

THE LINGUA-U ATLAS

A derivation of the frame, and an entry for every address

Version 1.0

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A companion to The Lingua-U Whitepaper, Alpha v1.2

Addresses per WP Alpha v1.2; glosses per DS v0.2.1

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Front Matter

This volume is a companion to *The Lingua-U Whitepaper, Alpha v1.2*. Where the two disagree, the Whitepaper governs addresses and this volume governs glosses. Neither is final.

On that line. It appears at the front and the back, and it is a version stamp rather than a citation. *WP* is the Whitepaper. *DS* is the Derivation Spec — the internal document that governs the generator which produced these entries, and which is not published. **You do not need it.** Everything required to derive any gloss in this book is printed in Chapter 1, and a check runs on every build confirming that no component the generator can emit is missing from that chapter.

The stamp matters for one reason: a gloss generated under a superseded spec is invalid rather than merely dated. If you are ever holding two printings of this Atlas that disagree, the stamp says which frame produced which, and the later one governs.

Contents

Front Matter	2
Contents.....	2
What this volume is	3
The statement the Whitepaper’s twelfth chapter requires	4
What this volume does not claim	5
How to read it.....	5
Two absences a reader will notice.....	6
A note on the notation	6
On the value names.....	7
Status	7
Part I · The Derivation	7
Chapter 1 · The Frame	8
Chapter 2 · Sub-manner within domain 0	15
Chapter 3 · Place within domain 0.....	17
Chapter 4 · Laryngeal state within domain 0	20
Chapter 5 · Sub-manner within domain 1	23
Chapter 6 · Place within domain 1.....	25
Chapter 7 · Laryngeal state within domain 1	27
Chapter 8 · Sub-manner within domain 2	30
Chapter 9 · Place within domain 2.....	32

Chapter 10 · Laryngeal state within domain 2.....	34
Chapter 11 · Vowels.....	36
Part II · The Atlas	42
Domain 0 — closure and release.....	43
Domain 1 — sustained constriction.....	60
Domain 2 — open resonance.....	81
The vowel tiers and the Center	102
Appendix · The Construction Record	111
§A.1 · The value names.....	111
§A.2 · The affricates	111
§A.3 · The marked laryngeal setting	112
§A.4 · A fourth position for vowels	113
§A.5 · Secondary articulation as place.....	114
§A.6 · Reference dialect	115
§A.7 · Glyphs for the vowel tiers	115
§A.8 · Glottocodes	115
§A.9 · Missing attestation for the assigned cells.....	116
§A.10 · Does sub-manner 0 belong in domain 0?.....	116
§A.11 · Defects found and closed.....	117
§A.12 · Standing checks.....	118
Index of Addresses	118
Index of Sounds.....	122

What this volume is

Lingua-U assigns every speech sound an address made of ternary digits, and reads a meaning off that address rather than attaching one to the sound. The Whitepaper sets out the frame and argues for it. This volume does the thing the frame was built to make possible: it derives a gloss for every address in the system and prints all ninety-four.

It is a separate book so that the Whitepaper can stay short. An argument and a reference work want different shapes, and binding them together would have damaged both.

Nothing here is assigned. Every word in every gloss traces to a component selected by a digit, and the components are listed in full in Chapter 1. If a gloss contains vocabulary the address did not license, that is a defect and this volume would like to hear about it.

The statement the Whitepaper's twelfth chapter requires

The Whitepaper declines to do what this book does, and says so plainly. Its Chapter 12 names the assignment of meanings to all eighty-one tetragrams as a temptation, records that an earlier draft of the system yielded to it, notes that the resulting assignments did not survive testing, and concludes that the geometry should be stable before anything is built on it.

That reservation has not been withdrawn, and this volume does not claim the condition has been met.

It claims something narrower. **The geometry is now stable enough to be tested by building on it, and a derivation layer that fails will fail visibly.** Those are different claims, and the difference is the whole justification for this book.

The earlier attempt failed in a specific way that is worth naming, because it is the failure this volume is designed to make impossible. Meanings had been attached to sounds directly, from word lists. When roughly four-fifths of that semantic layer was randomly permuted and the result shown to readers, nobody could tell. The assignments carried no information: any of them could have justified any sound after the fact, which is the same as saying none of them were doing any work.

A derived gloss cannot fail that way undetectably. Exchange two of them and the derivation breaks in public — one entry is now describing a sound made at the lips as though it were made at the back of the throat, and the components no longer match the digits they came from. The permutation test that dismantled the predecessor is applied to this volume as a standing check, and it is listed among the others in the Appendix.

So the honest position is this. The Whitepaper's caution was correct and remains correct. This book is not the elaboration that caution was warning against; it is the instrument that makes the warning testable. If the frame is wrong, the fastest way to find out is to derive everything from it and look at what comes out.

Three things did come out, during the writing. A component table misdescribed the laryngeal setting of one sound, then — after repair — misdescribed two others in the opposite direction. A punctuation choice made twenty-four glosses impossible to parse. And a rule for the associative vocabulary turned out never to have been specified at all, so the generator was choosing arbitrarily and saying so. Each was found by the apparatus rather than by inspection, each was repaired at a table rather than at an entry, and all three are recorded in the Appendix with the arguments that produced them.

That record is the best evidence this volume can offer for its own reliability, and it is better evidence than an absence of errors would have been.

What this volume does not claim

It does not claim that the glosses are meanings. They are consequences — what the frame says, given an address. Whether they carry any phenomenological weight, whether practitioners converge on them, and whether the working readings of the three values hold beyond the first position are all open, and the Whitepaper says so.

It does not claim the frame is finished. Ten questions remain open. Three are consequential enough to suspend or qualify parts of the book, and each is stated where it bites rather than collected quietly at the back.

It does not claim the empirical layer is complete. Attestation figures are missing for the twenty-four consonants of the reference variety, for reasons of data supply rather than of linguistics, with the perverse result that **the most ordinary sounds in the book are the ones it says least about**. A blank in an attestation slot is a gap in the pipeline. It is not a low number, and it is not a fact about the sound.

How to read it

Part I derives. Part II looks up.

Part I is eleven chapters. Chapter 1 states the frame completely enough to use — the four positions, the component lexicon, the composition rules — and a reader who works through it should be able to derive any entry in Part II without turning to it. That is the acceptance test of the whole volume, and where it fails, the responsible chapter says so.

Chapters 2 through 11 take the frame apart by slices. A slice is one value of one position, read across everything beneath it: what it contributes to every gloss passing through it, how it reads under each of the sub-manners or apertures below, and what it leaves undetermined. **Cells inherit their glosses from the slices that intersect at them**. No cell owns anything. That claim is restated in every section, not for emphasis but because a reader who forgets it will read Part II as a dictionary, which it is not.

Part II is ninety-four entries. Each has five blocks in a fixed order, and the order is load-bearing:

ADDRESS is definitional and true by construction.

ARTICULATION tells you what your mouth does. It uses no system vocabulary and no digits and is meant to work for someone who has read none of Part I. Where a sound has a neighbor differing at exactly one position, this block gives a body instruction that makes that one difference palpable — a hand in front of the mouth, two fingers on the throat, a pinched nose.

DERIVATION is deterministic. Given the address and the tables, it could not have come out otherwise.

RESONANCE is offered and marked discardable. It is not derived, it is not evidence, and deleting every resonance block in the book would leave the Atlas complete and correct. Most entries have none, and the dash is the honest answer rather than an omission.

ATTESTATION is empirical and sits in its own slot so that it never reads as meaning. *This cell means X* and *some language has a sound here* must never be confusable, and a well-attested cell is not a better-founded one.

The reader meets the frame, then the body, then the gloss, then what is offered, then the evidence. A gloss met before the articulation reads as an assertion about a sound. Met after it, it reads as what it is.

The Appendix is the construction record — the ten open questions, the defects found and closed, and the checks that stay in force. It is kept in one place because most of its entries bear on more than one slice, and because a reader working through a slice should be reading about speech rather than about the document.

Two absences a reader will notice

Nine entries have no gloss. The affricates ship as address and articulation only. Their derivations are complete and correct and are being withheld, because a question about their *addresses* is unresolved — whether an affricate has a cell of its own or is better read as two sounds fused. A formally impeccable derivation from a false premise is worse than an absent gloss and far harder to detect, since nothing on the surface of a gloss reveals whether its address was right. Two of the nine hold consonants English speakers use in *church* and *judge*. The gap is deliberate, and it is a refusal rather than an omission.

Nine entries have no articulation. These addresses are formally unreachable: the frame's own rules make them unbuildable, and no sound has ever occupied them. Their glosses are printed in full anyway, and they are among the most useful pages in the book. A gloss derived for an address that no sound occupies is a gloss that could not have been taken from a sound — which is a stronger demonstration than any permutation test can offer, because here there was never anything to reverse-engineer from.

A note on the notation

Lingua-U borrows the Tai Xuan Jing symbols encoded in Unicode. Consonant glyphs follow from an address by arithmetic; the vowel glyphs come from a lookup table, because they are split across two Unicode blocks and four of them follow a different tradition's ordering entirely.

The Unicode character names have no function here, and readers should be warned before they go looking. The names are known to be erroneous — the standard's own working documents record that two of its terms were transposed throughout the block — and they derive from a divinatory sequence unrelated to anything in this system. They land

arbitrarily. The symbol for /w/ happens to be named CLOSED MOUTH and the symbol for /m/ happens to be named CLOSURE, which are apt by pure chance. The symbol for /p/ is named DEFECTIVENESS OR DISTORTION, which is not.

None of this signifies, in either direction. Mathematical notation repurposes shapes routinely, and the aleph of set theory carries no Kabbalistic content.

A practical warning for anyone reproducing these pages: the characters live in the Supplementary Multilingual Plane and are missing from most typefaces. Four of the digrams are absent even from fonts that cover the Tai Xuan Jing block. Embed them as artwork rather than trusting font fallback.

On the value names

The three ternary values are called Hahn, Sheen, and Yun throughout. **These names are provisional and will be replaced.**

Nothing in this book depends on them. No argument turns on how they sound, no mnemonic is built on their phonetics, and no sentence takes the form *as the name suggests*. This is enforced rather than intended: the manuscript is checked by substituting arbitrary strings for all three and reading for damage. Prose that breaks under substitution is a defect and is repaired.

The rule exists because an earlier version of the system failed it, and produced glosses chosen for how they looked beside a value name rather than for what the articulation warranted.

Status

Provisional throughout. Ten open questions, two of them awaiting data rather than decisions. Nine entries under quarantine. A frame that has been wrong three times in ways this book records.

A reader who wants a system to believe should wait for a later draft. A reader who wants an instrument to work with, and to break, can begin at Chapter 1.

Part I · The Derivation

Part I derives. Chapter 1 states the frame completely enough to use; Chapters 2 through 11 take it apart one slice at a time. A reader who works through Part I should be able to produce any entry in Part II without turning to it.

Chapter 1 · The Frame

This chapter states the frame completely enough to use. It is not a summary of the Whitepaper and does not argue for anything. The Whitepaper argues; this volume specifies. A reader who has the Whitepaper open beside them will find nothing new here except the gloss layer, which the Whitepaper does not contain. A reader who does not have it should still be able to work through every chapter that follows, and to derive any entry in the Atlas from this chapter and the component tables alone.

That last claim is the acceptance test of the whole volume, and it is worth stating as a condition rather than a promise. Where the derivation cannot presently be completed from what is printed, the responsible chapter says so and names the question that blocks it.

1.1 · What an address is

Every sound in Lingua-U has an address: a string of ternary digits. Its meaning is read off that address rather than assigned to it.

This is the mechanism the whole system rests on, and its point is negative before it is positive. When meaning is assigned to a sound directly, any assignment can be justified after the fact, and the justification carries no information — which is why an earlier version of this system survived having roughly four-fifths of its semantic layer randomly shuffled. When meaning is derived positionally, exchanging two assignments breaks the derivation visibly: one is describing a sound made at the lips as though it were made at the velum. The system resists rearrangement by construction rather than by assertion.

Three tiers of address are in use, distinguished by length:

Length	Tier	Holds	Example
1 digit	Monogram	cardinal vowels	0 = /ɑ/
2 digits	Digram	secondary vowels	01 = /æ/
4 digits	Tetragram	consonants	0100 = /p/

Addresses are always zero-padded to their tier length, so length alone identifies the tier. The string 01 can only be a digram; 0100 can only be a tetragram, and never reads as one hundred.

The schwa, /ə/, has no address. It is the Center, and its lack of an address is a structural fact rather than an omission — see §1.7.

1.2 · The four positions

The four positions of a consonant address correspond to four dimensions of articulation. They are named in prose — domain, sub-manner, place, laryngeal — and numbered I through IV in tables.

Position I — Domain. The coarsest cut, distinguishing sounds by what fundamentally happens in the vocal tract.

Digit	Class	Character
0	stops, affricates, /h/	closure and release; the sound is an event
1	fricatives	sustained constriction; the sound is a channel
2	nasals, liquids, glides	open resonance; the sound is a continuum

Position II — Sub-manner. Read relative to the domain.

Digit	in domain 0	in domain 1	in domain 2
0	unobstructed breath	non-sibilant	glide
1	stop	sibilant	liquid
2	affricate	lateral fricative	nasal

Position III — Place. Eight places of articulation collapsed into three. This is a design decision, not a discovery.

Digit	Region
0	labial, front
1	coronal, mid
2	dorsal, postalveolar, glottal

Position IV — Laryngeal.

Digit	State
0	voiceless
1	modal voiced
2	marked: aspirated or breathy

Two worked readings. The consonant /m/ has the address 2201: open resonance, sealed by full closure, at the outer threshold, modally voiced. The consonant /s/ has the address 1110: sustained friction, concentrated, at the central point of contact, on breath alone. Exchange the two and the derivation fails visibly — one would be calling a labial sound coronal and a voiced one voiceless.

1.3 · Branching, not coordinates

The single most consequential fact about the frame is that it is **not** four independent axes.

Position II is read within the domain fixed by Position I. A 2 at sub-manner means affricate inside the first domain and nasal inside the third; these are not variants of one meaning but different meanings occupying the same digit. Position IV behaves the same way at its third value, where the component depends on Positions I and II jointly (§1.5).

Lingua-U therefore composes along a ternary decision tree. Each successive position differentiates the space the preceding positions have generated, and a digit's contribution is conditional on the digits before it. Every rule in this volume that looks like a coordinate lookup is in fact a path through a tree, and the difference shows up wherever a reader tries to carry a statement about one domain into another.

One symptom of this is worth flagging in advance, because it recurs in every place chapter. **Position III is ordinal, not anatomical.** It ranks the loci that the preceding two digits have made available, outermost to inwardmost. It does not name a region of the mouth. Within domain 0 alone, the inwardmost available locus is glottal under one sub-manner, dorsal under another, and postalveolar under a third — three quite different places, one unchanging phrase. A reader who converts a place component into a feature label will derive correctly in some regions of the frame and incorrectly in others.

1.4 · The component lexicon

Twenty components for consonants, seven for vowels, printed here in full. A reader who has this section does not need the Derivation Spec to derive any entry in Part II.

Position I — domain. The head of every gloss.

	Component	Short
0	<i>an event of closure and release</i>	release
1	<i>a channel of sustained constriction</i>	channel
2	<i>a continuum of open resonance</i>	resonance

Position II — sub-manner. Looked up in the column for the domain fixed by Position I. The same digit names different things in different columns; this is the branching described at §1.3, and reading across the wrong column is the commonest way to derive a gloss incorrectly.

	in domain 0	in domain 1	in domain 2
0	<i>breath unobstructed</i>	<i>friction diffuse</i>	<i>resonance in motion</i>
1	<i>closure complete</i>	<i>friction concentrated</i>	<i>resonance flowing</i>
2	<i>closure delayed in release</i>	<i>friction channeled laterally</i>	<i>resonance sealed</i>

	short, dom. 0	short, dom. 1	short, dom. 2
0	unobstructed	diffuse	moving
1	complete	concentrated	flowing
2	delayed	lateral	sealed

Position III — place. Uniform across the frame.

Component	Short
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	Component	Short
0	<i>at the outer threshold</i>	outer
1	<i>at the central point of contact</i>	central
2	<i>inward toward the throat</i>	inward

Position IV — laryngeal. Values 0 and 1 are uniform. Value 2 is conditional on Positions I and II jointly, and is set out at §1.5.

	Condition	Component	Short
0	any	<i>on breath alone</i>	breath
1	any	<i>with voice</i>	voice
2	$(I,II) \in \{(0,1), (0,2), (1,1)\}$	<i>released into breath</i>	released
2	domain 2, any sub-manner	<i>resonant through breath</i>	throughvoice
2	all remaining	<i>voiced through breath</i>	throughbreath

Vowel components. The vowel frame uses these instead; nothing crosses between the two sets.

	Aperture (I)	short	Orientation (II)	short
0	<i>the mouth fully open</i>	open	<i>the tongue at rest in the center</i>	centered
1	<i>the mouth half open</i>	half	<i>the tongue advanced</i>	advanced
2	<i>the mouth nearly closed</i>	closed	<i>the tongue withdrawn</i>	withdrawn

Monograms additionally take a tenseness term, *held at full extension* (short: full).

That is 20 components for consonants and 7 for vowels. **No other vocabulary may enter a derived gloss.** No term is optional, no term may be reordered for euphony, and no term may be swapped for a near-equivalent that reads better in running prose.

Composition is mechanical. Take the head from Position I, the sub-manner term looked up in the right domain column, the place term, and the laryngeal term, and join them in address order, comma-separated.

The prohibition on near-equivalents is easy to violate without noticing. The Whitepaper’s own prose glosses — *a concentrated constriction at the center of the mouth, sounded on breath alone* — are compressed literary renderings, not a third gloss form. They are a style decision made downstream and nothing in this volume licenses them.

1.5 · The marked laryngeal setting

Position IV value 2 requires its own paragraph, because the Whitepaper’s table collapses two opposite laryngeal configurations into one cell. Aspiration is a spread glottis; breathy voice is a slack one. They are not degrees of a single thing.

The frame resolves this by selecting the component from Positions I and II jointly. Aspiration is contributed where the manner produces a high-pressure articulation with a

discrete release — stops, affricates, and sibilant fricatives. Everywhere else, a marked laryngeal setting is breathy voice, framed to agree with its head:

Condition	Component
stops, affricates, sibilant fricatives	released into breath
open-resonance domain	resonant through breath
all remaining	voiced through breath

This is the only place in the frame where a rule was derived from checking the output rather than from the architecture. Two successive formulations of it produced glosses that were correctly derived and wrong about the sound — first at 0022 /h/, then at 1112 /s^h/ and 1122 /j^h/. Both were caught by comparing generated components against the attested occupants in the Whitepaper’s Appendix A. The rule above is verified against all sixteen occupied value-2 cells.

