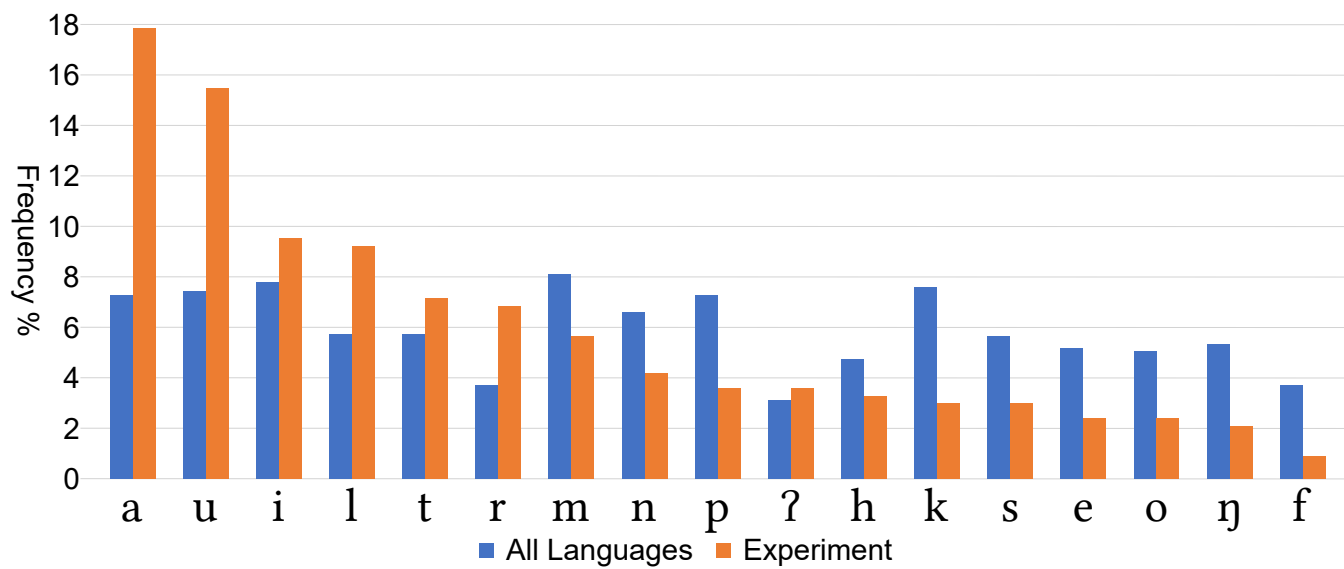


Appendix 1 - Prior Segment Frequencies



Appendix 2 - Prior Frequencies

	e	i	a	u	o	m	n	ŋ	l	r	t	p	ʔ	h	s	k	f
e									3					3			
i									4	1	4	3		4	2		
a				1			2	1	1	5			6	2	4	2	3
u			1						5	5	8		7	1	2	6	
o							3		1	2							
m																	
n			2					5									
ŋ			1		3		5										
l	3	4	1	5	1					21	7						
r		1	5	5	2				21		7						
t		4		8					7	7			6				
p		3															6
ʔ			6	7							6					8	
h	3	4	2	1											10		
s		2	4	2											10		
k			2	6										8			
f			3									6					

