Phonetic structures of Khonoma Angami

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Angami is a Tibeto-Burman language spoken in the Naga Hills in the northeastern parts of India. There are several dialects, the most prominent being Chokri, Khonoma, and Kohima. The last is considered the standard variety for publications and is taught in schools. Although there is no Angami written literature, there are published translations of textbooks and religious writings (Ravindran 1974). Published descriptions of Kohima dialect include Burling (1960), Ravindran (1974) and Giridhar (1980). The various dialects are mutually intelligible but differ in tonal and segmental inventory. This study describes the phonetic inventory of one of the smaller Angami dialects, Khonoma, which is spoken by about 4,000 people in the extreme west of the Angami region. Further information about the phonology and grammar of Khonoma Angami can be found in Chase (forthcoming).

The data for this study are recordings of two female and four male adult native speakers, made in February 1992 at the Linguistics Department of Deccan College, Pune, India. All of the speakers were students at institutions in the neighborhood of Pune. The primary corpus is a list of words spoken in isolation and in the frame *a²* ___ *sɨ³ʃu²to³*, "I write ___", which was recorded by all six speakers. One of the female speakers (NC) recorded the complete set of material on two separate occasions, giving us seven sets of recordings in all. There are also palatographic samples and airflow data for selected phonemes, some of which have been previously reported in Bhaskararao and Ladefoged (1991).

VOWELS

Khonoma Angami has 6 vowels, which we shall transcribe as [i, e, a, o, u, ə]. Each of them can occur on any one of the four tones. The vowels occur only in open syllables, and there are no contrasting lengths. Although diphthongs do occur, they are very infrequent, and will not be discussed in this paper.

The following sets of words illustrate contrasting vowel qualities.

i	*pi*^{2}	'mushroom'	*mi*^{1}	'fire'
e	*pe*^{3}	'to shiver'	*me*^{2}	'always'
a	*ta*^{3}	'to chew'	*ma*^{3}	'price'
o	*po*^{4}	'one'	*mo*^{3}	'to moo'
u	*pu*^{3}	'to bloom'	*mu*^{4}	'sweet'
ə	*pfə*^{4}	'to carry'	*mə*^{4}	'to refuse'

The seven sets of recordings of all these words were analyzed, using the Kay CSL instrumentation, and the frequencies of the first three formants were determined. The formants were plotted on a graph of F1 and F2', a weighted average of F2 and F3, calculated by using the formula given by Fant (1973:52):

$$F2' = F2 + \frac{(F3 - F2)(F2 - F1)}{2(F3 - F1)}$$

Figure 1 shows the F1 and (F2'-F1) Hz values plotted on a Bark scale for each vowel spoken by the male speakers. Ellipses enclose all points within two standard deviations of the mean. Values for the two female speakers are shown in Figure 2.

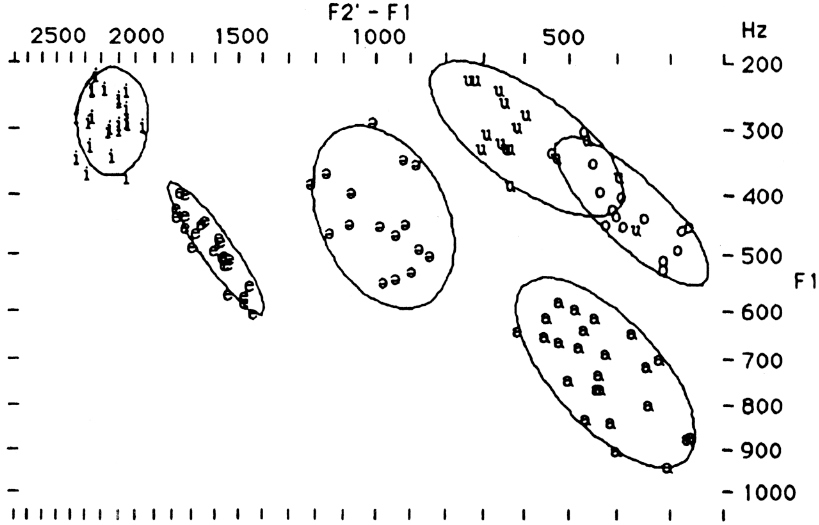

Figure 1. Angami vowels, male speakers (frequencies in Hz on a Bark scale).