The episode is recorded here rather than buried in a changelog because it is the clearest demonstration available of what the frame can and cannot do on its own. Derivation guarantees that a gloss follows from an address. It guarantees nothing whatever about the address being right.

1.6 · The two gloss forms and the sense range

The long form is canonical: the four components in address order, comma-separated.

1110 /s/ — a channel of sustained constriction, friction concentrated, at the central point of contact, on breath alone

The short form is four words, one per position, separated by middle dots.

1110 /s/ — channel · concentrated · central · breath

The short form is bijective with the address, so it is collision-free without needing to be checked, and it is the register for running text, the card deck, and verse. It carries a hazard: dropping the fourth word merges three addresses into one, silently. The truncated string is well-formed, reads naturally, and is now ambiguous across the laryngeal triple.

The sense range prints the full associative pool of every contributing position, grouped by source:

I narrowing · passage · sustaining **II** sharpening · parting · edge **III** center · handling · address **IV** unvoiced · cool · impersonal

Nothing is selected. An earlier version of the spec picked one member per position and could not say why that member rather than another, which meant the range was the one part of an entry that could not be predicted from the rules. Printing the pools whole removes the choice instead of hiding it, and it makes the compositional source of every associated word visible inside the entry.

Two consequences follow and are intended. Adjacent cells share most of their range, which reads repetitively — and is true, and is the same claim the rest of Part I spends its length making. And sense ranges are not injective: two cells differing at one position share three of four pools. Injectivity is a property of the gloss forms, not of the range.

1.7 · Vowels and the Center

Vowels run on their own two axes. A digram's first position gives aperture — open, mid, close — and its second gives orientation — central, front, back.

The three cardinal vowels take monograms, and here the frame does something it does nowhere else. **A monogram's digit is an identity index, not a coordinate.** It says which cardinal, not where that cardinal sits. Cardinals are therefore not compositional in the way every other address is, and their glosses are derived instead from their positions in the digram grid — /a/ at 02, /i/ at 21, /u/ at 22 — with a tenseness term appended. The monogram and the digram at the same coordinates stand to each other as tense to lax.

The schwa is the Center. It takes no symbol and no address, because a system that addresses sounds by their articulatory commitments has nothing to say about the sound defined by having none. It receives no derived gloss and no sense range, and nothing composes with it. An unaddressed point has nothing to compose with.

1.8 · How to read an entry

Every Atlas entry has five blocks in fixed order, and the order is load-bearing.

ADDRESS is definitional. It restates the address in system vocabulary and is true by construction.

ARTICULATION tells you what your mouth does. It uses no system vocabulary at all — no domains, no positions, no digits — and is meant to be legible to someone who has not read this chapter. Where a cell has a neighbor differing in exactly one digit, it gives a body instruction that makes that one digit palpable.

DERIVATION is deterministic. Given the address and the component tables, it could not have come out otherwise.

RESONANCE is offered and marked discardable. It is not derived, it is not evidence, and deleting every resonance block in the volume would leave the Atlas complete and correct. Where no honest resonance exists, the block reads –.

ATTESTATION is empirical and occupies its own slot precisely so that it never reads as meaning. *This cell means X* and *some language has a sound here* must never be confusable.

The reader meets the frame, then the body, then the gloss, then what is offered, then the evidence. A gloss encountered before the articulation reads as an assertion about a sound. Encountered after it, it reads as what it is: a consequence of an address.

1.9 · What the frame contains

Ninety-four entries: eighty-one consonant tetragrams, nine vowel digrams, three cardinal monograms, and the Center.

Of the eighty-one tetragrams, twenty-four hold consonants of the reference variety, thirty-nine hold segments attested elsewhere in the world's languages, nine are well formed and unoccupied, and nine cannot be reached at all.

Those last two categories deserve their standing, and both are listed here so that a reader can check any entry against them rather than inferring membership.

The nine unreachable addresses. 0000, 0001, 0002, 0010, 0011, 0012, 2010, 2011, 2012. These are printed in full, with derivation intact and articulation suppressed. They are not errata. A gloss that can be derived for an address no sound occupies is a gloss that was not taken from a sound — which is a stronger demonstration than the shuffle test can offer, since here there was never a sound from which a plausible-seeming meaning could have been reverse-engineered. Two of them, 0000 and 0002, are contested: they would have occupants under a reading that admits secondary articulation as place, and the frame currently does not admit it.

The nine well-formed and unoccupied addresses. 0021, 1012, 1102, 1201, 1202, 1220, 1222, 2100, 2102. Every one is producible; no surveyed language uses any of them to distinguish words. Their articulations are written in the conditional mood.

The nine quarantined addresses. The affricates, 0200 through 0222 — that is, every address with 0 at the first position and 2 at the second. They ship as stubs: address and articulation only. Their derivations are complete and correct and are being withheld, because the addresses themselves are under question. A formally impeccable derivation from a false premise is worse than an absent gloss and harder to detect, since nothing on the surface of a gloss reveals whether its address was right. Two of the nine hold consonants that English speakers use daily. The gap in the printed volume is deliberate.

1.10 · Status

The Whitepaper's Chapter 12 declines to do what this volume does. It names the assignment of meanings to all eighty-one tetragrams as a temptation being resisted, on the grounds that the geometry should be stable before anything is built on it.

That reservation has not been withdrawn, and this volume does not claim the condition is met. It claims something narrower: that the geometry is now stable enough to be *tested* by building on it, and that a derivation layer which fails will fail visibly and in ways that point back at specific rules. The frame is provisional and is marked as provisional. Six questions remain open, three of them consequential enough to suspend or qualify parts of the Atlas, and each is stated where it bites rather than collected out of the way at the end.

A reader who wants a system to believe should wait. A reader who wants an instrument to work with, and to break, can start at Chapter 2.

Domain 0 holds the sounds made by closing the tract and opening it again — the stops, the affricates, and the one segment that closes nothing. Its head component is *an event of closure and release*, and everything below inherits it.

Three positions vary beneath that head, and each is treated as a slice: what the slice contributes to every gloss passing through it, how it reads across the positions perpendicular to it, and what it leaves undetermined. No section enumerates cells. Sounds are named where they illustrate a slice, which is the opposite of enumeration — a slice that cannot be shown in real speech is a slice a reader has no way to check.

Construction notes, open questions, and the spec defects these chapters found are collected in the Appendix. They are not argued here.

Chapter 2 · Sub-manner within domain 0

Position II is read within the domain (Chapter 1 §1.3). Its three values do not name three general manners of articulation; they name three ways of managing a closure, and they mean something different under each of the other two domain heads.

2.1 · II = 0 — *breath unobstructed*

Position II = 0, throughout domain 0. Nine cells.

The value that empties the domain's own premise. The head promises a closure and a release; this sub-manner withholds the closure and leaves only the release — breath moving through a tract that is shaped for a vowel and committed to nothing.

What the nine cells share is not a sound but a subtraction. Remove supralaryngeal contact from an event of closure and release and almost nothing survives: the only place left to constrict is the larynx itself, and the only thing left to vary is what the larynx does.

Read across the positions beneath, the slice is nearly empty, and the emptiness is structural rather than accidental. Six of the nine cells are formally unreachable. Under *at the outer threshold* and *at the central point of contact* there is nothing at all — a labial or coronal locus requires a supralaryngeal articulator, and this sub-manner has withdrawn every one of them. The whole of the slice's occupancy sits at the innermost locus: /h/, the voiceless glottal fricative assigned to English, and /ɦ/, its breathy-voiced counterpart, attested in Dutch, Kharia, and Reḇe at around three and a half per cent of surveyed inventories. Between them sits one well-formed cell that no surveyed language fills.

Two sounds in nine addresses is the sparsest occupancy in the frame, and it is worth being precise about why. The cells are not empty because the world's languages happen not to have gone there. They are empty because the frame's own rules make them unbuildable:

Position III ranks loci, this sub-manner has left only one locus standing, and two of the three ranks therefore have nothing to rank.

The gloss *breath unobstructed* does not belong to /h/. It belongs to the slice, and /h/ inherits it — as does /ɦ/, and as does the unattested cell between them, which receives a complete and correct gloss without any sound to hang it on. What distinguishes /h/ from /ɦ/ within the slice is entirely Position IV.

That last point is why this slice repays attention out of proportion to its size. It is the one place in domain 0 where a reader can watch the laryngeal position work alone, with every other variable removed by construction. Hold /h/, then voice it into /ɦ/. Nothing above the larynx moves, because there is nothing above the larynx to move.

Atlas range. Addresses 0000–0022.

2.2 · II = 1 — *closure complete*

Position II = 1, throughout domain 0. Nine cells.

The prototype case, and the one the domain was written for. The closure is total, held, and then released; the release is the sound. Nine cells, all reachable, all occupied — which is true of no other sub-manner slice in the frame.

What the cells share is a single articulatory event repeated at three loci and three laryngeal settings. Read across, it gives the stop series entire:

At the outer threshold, /p/, /b/, and aspirated /p^h/. At the central point of contact, /t/, /d/, /t^h/. Inward toward the throat, /k/, /g/, /k^h/.

The first two of each triple are English; the third is not, and is more widely attested than almost anything else in the domain — /p^h/ in nineteen per cent of surveyed inventories, /k^h/ in twenty, /t^h/ in thirteen, across languages as unrelated as Iron Ossetic, Burushaski, Lao, and Bengali. A reader whose ear is English will find the third member of each triple slightly foreign, and should notice that the survey does not agree.

The gloss *closure complete* belongs to none of these nine sounds. It belongs to the slice, and each inherits it. What separates /p/ from /t/ is entirely Position III; what separates /p/ from /b/ is entirely Position IV; and what separates /p/ from /pf/ — the affricate one slice over — is entirely Position II, this slice against the next.

This is the cleanest three-by-three in the frame, and it is worth using as the reference case before reading anything else. Every claim Part I makes about inheritance can be tested here, because nothing is missing: three loci, three laryngeal states, nine cells, nine sounds. A reader who can predict all nine glosses from this section and the two that follow has understood the apparatus, and can take the sparser slices on the same terms.

One caution. The completeness is a fact about stops, not about the frame. Stops are the most robustly attested consonants in the world's languages, and this slice is full because of

phonetics rather than because the geometry is working especially well here. The geometry works identically at §2.1, where it produced six unbuildable cells.

Atlas range. Addresses 0100–0122.

2.3 · II = 2 — *closure delayed in release*

Position II = 2, throughout domain 0. Nine cells, all quarantined.

The affricates. The closure is complete, as at §2.2, but the release is not clean: the articulators part slowly enough that friction forms in the gap, and the sound is a stop and a fricative in sequence, occupying one segment slot.

Read across, the slice is well populated. At the outer threshold, /pf/ and /ɱv/, attested in German, Sango, and Beembe among others, with aspirated /p^h/ rare at two-tenths of a per cent. At the central point of contact, /ts/ and /dz/, both common — /ts/ in twenty-two per cent of inventories, in Burushaski, Georgian, Shigatse Tibetan — with /ts^h/ at six. Inward toward the throat, English /tʃ/ and /dʒ/, and aspirated /tʃ^h/ in Hindi, Burmese, and Tsimané.

These nine cells ship without glosses. Their derivations are complete and correct and are being withheld. The reason is not a defect in the derivation but a question about the address: whether an affricate belongs in this domain at all, or is better read as a fusion of a stop and a fricative, in which case it has no address of its own and these nine cells are vacant. The question is open (Appendix §A.2).

A formally impeccable derivation from a false premise is worse than an absent gloss and harder to detect, because nothing on the surface of a gloss reveals whether its address was right. The nine stubs are the frame declining to publish something it cannot yet stand behind.

Two of them hold the consonants English speakers use in *church* and *judge*. The gap in the printed volume is deliberate, and it will look like an omission; it is a refusal.

What the slice does determine, meanwhile, is worth stating even under quarantine. If the addresses hold, *closure delayed in release* belongs to the slice and not to /ts/, and what distinguishes /ts/ from /t/ is Position II alone — the same closure at the same locus with the same laryngeal state, released slowly rather than cleanly. A reader can feel the difference by making /t/, then making it again while parting the tongue by degrees.

Atlas range. Addresses 0200–0222.

Chapter 3 · Place within domain 0

Position III is uniform across the frame (Chapter 1 §1.4), but its referents are not. **The position is ordinal, not anatomical.** It ranks the loci the preceding two digits have left

available, outermost to inwardmost, and does not name a region of the mouth. Within this domain alone, the inwardmost rank is glottal under one sub-manner, velar under another, and postalveolar under a third.

A reader who converts a place component into a feature label will derive correctly in some regions of the frame and incorrectly in others. This is the most common way to misread an address.

3.1 · III = 0 — at the outer threshold

Position III = 0, throughout domain 0. Nine cells.

The outermost of the three ranked loci: the articulation happens at the boundary of the body, where the tract opens onto the world. Under this domain the rank resolves to the lips.

Read across the sub-manners, the slice divides sharply. Under *closure complete* it gives /p/, /b/, and /p^h/ — the bilabial stops, among the most widely attested consonants there are. Under *closure delayed in release* it gives the labiodental affricates /pf/ and /ɱv/, plus rare aspirated /p^h/, all three under quarantine. Under *breath unobstructed* it gives nothing: three formally unreachable cells, because a labial locus requires lips in contact and that sub-manner has withdrawn them.

The slice therefore holds the frame's best-attested sounds and one of its emptiest regions side by side, for a reason that has nothing to do with place. The outer locus depends more than the other two on a closure existing. The innermost survives the loss of supralaryngeal contact — that is where /h/ lives — but the outermost does not survive it at all.

The gloss *at the outer threshold* does not belong to /p/. It belongs to the slice, and /p/ inherits it, as does /pf/, as do the three unreachable cells no sound can occupy. What distinguishes /p/ from /pf/ within the slice is entirely Position II.

Two of the unreachable cells here are contested. If Position III were read as admitting secondary articulation — treating the lip-rounding in /ɱ/ and /h^w/ as a place feature — those cells would have occupants, and the slice's emptiness under *breath unobstructed* would partly dissolve. The frame currently does not read it that way (Appendix §A.5).

A note on the pool. The sense-range words attached to this component — *lip · boundary · meeting* — read as more concrete and more evocative than the component itself. That warmth is a property of the pool, published once in the lexicon at Chapter 1 §1.4, not something discovered at any address. A reader who finds *meeting* suggestive is responding to a word the frame chose, not to a fact about labials.

Atlas range. Addresses 0000, 0010, 0020, 0100, 0110, 0120, 0200, 0210, 0220.

3.2 · III = 1 — at the central point of contact

Position III = 1, throughout domain 0. Nine cells.

The middle rank: the articulation happens where the tongue meets the roof of the mouth at its most dexterous point. Under this domain the rank resolves to the alveolar ridge and its immediate neighbourhood.

Read across the sub-manners, the pattern matches §3.1 in shape and differs in weight. Under *closure complete* it gives /t/, /d/, and /t^h/. Under *closure delayed in release* it gives /ts/, /dz/, and /ts^h/ — quarantined, but the most robustly attested affricates in the survey, with /ts/ appearing in more than a fifth of inventories. Under *breath unobstructed* it gives three unreachable cells, for the same reason as at §3.1: a coronal locus needs a tongue in contact, and that sub-manner has withdrawn it.

What separates this slice from the outer one is not structure but density. Both have six reachable cells and three unreachable ones. This slice's occupants are more frequent almost across the board, which reflects a well-known asymmetry in the world's phonologies rather than anything the frame encodes: coronal articulations are the cheapest to make and the most finely controlled, and languages use them heavily.

The gloss *at the central point of contact* belongs to none of these sounds. It belongs to the slice, and /t/ inherits it exactly as /ts/ does. What distinguishes them is Position II alone.

The component's own wording repays a second look. *Contact* is doing real work — this is the only one of the three place components that names touching, and it is the rank at which the tongue is most fully in charge. The outer rank names a threshold; the inner one names a direction. Only the middle one names a meeting of surfaces.

Atlas range. Addresses 0001, 0011, 0021, 0101, 0111, 0121, 0201, 0211, 0221.

3.3 · III = 2 — inward toward the throat

Position III = 2, throughout domain 0. Nine cells.

The innermost of the three ranked loci. Within this domain the rank spans a wider stretch of tract than either of the others, and this is the clearest available demonstration that the position ranks rather than names.

Read across the sub-manners, the inwardmost available locus is a different place each time. Under *closure complete* it is the velum: /k/, /g/, /k^h/. Under *closure delayed in release* it is the postalveolar region: /tʃ/, /dʒ/, /tʃ^h/, quarantined. Under *breath unobstructed* it is the glottis: /h/ and /ɦ/. Velar, postalveolar, glottal — three distinct regions, one unchanging phrase, and the phrase is correct in every case because it was never a claim about anatomy.

This slice is also the only one in the domain with occupancy under all three sub-manners. The reason is the one given at §3.1: the innermost rank survives the loss of supralaryngeal

contact, and the other two do not. When everything else is stripped away, something is still available at the back of the tract, and it is /h/.

The gloss *inward toward the throat* does not belong to /k/. It belongs to the slice, and /k/ inherits it, as do /tʃ/ and /h/ — three sounds a phonetician would not group together, sharing a component because they occupy the same rank in three different neighbourhoods.

A reader who wants a single test of whether they have understood Position III should try to predict, from this section alone, what the innermost locus resolves to under a sub-manner the domain does not have. The answer is that the question is malformed: the rank has no content until the preceding digits supply the candidates.

Atlas range. Addresses 0002, 0012, 0022, 0102, 0112, 0122, 0202, 0212, 0222.

Chapter 4 · Laryngeal state within domain 0

Position IV contributes the last component of every long form and the fourth word of every short form. Two of its values are uniform across the frame; the third is conditional on Positions I and II jointly, for reasons recorded at Appendix §A.3.

Four complete laryngeal triples are occupied in this domain, and three more would be if the quarantine lifted. Within a triple the first three components are constant and the whole of the difference sits in the fourth term, which makes this chapter the natural home for the proprioceptive tests the Atlas uses throughout.

4.1 · IV = 0 — on breath alone

Position IV = 0, throughout domain 0. Nine cells.