Appendix 2 - Prior Frequencies

o → l

Sleep.Primary				
u	r	o	η	-
k	u	l	o	m

η → a

White.Primary				
t	i	a	η	-
t	i	?	a	n

r → i

Fish.Primary				
k	u	r	i	l
u	t	i	l	-

u → h

Walk.Primary				
u	t	u	?	-
h	u	t	u	p

u → a

Black.Primary				
a	u	-	-	
?	a	?	u	

l → o

Sleep.Primary				
k	u	l	o	m
u	r	o	η	-

a → l

Water.Primary				
i	a	r	a	-
i	s	a	l	a

a → η

White.Primary				
t	i	?	a	n
t	i	a	η	-

l → a

Water.Primary				
i	s	a	l	a
i	a	r	a	-

i → r

Fish.Primary				
u	t	i	l	-
k	u	r	i	l

h → u

Walk.Primary				
h	u	t	u	p
u	t	u	?	-

Appendix 2 - Prior Frequencies

a → u

Black.Primary				
?	a	?	u	
a	u	-	-	

s → u

Walk.Primary				
s	u	r	u	p
u	t	u	?	-

Walk.Primary				
s	u	l	u	p
u	t	u	?	-

n → a

White.Primary				
t	i	a	n	-
t	i	?	a	n

White.Primary				
t	i	a	n	-
t	i	?	a	n

o → r

Sleep.Primary				
u	r	o	η	-
?	u	r	o	m

Sleep.Primary				
u	r	o	η	-
k	u	r	o	m

k → a

Black.Primary				
a	k	u	-	
?	a	?	u	

Black.Primary				
a	k	u	-	
?	a	?	u	

s → i

Wind.Primary				
s	i	r	u	
i	t	u	-	

Wind.Primary				
s	i	l	u	
i	t	u	-	

u → s

Walk.Primary				
u	t	u	?	-
s	u	r	u	p

Walk.Primary				
u	t	u	?	-
s	u	l	u	p

a → n

White.Primary				
t	i	?	a	n
t	i	a	n	-

White.Primary				
t	i	?	a	n
t	i	a	n	-

a → k

Black.Primary				
?	a	?	u	
a	k	u	-	

Black.Primary				
?	a	?	u	
a	k	u	-	

h → a

Water.Primary				
i	h	a	r	a
i	a	r	a	-

Grass.Primary				
h	a	p	i	?
a	f	i	-	-

i → s

Wind.Primary				
i	t	u	-	
s	i	r	u	

Wind.Primary				
i	t	u	-	
s	i	l	u	

Appendix 2 - Prior Frequencies

r → o

Sleep.Primary	Sleep.Primary
? u r o m	k u r o m
u r o η -	u r o η -

a → h

Water.Primary	Grass.Primary
i a r a -	a f i - -
i h a r a	h a p i ?

p → i

Grass.Primary	Grass.Primary	Grass.Primary
h a p i ?	s a p i -	s a p i -
a f i - -	a f i - -	a f i - -

h → e

Child.Primary	Child.Primary	Child.Primary
h e l u	h e l u	h e l u
e l u -	e l u -	e l u -

e → l

Child.Primary	Child.Primary	Child.Primary
h e l u	h e l u	h e l u
e l u -	e l u -	e l u -

l → e

Child.Primary	Child.Primary	Child.Primary
e l u -	e l u -	e l u -
h e l u	h e l u	h e l u

η → o

Sleep.Primary	Sleep.Primary	Sleep.Primary
u r o η -	u r o η -	u r o η -
? u r o m	k u r o m	k u l o m

o → η

Sleep.Primary	Sleep.Primary	Sleep.Primary
? u r o m	k u r o m	k u l o m
u r o η -	u r o η -	u r o η -

a → f

Grass.Primary	Grass.Primary	Grass.Primary
h a p i ?	s a p i -	s a p i -
a f i - -	a f i - -	a f i - -

i → p

Grass.Primary	Grass.Primary	Grass.Primary
a f i - -	a f i - -	a f i - -
h a p i ?	s a p i -	s a p i -

e → h

Child.Primary	Child.Primary	Child.Primary
e l u -	e l u -	e l u -
h e l u	h e l u	h e l u

Appendix 2 - Prior Frequencies

f → a

Grass.Primary	Grass.Primary	Grass.Primary
a f i - -	a f i - -	a f i - -
h a p i ?	s a p i -	s a p i -

t → i

Fish.Primary	Wind.Primary	Wind.Primary	Wind.Primary
? u t i l	i t u -	i t u -	i t u -
u t i l -	h i t u	s i r u	s i l u

a → s

Water.Primary	Water.Primary	Grass.Primary	Grass.Primary
i a r a -	i a r a -	a f i - -	a f i - -
i s a r a	i s a l a	s a p i -	s a p i -

i → h

Wind.Primary	Green.Primary	Green.Primary	Green.Primary
i t u -	l a i - -	l a i - -	l a i - -
h i t u	l a h i ?	l a h i k	l a h i k

h → i

Wind.Primary	Green.Primary	Green.Primary	Green.Primary
h i t u	l a h i ?	l a h i k	l a h i k
i t u -	l a i - -	l a i - -	l a i - -