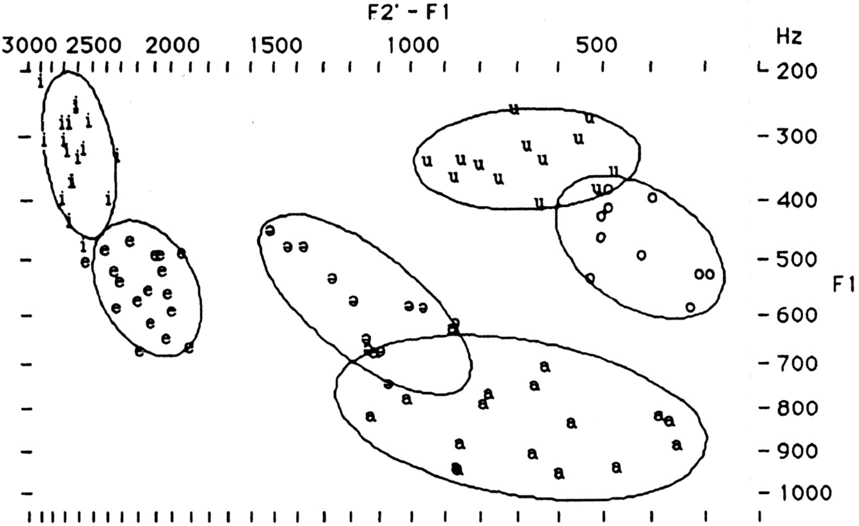

Figure 2. Angami vowels, female speakers (frequencies in Hz on a Bark scale).

The mean formant frequencies of the six vowels as spoken by the six speakers are as shown in Table 1. It is apparent from the plots and the mean formant frequencies that /i/ is a high front unrounded vowel close to cardinal [i]; /e/ is a mid-front unrounded vowel between cardinal [e] and [ɛ]; /a/ is a low central unrounded vowel between cardinal [a] and [ɑ]; /o/ is a mid-high back rounded vowel close to cardinal [o]; /u/ is a high rounded vowel near cardinal [u], but forward toward [ʉ]; and /ə/ is a mid-central vowel that covers a range from the canonical [ə] upward toward [ɨ].

Table 1. The frequencies of the first three formants of the Angami vowels.

Vowel	*Male speakers*			*Female speakers*		
	F1	F2	F3	F1	F2	F3
i	301	2403	3028	347	2703	3238
e	520	2054	2776	577	2419	3193
a	749	1187	2640	841	1365	3082
o	470	864	2618	508	814	2725
u	331	941	2374	354	855	2700
ə	457	1438	2584	603	1482	2982

Vowels vary allophonically depending on the preceding consonant. Figure 3 gives a sample for the vowel [u], which is pronounced farther forward after [s] than after the bilabials [p] and [m]. Since a complete set of consonants before [u] was not available, we do not know the full range of contexts for this process.

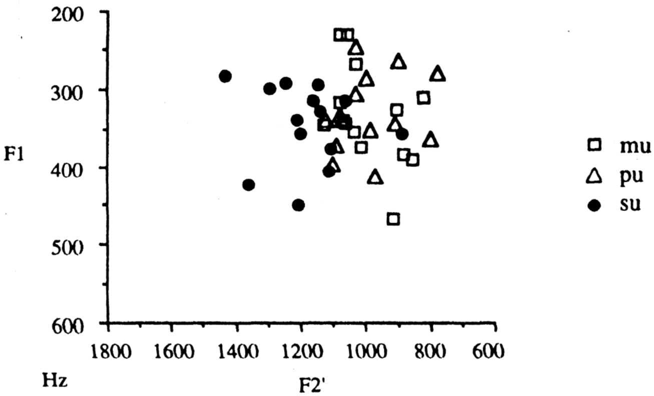

Figure 3. Distribution of [u] vowels in the contexts [mu], [pu], and [su], as spoken in isolation and in a frame by all six speakers

TONES

Khonoma Angami has four tones. (Five tones are reported for the Kohima dialect by Burling 1960 and Ravindran 1974, although they do not characterize each of the tones in the same way.) Throughout this paper the highest tone is indicated by superscript 1 and the lowest by superscript 4. The four tones are exemplified in the following minimal sets:

g^{w}*e*^{1}	'to bud'	*ke*^{3}*ɻi*^{1}	'to twist'
g^{w}*e*^{2}	'to occupy'	*ke*^{3}*ɻi*^{2}	'to marry'
g^{w}*e*^{3}	'to be thin'	*ke*^{3}*ɻi*^{3}	'to be ill at ease'
g^{w}*e*^{4}	'physique'	*ke*^{3}*ɻi*^{4}	'to mix'
su^{1}	'to wash face'	*ke*^{3}*ba*^{1}	'snare'
su^{2}	'in place of'	*ke*^{3}*ba*^{2}	'time'
su^{3}	'to block (as of view)'	*ke*^{3}*ba*^{3}	'to place on top of each other'
su^{4}	'deep'	*ke*^{3}*ba*^{4}	'to play, mess about in mud'

The Khonoma Angami tones are illustrated in Figure 4. The four words (the fourth set shown above) were each cut out from the frame in which they were spoken. The arrows indicate the onset of the fifth harmonic in the second syllable of each of the four words. As the first syllable in each of the words is on tone 3, the tone rises during the second syllable of each of the first two words. In the fourth word, in which the second syllable has a low tone, there is a breathy voice quality, which makes it difficult to see the harmonics.