The vocal folds are apart and the airstream passes without setting them in motion. The sound is shaped entirely above the larynx.

Read across the slices above it, this is the domain's most familiar territory. Under *closure complete* it gives /p/, /t/, /k/. Under *closure delayed in release* it gives /pf/, /ts/, /tʃ/. Under *breath unobstructed* it gives /h/, plus two unreachable cells.

Six of the nine are English consonants, and the familiarity is a hazard worth flagging. These entries carry no attestation figures at all, because the source survey reports inventories for its candidate segments and not for the reference variety's own — a gap in the data pipeline (Appendix §A.9), not a finding about the sounds. A reader who finds this slice self-evident and the sparser ones speculative is responding to their own inventory. The derived gloss here rests on exactly what every other gloss in the frame rests on: the address, and nothing else.

The gloss *on breath alone* does not belong to /p/. It belongs to the slice, and /p/ inherits it, as does /h/ — which shares with /p/ no closure, no locus, and no articulator, only a larynx doing nothing.

This slice supports the frame's best proprioceptive test, and it can be run three times over in this domain alone. Take the stop pairs with sub-manner and place held fixed and one digit moving: rest two fingers on your throat and say /p/, then /b/; /t/, then /d/; /k/, then /g/. The lips, the tongue, and the closure are identical within each pair. The only thing that changes is whether the folds are engaged, and you can feel it under your fingers before you hear it.

A reader who has done that has felt Position IV directly, and felt it as something separable from the closure and its locus — which is the claim the frame makes by putting it last.

Atlas range. Addresses 0000, 0010, 0020, 0100, 0110, 0120, 0200, 0210, 0220.

4.2 · IV = 1 — *with voice*

Position IV = 1, throughout domain 0. Nine cells.

The folds are brought together and vibrate under airflow. Everything above the larynx is as it was in §4.1.

Read across, the slice gives /b/, /d/, /g/ under *closure complete*; /ɱv/, /dz/, /dʒ/ under *closure delayed in release*, quarantined; and nothing at all under *breath unobstructed*, where two of the three cells are unreachable and the third — breathy /ɦ/ — belongs to the next slice rather than this one.

That last detail is worth pausing on. The unobstructed sub-manner has no modally voiced occupant anywhere in the survey. A voiced sound with no supralaryngeal constriction and no breathiness is, in articulatory terms, a vowel — and vowels are addressed elsewhere, under a different geometry entirely. The frame does not say this; it simply leaves the cell formally unreachable. But the reason it is unreachable is that the sound it would name has already been given a different kind of address.

The gloss *with voice* belongs to the slice. /b/ inherits it, and so does /dz/, and the two share nothing else: different sub-manner, different locus, different manner of release.

The sense-range pool attached to this component — *sounded · warm · personal* — is, with its counterpart at §4.1, the most affect-laden vocabulary in the frame. It is worth knowing that this was a decision rather than an observation. Nothing about vocal fold vibration is warm or personal; the words were chosen, published once in the lexicon at Chapter 1 §1.4, and enter every voiced cell by rule. A reader who feels that /b/ is warmer than /p/ may well be right, but the frame is not evidence for it.

Atlas range. Addresses 0001, 0011, 0021, 0101, 0111, 0121, 0201, 0211, 0221.

4.3 · IV = 2 — the marked laryngeal setting

Position IV = 2, throughout domain 0. Nine cells.

The only slice in the domain whose component is not constant across it, and the variation is the point.

Under *closure complete* and *closure delayed in release*, the component is *released into breath*: the closure opens and a period of unvoiced airflow follows before voicing resumes. Under *breath unobstructed*, it is *voiced through breath*: the folds vibrate while staying open enough for continuous audible airflow, so that voice and breath are simultaneous rather than sequential.

These are opposite configurations. Aspiration spreads the glottis; breathy voice slackens it. The Whitepaper's Table 6.4 collapses them into a single value, and one phrase cannot honestly cover both — so the frame selects between them using Positions I and II.

Read across, the slice gives the aspirated stops /p^h/, /t^h/, /k^h/, the three most robustly attested cells in the domain at thirteen to twenty per cent of surveyed inventories, well above anything else here that is not simply assigned. Under the affricates it gives /p^hf/, /ts^h/, /tʃ^h/, quarantined. Under *breath unobstructed* it gives /h/ at three and a half per cent, plus one unreachable cell and one that is unreachable and contested.

The gloss belongs to the slice, not to /p^h/ — but here the slice hands down two different things depending on what sits above it, a shape no other slice in Part I has. What distinguishes /p^h/ from /h/ is not one position but the interaction of two.

The rule producing this split was wrong twice before it was right, and the record is at Appendix §A.3. It belongs there rather than here because the failure was a property of a table, not of these sounds. One consequence does belong in this section: a derived gloss can be perfectly correct and still false about the sound at its address. Derivation guarantees that a gloss follows from an address. It guarantees nothing about the address being right.

Atlas range. Addresses 0002, 0012, 0022, 0102, 0112, 0122, 0202, 0212, 0222.

Domain 1 holds the sounds made by narrowing the tract without closing it — the fricatives. Its head component is *a channel of sustained constriction*, and everything below inherits it.

This is the only domain in the frame with no unreachable cells and none under quarantine. All twenty-seven addresses carry a full derivation, and twenty-three of them hold a sound. What Part I claims about inheritance can be observed here rather than inferred, and the gaps that remain are empirical — languages that happen not to have gone somewhere — rather than formal.

Sounds are named where they illustrate a slice. Construction notes and open questions are in the Appendix.

Chapter 5 · Sub-manner within domain 1

Position II is read within the domain (Chapter 1 §1.3). Under this head its three values sort fricatives by how the airstream is shaped once the channel is made: spread thin, gathered into a groove, or diverted around the sides of the tongue.

5.1 · II = 0 — *friction diffuse*

Position II = 0, throughout domain 1. Nine cells.

The unmarked case. A constriction is made and air passes through it turbulently, with nothing done to focus the turbulence. The noise is broad-band and comparatively quiet, and it takes its character from where the constriction sits rather than from any shaping of the stream.

What the nine cells share is an absence: no groove, no lateral escape, just a gap and air crossing it.

Read across the positions beneath, the slice gives the non-sibilant fricatives at all three ranks. At the outer threshold, /f/ and /v/, with breathy /ɸ/ attested at a tenth of a per cent in Isoko, Parauk, and Ronga. At the central point of contact, /θ/ and /ð/ — the two English sounds most often named as unusual, and rightly: they appear in a small minority of the world's inventories — with one well-formed cell above them that no surveyed language fills. Inward toward the throat, /x/ and /ɣ/, which are far commoner than English speakers expect, at eighteen and fourteen per cent of inventories, in Irish, Bulgarian, Tundra Nenets, Meadow Mari, and Igbo; and breathy /ɸ/, attested in Xhosa alone.

The gloss *friction diffuse* does not belong to /f/. It belongs to the slice, and /f/ inherits it, as does /x/ — two sounds separated by the whole length of the tract, sharing a component because neither does anything to concentrate its noise. What distinguishes /f/ from /s/ is entirely Position II, this slice against the next.

That contrast is the one to hold onto, because it is the slice's whole content. Say /f/ and /s/ in succession and attend not to where your mouth is but to the quality of the hiss: /f/ is dull and low, /s/ is bright and sharp. The difference is not the place of the constriction — both are near the front — but whether the tongue has grooved to focus the stream. This slice is the sounds that have not.

Atlas range. Addresses 1000–1022.

5.2 · II = 1 — *friction concentrated*

Position II = 1, throughout domain 1. Nine cells.

The sibilants. A groove is formed along the midline of the tongue, the airstream is funneled through it, and the jet strikes the teeth downstream. The result is the loudest class of consonant in speech.

What the cells share is that focusing, and it is a real articulatory commitment rather than a matter of degree: the tongue must be shaped, held, and aimed.

Read across, the slice is fully occupied. At the outer threshold, labialized /s^w/ and /z^w/, attested in Lao, Dan, Avar, and Kabardian, with one unfilled cell above them. At the central point of contact, /s/ and /z/, with aspirated /s^h/ in Shan, Burmese, and Korean. Inward toward the throat, /ʃ/ and /ʒ/, with aspirated /ʃ^h/ in Barbareño and Baima.

The two most-attested consonants in the world's languages sit in this slice, and the frame gives them no special standing. /s/ receives its gloss the way the unfilled cell at the outer threshold receives one — from the intersection of four positions, with frequency entering nowhere.

The gloss *friction concentrated* does not belong to /s/. It belongs to the slice, and /s/ inherits it, as does /ʃ/, and as does the empty cell. What distinguishes /s/ from /ʃ/ is entirely Position III; what distinguishes /s/ from /z/ is entirely Position IV.

This slice is where the frame's standard proprioceptive test is usually run, and it can be run twice here. Rest two fingers on your throat and hold /s/, then switch to /z/ without moving your tongue. Nothing above the larynx changes — the groove stays where it is, the jet keeps striking the same teeth — and the buzz under your fingers is the whole of the difference. Then try /s/ against /ʃ/: now the larynx is doing the same thing throughout, and what moves is the tongue, backward by a centimetre or so, changing the resonant space in front of the groove. One test isolates Position IV; the other isolates Position III.

Atlas range. Addresses 1100–1122.

5.3 · II = 2 — *friction channeled laterally*

Position II = 2, throughout domain 1. Nine cells.

The tongue makes contact along the midline — as it would for a stop — and the air escapes around one or both sides, fricating as it goes. It is the only sub-manner in the frame that routes the airstream off the central axis.

What the cells share is that diversion, and it is worth noticing how strange the resulting class is: these sounds are made with the tongue in a closure posture, yet they are fricatives, because the closure is incomplete in a direction the other sub-manners never use.

Read across, the slice is the sparsest in the domain. At the outer threshold, labialized /t^w/, attested in Avar and Ronga at a tenth of a per cent, above two unfilled cells. At the central point of contact, /t/ and /k/ — the voiceless and voiced alveolar lateral fricatives, in Northern Khanty, Yuchi, Nootka, Daba, and Margi at five and two per cent — with breathy

/ɬ/ attested only in Xhosa. Inward toward the throat, one retroflex lateral fricative recorded in Ao, flanked by two cells no language fills.

Four of the nine are well formed and unoccupied, which is the highest proportion in the domain. The reason is phonetic rather than formal: lateral frication is expensive to produce and easy to confuse with the lateral approximants one domain over, and languages that acquire it tend to acquire one or two members rather than a series.

The gloss *friction channeled laterally* does not belong to /ɬ/. It belongs to the slice, and /ɬ/ inherits it, as do the four empty cells, which receive complete glosses with no sound to attach them to.

A reader who has never made one of these can build /ɬ/ from a sound they have. Say /l/ and hold it. Now, without moving the tongue, blow harder — hard enough that the air rushing past the sides of the tongue turns noisy. That noise is /ɬ/. The tongue has not moved: only the manner has, from resonance to friction, which in address terms is a change at Position I rather than anywhere in this chapter.

Atlas range. Addresses 1200–1222.

Chapter 6 · Place within domain 1

Position III is uniform across the frame (Chapter 1 §1.4), but its referents are not. **The position is ordinal, not anatomical.** It ranks the loci the preceding two digits have left available, outermost to inwardmost.

In this domain the ranking is gentler than in domain 0 — the three ranks resolve to labial, coronal, and dorsal-or-postalveolar throughout — but the ranking is still doing the work, and the sub-manners disagree about what the outermost rank means.

6.1 · III = 0 — at the outer threshold

Position III = 0, throughout domain 1. Nine cells.

The outermost rank: the constriction sits at the front of the tract, near the boundary of the body.

Read across the sub-manners, this slice is where the ordinal reading is easiest to see, because the three sub-manners resolve it three different ways. Under *friction diffuse* the outermost locus is labiodental: /f/, /v/, /ɸ/ — the lower lip against the upper teeth. Under *friction concentrated* it is not labial at all, because a groove cannot be formed at the lips; it resolves instead to labialized coronals, /s^w/ and /z^w/, where the front-ness is carried by rounding rather than by the constriction itself. Under *friction channeled laterally* it resolves the same way, to /ɬ^w/.

Six of the nine cells hold sounds, but only three of them are anatomically front. The other three are coronal sounds wearing a labial modification, ranked outermost because that is the frontmost option their sub-manner allows.

This is the clearest evidence in Part I that Position III ranks rather than names. A reader who had taken *at the outer threshold* to mean “labial” would look at /s^w/ and conclude the frame had made a mistake. It has not. The rank is relative to what the preceding digits permit, and under a sub-manner that cannot be labial, the outermost thing available is a coronal with the lips rounded.

The gloss *at the outer threshold* does not belong to /f/. It belongs to the slice, and /f/ inherits it, as does /s^w/ — sounds that share no articulator, grouped because they occupy the same rank under different constraints.

Atlas range. Addresses 1000, 1001, 1002, 1100, 1101, 1102, 1200, 1201, 1202.

6.2 · III = 1 — *at the central point of contact*

Position III = 1, throughout domain 1. Nine cells.

The middle rank, and in this domain it resolves consistently to the coronal region — the tongue tip and blade working against the teeth and the alveolar ridge.

Read across, every sub-manner is occupied here. Under *friction diffuse*, /θ/ and /ð/. Under *friction concentrated*, /s/, /z/, /s^h/. Under *friction channeled laterally*, /ɬ/, /ɮ/, /ɮ̥/. Eight of nine cells hold a sound.

This is the densest slice in the frame, and the reason is the one visible everywhere in phonology: the tongue tip is the fastest and most precisely controlled articulator the body has, so languages put a great deal of contrastive work through it. Nothing about the frame predicts this. The frame supplies twenty-seven equally well-formed addresses per domain and is indifferent to which get used.

The gloss *at the central point of contact* does not belong to /s/. It belongs to the slice, and /s/ inherits it, as do /θ/ and /ɬ/ — three sounds with the tongue in three quite different postures, sharing a rank.

The trio is worth making in sequence, because the tongue tip is in nearly the same place for all three and the differences are entirely in what the rest of the tongue does. For /θ/ the tongue is flat and the air spills over it. For /s/ it grooves and the air is aimed. For /ɬ/ the midline seals and the air goes around. Same rank, same articulator, three sub-manners — which is to say the whole of Chapter 5 can be felt at this one locus.

Atlas range. Addresses 1010, 1011, 1012, 1110, 1111, 1112, 1210, 1211, 1212.

6.3 · III = 2 — *inward toward the throat*

Position III = 2, throughout domain 1. Nine cells.

The innermost rank. As in domain 0, it resolves to different regions under different sub-manners, though the spread is narrower here.

Read across: under *friction diffuse* it is velar, giving /x/ and /ɣ/ — two of the best-attested sounds in the whole domain, at eighteen and fourteen per cent — plus breathy /ɣ/ in Xhosa. Under *friction concentrated* it is postalveolar rather than velar, giving /ʃ/, /ʒ/, /ʃʰ/; a groove cannot be maintained as far back as the velum, so the sub-manner stops short. Under *friction channeled laterally* it is retroflex, giving one sound recorded in Ao between two empty cells.

Velar, postalveolar, retroflex: three regions, one component, correct in each case because the component ranks rather than names.

The gloss *inward toward the throat* does not belong to /x/. It belongs to the slice, and /x/ inherits it, as does /ʃ/ — which is not, by any anatomical measure, further back than /s/ by very much, and is nowhere near the throat. It is simply the innermost place its sub-manner can reach.

English speakers have /ʃ/ and not /x/, which makes this slice a good test of whether attestation is being confused with well-foundedness. /ʃ/ will feel ordinary and /x/ exotic. The survey says /x/ is in eighteen per cent of the world's inventories, and the frame says both cells are derived identically. Neither the familiarity nor the frequency enters the gloss.

Atlas range. Addresses 1020, 1021, 1022, 1120, 1121, 1122, 1220, 1221, 1222.

Chapter 7 · Laryngeal state within domain 1

Position IV contributes the last component of every long form and the fourth word of every short form. Two of its values are uniform across the frame; the third is conditional on Positions I and II jointly, and the argument that settled how it should be conditioned was made in this domain (Appendix §A.3).

All nine laryngeal triples in this domain are reachable, which is true of no other. Twenty-seven addresses, twenty-seven distinct glosses, and within each triple the first three components hold constant while the last one varies.

7.1 · IV = 0 — *on breath alone*

Position IV = 0, throughout domain 1. Nine cells.

The folds are apart and the airstream passes without setting them in motion. In a domain of sustained constrictions this is the default condition: turbulence needs airflow, and voicing impedes it.

Read across, the slice gives /f/, /θ/, /x/ under *friction diffuse*; /s^w/, /s/, /ʃ/ under *friction concentrated*; and /t^w/, /t/, one empty cell under *friction channeled laterally*. Eight of nine occupied.

Voiceless fricatives are, as a class, more widely attested than their voiced counterparts, and this slice bears that out cell by cell against §7.2. The asymmetry has a straightforward aerodynamic cause — vibrating folds reduce the pressure drop across the constriction, and friction needs that pressure — and it is entirely absent from the frame, which offers the two slices identical treatment.

The gloss *on breath alone* does not belong to /s/. It belongs to the slice, and /s/ inherits it, as does /f/, as does /t/ — three sounds whose only common property is a larynx doing nothing.

Four of these are English consonants and carry no attestation figures at all, because the source survey reports inventories for candidate segments and not for the reference variety's own (Appendix §A.9). A reader should be careful not to read a blank as a low number. It is a gap in the pipeline, not a fact about the sound.

Atlas range. Addresses 1000, 1010, 1020, 1100, 1110, 1120, 1200, 1210, 1220.

7.2 · IV = 1 — with voice

Position IV = 1, throughout domain 1. Nine cells.

The folds vibrate while the constriction is held. Everything above the larynx is as it was in §7.1, and the sound is a fricative and a voiced continuant at once — two things happening in the same segment, which is why this class is aerodynamically awkward and comparatively rare.

Read across: /v/, /ð/, /ɣ/ under *friction diffuse*; /z^w/, /z/, /ʒ/ under *friction concentrated*; /ʒ/ and one retroflex lateral under *friction channeled laterally*, with one empty cell.

Compare each against its voiceless counterpart in §7.1 and the frequencies drop almost without exception — /x/ at eighteen per cent against /ɣ/ at fourteen, /t/ at five against /ʒ/ at under two. The frame records both numbers in the attestation slot and lets neither touch the gloss.

The gloss *with voice* belongs to the slice. /v/ inherits it, and so does /ʒ/, and so does the Ao retroflex lateral, which most readers will never have heard.