i → t

Fish.Primary	Wind.Primary	Wind.Primary	Wind.Primary
u t i l -	h i t u	s i r u	s i l u
? u t i l	i t u -	i t u -	i t u -

i → l

Fish.Primary	Fish.Primary	Fish.Primary	Fish.Primary
? u t i l	u t i l -	k u r i l	k u l i l
u t i l -	k u l i l	u t i l -	u t i l -

s → a

Water.Primary	Water.Primary	Grass.Primary	Grass.Primary
i s a r a	i s a l a	s a p i -	s a p i -
i a r a -	i a r a -	a f i - -	a f i - -

l → i

Fish.Primary	Fish.Primary	Fish.Primary	Fish.Primary
u t i l -	u t i l -	u t i l -	k u l i l
? u t i l	k u r i l	k u l i l	u t i l -

Appendix 3 - Symbols

Ψ	Phylogeny The (possibly unknown) relationship between entities resulting from an evolutionary tree
τ	Tree topology Information on the relationships of the languages
μ	Substitution rate the rate at which the language changes
N	Sampled languages The number of languages in a sample
v	Expected events The expected number of evolutionary events that occurred between two languages
t	Past times Times of branch events
\mathcal{B}	Possible rooted trees
A	Segmental alignment Constructed by combining the word segment information for the languages of interest with information on the homology of the segments
S	Segmental information Information on the homology of the segments
s	Segment Linguistic segment
s_i	ith segment
H	Homology map The map describing the alignment of the segments
Q	Rate Matrix
β	Rate matrix scaling factor Scales the rate matrix such that the average rate of segmental substitution is one
P	Probability The probability the process ends in certain state
P	Marginal Likelihood The probability of an event occurring
π	Equilibrium distribution
λ	Rate of segment insertion
μ	Rate of segment deletion
n	Word length

Appendix 3 - Symbols

Number of segments in a word

r **Rate parameter**

θ **Rate parameters**

Parameters associated with the rate matrix

θ' **Proposal**

New value proposal

q **Proposal probability**

Probability of new proposal

u **Random number**

R **Acceptance probability**

Probability of accepting a proposed value

\mathcal{M} **Model**

Mathematical model for linguistic parameters

BF **Bayes Factor**

A numerical factor related to the quality of the model fit

X **Unknown**

Appendix 4 - Words containing each segment

a	0061	8
ihara iara isara isala na? na nak nak popat fofa? popat popat lami lami lami lami narit nari? narit nalit mumar mumar mumar mumar alah ala alas alas atar atar arar alal ?a?u au aku aku ti?an tian tian tian lahi? lai lahi lahi hapi? afi sapi sapi		
e	0065	15
helu elu helu helu tetu tetu teru telu		
f	0066	13
fofa? afi		
h	0068	7
ihara hitu helu helu helu alah hutup lahi? lahi lahi hapi?		
i	0069	3
?util util kuril kulil ihara iara isara isala hitu itu siru silu lami lami lami lami narit nari? narit nalit ti?an tian tian tian lahi? lai lahi lahi hapi? afi sapi sapi		
k	006B	5
kuril kulil nak nak kurom kulom aku aku lahi lahi		
l	006C	4
?util util kuril kulil isala ulu silu lami lami lami lami nalit helu elu helu helu alah ala alas alas sulup lumun kulom alal telu lahi? lai lahi lahi		
m	006D	14
lami lami lami lami mumar mumar mumar mumar rumun rumur rumun lumun ?urom kurom kulom		
n	006E	10
na? na nak nak narit nari? narit nalit rumun rumun lumun ti?an tian tian		
o	006F	12
popat fofa? popat popat ?urom uro? kurom kulom		
p	0070	11
popat popat popat hutup surup sulup hapi? sapi sapi		
r	0072	6
kuril ihara iara isara uru? uru uru siru narit nari? narit surup rumun rumur rumun ?urom uro? kurom atar atar arar teru		
s	0073	9
isara isala siru silu alas alas surup sulup sapi sapi		
t	0074	2
?util util popat popat popat hitu itu narit narit nalit hutup utu? atar atar ti?an tian tian tian tetu tetu teru telu		