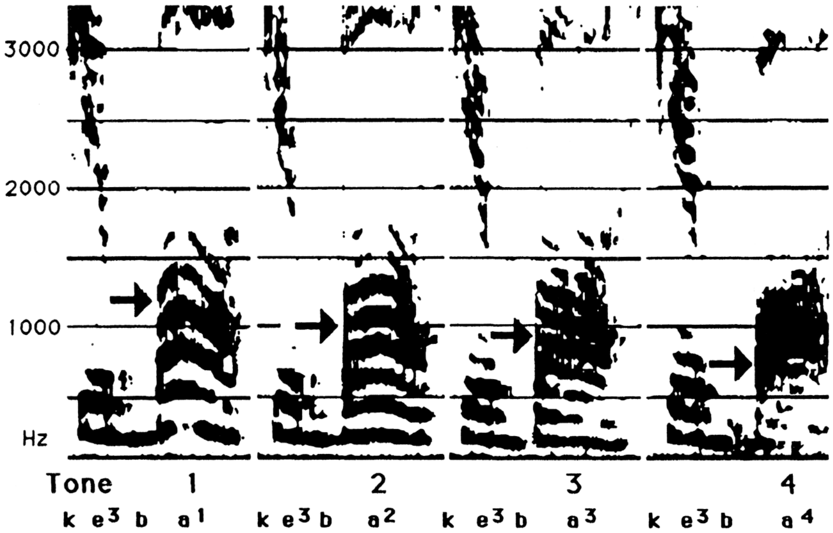

Figure 4. Narrow band spectrograms illustrating the four Angami tones.

Table 2 gives the average fundamental frequencies corresponding to the four tones for male and female speakers. The pitches are reliably different (significant at the .0001 level in analysis of variance), both by gender and by individual speaker.

Table 2. Mean fundamental frequencies of tones 1-4 in Hz.

	male	*female*
Tone 1	165	287
Tone 2	141	230
Tone 3	127	206
Tone 4	110	173

ANGAMI CONSONANTS

The following set of words illustrates the consonants, using (as in previously cited parts of the list) the conventional Angami orthography, with the addition of tone markings and using [ə] in the place of 'ü'. As we will see, not all these sounds are phonologically contrastive.

pʰ	*phe*^{4}	'to uproot'	tʰ	*the*^{3}	'to squeeze'	kʰ	*kha*^{2}	'to prohibit'
p	*pe*^{3}	'to shiver'	t	*te*^{2}	'to catch'	k	*ka*^{2}	'to spoon out'
b	*be*^{3}	'to cut'	d	*de*^{4}	'to hem'	g	*ga*^{2}	'to winnow'
m̥ʰ	*mhe*^{4}	'to blow'	n̥ʰ	*nhe*^{4}	'to blow the nose'	ɲ̊ʰ	*nyhie*^{4}	'to paste onto a wall'
m	*me*^{1}	'mouth'	n	*ne*^{1}	'to push'	ɲ	*nyie*^{3}	'thousand'
						ŋ	*ngu*^{2}	'to see'
			s	*se*^{4}	'to deceive'	h	*ha*^{3}	'to breathe'
v	*va*^{3}	'to illuminate'	z	*ze*^{4}	'to sleep'			
			ʃ	*sha*^{1}	'road'			
			ʒ	*zha*^{1}	'big'			
			ɹ̥	*rha*^{3}	'to afford'			
			ɹ	*ra*^{3}	'village'			
ʍ	*whi*^{4}	'to roam'	ɹ̥ə	*rhə*^{3}	'to plan'	j̊	*yha*^{4}	'to dig out'
w	*we*^{2}	'we'	ɹə	*rə*^{3}	'to aim at'	j	*ya*^{1}	'to shade'
			l̥ʰ	*lha*^{3}	'to rummage'			
			l	*la*^{1}	'for'			
pf	*pfə*^{4}	'to carry'	ts	*tsa*^{1}	'little'	tʃ	*ca*^{1}	'white'
pʰɹ	*phrə*^{3}	'to read'				kʰɹ	*khru*^{2}	'to bury'
pɹ	*prə*^{2}	'hailstone'				kɹ	*kru*^{1}	'to flow'
						kʍ	*khwe*^{4}	'cloth'
						kʷ	*ke*^{3}*kwe*^{2}	'to tidy'
						gʷ	*gwe*^{3}	'to be thin'
						kʰf	*khfə*^{4}	'bitter'
						kv	*kvə*^{3}	'to step up'
						gv	*gvə*^{2}	'to bear fruit'