This slice is the best place in the frame to run the throat test, because every cell has a voiceless twin one digit away and the constriction can be held indefinitely. Take /f/ and /v/, then /θ/ and /ð/, then /s/ and /z/, then /ʃ/ and /ʒ/. Four pairs, fingers on the throat, tongue motionless within each pair. Position IV is the only thing moving, and it is the only position in the frame you can feel from outside the body.

Atlas range. Addresses 1001, 1011, 1021, 1101, 1111, 1121, 1201, 1211, 1221.

7.3 · IV = 2 — the marked laryngeal setting

Position IV = 2, throughout domain 1. Nine cells.

Like its counterpart in domain 0, this slice hands down two different components depending on the sub-manner above it — and this domain is where the rule governing that was found to be wrong.

Under *friction concentrated*, the component is *released into breath*: the sibilants at this value are aspirated, with a puff of voiceless air following the frication. Under *friction diffuse* and *friction channeled laterally*, it is *voiced through breath*: the folds vibrate while staying open enough for continuous audible airflow.

Read across: aspirated /s^h/ in Shan, Burmese, and Korean, and /ʃ^h/ in Barbareño and Baima, under the concentrated sub-manner. Breathy /ɹ/ in Isoko and Parauk, /ɹ̥/ and /ɹ̥̥/ in Xhosa, under the other two. Five occupied cells, every one of them in the Rare band or at the survey's floor.

This is the thinnest laryngeal slice in the domain, and the sparsity has an ordinary cause: breathy and aspirated fricatives are both hard to produce and easy to lose, so few languages keep them. The frame's treatment of these five cells is identical to its treatment of /s/.

The gloss belongs to the slice, and the slice hands down two things. What distinguishes /s^h/ from /ɹ̥/ is not one position but the interaction of two — which is what it means for a component to be conditional.

Earlier versions of the frame gave this whole slice a single component, *voiced through breath*, and that was correct for /ɹ̥/, /ɹ̥̥/, and /ɹ̥̥̥/ and false for /s^h/ and /ʃ^h/, which have no voicing whatever. The gloss asserted voice of a voiceless segment. It was correctly derived and wrong about the sound, and the repair had to be made at the component table rather than at the affected entries. The record is at Appendix §A.3.

Atlas range. Addresses 1002, 1012, 1022, 1102, 1112, 1122, 1202, 1212, 1222.

Domain 2 holds the sounds made without turbulence — the glides, the liquids, and the nasals. Its head component is *a continuum of open resonance*, and everything below inherits it.

These are the sounds that can be sung. Air moves through the tract fast enough to set the vocal folds going and slowly enough that nothing hisses, and the constrictions here shape a resonance rather than obstructing a stream. Three of the domain's twenty-seven cells are formally unreachable; the remaining twenty-four all carry full treatment, and twenty-two hold a sound.

Sounds are named where they illustrate a slice. Construction notes and open questions are in the Appendix.

Chapter 8 · Sub-manner within domain 2

Position II is read within the domain (Chapter 1 §1.3). Under this head its three values sort resonants by how much the tract is closed: not at all, partially, or completely with an escape route through the nose.

8.1 · II = 0 — *resonance in motion*

Position II = 0, throughout domain 2. Nine cells.

The glides. No contact anywhere, and the defining property is not a posture but a movement: the tract is traveling from one shape toward another, and the sound is what that transit sounds like. A glide held still stops being a glide and becomes a vowel.

What the nine cells share is that refusal to settle. This is the only sub-manner in the frame whose content is temporal.

Read across, the slice divides oddly. At the outer threshold, the labial-velar glides: /w/, voiceless /w̥/ in Breton, Sumo, and Washo, and breathy /w̤/ in Angami and Ikalanga. Inward toward the throat, the palatals: /j/, voiceless /j̥/ in Aleut, Hopi, and Lakkia, and breathy /j̤/ recorded in Dhangar. Between them, at the central point of contact, three formally unreachable cells — a coronal glide is not a thing the tract will make, because the tongue tip cannot approach the alveolar ridge closely enough to shape a resonance without either touching it (giving a liquid) or leaving it (giving a vowel).

The gloss *resonance in motion* does not belong to /w/. It belongs to the slice, and /w/ inherits it, as does /j/, as do the three cells no sound can occupy. What distinguishes /w/ from /j/ is entirely Position III.

This slice is where the consonant frame comes closest to the vowel frame and declines to merge with it. /w/ and /u/ are the same tongue and lip posture; /j/ and /i/ likewise. What separates them is not articulation but function — whether the sound holds a position or passes through one — and the frame encodes that by addressing them in different tiers entirely. A reader can feel the boundary by saying *we* very slowly. There is a moment where the /w/ stops being a movement and becomes a vowel, and the frame's two address systems meet at exactly that moment without overlapping.

Atlas range. Addresses 2000–2022.

8.2 · II = 1 — *resonance flowing*

Position II = 1, throughout domain 2. Nine cells.

The liquids. There is contact, or near-contact, and the airstream goes around it — over the sides of the tongue for the laterals, past a curled or bunched tongue for the rhotics. The resonance is shaped by an obstacle it does not have to fight.

What the cells share is that routing. This is the same maneuver the lateral fricatives perform one domain over, run at a wider aperture: seal the midline, let the air out at the edges, but do not narrow the gap enough to make noise.

Read across: at the outer threshold, one unfilled cell, the Mandarin labialized rhotic, and another unfilled cell — a nearly empty rank. At the central point of contact, /l/, voiceless /l̥/ in Dingri Tibetan and Xumi, breathy /l̥/ in Sumi, Bengali, and Nepali. Inward toward the throat, English /ɹ/, voiceless retroflex /ɹ̥/ in Lai, Toda, and Wakhi, and breathy /ɹ̥/ in Sindhi and Kharia.

The gloss *resonance flowing* does not belong to /l/. It belongs to the slice, and /l/ inherits it, as does /ɹ/ — two sounds that English speakers famously find difficult to keep apart when they belong to a language that does not distinguish them, and which the frame separates at Position III alone.

The kinship with domain 1 is worth making physically. Say /l/, hold it, and blow harder until the escaping air turns noisy: you have made /ɹ̥/, and you have moved one digit at Position I without touching anything else. The tongue never moved. This is the clearest demonstration in Part I that Position I is a genuine dimension rather than a taxonomic label — the difference between a fricative and a resonant is a matter of how hard you push.

Atlas range. Addresses 2100–2122.

8.3 · II = 2 — *resonance sealed*

Position II = 2, throughout domain 2. Nine cells.

The nasals. The oral tract is closed completely — as completely as for a stop — and the velum drops, so the resonance escapes through the nose. The sound is a closure that rings.

What the cells share is the paradox in that description. These are the only sounds in the frame made with a full oral closure that are nonetheless continuants: you can hold /m/ for as long as you have breath, though your lips never part.

Read across, the slice is the best-populated in the domain and one of the best-populated in the frame. At the outer threshold, /m/, voiceless /m̥/ in Ndonga and Shixing, breathy /m̥/ in Sumi and Sindhi. At the central point of contact, /n/, /n̥/ in Themchen Tibetan and Hopi, /n̥/ in Sindhi and Angami. Inward toward the throat, /ŋ/, /ŋ̥/ in Aleut and Mien, and breathy /ŋ̥/ in Angami and Khezha. Nine cells, nine sounds.

The gloss *resonance sealed* does not belong to /m/. It belongs to the slice, and /m/ inherits it, as does /ŋ/, as do all seven of the marked-laryngeal nasals most readers have never made.

The relationship with domain 0 is exact and worth stating. /m/ and /b/ are the same closure at the same locus with the same laryngeal state; /n/ and /d/ likewise; /ŋ/ and /g/ likewise. The only difference is the velum, up or down, which the frame encodes at Position I — so a nasal and its corresponding stop differ in the first digit and agree in the other three. Pinch your nose and try to say /m/. What comes out is a stop, because you have closed the only exit the resonance had.

Atlas range. Addresses 2200–2222.

Chapter 9 · Place within domain 2

Position III is uniform across the frame (Chapter 1 §1.4) and ordinal rather than anatomical. In this domain the three ranks resolve to labial, coronal, and dorsal-or-palatal, with one complication the other domains do not have: two of the sounds ranked outermost are made at two places at once.

9.1 · III = 0 — at the outer threshold

Position III = 0, throughout domain 2. Nine cells.

The outermost rank: the constriction nearest the boundary of the body.

Read across: under *resonance in motion* it gives /w/ and its voiceless and breathy variants; under *resonance flowing*, one Mandarin labialized rhotic between two empty cells; under *resonance sealed*, /m/, /ṃ/, /ṁ/.

The complication sits in the glides. /w/ is labial-velar — the lips round *and* the tongue body raises toward the velum, simultaneously and inseparably. Ranked outermost, it is filed by the frontmost of its two constrictions, and its back constriction goes unrecorded. The frame has three place ranks and this sound needs two of them.

That is not a defect so much as a declared cost. Whitepaper Chapter 6 collapses eight places of articulation into three, and any such collapse loses information; the question is only whether what it loses matters. Here it does something specific: /w/ and /j/ end up at opposite ends of the place ranking despite sharing a velar or palatal component, and a reader deriving their glosses will find them further apart than they are. The consequence is recorded at Appendix §A.5, where the same question arises from the other direction.

The gloss *at the outer threshold* does not belong to /m/. It belongs to the slice, and /m/ inherits it, as does /w/ — which is only partly a labial sound and is ranked as though it were wholly one.

Atlas range. Addresses 2000, 2001, 2002, 2100, 2101, 2102, 2200, 2201, 2202.

9.2 · III = 1 — *at the central point of contact*

Position III = 1, throughout domain 2. Nine cells.

The middle rank, resolving as everywhere to the coronal region.

Read across, this slice contains both the domain's fullest sub-manner and its emptiest. Under *resonance sealed* it gives /n/, /ɲ/, /ɳ/ — /n/ being, by most surveys, the single most widely attested consonant in human language. Under *resonance flowing* it gives /l/, /ɭ/, /ɻ/. Under *resonance in motion* it gives nothing at all: three formally unreachable cells, because the coronal region has no room for a glide.

Six sounds and three impossibilities in one rank, and the split falls exactly along the sub-manner axis. The reason is a geometric one about the tongue tip: it can touch the alveolar ridge, giving /n/ and /l/, or it can rest away from it, giving a vowel, but it cannot hover in the narrow band between that a glide would require. The other two ranks have that band; this one does not.

The gloss *at the central point of contact* does not belong to /n/. It belongs to the slice, and /n/ inherits it, as does /l/, as do the three cells that cannot be filled — which receive complete glosses describing a locus at which their sub-manner cannot operate.

Those three unreachable cells are the cleanest demonstration in the frame of what derivation is. A gloss exists for them. It is correct, it follows from four digits, and there has never been a sound at that address from which it could have been reverse-engineered.

Atlas range. Addresses 2010, 2011, 2012, 2110, 2111, 2112, 2210, 2211, 2212.

9.3 · III = 2 — *inward toward the throat*

Position III = 2, throughout domain 2. Nine cells.

The innermost rank, resolving differently under each sub-manner: palatal for the glides, retroflex for the liquids, velar for the nasals.

Read across: /j/, /j̠/, /jʱ/ under *resonance in motion*; English /ɹ/ with retroflex /ɹ̠/ and /ɹ̡/ under *resonance flowing*; /ɳ/, /ɳ̠/, and palatal breathy /ɲ̠/ under *resonance sealed*. All nine occupied.

Palatal, retroflex, velar. The palatal glide /j/ is made further forward than the retroflex liquid, and both are further forward than /ɳ/ — so this rank is not even monotonic in anatomical terms. It is monotonic within each sub-manner, which is all the frame claims. A reader who expects the innermost rank to mean “further back than the middle rank” will find /j/ a counterexample and should re-read the ordinal claim at the head of this chapter.

The gloss *inward toward the throat* does not belong to /ŋ/. It belongs to the slice, and /ŋ/ inherits it, as does /j/ — a sound made with the tongue high and forward, nowhere near the throat, ranked innermost because it is the innermost thing its sub-manner reaches.

English has /j/, /ɹ/, and /ŋ/, one from each sub-manner, which makes this the rank an English reader can populate entirely from their own mouth. Say *young, run, sing*, and attend to the tongue body. It is high and forward, curled and central, and low and back — three postures that share nothing except being, each within its own sub-manner, the innermost available.

Atlas range. Addresses 2020, 2021, 2022, 2120, 2121, 2122, 2220, 2221, 2222.

Chapter 10 · Laryngeal state within domain 2

Position IV contributes the last component of every long form and the fourth word of every short form. Two of its values are uniform across the frame; the third is conditional on Positions I and II jointly, and this is the only domain in which that conditionality makes no difference — all nine cells at the marked value take the same component.

That uniformity is why this domain served as the control when the conditional rule was being diagnosed (Appendix §A.3).

10.1 · IV = 0 — *on breath alone*

Position IV = 0, throughout domain 2. Nine cells.

The folds are apart. In a domain whose sounds are defined by resonance, this is the marked case rather than the default: a resonant with no voicing is a shape with very little in it, audible mainly as shaped breath.

Read across, every reachable cell is occupied: /w̥/ and /j̥/ under *resonance in motion*, /l̥/ and /ɹ̥/ under *resonance flowing*, /m̥/, /n̥/, /ŋ̥/ under *resonance sealed*, with the three unreachable coronal glides making up the rest.

Not one of these is English, and every one is rare — from /l̥/ and /m̥/ at around two per cent of surveyed inventories down to sounds recorded in a handful of languages. This is the least familiar slice in the frame for an English reader, and it is derived exactly as §10.2 is.

The gloss *on breath alone* does not belong to /m̥/. It belongs to the slice, and /m̥/ inherits it, as does /w̥/, as do the three unreachable cells.

Most readers can make these without instruction. Say /m/ and then stop voicing it while keeping the lips closed and the air moving: the result is /m̥/, a nasal made of breath, which Ndonga and Themchen Tibetan use contrastively. The same subtraction works on /n/, /ŋ/, /l/, /w/, and /j/. Six voiceless resonants, none of them English, all of them available to an English mouth in about a minute.

Atlas range. Addresses 2000, 2010, 2020, 2100, 2110, 2120, 2200, 2210, 2220.

10.2 · IV = 1 — *with voice*

Position IV = 1, throughout domain 2. Nine cells.

The folds vibrate. For this domain that is the default condition and the reason the domain coheres: without voicing there is nothing for the tract's shape to resonate.

Read across: /w/ and /j/ under *resonance in motion*; the Mandarin labialized rhotic, /ɭ/, and /ɮ/ under *resonance flowing*; /m/, /n/, /ŋ/ under *resonance sealed*. Eight occupied cells, and seven of the eight are English consonants — the highest concentration of the reference variety anywhere in the frame.

That concentration produces the frame's most severe data blank. Because the source survey reports inventories for candidate segments and not for the reference variety's own, seven of these nine cells carry no attestation figure at all (Appendix §A.9). The domain's most ordinary sounds are the ones about which the printed Atlas says least, while /ɭ/ two slices away carries a precise figure. A reader scanning attestation columns would conclude that this slice is poorly evidenced. It is the opposite: these are among the most common consonants on earth, and the blank is a pipeline artefact.

The gloss *with voice* belongs to the slice. /m/ inherits it, and so does /j/, and the two share nothing else — one is a full closure, the other no closure at all.

The sense-range pool attached to this component, *sounded · warm · personal*, enters every cell here by rule. It is worth knowing it was chosen rather than found. That /m/ feels warm is a fact about /m/ and its uses, or about the reader; it is not something the frame discovered.

Atlas range. Addresses 2001, 2011, 2021, 2101, 2111, 2121, 2201, 2211, 2221.

10.3 · IV = 2 — *resonant through breath*

Position IV = 2, throughout domain 2. Nine cells.

The folds vibrate while staying open enough for continuous audible airflow, so that voice and breath sound together. This is breathy voice, and unlike its counterparts in the other two domains it is uniform across the whole slice: no sub-manner here admits aspiration, so the component does not vary.

Read across: /w/ and /j^h/ under *resonance in motion*; /ɭ/ and /ɮ/ under *resonance flowing*; /ṃ/, /ṇ/, /ṅ/ under *resonance sealed*. Seven occupied cells, with the three unreachable coronal glides making up the nine. Every occupant is in the Rare band — /ɭ/ at seven-tenths of a per cent, /ṃ/ at eight, most of the rest below — and they cluster in South Asia: Sindhi, Nepali, Bengali, Sumi, Angami, Khezha.

The gloss *resonant through breath* does not belong to /m/. It belongs to the slice, and /m/ inherits it, as does /j^h/.

This slice is the frame's control case. When the conditional rule at Position IV was found to be misdescribing sounds in the other two domains, it was the fact that domain 2 has no exceptions — that a domain-wide component is exactly right here and exactly wrong there — that identified what the rule was actually tracking. The record is at Appendix §A.3.

An English speaker can approximate a breathy nasal by sighing through /m/ — letting a good deal more air escape than voicing alone requires, so the tone acquires a murmur. The difference from /m/ is small and entirely laryngeal, which is what makes these sounds easy to lose and rare in the survey. Sindhi holds four of them in contrast.

Atlas range. Addresses 2002, 2012, 2022, 2102, 2112, 2122, 2202, 2212, 2222.

Chapter 11 · Vowels

The consonant frame addresses obstruction: what closes, how, where, and what the larynx does while it happens. Vowels have no obstruction to describe. They are the sounds made with the tract open enough that nothing impedes the airstream, and what distinguishes one from another is the shape of the resonating space rather than any event within it.

So the vowel frame runs on its own geometry, and it is smaller. Two positions, not four: **aperture** — how far the mouth is open — and **orientation** — where the tongue body sits along the front-to-back axis. Nine digrams. There is no laryngeal position, because vowels are voiced by definition, and no position for lip rounding at all, which has consequences taken up at §11.6.

Three vowels sit at the extreme corners of that space and take a shorter address: a single digit, a **monogram**. These are the cardinals, and they behave unlike anything else in the frame (§11.7).

One vowel takes no address at all (§11.8).

This chapter treats aperture and orientation as slices, in the manner of Chapters 2 through 10, then handles the two tiers that do not compose. Sounds are named where they illustrate a slice. Construction notes are in the Appendix.

11.1 · 1 = 0 — the mouth fully open

Aperture 0, across all three orientations. Three cells.