Appendix 4 - Words containing each segment

u	0075	1
ʔutil util kurul kulil uruʔ uru uru ulu hitu itu siru silu helu elu helu helu mumarj mumarj mumarj mumarj hutup utuʔ surup sulup rumun rumurj rumun lumun ʔurom uroŋ kurom kulom ʔaʔu au aku aku tetu tetu teru telu		
ŋ	0148	16
mumarj mumarj mumarj mumarj rumurj uroŋ tianj		
ʔ	0294	0
ʔutil naʔ fofaʔ uruʔ nariʔ utuʔ ʔurom ʔaʔu tiʔan lahiʔ hapiʔ		

Appendix 5 - Word Lists by Language

Language A

Cognate	IPA	Sounds
Fish-Primary	ʔutil	GlottalStop-u-t-e-l
Water-Primary	ihara	e-h-ah-r-ah
Earth-Primary	naʔ	n-ah-GlottalStop
Rain-Primary	popat	p-oh-p-ah-t
Cloud-Primary	uruʔ	u-r-u-GlottalStop
Wind-Primary	hitu	h-e-t-u
Man-Primary	lami	l-ah-m-e
Woman-Primary	narit	n-ah-r-e-t
Child-Primary	helu	h-ay-l-u
House-Primary	mumaŋ	m-u-m-ah-nya
Forest-Primary	alah	ah-l-ah-h
Walk-Primary	hutup	h-u-t-u-p
Speak-Primary	rumun	r-u-m-u-n
Sleep-Primary	ʔurom	GlottalStop-u-r-oh-m
Bathe-Primary	atar	ah-t-ah-r
Black-Primary	ʔaʔu	GlottalStop-ah-GlottalStop-u
White-Primary	tiʔan	t-e-GlottalStop-ah-n
Red-Primary	tetu	t-ay-t-u
Green-Primary	lahiʔ	l-ah-h-e-GlottalStop
Grass-Primary	hapiʔ	h-ah-p-e-GlottalStop

Language B

Cognate	IPA	Sounds
Fish-Primary	util	u-t-e-l
Water-Primary	iara	e-ah-r-ah
Earth-Primary	na	n-ah
Rain-Primary	fofaʔ	f-oh-f-ah-GlottalStop
Cloud-Primary	uru	u-r-u
Wind-Primary	itu	e-t-u
Man-Primary	lami	l-ah-m-e
Woman-Primary	nariʔ	n-ah-r-e-GlottalStop
Child-Primary	elu	ay-l-u
House-Primary	mumaŋ	m-u-m-ah-nya
Forest-Primary	ala	ah-l-ah
Walk-Primary	utuʔ	u-t-u-GlottalStop
Speak-Primary	rumuŋ	r-u-m-u-nya
Sleep-Primary	uroŋ	u-r-oh-nya
Bathe-Primary	atar	ah-t-ah-r
Black-Primary	au	ah-u
White-Primary	tiaŋ	t-e-ah-nya
Red-Primary	tetu	t-ay-t-u
Green-Primary	lai	l-ah-e
Grass-Primary	afi	ah-f-e

Language C

Cognate	IPA	Sounds
Fish-Primary	kuril	k-u-r-e-l
Water-Primary	isara	e-s-ah-r-ah
Earth-Primary	nak	n-ah-k

Appendix 5 - Word Lists by Language

Rain-Primary	popat	p-oh-p-ah-t
Cloud-Primary	uru	u-r-u
Wind-Primary	siru	s-e-r-u
Man-Primary	lami	l-ah-m-e
Woman-Primary	narit	n-ah-r-e-t
Child-Primary	helu	h-ay-l-u
House-Primary	mumaŋ	m-u-m-ah-nya
Forest-Primary	alas	ah-l-ah-s
Walk-Primary	surup	s-u-r-u-p
Speak-Primary	rumun	r-u-m-u-n
Sleep-Primary	kurom	k-u-r-oh-m
Bathe-Primary	arar	ah-r-ah-r
Black-Primary	aku	ah-k-u
White-Primary	tian	t-e-ah-n
Red-Primary	teru	t-ay-r-u
Green-Primary	lahik	l-ah-h-e-k
Grass-Primary	sapi	s-ah-p-e