The consonant phonemes are as in the chart below. In the Khonoma dialect there are three-way contrasts in voice onset time among the plosives, but not among the affricates. Other dialects of Angami have a three way contrast at least among the affricates [tʃʰ, tʃ, dʒ]. All the other consonants also contrast in voice onset time, with the exception of /v, ŋ, h/. [f] does occur, but only as an allophone of [p]. [h] is in free variation with [x]. The retroflex [ɻ] is laminal before high vowels, but sublaminal before other vowels. The syllable [ɻə] can optionally be pronounced as a syllabic [ɻ̩], as it is in about half the instances in our recordings. This rhotic vowel has average formant values at 475, 1542, 1997, and 3150 Hz. Its location in the F1 x F2 vowel space is similar to that of [ə], but acoustically it is differentiated by the lowering of F3 and F4 that is characteristic of retroflexion.

Khonoma Angami consonant phonemes

	Bilabial	Labio-dental	Alveolar	Post-alveolar	Retroflex	Palatal	Velar	Labial velar	Glottal
Plosive	pʰ p b		tʰ t d				kʰ k g	kʍ kʷ gʷ	
Affricate			ts	tʃ					
Nasal	m̥ʰ m		n̥ʰ n			ɲ̊ʰ ɲ	ŋ		
Fricative		v	s z	ʃ ʒ					h
Approx.					ɻ̊ ɻ	j̊ j		ʍ w	
Lateral			l̥ʰ l						

In addition to whatever affricates may occur, all dialects of Angami have consonant clusters involving [ɻ]. There are also sequences of consonants that result from a labiodentalization process which is recognized in the orthography. Labial and labialized consonants have allophones whose distribution is summarized in Table 3. For such cases, the consonant chart gives the allophone with the broadest distribution. An additional allophone, [bv], appears in the literature on Kohima Angami (e.g. [bvə] 'swollen', in Ravindran 1974:30), but it does not occur in Khonoma Angami.

Table 3. Allophonic distribution of consonants.

Phoneme or cluster	*Realization before [ə]*	*Realization elsewhere*
/p/	[f]	[p]
/m̥ʰ/	[ɱʰ]	[m̥ʰ]
/m/	[ɱ]	[m]
/kʰw/	[kʰf]	[kʰw]
/kw/	[kv]	[kw]
/gw/	[gv]	[gw]

VOICE ONSET TIME

As we have noted, Angami stops display a three-way distinction in the timing of the onset of voicing. The voiced stops, like those in most of the languages spoken in India, are usually voiced throughout the closure. In our data this means that they may be said to be pre-voiced for an average of 160 ms prior to the stop burst, the voicing then continuing into the following vowel. Voiceless unaspirated stops have an average voiceless interval of 15 ms between the stop burst and the onset of the following vowel. For aspirated stops, the voiceless interval averages 82 ms. A breakdown of voice onset times for the separate places of articulation is shown in Table 4. The VOT durations for the voiceless aspirated and unaspirated stops, both in isolated words and in a frame sentence, are similar to those recorded by Lisker and Abramson (1964) for other languages that make a three-way VOT contrast. The duration of voicing in Angami voiced stops, however, is noticeably longer than in the languages recorded by Lisker and Abramson: about 50% longer in isolated words and 125% longer within a frame sentence.

Table 4. Voice onset times for Angami stop consonants (measured in ms from the stop release).

Place of articulation:	*Bilabial*	*Dental*	*Velar*	*Average*
In isolated word:				
Voiced	-149	-152	-118	-140
Voiceless unaspirated	10	9	20	13
Voiceless aspirated	83	55	91	77
In frame sentence:				
Voiced	-172	-201	-169	-180
Voiceless unaspirated	10	14	29	17
Voiceless aspirated	83	70	108	87

VOICELESS NASALS

The voiceless nasals of Angami differ from those reported for other South and Southeast Asian languages in that they are aspirated. They are not like the voiceless nasals in Burmese, for example, which consist of a voiceless portion followed by a short voiced portion just before the release of the articulatory stricture into the following vowel. The nasal continues for a short time into the vowel before the velic stricture is closed. In Angami the voiceless nasals remain voiceless throughout the nasal articulation and even beyond the release; voicing of the following vowel begins well after the articulatory stricture has been released. The timing of glottal vibration (voicing) relative to the velic and articulatory strictures is shown schematically in Figure 5. Although the figure shows distinct events, the actual articulation and acoustic signal are blended at the segment boundaries. The Angami aspiration and vowel may be partly nasalized; the vowel may be only partly voiced at the beginning.