The jaw is dropped and the tongue lies low. The resonating space above it is at its largest, and the sound carries further than any other vowel class — which is why open vowels are what people shout with.

Read across the orientations: at the center, [a]; advanced, /æ/; withdrawn, /ɑ/.

Only /æ/ belongs to the reference variety, and this is the slice where the reference variety is most conspicuously out of step with the world. The central cell holds [a], recorded in roughly eighty-six per cent of surveyed inventories — the most widely attested vowel there is after /i/ — and General American does not have it. The withdrawn cell holds /ɑ/ in the cardinal tier, and the digram there is vacant because the reference variety has no lax counterpart to it; RP fills it with the LOT vowel /ɒ/, recorded in a couple of hundred inventories.

Two of three cells empty, and neither emptiness is a gap in the world's vowel systems. Both are gaps in English.

The gloss *the mouth fully open* does not belong to /æ/. It belongs to the slice, and /æ/ inherits it, as does [a], as does the vacant cell at the back. What distinguishes /æ/ from [a] is entirely Position II.

A reader can hear the slice by saying *cat*, then trying to say it with the tongue pulled back and the jaw held where it is. The vowel that results is not English and is extremely common elsewhere.

Atlas range. Addresses 00, 01, 02.

11.2 · I = 1 — *the mouth half open*

Aperture 1, across all three orientations. Three cells.

The jaw is partly closed and the tongue is raised from the floor of the mouth without approaching the roof. The middle band, and the only vowel slice in the frame that the reference variety fills completely.

Read across: at the center, /ʌ/; advanced, /ɛ/; withdrawn, /ɔ/. The vowels of *cup*, *bed*, and — for many speakers — *thought*.

The middle aperture is where a three-by-three grid loses the most. Phonetic description separates open-mid from close-mid, and this frame does not: General American /ɔ/ and Spanish /o/ would share the cell at 12. The symbols in this slice are conventional representatives of regions of vowel space, not exact articulations, and this is truer here than at the extremes, where the corners of the space do the separating.

The central cell, 10, is worth pausing on. Its occupant /ʌ/ is nearly identical to the schwa, and many analyses treat the two as one phoneme appearing in stressed and unstressed positions. The frame assigns /ʌ/ this address and leaves the schwa unaddressed, which resolves a real collision (§11.8) — but a reader should know that the boundary between the frame's most ordinary vowel cell and its unaddressed Center is a matter of stress rather than of articulation.

The gloss *the mouth half open* does not belong to /ɛ/. It belongs to the slice, and /ɛ/ inherits it, as do /ʌ/ and /ɔ/. What distinguishes them is entirely Position II.

Atlas range. Addresses 10, 11, 12.

11.3 · I = 2 — *the mouth nearly closed*

Aperture 2, across all three orientations. Three cells.

The tongue is high, close enough to the roof of the mouth to shrink the resonating space substantially, but not close enough to make friction — the point past which a vowel becomes a consonant.

Read across: at the center, /i/, which General American lacks and Russian has, recorded in a few hundred inventories; advanced, /ɪ/; withdrawn, /ʊ/. The vowels of *bit* and *put*, either side of a gap.

This is the slice where the two vowel tiers touch, and it is the best place to see how. Two of the three cardinals sit at these coordinates: /i/ at 21 and /u/ at 22 — the same aperture, the same orientation, occupied in the digram tier by /ɪ/ and /ʊ/. The cardinal and the digram at one coordinate are the tense and lax forms of the same region. *Beat* and *bit* are the same address read at two tiers.

That relation is what the tenseness component records, and it exists only here and at 02.

The gloss *the mouth nearly closed* does not belong to /ɪ/. It belongs to the slice, and /ɪ/ inherits it, as does /ʊ/, as does /i/ — and the cardinals inherit it too, by a different route (§11.7).

Say *beat*, then *bit*, then *beat* again, attending to how much effort the tongue is making. The address does not change. What changes is whether the position is held at its limit.

Atlas range. Addresses 20, 21, 22.

11.4 · II = 0 — *the tongue at rest in the center*

Orientation 0, across all three apertures. Three cells.

The tongue body neither advances nor retracts. Aperture varies; the front-to-back axis is at its neutral point.

Read across the apertures: fully open, [a]; half open, /ʌ/; nearly closed, /ɪ/.

Only /ʌ/ is General American, and the column is thin for a reason that has nothing to do with the frame. Central vowels are perceptually less distinct than peripheral ones — there is less acoustic room between them and their neighbors — so languages that build large vowel inventories tend to build them around the edges of the space and leave the middle sparse. English is unusual only in how thoroughly it does this.

Yet the world does not agree even here. The open central cell holds the single most common vowel in the survey after /i/, and English has neither it nor the close central vowel above it.

The gloss *the tongue at rest in the center* does not belong to /ʌ/. It belongs to the slice, and /ʌ/ inherits it, as do [a] and /ɪ/.

This column has a further property: it runs alongside the Center without ever containing it. The schwa is central and mid — the coordinates of 10 — and is deliberately left unaddressed. The column is therefore the closest the addressed frame comes to the sound it declines to address, and 10 is the cell where the two nearly touch.

Atlas range. Addresses 00, 10, 20.

11.5 · II = 1 — *the tongue advanced*

Orientation 1, across all three apertures. Three cells.

The tongue body is pushed forward, narrowing the space in front of it and enlarging the space behind. The resulting resonance is bright.

Read across: fully open, /æ/; half open, /ɛ/; nearly closed, /ɪ/. The vowels of *cat*, *bed*, and *bit* — all three English, a fully occupied column.

The cardinal /i/ sits at the top of this column, at the same coordinates as /ɪ/, and is the frame's most widely attested vowel of any kind. Front vowels are cheap and distinct: the tongue is already forward for most consonants, and the acoustic separation between /i/, /ɛ/, and /æ/ is large. Almost every language has at least two of them.

The gloss *the tongue advanced* does not belong to /ɛ/. It belongs to the slice, and /ɛ/ inherits it, as do /æ/ and /ɪ/. What distinguishes them is entirely Position I.

Say *cat*, *bet*, *bit* in sequence and attend to the jaw rather than the tongue. The tongue stays forward throughout; the jaw closes by degrees. That is one position moving against another held fixed, which is the same demonstration the consonant chapters run at the laryngeal position.

Atlas range. Addresses 01, 11, 21.

11.6 · II = 2 — *the tongue withdrawn*

Orientation 2, across all three apertures. Three cells.

The tongue body retracts toward the back of the mouth. The resonance darkens.

Read across: fully open, the vacant cell where RP's /ɒ/ would sit; half open, /ɔ/; nearly closed, /ʊ/. Two of the three cardinals also sit in this column, /ɑ/ at the open corner and /u/ at the close one.

This slice is where the frame's largest omission shows. In most of the world's languages, back vowels are rounded and front vowels are not — the two features travel together so reliably that many descriptions treat backness and rounding as one dimension. The frame encodes only backness. It has no position for the lips at all.

That works as long as the correlation holds. It stops working for the front rounded vowels — /y/, /ø/, and their relatives, which are common across northern Europe and much of Asia. These are front in tongue position and rounded in lip posture, and the frame has no coordinate for the second half of that description.

The frame's answer is fusion: /y/ is written by combining the address of /i/ with the address of /u/, taking the tongue from one and the lips from the other. That is a real solution rather than an evasion, and it is consistent with how the frame handles simultaneity elsewhere. But it means lip rounding is representable only by reference to another vowel, never in its own right, and a language with a full front-rounded series has to spell every member as a fusion.

Whether a third vowel position should carry rounding is open (Appendix §A.4). It is the strongest candidate for one.

The gloss *the tongue withdrawn* does not belong to /ʊ/. It belongs to the slice, and /ʊ/ inherits it, as does /ɔ/, as does the vacant open cell.

Atlas range. Addresses 02, 12, 22.

11.7 · The cardinals — where composition stops

Monograms 0, 1, 2. Three entries.

Three vowels take a single-digit address: /ɑ/, /i/, and /u/. They are the extreme corners of the vowel space, the points past which the tongue cannot go while still making a vowel.

A monogram's digit does not compose. This is the only place in the frame where that is true, and it is worth stating flatly because everything else in this volume rests on the opposite. The digit is an identity index. It says *which cardinal* — the first, the second, the third — and it says nothing whatever about where that cardinal sits. Read as a coordinate it means nothing: there is no sense in which /i/ is “one” of anything.

So the cardinals cannot be glossed the way every other address is glossed, and the frame derives them by a different route. Each cardinal is located in the digram grid — /ɑ/ at 02, /i/ at 21, /u/ at 22 — and its gloss is composed from those coordinates, with a tenseness component appended. /i/ receives *the mouth nearly closed, the tongue advanced, held at full extension*.

The relation between the tiers follows from this. A monogram and a digram at the same coordinates are the same region of vowel space held at its limit and held short of it: tense and lax. /i/ and /ɪ/, /u/ and /ʊ/. The third pair does not exist in the reference variety — the cell at 02 is vacant — so /ɑ/ stands alone.

Every cardinal entry in the Atlas states in its address block that the digit is an index and that the gloss derives from digram coordinates. Without that line the entry misrepresents the system, by implying a composition that did not happen.

What this costs. The cardinals are the frame's three most important vowels and the only addresses that require a special rule to gloss. A reader could reasonably ask why they have a tier of their own rather than simply being the digrams at 02, 21, and 22 with a tenseness marker. The answer the frame gives is that cardinality is a fact about the vowel space — these are its corners — and deserves to be visible in the notation. Whether that is worth an exception to compositionality is a fair question, and it has not been argued anywhere.

Atlas range. Monograms 0, 1, 2.

11.8 · The Center

No address. One entry.

The schwa takes no symbol and no address. It is the Center of the system, and its position is outside the frame rather than at the middle of it.

This is not an evasion. The schwa is the vowel of minimal articulatory commitment — the tongue at rest, the mouth neither open nor closed, neither forward nor back. It is what English vowels reduce to when unstressed, which is to say it is what remains when the distinguishing effort is withdrawn. **A system that addresses sounds by their articulatory commitments has nothing to say about the sound defined by having none.**

The consequences are exact and they are strict. The Center receives no derived gloss and no sense range; its derivation block records why rather than what. Nothing composes with it, because an unaddressed point has nothing to compose with. It may carry an articulation block and a resonance block, since neither requires an address.

There is a practical benefit and an honest caveat. The benefit is that /ə/ and /ʌ/ are close to identical in General American, distinguished chiefly by stress, and many analyses treat them as one phoneme in two environments. Addressing /ʌ/ at 10 and leaving /ə/ unaddressed resolves a genuine collision cleanly. The caveat is that this is a convenient resolution of a near-merger, not a discovery about the sound. If the frame had a fourth vowel position, or a different reference dialect, the collision might not arise and the argument for the Center would rest on the articulatory point alone.

That argument is strong enough to stand by itself, and the entry should be read as resting on it.

Atlas range. The Center.

11.9 · What takes no address

Three classes of vowel phenomenon are represented without receiving cells of their own. They are listed here because a reader looking for them in the Atlas will not find them, and their absence is structural rather than an omission.

Diphthongs are sequences. /eɪ/ is written as the movement from /ɛ/ to /ɪ/, /aʊ/ as the movement from /a/ to /ʊ/. They are trajectories rather than positions, and the frame addresses positions.

This was not always so. An earlier version treated /aɪ/ as a fundamental vowel in its own right, which is doubly hard to defend: it is a movement rather than a state, and it was a single long vowel in Middle English. A frame resting on its present value would be resting on a sound change of the last six hundred years.

Rhotacized vowels are modifications. The vowel of *bird* is written as the mid-central vowel bearing a rhotic modifier, not as a sequence. Rhotacization is simultaneous: the tongue holds its rhotic configuration throughout rather than moving into it afterward, and there is no moment at which a speaker of *bird* has produced a vowel and not yet a rhotic. Writing it as a sequence would misapply the notation — and would additionally require the Center to participate in a composition, which §11.8 forbids.

Vowels outside the reference inventory extend by fusion. /y/ combines the tongue position of /i/ with the lip posture of /u/. This is the mechanism discussed at §11.6, and it carries the frame beyond English without adding cells.

None of these three requires a new address, and that is the point. The vowel frame is nine digrams, three monograms, and one unaddressed Center; everything else in a vowel system is built from them by operations the notation already has.

Part II · The Atlas

Ninety-four entries, one per address. Each has five blocks in a fixed order: **ADDRESS, ARTICULATION, DERIVATION, RESONANCE, ATTESTATION**. The order is load-bearing — see the front matter.

Nine entries carry no gloss (the affricates, under quarantine) and nine carry no articulation (the unreachable addresses). Both are deliberate.

Domain 0 — closure and release

Twenty-seven entries. Nine are formally unreachable and carry a derivation without an articulation. Nine are quarantined and carry an articulation without a derivation. Both kinds are printed in full rather than demoted; an entry that shows what the frame declines to do is doing as much work as one that shows what it does.

0000 ·

ADDRESS — *definitional*

0 · 0 · 0 · 0. Domain: closure and release. Sub-manner: unobstructed breath. Place: outermost rank. Laryngeal: voiceless. Glyph U+1D306.

ARTICULATION — *what your mouth does*

— *No sound occupies this address; there is nothing to produce.*

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *breath unobstructed*

III → *at the outer threshold*

IV → *on breath alone*

Long: an event of closure and release, breath unobstructed, at the outer threshold, on breath alone

Short: release · unobstructed · outer · breath

Range:

I opening · breaking · beginning

II emptiness · unimpeded · through

III lip · boundary · meeting

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Formally unreachable. Contested: occupants exist under a reading that admits secondary articulation as place (Appendix §A.5). The Unicode name TETRAGRAM FOR CENTRE is unrelated to the vowel Center.

0001 ·

ADDRESS — *definitional*

0 · 0 · 0 · 1. Domain: closure and release. Sub-manner: unobstructed breath. Place: outermost rank. Laryngeal: modal voiced. Glyph U+1D307.

ARTICULATION — *what your mouth does*
 — *No sound occupies this address; there is nothing to produce.*

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *breath unobstructed*

III → *at the outer threshold*

IV → *with voice*

Long: an event of closure and release, breath unobstructed, at the outer threshold, with voice

Short: release · unobstructed · outer · voice

Range:

I opening · breaking · beginning

II emptiness · unimpeded · through

III lip · boundary · meeting

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Formally unreachable.

0002 · 

ADDRESS — *definitional*

0 · 0 · 0 · 2. Domain: closure and release. Sub-manner: unobstructed breath. Place: outermost rank. Laryngeal: marked. Glyph U+1D308.

ARTICULATION — *what your mouth does*
 — *No sound occupies this address; there is nothing to produce.*

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *breath unobstructed*

III → *at the outer threshold*

IV → *voiced through breath*

Long: an event of closure and release, breath unobstructed, at the outer threshold, voiced through breath

Short: release · unobstructed · outer · throughbreath

Range:

I opening · breaking · beginning

II emptiness · unimpeded · through

III lip · boundary · meeting

IV veiling · mingling · softened

RESONANCE — *not derived; discard freely*

ATTESTATION — *empirical*

Formally unreachable. Contested: occupants exist under a reading that admits secondary articulation as place (Appendix §A.5).

0010 ·

ADDRESS — *definitional*

0 · 0 · 1 · 0. Domain: closure and release. Sub-manner: unobstructed breath. Place: middle rank. Laryngeal: voiceless. Glyph U+1D309.

ARTICULATION — *what your mouth does*

— *No sound occupies this address; there is nothing to produce.*

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *breath unobstructed*

III → *at the central point of contact*

IV → *on breath alone*

Long: an event of closure and release, breath unobstructed, at the central point of contact, on breath alone

Short: release · unobstructed · central · breath

Range:

I opening · breaking · beginning

II emptiness · unimpeded · through

III center · handling · address

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

ATTESTATION — *empirical*

Formally unreachable.

0011 ·

ADDRESS — *definitional*

0 · 0 · 1 · 1. Domain: closure and release. Sub-manner: unobstructed breath. Place: middle rank. Laryngeal: modal voiced. Glyph U+1D30A.

ARTICULATION — *what your mouth does*

— *No sound occupies this address; there is nothing to produce.*

DERIVATION — *deterministic; see Chapter 1*I → *an event of closure and release*II → *breath unobstructed*III → *at the central point of contact*IV → *with voice***Long:** an event of closure and release, breath unobstructed, at the central point of contact, with voice**Short:** release · unobstructed · central · voice**Range:****I** opening · breaking · beginning**II** emptiness · unimpeded · through**III** center · handling · address**IV** sounded · warm · personal**RESONANCE** — *not derived; discard freely*

—

ATTESTATION — *empirical*

Formally unreachable.

0012 · **ADDRESS** — *definitional*

0 · 0 · 1 · 2. Domain: closure and release. Sub-manner: unobstructed breath. Place: middle rank. Laryngeal: marked. Glyph U+1D30B.

ARTICULATION — *what your mouth does*— *No sound occupies this address; there is nothing to produce.***DERIVATION** — *deterministic; see Chapter 1*I → *an event of closure and release*II → *breath unobstructed*III → *at the central point of contact*IV → *voiced through breath***Long:** an event of closure and release, breath unobstructed, at the central point of contact, voiced through breath**Short:** release · unobstructed · central · throughbreath**Range:****I** opening · breaking · beginning**II** emptiness · unimpeded · through**III** center · handling · address**IV** veiling · mingling · softened**RESONANCE** — *not derived; discard freely*

—

ATTESTATION — *empirical*
Formally unreachable.

0020 ·  · /h/

ADDRESS — *definitional*

0 · 0 · 2 · 0. Domain: closure and release. Sub-manner: unobstructed breath. Place: innermost rank. Laryngeal: voiceless. Glyph U+1D30C. Transliterated H.

ARTICULATION — *what your mouth does*

Open your mouth as though you were about to say a vowel — any vowel — and then, instead of voicing it, simply push breath out through the shape you have made. That is the whole sound. Your tongue and lips are already wherever the next vowel needs them; nothing here is added on top. Because of that, this sound has no fixed shape of its own — it borrows the shape of whatever follows it. Say *he*, then *who*, and notice that the breath at the start is made in two quite different mouths.

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *breath unobstructed*

III → *inward toward the throat*

IV → *on breath alone*

Long: an event of closure and release, breath unobstructed, inward toward the throat, on breath alone

Short: release · unobstructed · inward · breath

Range:

I opening · breaking · beginning

II emptiness · unimpeded · through

III depth · origin · interior

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

Almost every tradition that assigns significance to breath arrives at this sound, and it is worth asking how much of that is the sound and how much is the fact that it is barely a sound at all. It is the consonant that adds nothing — no closure, no place, no voice.