Language D

Cognate	IPA	Sounds
Fish-Primary	kulil	k-u-l-e-l
Water-Primary	isala	e-s-ah-l-ah
Earth-Primary	nak	n-ah-k
Rain-Primary	popat	p-oh-p-ah-t
Cloud-Primary	ulu	u-l-u
Wind-Primary	silu	s-e-l-u
Man-Primary	lami	l-ah-m-e
Woman-Primary	nalit	n-ah-l-e-t
Child-Primary	helu	h-ay-l-u
House-Primary	mumaŋ	m-u-m-ah-nya
Forest-Primary	alas	ah-l-ah-s
Walk-Primary	sulup	s-u-l-u-p
Speak-Primary	lumun	l-u-m-u-n
Sleep-Primary	kulom	k-u-l-oh-m
Bathe-Primary	alal	ah-l-ah-l
Black-Primary	aku	ah-k-u
White-Primary	tian	t-e-ah-n
Red-Primary	telu	t-ay-l-u
Green-Primary	lahik	l-ah-h-e-k
Grass-Primary	sapi	s-ah-p-e

Appendix 6 - Segment Groups

Where symbols appear in pairs, the one to the right represents a rounded vowel.

Vowel

	Front	Near-Front	Central	Near-Back	Back
Close	i				u
Near-close					
Close-mid	e				o
Mid					
Open-mid					
Near-open					
Open		a			

Long-Vowel

	Front	Near-Front	Central	Near-Back	Back
Close					
Near-close					
Close-mid					
Mid					
Open-mid					
Near-open					
Open					

Nasal-Vowel

	Front	Near-Front	Central	Near-Back	Back
Close					
Near-close					
Close-mid					
Mid					
Open-mid					
Near-open					
Open					

Long-Nasal-Vowel

	Front	Near-Front	Central	Near-Back	Back
Close					
Near-close					
Close-mid					
Mid					

Appendix 6 - Segment Groups

Open-mid					
Near-open					
Open					

Vowel-Diphthong

	Front	Near-Front	Central	Near-Back	Back
Close					
Near-close					
Close-mid					
Mid					
Open-mid					
Near-open					
Open					

Nasal-Vowel-Diphthong

	Front	Near-Front	Central	Near-Back	Back
Close					
Near-close					
Close-mid					
Mid					
Open-mid					
Near-open					
Open					

Vowel-Non-Syllabic

	Front	Near-Front	Central	Near-Back	Back
Close					
Near-close					
Close-mid					
Mid					
Open-mid					
Near-open					
Open					

Vowel-Diphthong-Non-Syllabic

	Front	Near-Front	Central	Near-Back	Back
Close					
Near-close					
Close-mid					

Appendix 6 - Segment Groups

Mid					
Open-mid					
Near-open					
Open					

Pulmonic Consonants

Manner	Bilabial	Labio-Dental	Alveolar	Velar	Glottal
Nasal, Stop					
Nasal	m		n	ŋ	
Stop	p		t	k	ʔ
Sibilant, Fricative			s		
Fricative		f			h
Approximant					
Tap/Flap					
Trill			r		
Lateral, Fricative					
Lateral, Approximant			l		
Lateral, Tap/Flap					

Shaded areas denote articulations judged to be impossible. Where symbols appear in pairs, the one to the right represents a modally voiced consonant.

Non-Pulmonic Consonants

Manner
Stop
Ejective, Stop
Ejective, Fricative
Ejective, Lateral, Fricative
Tenuis, Click
Nasal, Click
Tenuis, Lateral, Click
Implosive
Lateral, Approximant

Shaded areas denote articulations judged to be impossible. Where symbols appear in pairs, the one to the right represents a modally voiced consonant.

Pulmonic Affricates

Manner
Sibilant
Lateral
Voiced
Non-Sibilant

Shaded areas denote articulations judged to be impossible.