The voiceless nasals in Angami sound very different from those in Burmese. As noted above, there is no voiced portion towards the end of the voiceless nasal consonant, but instead, before the voicing for the vowel begins, the oral occlusion is released while air is still flowing out through the nose. The auditory impression is that there is an epenthetic voiceless plosive after the voiceless nasal and before the vowel. But this is an incorrect description as a plosive involves a complete stoppage of the air, which is then released orally. In Angami voiceless nasals there is continuous nasal airflow, which even persists into the following vowel.

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                                NASAL              VOWEL
Burmese
VELIC STRICTURE                 |-------open---------|------closed-------|
ARTICULATORY STRICTURE          |----closed-----|----------open----------|
GLOTTIS                         |--voiceless--|--------- voicing---------|

Angami
VELIC STRICTURE                 |-------open---------|------closed-------|
ARTICULATORY STRICTURE          |----closed-----|----------open----------|
GLOTTIS                         |--voiceless--------|----voicing---------|
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*Figure 5. Overlap of glottal vibration (voicing) with velum opening and the release of the articulatory stricture in Burmese and Angami voiceless nasals. ** indicates the aspirated portion.*

The structure of these unusual voiceless nasals may be seen in the aerodynamic records in Figure 6 (from Bhaskararao and Ladefoged, 1991), which show examples of each of the three voiceless nasals extracted from the frame sentence, as pronounced by one speaker. Significant moments in time are marked with arrows in the top example. At time (1) the articulators (in this case, the lips) close, and after a few vibrations of the vocal cords voicing ceases. The line indicating the oral airflow slopes slightly upwards from this point, probably because the lips are being pushed forward into the mouthpiece. At time (2) the articulators open and there is a rapid flow of air from the mouth. At the same time the airflow from the nose drops, but the velum is still lowered so that there is still a considerable flow of air through the nose. At time (3) voicing starts, probably with somewhat breathy vibrations, as there is a high rate of airflow through the mouth, as well as through the nose. If we take it that the vowel begins at this point, then we must consider at least the first part of it to be nasalized.

A similar sequence of events may be seen in the records for the other two voiceless nasals in this language. The oral airflow on the release of the

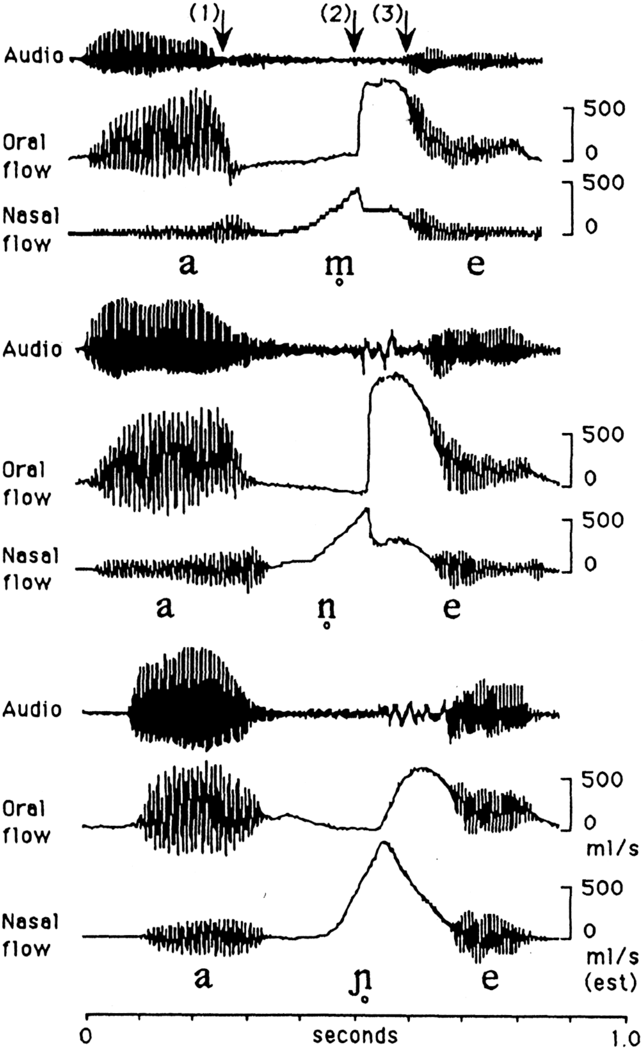

Figure 6. Angami aerodynamic records. See text for explanation.

alveolar closure (in the middle set of records) is particularly strong. It even causes some artifacts on the audio record which was made via a microphone held just outside the oral mask. It is hardly surprising that this sharp increase in oral airflow in the voiceless alveolar nasal gives rise to the auditory impression of there being an epenthetic voiceless alveolar plosive. But, although the nasal airflow drops at this moment, it still remains at about 500 ml/s, so this cannot be described as a regular plosive. The voiceless palatal nasal at the bottom of the figure shows a far less sharp release of the oral air. The nasal airflow also drops more slowly, and we may conclude from this and the comparatively smaller oral airflow that there is an oral obstruction comparable to a voiceless palatal fricative accompanying this voiceless nasal.

