow of air. In essence, they are phonetically both stops and continuants. Thus, I will assume the following feature specifications.

(19) PSM feature chart for Maori nasal consonants (option 2)

		C-place		C-manner	
		[lab]	[cor]	[closed]	[open]
Stop+ Continuant	/ŋ/			✓	✓
	/m/	✓		✓	✓
	/n/		✓	✓	✓

This has both an advantage and a disadvantage. The advantage of analyzing nasals in some languages as a combination of a stop gesture and a continuant gesture is that this may help to explain why nasals in some language behave like stops, but in other languages they seem to behave like continuants. While allowing phonetic nasals to map to a C-manner[nasal] feature in other languages would account for why they do not behave like either stops or continuants on some languages.

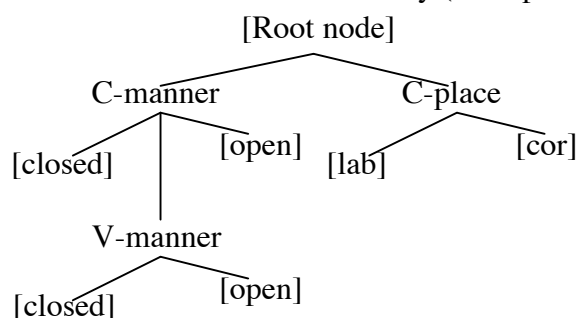
The disadvantage of specifying nasals in Maori as both a stop and a continuant is that we must allow for a fairly abstract mapping between C-manner[open] and phonetic implementation. Note that C-manner[open] is typically mapped to a spread glottis, but for nasals it would have to map to a lowered velum (note that the nasals are not “aspirated” or “voiceless” in Maori. This means that C-manner[open] would have to map to something like “continuous airflow” rather than “spread glottis” in this language.

I will assume the following feature specifications for Maori segments. As we have seen, there are some areas in which there are other options. This requires further investigation. Note the economy of feature use, representations and the symmetry across the inventory.

(20) PSM feature chart for Maori segments (one possibility)

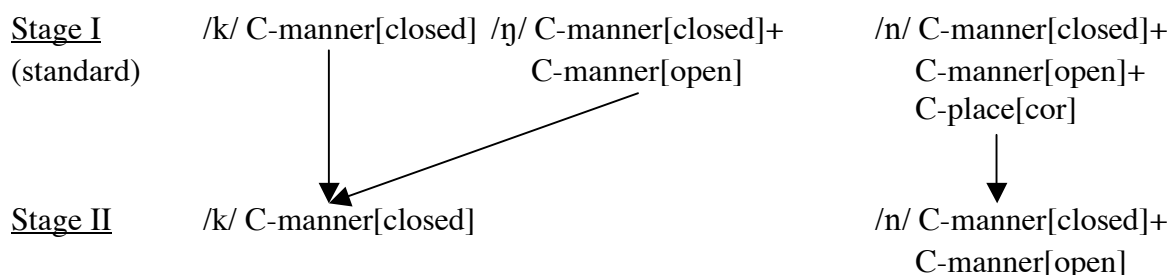
		C-place		C-manner		V-manner	
		[lab]	[cor]	[closed]	[open]	[closed]	[open]
Mannerless	/w/	✓					
	/ɾ/		✓				
Stop	/k/			✓			
	/p/	✓		✓			
	/t/		✓	✓			
Stop+ Continuant	/ŋ/			✓	✓		
	/m/	✓		✓	✓		
	/n/		✓	✓	✓		
Continuant	/h/				✓		
	/f/	✓			✓		
High	/i/					✓	
	/ʉ/	✓				✓	
	/ɛ/		✓			✓	
Low	/ɑ/						✓
	/ɔ/	✓					✓

(21) Maori PSM Feature Geometry (one option)