Whatever it seems to carry, it is carrying on loan from the vowel after it.

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

0021 · **ADDRESS** — *definitional*

0 · 0 · 2 · 1. Domain: closure and release. Sub-manner: unobstructed breath. Place: innermost rank. Laryngeal: modal voiced. Glyph U+1D30D.

ARTICULATION — *what your mouth does*

You can produce this, but you will find it turns into something else. Make the breathy sound at the start of *hoed* in Dutch, then bring the vocal folds fully together so that the tone is clean rather than murmured — while adding no constriction anywhere in the mouth. What comes out is a vowel. That is why no surveyed language uses this as a consonant: a fully voiced sound with nothing narrowing the tract above the larynx has already crossed into the other half of the system.

Producible but unattested: no surveyed language uses this contrastively.

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *breath unobstructed*

III → *inward toward the throat*

IV → *with voice*

Long: an event of closure and release, breath unobstructed, inward toward the throat, with voice

Short: release · unobstructed · inward · voice

Range:

I opening · breaking · beginning

II emptiness · unimpeded · through

III depth · origin · interior

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Well formed and unattested. No surveyed language fills this cell.

0022 · · /h/**ADDRESS** — *definitional*

0 · 0 · 2 · 2. Domain: closure and release. Sub-manner: unobstructed breath. Place: innermost rank. Laryngeal: marked. Glyph U+1D30E. Transliterated H:, plain HH.

ARTICULATION — *what your mouth does*

Say the English *h* in *ahead*, then make it again while letting the vocal folds buzz at the same time — not a clean tone, but a murmur, as though sighing and speaking at once. The airflow stays continuous and the mouth stays open. Dutch speakers make this at the start of *hoed*.

Rest two fingers on your throat: with the English sound you feel nothing, with this one you feel a faint vibration that never becomes a clear pitch. Nothing above the larynx has moved.

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *breath unobstructed*

III → *inward toward the throat*

IV → *voiced through breath*

Long: an event of closure and release, breath unobstructed, inward toward the throat, voiced through breath

Short: release · unobstructed · inward · throughbreath

Range:

I opening · breaking · beginning

II emptiness · unimpeded · through

III depth · origin · interior

IV veiling · mingling · softened

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Attested band, 3.5% of surveyed inventories. Dutch, Kharia, Reḃe.

0100 ·  · /p/

ADDRESS — *definitional*

0 · 1 · 0 · 0. Domain: closure and release. Sub-manner: stop. Place: outermost rank.

Laryngeal: voiceless. Glyph U+1D30F. Transliterated P.

ARTICULATION — *what your mouth does*

Press your lips together, build up a little air behind them, and let them part sharply. There is no voice — the vocal folds stay apart throughout — so the only sound is the burst itself. Hold two fingers to your throat and say *spin*: you will feel nothing at the start. Now say *pin*. In English the burst there is followed by a puff of breath, which is a different sound; the one described here is the *spin* version.

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *closure complete*

III → *at the outer threshold*

IV → *on breath alone*

Long: an event of closure and release, closure complete, at the outer threshold, on breath alone

Short: release · complete · outer · breath

Range:

- I opening · breaking · beginning
- II sealing · stopping · finality
- III lip · boundary · meeting
- IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

The first closure a child makes, and the one that recurs in words for *father* across unrelated language families. This is usually explained by the lips being the easiest articulator to control and the most visible to an infant. That explanation is sufficient, and the sound needs no further significance to be interesting.

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

0101 ·  · /b/

ADDRESS — *definitional*

0 · 1 · 0 · 1. Domain: closure and release. Sub-manner: stop. Place: outermost rank. Laryngeal: modal voiced. Glyph U+1D310. Transliterated B.

ARTICULATION — *what your mouth does*

Press your lips together as for the sound in *spin*, but start the vocal folds buzzing before you release. The lips do exactly what they did before; the difference is entirely at the throat. Rest two fingers there and alternate: *pa, ba, pa, ba*. The lips are identical in every one. What you feel under your fingers on the second and fourth is the whole of the difference, and you can feel it a moment before the lips part.

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *closure complete*

III → *at the outer threshold*

IV → *with voice*

Long: an event of closure and release, closure complete, at the outer threshold, with voice

Short: release · complete · outer · voice

Range:

I opening · breaking · beginning

II sealing · stopping · finality

III lip · boundary · meeting

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

0102 · · /pʰ/
ADDRESS — *definitional*

0 · 1 · 0 · 2. Domain: closure and release. Sub-manner: stop. Place: outermost rank. Laryngeal: marked. Glyph U+1D311. Transliterated P', plain PH.

ARTICULATION — *what your mouth does*

Press your lips together, release them sharply, and let a clear puff of breath escape before the following vowel begins. Hold your palm a few inches from your mouth and say *pin* — you will feel the puff. Now say *spin*, and you will not. English uses both, but never to distinguish one word from another; in Hindi, Thai, and Ossetic the two are separate sounds, and swapping them changes the word. Everything at the lips is the same in both.

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *closure complete*

III → *at the outer threshold*

IV → *released into breath*

Long: an event of closure and release, closure complete, at the outer threshold, released into breath

Short: release · complete · outer · released

Range:

I opening · breaking · beginning

II sealing · stopping · finality

III lip · boundary · meeting

IV aftermath · escape · consequence

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Common band, 19.3% of surveyed inventories. Iron Ossetic, English, Kham Tibetan.

0110 · · /t/
ADDRESS — *definitional*

0 · 1 · 1 · 0. Domain: closure and release. Sub-manner: stop. Place: middle rank. Laryngeal: voiceless. Glyph U+1D312. Transliterated T.

ARTICULATION — *what your mouth does*

Put the tip of your tongue against the ridge just behind your upper teeth, seal it all the way round so no air escapes at the sides, build a little pressure, and let go. No voicing at any point. This is the sound at the end of *cat*. If you rest a finger lightly on your tongue tip you

can feel the seal and the release as two distinct moments — the closure is silent, and all the sound is in the opening.

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *closure complete*

III → *at the central point of contact*

IV → *on breath alone*

Long: an event of closure and release, closure complete, at the central point of contact, on breath alone

Short: release · complete · central · breath

Range:

I opening · breaking · beginning

II sealing · stopping · finality

III center · handling · address

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

0111 ·  · /d/

ADDRESS — *definitional*

0 · 1 · 1 · 1. Domain: closure and release. Sub-manner: stop. Place: middle rank. Laryngeal: modal voiced. Glyph U+1D313. Transliterated D.

ARTICULATION — *what your mouth does*

Make the same seal behind your upper teeth as for the sound at the end of *cat*, but set the vocal folds going before you release. The tongue has not moved at all. Fingers on your throat, say *to*, then *do*. Nothing your tongue does differs between them. Some speakers find it easier to feel by holding the closure a moment longer than usual: with the voiced sound there is a low hum trapped behind the tongue, with the voiceless one there is silence.

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *closure complete*

III → *at the central point of contact*

IV → *with voice*

Long: an event of closure and release, closure complete, at the central point of contact, with voice

Short: release · complete · central · voice

Range:

I opening · breaking · beginning
 II sealing · stopping · finality
 III center · handling · address
 IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

0112 ·  · /tʰ/

ADDRESS — *definitional*

0 · 1 · 1 · 2. Domain: closure and release. Sub-manner: stop. Place: middle rank. Laryngeal: marked. Glyph U+1D314. Transliterated T', plain TH.

ARTICULATION — *what your mouth does*

Seal the tongue tip behind your upper teeth, release it, and let a puff of breath follow before the vowel arrives. English does this at the start of *top* without treating it as a separate sound; Thai, Lao, and Burushaski do treat it as one. Palm in front of your mouth, compare *top* with *stop*: the puff is present in the first and absent in the second, and your tongue has done the same thing both times.

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *closure complete*

III → *at the central point of contact*

IV → *released into breath*

Long: an event of closure and release, closure complete, at the central point of contact, released into breath

Short: release · complete · central · released

Range:

I opening · breaking · beginning

II sealing · stopping · finality

III center · handling · address

IV aftermath · escape · consequence

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Common band, 13.3% of surveyed inventories. Northeastern Thai, Burushaski, Lao.

0120 · · /k/**ADDRESS** — *definitional*

0 · 1 · 2 · 0. Domain: closure and release. Sub-manner: stop. Place: innermost rank.
Laryngeal: voiceless. Glyph U+1D315. Transliterated K.

ARTICULATION — *what your mouth does*

Raise the back of your tongue against the soft palate — the fleshy part of the roof of your mouth, well behind the hard ridge — seal it, and release. This is the sound at the end of *back*. The articulator here is the tongue *body* rather than the tip, which is why it feels less precise than the other two closures; try alternating the sounds at the ends of *cat* and *back* and notice how much further the contact travels.

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *closure complete*

III → *inward toward the throat*

IV → *on breath alone*

Long: an event of closure and release, closure complete, inward toward the throat, on breath alone

Short: release · complete · inward · breath

Range:

I opening · breaking · beginning

II sealing · stopping · finality

III depth · origin · interior

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

The closure furthest from the outside world that still counts as an oral consonant, and the one that dies soonest when you try to sustain it. A reader looking for a sound that enacts limitation could do worse, and should notice that they went looking.

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

0121 · · /g/**ADDRESS** — *definitional*

0 · 1 · 2 · 1. Domain: closure and release. Sub-manner: stop. Place: innermost rank.
Laryngeal: modal voiced. Glyph U+1D316. Transliterated G.

ARTICULATION — *what your mouth does*

Make the same closure at the soft palate as for the end of *back*, and voice it. Say *bag*, then *back*, with fingers on your throat. The tongue body sits identically in both. This is the closure hardest to hold while voicing — the space behind it is small, it fills with air quickly,

and the pressure that builds up chokes the vibration off. If you try to hum this sound for more than a second you will feel it die.

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *closure complete*

III → *inward toward the throat*

IV → *with voice*

Long: an event of closure and release, closure complete, inward toward the throat, with voice

Short: release · complete · inward · voice

Range:

I opening · breaking · beginning

II sealing · stopping · finality

III depth · origin · interior

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

0122 ·  · /kʰ/

ADDRESS — *definitional*

0 · 1 · 2 · 2. Domain: closure and release. Sub-manner: stop. Place: innermost rank.

Laryngeal: marked. Glyph U+1D317. Transliterated K', plain KH.

ARTICULATION — *what your mouth does*

Close the back of the tongue against the soft palate, release, and let breath follow before the vowel. Palm in front of your mouth: say *kill*, then *skill*. The first has the puff, the second does not. Bengali, Laz, and Burushaski use the difference to separate words. This is the most widely attested of the three aspirated closures in the world's languages, appearing in about one inventory in five.

DERIVATION — *deterministic; see Chapter 1*

I → *an event of closure and release*

II → *closure complete*

III → *inward toward the throat*

IV → *released into breath*

Long: an event of closure and release, closure complete, inward toward the throat, released into breath

Short: release · complete · inward · released

Range:

- I opening · breaking · beginning
- II sealing · stopping · finality
- III depth · origin · interior
- IV aftermath · escape · consequence

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Common band, 19.9% of surveyed inventories. Laz, Bengali, Burushaski.

0200 ·  · /pf/

ADDRESS — *definitional*

0 · 2 · 0 · 0. Domain: closure and release. Sub-manner: affricate. Place: outermost rank. Laryngeal: voiceless. Glyph U+1D318. Transliterated PF.

ARTICULATION — *what your mouth does*

Press your lips together as for the start of *pin*, then part them slowly rather than sharply, so that instead of a clean burst the air escapes as friction between your lower lip and upper teeth. The result is a closure and a hiss fused into one sound. German has it at the start of *Pfeffer*. English speakers can build it by saying *cup full* quickly and letting the two consonants collapse together.

DERIVATION — *deterministic; see Chapter 1*

— *Withheld under quarantine (Appendix §A.2). The derivation is complete and correct; the address is under question.*

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Attested band, 1.3% of surveyed inventories. German, Beembe, Ngiemboon.

0201 ·  · /mjv/

ADDRESS — *definitional*

0 · 2 · 0 · 1. Domain: closure and release. Sub-manner: affricate. Place: outermost rank. Laryngeal: modal voiced. Glyph U+1D319. Transliterated BV.

ARTICULATION — *what your mouth does*

Make the fused lip closure and friction described for the German *Pfeffer* sound, and voice it throughout. The vocal folds are running from the moment the lips meet, so the closure hums rather than being silent. Sango and Mambila use this. Rest fingers on your throat and

compare with the voiceless version: everything at the lips and teeth is the same, and only the throat differs.

DERIVATION — *deterministic; see Chapter 1*

— *Withheld under quarantine (Appendix §A.2). The derivation is complete and correct; the address is under question.*

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Attested band, 1.5% of surveyed inventories. Sango, Gu'de, Mambila.

0202 ·  · /pf^h/

ADDRESS — *definitional*

0 · 2 · 0 · 2. Domain: closure and release. Sub-manner: affricate. Place: outermost rank. Laryngeal: marked. Glyph U+1D31A. Transliterated PF', plain PFH.

ARTICULATION — *what your mouth does*

Make the lip closure with its fricated release, and then let a puff of breath follow before the vowel. Three things happen in sequence — closure, friction, breath — in what the system counts as a single sound. This is rare; Beembe and Khezha have it. If you can make the German *Pfeffer* sound and can aspirate a *p*, you can combine them.

DERIVATION — *deterministic; see Chapter 1*

— *Withheld under quarantine (Appendix §A.2). The derivation is complete and correct; the address is under question.*

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.2% of surveyed inventories. Beembe, Copi, Khezha. Glottocodes pending (Appendix §A.8).

0210 ·  · /ts/

ADDRESS — *definitional*

0 · 2 · 1 · 0. Domain: closure and release. Sub-manner: affricate. Place: middle rank. Laryngeal: voiceless. Glyph U+1D31B. Transliterated TS.

ARTICULATION — *what your mouth does*

Seal the tongue tip behind your upper teeth as for the sound at the end of *cat*, then release it slowly enough that the air hisses on the way out. What you get is the ending of *cats* — but

made as a single sound rather than two. Many languages begin words with it, which English never does. Try *cats* and then try to start a word with just the last part.

DERIVATION — *deterministic; see Chapter 1*

— *Withheld under quarantine (Appendix §A.2). The derivation is complete and correct; the address is under question.*

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Common band, 21.9% of surveyed inventories. Burushaski, Shigatse Tibetan, Georgian.

0211 ·  · /dz/

ADDRESS — *definitional*

0 · 2 · 1 · 1. Domain: closure and release. Sub-manner: affricate. Place: middle rank. Laryngeal: modal voiced. Glyph U+1D31C. Transliterated DZ.

ARTICULATION — *what your mouth does*

Make the same slow release behind the teeth as in the ending of *cats*, with the vocal folds running throughout. This is the sound at the end of *lads* when it is said quickly, and the start of *zoo* in some accents when preceded by a *d*. Chechen and Mingrelian have it word-initially. Fingers on the throat: the hiss becomes a buzz, and nothing on the tongue changes.

DERIVATION — *deterministic; see Chapter 1*

— *Withheld under quarantine (Appendix §A.2). The derivation is complete and correct; the address is under question.*

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Common band, 10.2% of surveyed inventories. Chechen, Mingrelian, Реѣ.

0212 ·  · /tʰ/

ADDRESS — *definitional*

0 · 2 · 1 · 2. Domain: closure and release. Sub-manner: affricate. Place: middle rank. Laryngeal: marked. Glyph U+1D31D. Transliterated TS', plain TSH.

ARTICULATION — *what your mouth does*

Make the fused closure and hiss of the *cats* ending, then add a puff of breath before the vowel arrives. Three things happen in a row — the tongue seals behind the teeth, the release hisses, and breath follows — and all of it counts as one sound. Chechen, Hakka, and Shigatse Tibetan distinguish it from the unaspirated version. English speakers sometimes

produce something close to it by accident at the start of a stressed syllable, but never in a way that changes a word. Palm in front of your mouth, the puff should be clearly separate from the hiss.

DERIVATION — *deterministic; see Chapter 1*

— *Withheld under quarantine (Appendix §A.2). The derivation is complete and correct; the address is under question.*

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Attested band, 6.4% of surveyed inventories. Chechen, Shigatse Tibetan, Hakka Chinese.

0220 ·  · /tʃ/

ADDRESS — *definitional*

0 · 2 · 2 · 0. Domain: closure and release. Sub-manner: affricate. Place: innermost rank. Laryngeal: voiceless. Glyph U+1D31E. Transliterated CH.

ARTICULATION — *what your mouth does*

Seal your tongue against the roof of your mouth a little further back than for the sound at the end of *cat* — around where the ridge begins to curve upward — and release slowly so that the air hisses. This is the sound at the start and end of *church*. Say *church* and hold the final sound: you can feel that it begins as a closure and ends as a hiss, without your tongue lifting away in between.

DERIVATION — *deterministic; see Chapter 1*

— *Withheld under quarantine (Appendix §A.2). The derivation is complete and correct; the address is under question.*

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

0221 ·  · /dʒ/

ADDRESS — *definitional*

0 · 2 · 2 · 1. Domain: closure and release. Sub-manner: affricate. Place: innermost rank. Laryngeal: modal voiced. Glyph U+1D31F. Transliterated J.

ARTICULATION — *what your mouth does*

Make the same closure and slow, hissing release as in *church*, with the vocal folds running from the start. This is the sound at both ends of *judge*. Fingers on your throat, alternate

church and *judge*. The tongue traces an identical path in each; only the throat differs, and it differs from the very beginning of the closure rather than at the release.

DERIVATION — *deterministic; see Chapter 1*

— *Withheld under quarantine (Appendix §A.2). The derivation is complete and correct; the address is under question.*

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

0222 ·  · /tʰ/

ADDRESS — *definitional*

0 · 2 · 2 · 2. Domain: closure and release. Sub-manner: affricate. Place: innermost rank. Laryngeal: marked. Glyph U+1D320. Transliterated CH', plain CHH.

ARTICULATION — *what your mouth does*

Make the closure and fricated release of the *church* sound, and follow it with a puff of breath before the vowel. Hindi, Burmese, and Tsimané distinguish this from the unaspirated version. Palm in front of your mouth: with English *church* you may feel a little air, but the sound described here has a clear separate puff, of the kind you feel at the start of *pin*.