These patterns were consistent across all repetitions for all of the six speakers of Khonoma Angami that we recorded (as well as for a further three speakers of Kohima Angami who were recorded). Oral airflow began a little over half way through the voiceless section. Unlike the Burmese and Mizo sounds described by Bhaskararao and Ladefoged (1991), in which there was always some voicing during the last part of the nasal, in Angami there was never any voicing during the nasal. There were notable differences among the Angami voiceless nasals. The general pattern of these differences was similar to that exemplified in Figure 6. The oral airflow was usually greatest during the alveolar nasal, and almost as great during the bilabial nasal. The palatal nasal usually had both a slower increase of nasal airflow and a slower decrease.

We measured the durations of the different parts of the voiceless nasals for the six speakers of the Khonoma dialect of Angami in two different ways. Table 5 shows measurements made on the aerodynamic records. In this set of measurements we were mainly concerned with relating the nasalized aspiration—that is, the voiceless part of the sound after the release of the oral stricture and before the commencement of voicing within the vowel—and the purely nasal consonantal part—that is, the part in which there was an oral closure but nasal flow. The consonant was not the only part with nasal airflow; nasalization invariably occurred during the preceding vowel. Nor, when it occurred after a voiced sound, was the nasal consonant entirely voiceless; there was always voicing extending into the consonant from the preceding vowel. The measurements in Table 5 reflect a certain amount of variation in the durations due to overall differences in speed among the speakers, the different degrees of emphasis which the speakers placed on the word, and their varying degree of accommodation to the experimental task. Nevertheless it is clear that in by far the majority of cases the duration of the nasalized aspiration is substantial.

Table 5. Durations in ms of (1) the nasal consonants and (2) the nasalized aspiration for six speakers of Khonoma Angami. Several sets of data were obtained for some of these speakers.

	bilabial		*dental*		*palatal*		*mean*	
Speaker	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
1 (a)	150	162	91	117	97	230	113	170
(b)	96	130	159	101	141	182	132	138
(c)	137	121	189	137	146	177	157	145
2 (a)	135	119	105	207	155	139	132	155
(b)	110	93	143	79	87	131	113	101
(c)	105	145	175	124	115	158	132	142
3 (a)	206	45	260	85	213	185	226	105
(b)	253	91	302	95	282	88	279	91
4	248	89	227	107	221	126	232	107
5	73	44	184	22	139	26	132	31
6	146	57	182	49	116	102	318	69
Mean	151	100	183	102	156	140	179	114

We also made measurements of the audio recordings of Khonoma Angami, using the Kay CSL analysis system. Figure 7 shows the waveform and spectrogram for the word [m̥e⁴] (to blow) as said within the frame sentence. Records of this kind enabled us to divide the nasal consonants into two parts, which were measured separately. The first, voiced, part extended from the time marked by the first arrow in the figure to the time marked by the second arrow; the second, voiceless, part was from the time marked by the second arrow in the figure to the time marked by the fourth arrow. The third arrow in the figure shows the moment of oral release within the consonant. The time between this point and the onset of voicing (the fourth arrow) corresponds to the aspiration, the voiceless part after the release of the oral closure, which was also measured. These acoustic records did not allow us to determine whether the aspiration was nasalized (as we could see it was from the aerodynamic records).

The average durations of the voiced and voiceless portions of the nasal consonant and of the aspiration are shown in Table 6, which also indicates the percentage of time occupied by each portion. The voiced portion is about half of the entire segment, the voiceless nasal somewhat more than one fourth, and the aspiration somewhat less than one fourth. In these measurements, therefore, the aspiration is a somewhat smaller proportion of the total than in the aerodynamic measurements, in which it accounted for about 40% of the entire segment. We are not sure of the reasons for this discrepancy. Obviously the complexity of the procedure for recording aerodynamic data (described in more detail in Ladefoged 1993) accounts for some of it, in that it may have