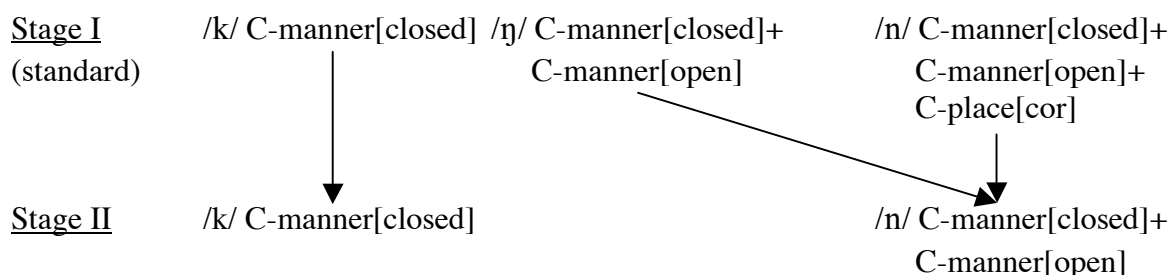
**Dialectal variation**

- The East Coast of the North Island speakers (and other scattered around the country) have free variation in the realization of /r/. It can be centrally or laterally released, i.e. [r]~[ɭ]. This is a phonetic alternation and does not involve phonological feature differences.
- Bay of Plenty speakers have only [m] and [n] nasals. This implies that one or the other (probably /n/ given the prominence of labiality in Maori) is placeless.
- Ngaitahu speakers substitute /k/ for [ŋ]. This implies the absence of the velar nasal as a contrastive segment, thus implying that one of the other nasals (probably /n/) is placeless.
- Note that Bay of Plenty and Ngaitahu both lack a velar nasal in their inventories, but they have chosen different neutralization strategies. In the Bay of Plenty, two nasal segments merge, but in Ngaitahu, two placeless segments merge. This is depicted in (22) and (23). Both dialects involve the loss of a phonologically coronal nasal.

(22) Ngaitahu velar nasal neutralization



(23) Bay of Plenty velar nasal neutralization



- Taranaki-Whanganui speakers consistently use [ʔ] where other dialects have [h], including substituting /ʔw/ for /f/. This leaves this dialect without fricatives of any kind, and it has enormous consequences on the structure of the contrastive system. The contrastive system of Taranaki-Whanganui is:

(24) Phonetic description of 10 contrastive consonants of Taranaki-Whanganui Maori

	Bilabial	Dento-alveolar	Velar	Glottal
Laryngeal stop	/ʔw/			/ʔ/
Oral stop	/p/	/t/	/k/	
Nas	/m/	/n/	/ŋ/	
Tap		/ɾ/		
Glide	/w/			

Interpreted using the PSM, we get the following:

(25) PSM feature chart for Taranaki-Whanganui Maori segments (one possibility)

		C-place		C-laryn	C-manner		V-manner	
		[lab]	[cor]	[closed]	[closed]	[open]	[closed]	[open]
Mannerless	/w/	✓						
	/ɾ/		✓					
Laryngeal stop	/ʔ/			✓				
	/ʔw/	✓		✓				
Oral stop	/k/				✓			
	/p/	✓			✓			
	/t/		✓		✓			
Continuant ¹	/ŋ/					✓		
	/m/	✓				✓		
	/n/		✓			✓		
High	/i/						✓	
	/a/	✓					✓	
	/ɛ/		✓				✓	
Low	/ɑ/							✓
	/ɔ/	✓						✓

Thus, the laryngeal opening gesture usually associated with the C-manner[open] segment in general Maori has been re-interpreted as a laryngeal gesture, given the feature C-laryngeal[closed] in this dialect. The labial fricative (realized as labialized glottal fricative in some dialects) is also re-interpreted as a labial glottal stop. This leaves the language without a phonological fricative, but there is still a set of continuants in the form of nasals. Note that the lack of a fricative in the inventory entails that the nasals cannot be phonologically a combination of C-manner[closed] and C-manner[open] in this dialect because of the PSM principle that any combination of features entails a set of segment composed of just those individual features. The only non-vowel continuants in this language are the nasals.

¹ Another interpretation of the nasals might be the introduction of a C-manner[nasal] feature.

Wish list

- Fuller description of the stress system
- Evidence for choosing one feature-specification option over another
- Actual data, rather than just generalizations
- OT analysis of the contrasts and distribution

References

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