Ejective Affricates

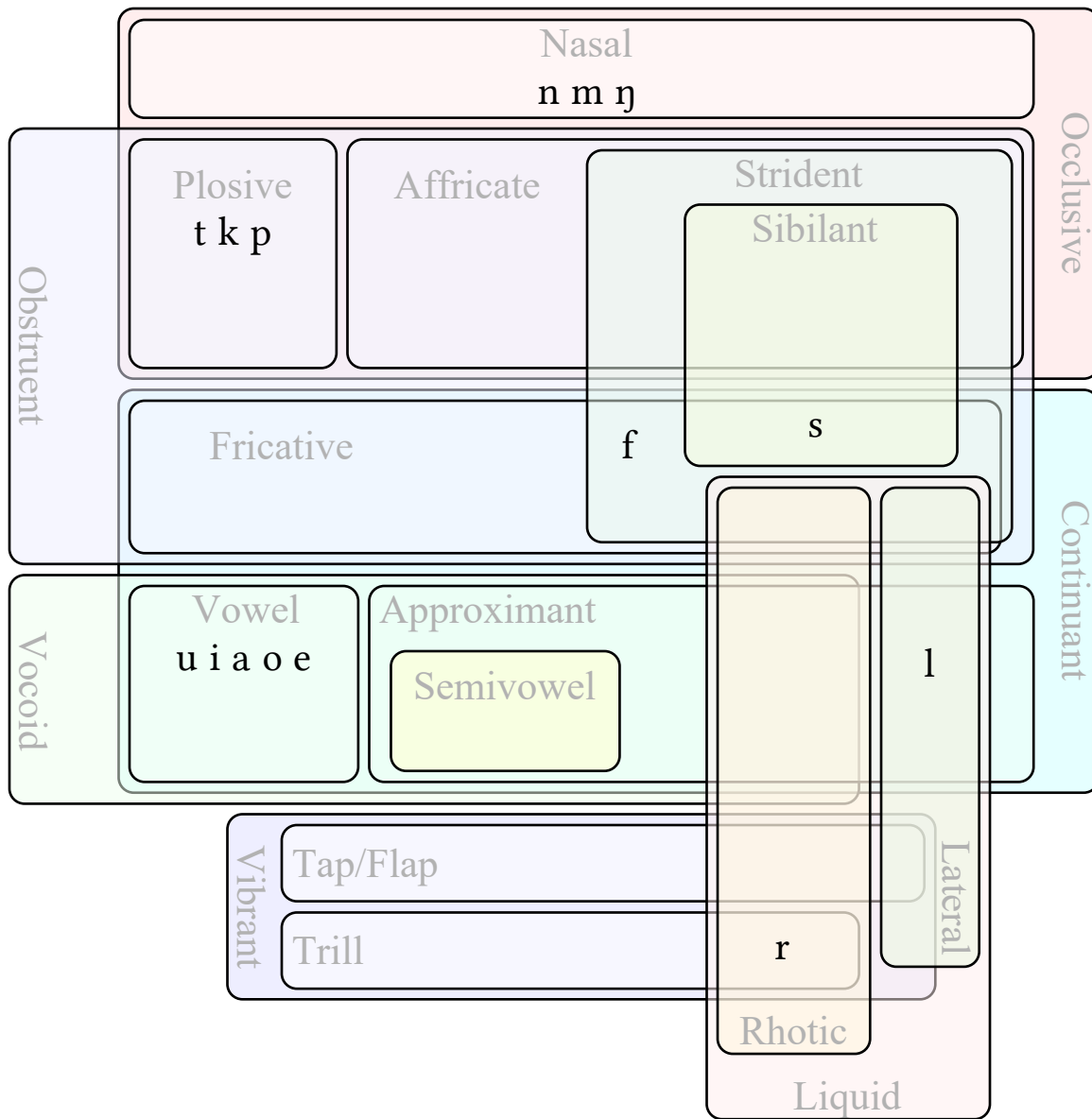
Manner
Central
Lateral

Shaded areas denote articulations judged to be impossible.