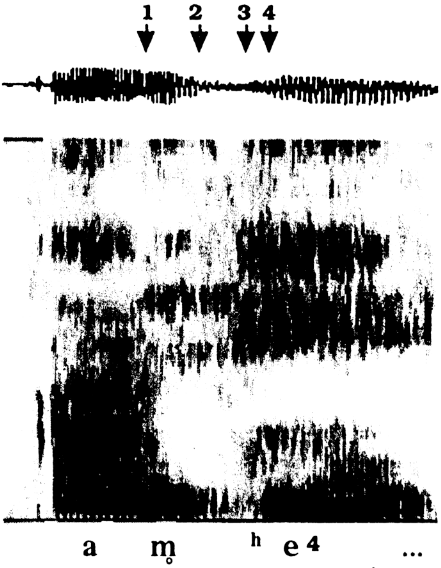

Figure 7. Waveform and spectrogram of the word [m̥e^4] *spoken in a frame, only the preceding word being shown here. The arrows indicate: (1) onset of oral closure, (2) end of voicing, (3) end of oral closure, and (4) onset of voicing of the following vowel.*

induced a more hyper-articulated style of speech. But some of the variation may be due to measurement procedures. What is comparatively easy to determine on acoustic records—onset and offset of voicing—is hard to see precisely on aerodynamic records; and what is easy to see on aerodynamic records—the onset of oral airflow when there is also nasal airflow—is often lost in the noise of the voiceless nasal on the acoustic records.

We also compared the durations of voiced and voiceless nasals. Voiceless nasals average 7-10% longer than their voiced counterparts. The difference, while interesting, is not great enough to support a theory that the aspirated voiceless nasal is really a cluster of nasal plus [h]. There is also no systematic phonological support for such a theory. Dantsuji (1984) discusses a similar finding for Burmese unaspirated voiceless nasals.

Table 6. Average duration in milliseconds and percentage of total duration for each portion of the voiceless nasal in VCV context.

	Voiced nasal	*Voiceless nasal*	*Aspiration*	*Total*
[m̥]	84 (41%)	73 (36%)	48 (23%)	205 ms
[n̥]	115 (55%)	54 (25%)	44 (20%)	213 ms
[ŋ̊]	94 (46%)	57 (28%)	54 (26%)	205 ms
Mean	98 ms (48%)	61 ms (29%)	49 ms (23%)	208 ms

ACOUSTIC CORRELATES OF PLACE OF ARTICULATION IN VOICELESS NASALS

When a word beginning with a voiceless nasal is preceded by a vowel, formant transitions from the vowel into the nasal give a distinct cue as to the place of articulation. But when the same word is spoken in isolation, there are no place cues at the beginning of the nasal. We are then left with the problem of determining how the voiceless nasals are distinguished from each other in these circumstances. They are all very similar sounds, but tests on speakers of the language left us in no doubt that they could distinguish between them.

Several aspects of the acoustic signal could serve as cues to place of articulation, among them:

1. the spectral pattern during the nasal portion
2. the frequencies of peaks in the spectrum at the time the nasal is released
3. the frequencies of peaks in the spectrum during the voiceless (aspiration) portion
4. timing of voice onset after the nasal release

We will consider each of these factors in turn. Each of them was measured in the words [m̥e^4] [n̥e^4], and [ŋ̊e^4] spoken in isolation by the six speakers.

The LPC (Linear Predictive Coding) spectrum of the kind used for analysis of vowels is inappropriate for the analysis of the nasal signal, in that it is an all pole model which cannot take the nasal zeroes into account. Instead an FFT (Fast Fourier Transform) of 128 points was used to determine the spectrum. The first pole was uniform at about 300 Hz for all nasals (as explained in Fujimura 1962). Therefore the frequency of the second pole was used as an indicator of spectral difference related to place of articulation. All factors were analyzed by means of T-tests between the pairs of consonant types.

Our findings with respect to the four points listed above were as follows:

1. There was no evidence that spectral patterns during the nasal closure varied systematically with place of articulation.

2. The mean frequency of the second pole of [ɲ̊] at the nasal release was significantly different (p<.001) from those of [m̥] and [n̥]. The means of [m̥] and [n̥] differed only at the p=.05 level. The mean frequencies were:

[m̥e^4]	1992 Hz
[n̥e^4]	2026 Hz
[ɲ̊e^4]	2692 Hz

3. The mean frequency of the second pole of [ɲ̊] at 30 ms after the nasal release was also significantly different (p<.001) from those of of [m̥] and [n̥]. The means of [m̥] and [n̥] were not significantly different. The mean frequencies were:

[m̥e^4]	2129 Hz
[n̥e^4]	2157 Hz
[ɲ̊e^4]	2769 Hz

Comparisons with the frequencies of the poles at the time of the release (reported in (2) above) show that the second pole of both [m̥] and [n̥] increases by about 140 Hz over the first 30 ms of the aspiration, but that of [ɲ̊] increases by about 180 Hz. The transitions, as well as the frequency at the time of release, distinguishes the palatal place of articulation.

4. The voice onset time of [m̥] was different from that of [n̥] and [ɲ̊] at the p<.08 level. The differences between [n̥] and [ɲ̊] were less significant. The mean onset times were:

[m̥e^4]	69 ms
[n̥e^4]	84 ms
[ɲ̊e^4]	92 ms

Since the data set is small (seven tokens of each consonant), the differences fail to reach a convincing level of probability. They can be taken only as indicative of trends that might be seen in a larger set of data. The palatal nasal can be distinguished from the others by its higher F2 frequency at the nasal release and during the aspiration, and the bilabial can be distinguished by its shorter voice onset time. No single factor among those tested appears adequate for distinguishing all three consonants, although the frequency of F2 at the nasal release might adequately differentiate them if there were more data.