DERIVATION — *deterministic; see Chapter 1*

— *Withheld under quarantine (Appendix §A.2). The derivation is complete and correct; the address is under question.*

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Attested band, 7.4% of surveyed inventories. Hindi, Burmese, Tsimané.

Domain 1 — sustained constriction

Twenty-seven entries, every one of them reachable and none quarantined — true of no other domain in the frame. Twenty-one hold an attested sound; the remaining six are well formed and unoccupied, and their articulations are written in the conditional: you can produce them, but no surveyed language uses them to distinguish words.

1000 · · /f/**ADDRESS** — *definitional*

1 · 0 · 0 · 0. Domain: sustained constriction. Sub-manner: non-sibilant. Place: outermost rank. Laryngeal: voiceless. Glyph U+1D321. Transliterated F.

ARTICULATION — *what your mouth does*

Rest your lower lip lightly against the edge of your upper teeth — touching, but not pressed — and blow. The air escapes through the gap in a broad, quiet hiss. Nothing is voiced. This is the sound at the start of *five*. Compare it with the sound at the start of *sit* and listen to the quality rather than the location: this one is dull and low, that one is bright and sharp. Both are made near the front of the mouth, and the difference is entirely in whether the tongue has grooved to focus the air.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction diffuse*

III → *at the outer threshold*

IV → *on breath alone*

Long: a channel of sustained constriction, friction diffuse, at the outer threshold, on breath alone

Short: channel · diffuse · outer · breath

Range:

I narrowing · passage · sustaining

II softening · spreading · haze

III lip · boundary · meeting

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

1001 · · /v/**ADDRESS** — *definitional*

1 · 0 · 0 · 1. Domain: sustained constriction. Sub-manner: non-sibilant. Place: outermost rank. Laryngeal: modal voiced. Glyph U+1D322. Transliterated V.

ARTICULATION — *what your mouth does*

Set your lower lip against your upper teeth exactly as for the start of *five*, and add voice. The lip does not move. Two fingers on your throat: say *fan*, then *van*, and the only thing that changes is the buzz under your fingers. This one is harder to hold than its voiceless twin,

because vibrating folds slow the airflow and the hiss weakens — try sustaining both for five seconds and you will hear the voiced one fade toward a hum.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction diffuse*

III → *at the outer threshold*

IV → *with voice*

Long: a channel of sustained constriction, friction diffuse, at the outer threshold, with voice

Short: channel · diffuse · outer · voice

Range:

I narrowing · passage · sustaining

II softening · spreading · haze

III lip · boundary · meeting

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

1002 ·  · /v/

ADDRESS — *definitional*

1 · 0 · 0 · 2. Domain: sustained constriction. Sub-manner: non-sibilant. Place: outermost rank. Laryngeal: marked. Glyph U+1D323. Transliterated V:, plain VH.

ARTICULATION — *what your mouth does*

Make the sound at the start of *van*, then let considerably more air through than the voicing needs, so the tone acquires a murmur — as though sighing and saying it at once. The lip and teeth stay where they were. Isoko and Parauk use this. If you find the murmur collapsing into a clean tone you are letting too little air through; if the buzz disappears entirely you are letting through too much and have arrived back at the sound in *fan*.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction diffuse*

III → *at the outer threshold*

IV → *voiced through breath*

Long: a channel of sustained constriction, friction diffuse, at the outer threshold, voiced through breath

Short: channel · diffuse · outer · throughbreath

Range:

I narrowing · passage · sustaining

II softening · spreading · haze

III lip · boundary · meeting

IV veiling · mingling · softened

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.1% of surveyed inventories. Isoko, Parauk, Ronga. Glottocodes pending (Appendix §A.8).

1010 ·  · /θ/

ADDRESS — *definitional*

1 · 0 · 1 · 0. Domain: sustained constriction. Sub-manner: non-sibilant. Place: middle rank. Laryngeal: voiceless. Glyph U+1D324. Transliterated TH.

ARTICULATION — *what your mouth does*

Put the tip of your tongue against the back of your upper front teeth, or lightly between the teeth, and keep it flat — no groove down the middle. Blow. The air spills over a wide, level surface and the hiss is soft and slightly muffled. This is the sound at the start of *thin*. Try it again with the tongue grooved instead of flat and you will produce the sound in *sin*: same articulator, same neighbourhood, wholly different noise.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction diffuse*

III → *at the central point of contact*

IV → *on breath alone*

Long: a channel of sustained constriction, friction diffuse, at the central point of contact, on breath alone

Short: channel · diffuse · central · breath

Range:

I narrowing · passage · sustaining

II softening · spreading · haze

III center · handling · address

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

English speakers tend to assume this sound is ordinary, and it is not: it appears in a small minority of the world's inventories and is among the last sounds children acquire.

Whatever plainness it seems to have is a fact about the reader's language rather than about the sound.

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

1011 ·  · /ð/

ADDRESS — *definitional*

1 · 0 · 1 · 1. Domain: sustained constriction. Sub-manner: non-sibilant. Place: middle rank. Laryngeal: modal voiced. Glyph U+1D325. Transliterated DH.

ARTICULATION — *what your mouth does*

Set the tongue tip against the back of the upper teeth as for the start of *thin*, and voice it. This is the sound at the start of *this*. Fingers on the throat, alternate *thigh* and *thy*: the tongue is motionless throughout, and the whole difference sits at the larynx. English spells both with the same two letters, which is why many speakers have never noticed they are two sounds.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction diffuse*

III → *at the central point of contact*

IV → *with voice*

Long: a channel of sustained constriction, friction diffuse, at the central point of contact, with voice

Short: channel · diffuse · central · voice

Range:

I narrowing · passage · sustaining

II softening · spreading · haze

III center · handling · address

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

1012 · 

ADDRESS — *definitional*

1 · 0 · 1 · 2. Domain: sustained constriction. Sub-manner: non-sibilant. Place: middle rank. Laryngeal: marked. Glyph U+1D326.

ARTICULATION — *what your mouth does*

You can produce this, though no surveyed language uses it to distinguish words. Make the

sound at the start of *this* and let extra air through, so the voicing becomes a murmur rather than a clean tone. The tongue stays flat behind the upper teeth. The result is stable and easy to sustain; it is simply a combination no language has settled on, which is worth noticing when the cell is described as empty.

Producible but unattested: no surveyed language uses this contrastively.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction diffuse*

III → *at the central point of contact*

IV → *voiced through breath*

Long: a channel of sustained constriction, friction diffuse, at the central point of contact, voiced through breath

Short: channel · diffuse · central · throughbreath

Range:

I narrowing · passage · sustaining

II softening · spreading · haze

III center · handling · address

IV veiling · mingling · softened

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Well formed and unattested. No surveyed language fills this cell.

1020 ·  · /x/

ADDRESS — *definitional*

1 · 0 · 2 · 0. Domain: sustained constriction. Sub-manner: non-sibilant. Place: innermost rank. Laryngeal: voiceless. Glyph U+1D327. Transliterated KH.

ARTICULATION — *what your mouth does*

Raise the back of your tongue toward the soft palate as though you were about to say the sound at the end of *back*, but stop just short of contact and blow through the narrow gap. The air rasps. This is the sound at the end of Scottish *loch* and German *Bach*. The test is whether you can sustain it: the closure in *back* ends the moment it opens, and this one can be held as long as you have breath. That difference is the whole distinction between two families of sound.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction diffuse*

III → *inward toward the throat*

IV → *on breath alone*

Long: a channel of sustained constriction, friction diffuse, inward toward the throat, on breath alone

Short: channel · diffuse · inward · breath

Range:

I narrowing · passage · sustaining

II softening · spreading · haze

III depth · origin · interior

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Common band, 18.2% of surveyed inventories. Irish, Tundra Nenets, Bulgarian.

1021 ·  · /ɣ/

ADDRESS — *definitional*

1 · 0 · 2 · 1. Domain: sustained constriction. Sub-manner: non-sibilant. Place: innermost rank. Laryngeal: modal voiced. Glyph U+1D328. Transliterated GH.

ARTICULATION — *what your mouth does*

Make the rasping sound at the end of Scottish *loch*, and voice it. Spanish speakers produce this between vowels in *lago* and *agua*, where the written *g* softens into a continuous sound rather than a closure. Fingers on your throat, alternate the two: the tongue holds the same near-contact at the soft palate in both, and only the folds change. Many English speakers find this one easier than its voiceless twin, because it is closer to a vowel.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction diffuse*

III → *inward toward the throat*

IV → *with voice*

Long: a channel of sustained constriction, friction diffuse, inward toward the throat, with voice

Short: channel · diffuse · inward · voice

Range:

I narrowing · passage · sustaining

II softening · spreading · haze

III depth · origin · interior

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Common band, 14.1% of surveyed inventories. Meadow Mari, Irish, Igbo.

1022 ·  · /ɣ/

ADDRESS — *definitional*

1 · 0 · 2 · 2. Domain: sustained constriction. Sub-manner: non-sibilant. Place: innermost rank. Laryngeal: marked. Glyph U+1D329. Transliterated GH:, plain GHH.

ARTICULATION — *what your mouth does*

Make the softened sound Spanish speakers use between the vowels of *lago*, then let enough extra air through that the voicing turns to a murmur. The tongue stays near the soft palate without touching it. Xhosa is the one language in the survey recorded with this. It is a delicate setting — too little air and it becomes an ordinary voiced sound, too much and the voicing drops out — which is a fair part of why so few languages keep it.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction diffuse*

III → *inward toward the throat*

IV → *voiced through breath*

Long: a channel of sustained constriction, friction diffuse, inward toward the throat, voiced through breath

Short: channel · diffuse · inward · throughbreath

Range:

I narrowing · passage · sustaining

II softening · spreading · haze

III depth · origin · interior

IV veiling · mingling · softened

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.0% of surveyed inventories. Xhosa. Glottocodes pending (Appendix §A.8).

1100 ·  · /sʷ/

ADDRESS — *definitional*

1 · 1 · 0 · 0. Domain: sustained constriction. Sub-manner: sibilant. Place: outermost rank. Laryngeal: voiceless. Glyph U+1D32A. Transliterated SW.

ARTICULATION — *what your mouth does*

Make the sound at the start of *sit* — tongue grooved, air aimed at the teeth — and at the

same time round your lips as though for *oo*. Both things happen together, from the beginning of the sound rather than at its end. Lao, Dan, and Avar treat this as a separate sound from the unrounded one. English speakers do it accidentally in *swim*, where the rounding of the following sound reaches back; the difference is that here nothing follows to explain it.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction concentrated*

III → *at the outer threshold*

IV → *on breath alone*

Long: a channel of sustained constriction, friction concentrated, at the outer threshold, on breath alone

Short: channel · concentrated · outer · breath

Range:

I narrowing · passage · sustaining

II sharpening · parting · edge

III lip · boundary · meeting

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Attested band, 1.2% of surveyed inventories. Lao, Dan, Avar.

1101 ·  · /zʷ/

ADDRESS — *definitional*

1 · 1 · 0 · 1. Domain: sustained constriction. Sub-manner: sibilant. Place: outermost rank.

Laryngeal: modal voiced. Glyph U+1D32B. Transliterated ZW.

ARTICULATION — *what your mouth does*

Groove the tongue and round the lips as for the rounded hiss of Lao and Avar, and voice it throughout. Kabardian and Dan use this. Fingers on your throat, compare with the voiceless version: the lips hold their rounding identically in both, the tongue keeps its groove, and only the folds differ. This is a rare sound and a stable one — nothing about it is hard to hold once the two gestures are running at once.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction concentrated*

III → *at the outer threshold*

IV → *with voice*

Long: a channel of sustained constriction, friction concentrated, at the outer threshold, with voice

Short: channel · concentrated · outer · voice

Range:

I narrowing · passage · sustaining

II sharpening · parting · edge

III lip · boundary · meeting

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.5% of surveyed inventories. Kabardian, Dan, Avar. Glottocodes pending (Appendix §A.8).

1102 · 

ADDRESS — *definitional*

1 · 1 · 0 · 2. Domain: sustained constriction. Sub-manner: sibilant. Place: outermost rank. Laryngeal: marked. Glyph U+1D32C.

ARTICULATION — *what your mouth does*

You can produce this, though no surveyed language uses it contrastively. Make the rounded hiss of Lao, then follow it with a clear puff of breath before the vowel begins — the puff you feel at the start of *pin*. Palm in front of your mouth to check. The combination is straightforward to make; what is unusual is that no language appears to have found a use for rounding and aspiration on the same sibilant.

Producible but unattested: no surveyed language uses this contrastively.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction concentrated*

III → *at the outer threshold*

IV → *released into breath*

Long: a channel of sustained constriction, friction concentrated, at the outer threshold, released into breath

Short: channel · concentrated · outer · released

Range:

I narrowing · passage · sustaining

II sharpening · parting · edge

III lip · boundary · meeting

IV aftermath · escape · consequence

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Well formed and unattested. No surveyed language fills this cell.

1110 ·  · /s/

ADDRESS — *definitional*

1 · 1 · 1 · 0. Domain: sustained constriction. Sub-manner: sibilant. Place: middle rank.

Laryngeal: voiceless. Glyph U+1D32D. Transliterated S.

ARTICULATION — *what your mouth does*

Raise the tip of your tongue toward the ridge behind your upper teeth — close, but not touching — and leave a narrow groove running down the middle. Push air through the groove; it strikes the teeth and hisses. The folds stay apart, so there is no buzz behind it. Rest two fingers on your throat and hold the sound, then switch to the start of *zoo* without moving your tongue. Everything above the larynx stays where it is.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction concentrated*

III → *at the central point of contact*

IV → *on breath alone*

Long: a channel of sustained constriction, friction concentrated, at the central point of contact, on breath alone

Short: channel · concentrated · central · breath

Range:

I narrowing · passage · sustaining

II sharpening · parting · edge

III center · handling · address

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

The most frequent obstruent in human language, and the one that arrives with least effort. Worth noticing, and worth not trusting.

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

1111 · · /z/**ADDRESS** — *definitional*

1 · 1 · 1 · 1. Domain: sustained constriction. Sub-manner: sibilant. Place: middle rank.
Laryngeal: modal voiced. Glyph U+1D32E. Transliterated Z.

ARTICULATION — *what your mouth does*

Groove the tongue behind the upper teeth exactly as for the start of *sit*, and voice it. This is the sound at the start of *zoo*. It is the frame's standard test, because nothing above the larynx moves between the two and you can feel the difference under your fingers before you hear it. Hold each for three seconds. The tongue does not shift by a millimetre; the buzz is the entire distinction.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction concentrated*

III → *at the central point of contact*

IV → *with voice*

Long: a channel of sustained constriction, friction concentrated, at the central point of contact, with voice

Short: channel · concentrated · central · voice

Range:

I narrowing · passage · sustaining

II sharpening · parting · edge

III center · handling · address

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

1112 · · /s^h/**ADDRESS** — *definitional*

1 · 1 · 1 · 2. Domain: sustained constriction. Sub-manner: sibilant. Place: middle rank.
Laryngeal: marked. Glyph U+1D32F. Transliterated S', plain SH.

ARTICULATION — *what your mouth does*

Make the hiss at the start of *sit*, and follow it with a distinct puff of breath before the vowel arrives. Korean, Burmese, and Shan use this to separate words from their unaspirated counterparts. Palm in front of your mouth: with English *sit* you feel almost nothing after the hiss, and here you should feel a clear separate escape of air, of the kind you get at the start of *pin*. The groove and the jet are unchanged.

DERIVATION — *deterministic; see Chapter 1*I → *a channel of sustained constriction*II → *friction concentrated*III → *at the central point of contact*IV → *released into breath***Long:** a channel of sustained constriction, friction concentrated, at the central point of contact, released into breath**Short:** channel · concentrated · central · released**Range:****I** narrowing · passage · sustaining**II** sharpening · parting · edge**III** center · handling · address**IV** aftermath · escape · consequence**RESONANCE** — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.8% of surveyed inventories. Shan, Burmese, Korean. Glottocodes pending (Appendix §A.8).

1120 ·  · //**ADDRESS** — *definitional*

1 · 1 · 2 · 0. Domain: sustained constriction. Sub-manner: sibilant. Place: innermost rank. Laryngeal: voiceless. Glyph U+1D330. Transliterated SH.

ARTICULATION — *what your mouth does*

Draw your tongue back about a centimetre from where it sits for the start of *sit*, so the groove opens onto a slightly larger space, and round your lips a little. Blow. The hiss drops in pitch and broadens. This is the sound at the start of *shoe*. Alternate *sip* and *ship* slowly: your larynx does nothing different, and you can feel the tongue slide backward and the lips push forward as a single movement.

DERIVATION — *deterministic; see Chapter 1*I → *a channel of sustained constriction*II → *friction concentrated*III → *inward toward the throat*IV → *on breath alone***Long:** a channel of sustained constriction, friction concentrated, inward toward the throat, on breath alone**Short:** channel · concentrated · inward · breath**Range:****I** narrowing · passage · sustaining

II sharpening · parting · edge
 III depth · origin · interior
 IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

1121 ·  · /3/

ADDRESS — *definitional*

1 · 1 · 2 · 1. Domain: sustained constriction. Sub-manner: sibilant. Place: innermost rank. Laryngeal: modal voiced. Glyph U+1D331. Transliterated ZH.

ARTICULATION — *what your mouth does*

Make the broad hiss at the start of *shoe* and voice it. English keeps this sound in the middle of *measure* and *vision*, and almost never at the start of a word. Fingers on your throat, say *pressure*, then *pleasure*. The tongue holds still, and keeps its slight rounding, through both; the folds do the rest. Many English speakers are surprised to find they have this sound at all.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction concentrated*

III → *inward toward the throat*

IV → *with voice*

Long: a channel of sustained constriction, friction concentrated, inward toward the throat, with voice

Short: channel · concentrated · inward · voice

Range:

I narrowing · passage · sustaining

II sharpening · parting · edge

III depth · origin · interior

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

1122 · · /ʃ̺/**ADDRESS** — *definitional*

1 · 1 · 2 · 2. Domain: sustained constriction. Sub-manner: sibilant. Place: innermost rank. Laryngeal: marked. Glyph U+1D332. Transliterated SH', plain SHH.