Appendix 6 - Segment Groups

Other Segments

Appendix 7 - Euler Feature Diagram

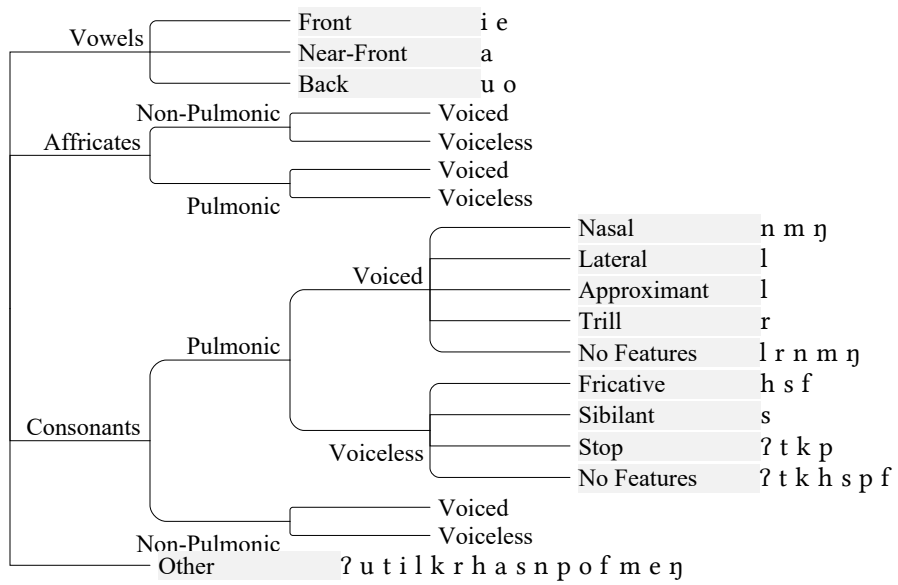


Appendix 8 - International Phonetic Alphabet

IPA Segments

a	e	f	h
0061 Open Near-Front Vocoid Vowel Continuant Parent Vowel	0065 Close-mid Front Vocoid Vowel Continuant Parent Vowel	0066 Labio-Dental Pulmonic Fricative Strident Obstruent Continuant Labial Dental	0068 Glottal Pulmonic Fricative
i	k	l	m
0069 Close Front Vocoid Vowel Continuant Parent Vowel	006B Velar Pulmonic Stop Occlusive	006C Alveolar Vocoid Voiced Pulmonic Lateral Approximant Rhotic Liquid	006D Bilabial Voiced Pulmonic Nasal Occlusive
n	o	p	r
006E Alveolar Voiced Pulmonic Nasal Occlusive	006F Close-mid Back Rounded Vocoid Vowel Continuant Parent Vowel	0070 Bilabial Pulmonic Stop Occlusive	0072 Alveolar Voiced Pulmonic Trill Rhotic Vibrant Liquid
s	t	u	ŋ
0073 Alveolar Pulmonic Sibilant Fricative Strident Obstruent Continuant	0074 Alveolar Pulmonic Stop Occlusive	0075 Close Back Rounded Vocoid Vowel Continuant Parent Vowel	014B Velar Voiced Pulmonic Nasal Occlusive
ʔ			
0294 Glottal Pulmonic Stop			

Appendix 9 - Feature Tree



Appendix 10 - Diacritics

Diacritics

Undefined escape character	~	Nasalized	..	Centralized
Advanced	-	Retracted	˘	RisingTone
Voiceless	ɰ	Implosive	̣	Syllabic
Ejective	ʕ	Pharyngealized	ˆ	Falling tone
Non-syllabic	̚	No audible release	̤	Rhotic hook
Advanced tongue root	ɿ	Apical	˙	Extra low tone
Less rounded	ɲ	Dental	˜	Velarized or Pharyngealized
↘ Global fall	ɣ	Velarized	ˊ	High tone
h Aspirated	j	Palatalized	̤	Creaky voiced
˘ Low tone	l	Lateral release	ˉ	Mid tone
◻ Laminal	ʌ	Linguo-Labial	̚	Nasal release
˙ More rounded	ɹ	Lowered	̚	Retracted tongue root
↗ Global rise	ɻ	Raised	˙	Extra high tone
˙ Breathy voiced	˘	Voiced	w	Labialized
˘ Extra short	x	Mid-centralized	↓	Down-step
↑ Up-step	ː	Long	˙	Half-long
Indeterminacy in french vowels		Begin Non-segmental notation		End non-segmental notation
ɕ Voiced epiglottal fricative	!	Post-alveolar click		Minor group
Dental click		Major group		Alveolar lateral click
‡ Palatal click	˙	Voiceless descender	-	Combining macron
⏟ Tie-bar below	⏟	Tie-bar above	‡	Ready made combination
→ Becomes		Separator		

Language A



A test language.

This language is not real

Language B



A test language.

This language is not real

Language C



A test language.

This language is not real

Language D



A test language.

This language is not real