VOICELESS APPROXIMANTS

Angami distinguishes between voiced and voiceless approximants [l]/[l̥], [ɹ]/[ɹ̥], [j]/[j̊], and [w]/[ʍ]. It is difficult to determine whether the voiceless approximants are aspirated like the voiceless nasals, since most of the approximant tokens do not display the instantaneous release which is characteristic of nasals and which demarcates the nasal portion before the release from the aspirated portion after the release. Among the approximants, only the laterals usually have a definite release followed by a voiceless non-lateral portion, similar to the structure of the nasals.

The voiceless approximants have a great deal of high-frequency noise, similar to the [χ] sound that is a variant of Angami [h]. Thus the [l̥] could be characterized as a lateral [h], the [ɹ̥] as a rhotacized [h], the [j̊] as a palatalized [h], and the [ʍ] as a labialized [h]. Although such a characterization is an extremely useful device for teaching non-Angami speakers how to make these sounds, there is no systematic evidence to favor their interpretation as [h] plus secondary articulation, instead of approximants. In fact, for [l̥] tokens that have a release, the high-frequency noise is not present during the voiceless lateral portion, but only during the portion after the release.

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APPENDIX: Transcription of recordings

Recording of 20 February 1992.
Speakers: Nichəmeno Chase (f), Ketouseno Vəprə (f), Sanyə Iralu (m), Vitsilhuto Dolie (m).

Recording of 25 February 1992.
Speakers: Nichəmeno Chase (again), Avise Terhəja, (m) Petevizo Terhəja (m).

Each word is spoken in isolation, then the list is repeated with each word in the frame: a^2 ____ si^{3}ʃu^{2}to^3 "I write ____". (Chase is the only subject who is reading the word list; the others repeat after her.)

be^3	to cut
pe^3	to shiver
p^{h}e^4	to uproot
de^4	to hem
te^2	to catch
t^{h}e^3	to squeeze/wring
ʒa^1	big
tʃa^1	white
ʃa^1	road
ga^2	to winnow
ka^2	to spoon out
k^{h}a^2	to prohibit
pfə^4	to carry
za^3	to place pot on stove
tsa^1	little
m̥^{h}e^4	to blow
me^1	mouth
n̥^{h}e^4	to blow the nose
ne^1	to push
ɲ̊^{h}e^4	to plaster onto a wall
ɲe^3	thousand
ŋu^2	to see
va^3	to illuminate
se^4	to deceive
ze^4	to sleep
ha^3	to breathe

ɻə^3	to plan
ɻ̊ə^3	to aim at
ɻa^3	to afford
ɻ̊a^3	village
j̊a^4	to operate/dig out
ja^1	to shade
ʎi^4	to roam
we^2	we
l̥^{h}a^3	to rummage
la^1	for
pɻə^2	hail stone
p^{h}ɻə^3	to read
kɻu^1	to flow
k^{h}ɻu^2	to bury
g^{w}e^3	to be thin
ke^{3}k^{w}e^2	to tidy
k^{hw}e^4	cloth
gvə^2	to bear fruit
kvə^3	to climb/step up
k^{h}fə^4	bitter
pi^2	mushroom
pe^3	to shiver
ta^3	to chew
po^4	one
pu^3	to bloom
pfə^4	to carry

mi^1	fire
me^2	always
ma^3	price
mo^3	to moo
mu^4	sweet
mə^4	to refuse
mie^1	body hair
g^{w}e^1	to bud
g^{w}e^2	to occupy
g^{w}e^3	to be thin
g^{w}e^4	physique
su^1	to wash face
su^2	in place of
su^3	to block (as of view)
su^4	deep
ke^{3}ɻi^1	to twist
ke^{3}ɻi^2	to marry
ke^{3}ɻi^3	to be ill at ease
ke^{3}ɻi^4	to mix

ke^{3}ba^1	snare
ke^{3}ba^2	time
ke^{3}ba^3	to place on top of each other
ke^{3}ba^4	to play or mess about in mud
pe^{3}zu^3	urine
pe^{3}zu^2	to urinate
ti^{3}ɻə^3	rain
ti^{1}ɻə^3	to rain
ɻə^{3}za^3	injury
ɻə^{3}za^2	to be injured
te^{3}ɻha^3	an item of traditional dress
te^{3}ɻha^4	to put on the te^{3}rha^3
vo^{3}kɻ(ə)^1	female pig
vo^{3}kɻ(ə)^2	male pig