ARTICULATION — *what your mouth does*

Make the hiss at the start of *shoe*, and let a clear puff of breath follow before the vowel. Barbareño and Baima distinguish this from the plain version; almost no other surveyed language does, which makes it one of the rarest sounds in this part of the frame. Palm in front of your mouth: the puff should be separate and audible, arriving after the hiss has finished rather than blending into it.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction concentrated*

III → *inward toward the throat*

IV → *released into breath*

Long: a channel of sustained constriction, friction concentrated, inward toward the throat, released into breath

Short: channel · concentrated · inward · released

Range:

I narrowing · passage · sustaining

II sharpening · parting · edge

III depth · origin · interior

IV aftermath · escape · consequence

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.1% of surveyed inventories. Barbareño, Baima. Glottocodes pending (Appendix §A.8).

1200 · · /t̺ʷ/**ADDRESS** — *definitional*

1 · 2 · 0 · 0. Domain: sustained constriction. Sub-manner: lateral fricative. Place: outermost rank. Laryngeal: voiceless. Glyph U+1D333. Transliterated SLW.

ARTICULATION — *what your mouth does*

Seal the tip of your tongue against the ridge behind your upper teeth as though for the sound at the end of *cat*, let the air escape noisily around the sides, and round your lips at the same time. Avar and Ronga use this. If the lateral hiss is unfamiliar, build it first without

the rounding — the instructions at the entry for the Welsh *ll* sound will get you there — and then add the lips once the airflow is stable.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction channeled laterally*

III → *at the outer threshold*

IV → *on breath alone*

Long: a channel of sustained constriction, friction channeled laterally, at the outer threshold, on breath alone

Short: channel · lateral · outer · breath

Range:

I narrowing · passage · sustaining

II diverting · skirting · aside

III lip · boundary · meeting

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.1% of surveyed inventories. Avar, Ronga. Glottocodes pending (Appendix §A.8).

1201 · 

ADDRESS — *definitional*

1 · 2 · 0 · 1. Domain: sustained constriction. Sub-manner: lateral fricative. Place: outermost rank. Laryngeal: modal voiced. Glyph U+1D334.

ARTICULATION — *what your mouth does*

You can produce this, though no surveyed language uses it contrastively. Make the rounded lateral hiss of Avar and voice it throughout, so the noise at the sides of the tongue carries a buzz underneath. The seal along the midline stays complete and the lips stay rounded. The combination is stable and unremarkable to produce; three of the nine cells in this part of the frame are empty for the same reason, which appears to be that lateral friction is expensive enough that languages acquire one or two members rather than a series.

Producible but unattested: no surveyed language uses this contrastively.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction channeled laterally*

III → *at the outer threshold*

IV → *with voice*

Long: a channel of sustained constriction, friction channeled laterally, at the outer threshold, with voice

Short: channel · lateral · outer · voice

Range:

I narrowing · passage · sustaining

II diverting · skirting · aside

III lip · boundary · meeting

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Well formed and unattested. No surveyed language fills this cell.

1202 · 

ADDRESS — *definitional*

1 · 2 · 0 · 2. Domain: sustained constriction. Sub-manner: lateral fricative. Place: outermost rank. Laryngeal: marked. Glyph U+1D335.

ARTICULATION — *what your mouth does*

You can produce this, though no surveyed language uses it contrastively. Make the voiced rounded lateral hiss described above, then let extra air through until the voicing becomes a murmur rather than a clean tone. Three gestures run at once — the midline seal, the rounded lips, the slackened folds — and holding all three steady is the difficulty. Nothing prevents the sound; it is simply a combination no language has taken up.

Producible but unattested: no surveyed language uses this contrastively.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction channeled laterally*

III → *at the outer threshold*

IV → *voiced through breath*

Long: a channel of sustained constriction, friction channeled laterally, at the outer threshold, voiced through breath

Short: channel · lateral · outer · throughbreath

Range:

I narrowing · passage · sustaining

II diverting · skirting · aside

III lip · boundary · meeting

IV veiling · mingling · softened

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Well formed and unattested. No surveyed language fills this cell.

1210 ·  · /t/

ADDRESS — *definitional*

1 · 2 · 1 · 0. Domain: sustained constriction. Sub-manner: lateral fricative. Place: middle rank. Laryngeal: voiceless. Glyph U+1D336. Transliterated SL.

ARTICULATION — *what your mouth does*

Make the sound at the start of *lot* and hold it, tongue where it is. Now, without moving anything, blow harder — hard enough that the air rushing past the sides of your tongue turns noisy. That noise is the sound. Welsh spells it *ll*, in *Llanelli*. The tongue has not moved at all between the two; what changed is how hard you pushed, which is the whole distinction between a sound that resonates and a sound that hisses.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction channeled laterally*

III → *at the central point of contact*

IV → *on breath alone*

Long: a channel of sustained constriction, friction channeled laterally, at the central point of contact, on breath alone

Short: channel · lateral · central · breath

Range:

I narrowing · passage · sustaining

II diverting · skirting · aside

III center · handling · address

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

A sound that most speakers of most languages have never made, and that anyone can make in about ten seconds by blowing harder on a sound they already have. It is a useful corrective to the idea that unfamiliar sounds are difficult ones.

ATTESTATION — *empirical*

Attested band, 4.8% of surveyed inventories. Northern Khanty, Euchee; Yuchi, Nootka.

1211 ·  · /ɬ/

ADDRESS — *definitional*

1 · 2 · 1 · 1. Domain: sustained constriction. Sub-manner: lateral fricative. Place: middle rank. Laryngeal: modal voiced. Glyph U+1D337. Transliterated ZL.

ARTICULATION — *what your mouth does*

Make the Welsh *ll* sound and voice it, so the hiss at the sides of the tongue runs over a buzz. Daba, Margi, and Mofu use this. Fingers on your throat and alternate with the voiceless version: the seal along the midline holds identically, the air keeps escaping at the sides, and only the folds change. This is harder to sustain than the voiceless one, because voicing steals the pressure that makes the sides hiss.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction channeled laterally*

III → *at the central point of contact*

IV → *with voice*

Long: a channel of sustained constriction, friction channeled laterally, at the central point of contact, with voice

Short: channel · lateral · central · voice

Range:

I narrowing · passage · sustaining

II diverting · skirting · aside

III center · handling · address

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Attested band, 1.6% of surveyed inventories. Daba, Margi, Mofu, South.

1212 ·  · /ɬ/

ADDRESS — *definitional*

1 · 2 · 1 · 2. Domain: sustained constriction. Sub-manner: lateral fricative. Place: middle rank. Laryngeal: marked. Glyph U+1D338. Transliterated ZL:, plain ZLH.

ARTICULATION — *what your mouth does*

Make the voiced lateral hiss described above, then let more air through until the voicing softens into a murmur. Xhosa is the one language in the survey recorded with this. The tongue stays sealed along the midline throughout. Of all the sounds in this part of the frame this is the most demanding to hold, because it asks the folds to be slack and the airflow at the sides to stay fast, and those two requirements pull against each other.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction channeled laterally*

III → *at the central point of contact*

IV → *voiced through breath*

Long: a channel of sustained constriction, friction channeled laterally, at the central point of contact, voiced through breath

Short: channel · lateral · central · throughbreath

Range:

I narrowing · passage · sustaining

II diverting · skirting · aside

III center · handling · address

IV veiling · mingling · softened

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.0% of surveyed inventories. Xhosa. Glottocodes pending (Appendix §A.8).

1220 · 

ADDRESS — *definitional*

1 · 2 · 2 · 0. Domain: sustained constriction. Sub-manner: lateral fricative. Place: innermost rank. Laryngeal: voiceless. Glyph U+1D339.

ARTICULATION — *what your mouth does*

You can produce this, though no surveyed language uses it contrastively. Curl your tongue tip back toward the roof of your mouth, well behind the ridge, seal it along the middle, and blow so the air hisses past the sides. It is the Welsh *ll* sound made further back, with the tongue turned up. The curl is what makes it awkward: the sides of a curled tongue sit differently against the teeth, and the escape route narrows.

Producible but unattested: no surveyed language uses this contrastively.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction channeled laterally*

III → *inward toward the throat*

IV → *on breath alone*

Long: a channel of sustained constriction, friction channeled laterally, inward toward the throat, on breath alone

Short: channel · lateral · inward · breath

Range:

I narrowing · passage · sustaining

II diverting · skirting · aside

III depth · origin · interior

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Well formed and unattested. No surveyed language fills this cell.

1221 · · /ʋ**ADDRESS** — *definitional*

1 · 2 · 2 · 1. Domain: sustained constriction. Sub-manner: lateral fricative. Place: innermost rank. Laryngeal: modal voiced. Glyph U+1D33A. Transliterated ZLR.

ARTICULATION — *what your mouth does*

Curl your tongue tip back behind the ridge, seal it along the midline, blow so the sides hiss, and voice it throughout. Ao is the only language in the survey recorded with this sound. Reaching it from the Welsh *ll* is a matter of curling the tongue back while keeping everything else — the seal, the lateral escape, the voicing — exactly as it was.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction channeled laterally*

III → *inward toward the throat*

IV → *with voice*

Long: a channel of sustained constriction, friction channeled laterally, inward toward the throat, with voice

Short: channel · lateral · inward · voice

Range:

I narrowing · passage · sustaining

II diverting · skirting · aside

III depth · origin · interior

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.0% of surveyed inventories. Ao. Glottocodes pending (Appendix §A.8).

1222 · **ADDRESS** — *definitional*

1 · 2 · 2 · 2. Domain: sustained constriction. Sub-manner: lateral fricative. Place: innermost rank. Laryngeal: marked. Glyph U+1D33B.

ARTICULATION — *what your mouth does*

You can produce this, though no surveyed language uses it contrastively. Make the curled lateral hiss described above, voiced, and then let extra air through until the tone murmurs.

It combines the three hardest settings in this part of the frame — the curl, the lateral escape, and the slack folds — and the fact that it can be produced at all is the point of printing it. The cell is empty in the world's languages, not in the mouth.

Producible but unattested: no surveyed language uses this contrastively.

DERIVATION — *deterministic; see Chapter 1*

I → *a channel of sustained constriction*

II → *friction channeled laterally*

III → *inward toward the throat*

IV → *voiced through breath*

Long: a channel of sustained constriction, friction channeled laterally, inward toward the throat, voiced through breath

Short: channel · lateral · inward · throughbreath

Range:

I narrowing · passage · sustaining

II diverting · skirting · aside

III depth · origin · interior

IV veiling · mingling · softened

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Well formed and unattested. No surveyed language fills this cell.

Domain 2 — open resonance

Twenty-seven entries. Three are formally unreachable — the coronal glides, which the tongue will not make — and carry a derivation without an articulation. The remaining twenty-four hold sounds, though only a handful belong to the reference variety.

2000 ·  · /w/

ADDRESS — *definitional*

2 · 0 · 0 · 0. Domain: open resonance. Sub-manner: glide. Place: outermost rank. Laryngeal: voiceless. Glyph U+1D33C. Transliterated HW.

ARTICULATION — *what your mouth does*

Round your lips and raise the back of your tongue as though starting the word *wet*, then make the same movement without letting the vocal folds engage — a whispered *w*, but deliberate rather than accidental. What comes out is shaped breath. Breton, Sumo, and Washo treat this as a sound in its own right. Fingers on your throat, alternate it with the

ordinary *w*: the lips round identically, the tongue travels the same path, and only the buzz appears and disappears.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance in motion*

III → *at the outer threshold*

IV → *on breath alone*

Long: a continuum of open resonance, resonance in motion, at the outer threshold, on breath alone

Short: resonance · moving · outer · breath

Range:

I carrying · dwelling · continuing

II approaching · gliding · toward

III lip · boundary · meeting

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.1% of surveyed inventories. Breton, Sumo, Washo. Glottocodes pending (Appendix §A.8).

2001 ·  · /w/

ADDRESS — *definitional*

2 · 0 · 0 · 1. Domain: open resonance. Sub-manner: glide. Place: outermost rank. Laryngeal: modal voiced. Glyph U+1D33D. Transliterated *w*.

ARTICULATION — *what your mouth does*

Round your lips as though for *oo*, raise the back of your tongue toward the soft palate, and then move out of that shape toward whatever vowel follows. The movement is the sound. Say *we* very slowly and listen for the moment the lips stop traveling and settle — before that moment you have a consonant, after it a vowel, and nothing about the mouth has changed except whether it is still going somewhere.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance in motion*

III → *at the outer threshold*

IV → *with voice*

Long: a continuum of open resonance, resonance in motion, at the outer threshold, with voice

Short: resonance · moving · outer · voice

Range:

I carrying · dwelling · continuing

II approaching · gliding · toward

III lip · boundary · meeting

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

2002 ·  · /w/**ADDRESS** — *definitional*

2 · 0 · 0 · 2. Domain: open resonance. Sub-manner: glide. Place: outermost rank. Laryngeal: marked. Glyph U+1D33E. Transliterated w:, plain WV.

ARTICULATION — *what your mouth does*

Make the sound at the start of *wet* and let considerably more air through than the voicing needs, so the tone carries a murmur underneath — as though sighing and speaking at once. The lips keep their rounding and the tongue its raised back. Angami and Ikalanga use this. Too little air and it collapses into an ordinary *w*; too much and the voicing drops out and you have the whispered version instead.

DERIVATION — *deterministic; see Chapter 1*I → *a continuum of open resonance*II → *resonance in motion*III → *at the outer threshold*IV → *resonant through breath***Long:** a continuum of open resonance, resonance in motion, at the outer threshold, resonant through breath**Short:** resonance · moving · outer · throughvoice**Range:**

I carrying · dwelling · continuing

II approaching · gliding · toward

III lip · boundary · meeting

IV suffusion · murmur · overlap

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.2% of surveyed inventories. Angami, Eastern Hill Balochi, Ikalanga. Glottocodes pending (Appendix §A.8).

2010 ·
ADDRESS — *definitional*

2 · 0 · 1 · 0. Domain: open resonance. Sub-manner: glide. Place: middle rank. Laryngeal: voiceless. Glyph U+1D33F.

ARTICULATION — *what your mouth does*

— *No sound occupies this address; there is nothing to produce.*

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance in motion*

III → *at the central point of contact*

IV → *on breath alone*

Long: a continuum of open resonance, resonance in motion, at the central point of contact, on breath alone

Short: resonance · moving · central · breath

Range:

I carrying · dwelling · continuing

II approaching · gliding · toward

III center · handling · address

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Formally unreachable.

2011 · **ADDRESS** — *definitional*

2 · 0 · 1 · 1. Domain: open resonance. Sub-manner: glide. Place: middle rank. Laryngeal: modal voiced. Glyph U+1D340.

ARTICULATION — *what your mouth does*

— *No sound occupies this address; there is nothing to produce.*

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance in motion*

III → *at the central point of contact*

IV → *with voice*

Long: a continuum of open resonance, resonance in motion, at the central point of contact, with voice

Short: resonance · moving · central · voice

Range:

I carrying · dwelling · continuing

II approaching · gliding · toward

III center · handling · address

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Formally unreachable.

2012 · 

ADDRESS — *definitional*

2 · 0 · 1 · 2. Domain: open resonance. Sub-manner: glide. Place: middle rank. Laryngeal: marked. Glyph U+1D341.

ARTICULATION — *what your mouth does*

— *No sound occupies this address; there is nothing to produce.*

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance in motion*

III → *at the central point of contact*

IV → *resonant through breath*

Long: a continuum of open resonance, resonance in motion, at the central point of contact, resonant through breath

Short: resonance · moving · central · throughvoice

Range:

I carrying · dwelling · continuing

II approaching · gliding · toward

III center · handling · address

IV suffusion · murmur · overlap

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Formally unreachable.

2020 · · /j/**ADDRESS** — *definitional*

2 · 0 · 2 · 0. Domain: open resonance. Sub-manner: glide. Place: innermost rank. Laryngeal: voiceless. Glyph U+1D342. Transliterated HY.

ARTICULATION — *what your mouth does*

Raise the front of your tongue toward the hard palate as though starting *yes*, and make the movement without voicing — a whispered *y*, held deliberately. The friction is faint and the sound is mostly shaped air. Aleut, Hopi, and Lakkia use it contrastively. Fingers on the throat and alternate with the ordinary sound: the tongue rises to the same height and travels the same way in both, and the folds do all the rest.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance in motion*

III → *inward toward the throat*

IV → *on breath alone*

Long: a continuum of open resonance, resonance in motion, inward toward the throat, on breath alone

Short: resonance · moving · inward · breath

Range:

I carrying · dwelling · continuing

II approaching · gliding · toward

III depth · origin · interior

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.7% of surveyed inventories. Aleut, Hopi, Lakkia. Glottocodes pending (Appendix §A.8).

2021 · · /j/**ADDRESS** — *definitional*

2 · 0 · 2 · 1. Domain: open resonance. Sub-manner: glide. Place: innermost rank. Laryngeal: modal voiced. Glyph U+1D343. Transliterated Y.

ARTICULATION — *what your mouth does*

Raise the front of your tongue high toward the hard palate, close enough to narrow the space in front of it but not close enough to make friction, and move out of that shape into the following vowel. This is the sound at the start of *yes*. Say *ye* slowly and you will hear it

resolve into the vowel of *eat* — the same tongue height, the tongue equally far forward, and the only difference is that one is passing through and the other has arrived.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance in motion*

III → *inward toward the throat*

IV → *with voice*

Long: a continuum of open resonance, resonance in motion, inward toward the throat, with voice

Short: resonance · moving · inward · voice

Range:

I carrying · dwelling · continuing

II approaching · gliding · toward

III depth · origin · interior

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

2022 ·  · /jʰ/

ADDRESS — *definitional*

2 · 0 · 2 · 2. Domain: open resonance. Sub-manner: glide. Place: innermost rank. Laryngeal: marked. Glyph U+1D344. Transliterated Y:, plain YH.

ARTICULATION — *what your mouth does*

Make the sound at the start of *yes*, then let extra air through until the tone murmurs rather than rings clean. The tongue stays high and forward throughout. Dhangar is the one language in the survey recorded with this. Of the breathy sounds in this part of the frame it is among the hardest to hold, because the tongue is already close to the roof of the mouth and the extra airflow tends to turn the sound into friction.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance in motion*

III → *inward toward the throat*

IV → *resonant through breath*

Long: a continuum of open resonance, resonance in motion, inward toward the throat, resonant through breath

Short: resonance · moving · inward · throughvoice

Range:

I carrying · dwelling · continuing
 II approaching · gliding · toward
 III depth · origin · interior
 IV suffusion · murmur · overlap

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.0% of surveyed inventories. Dhargar. Glottocodes pending (Appendix §A.8).

2100 · 

ADDRESS — *definitional*

2 · 1 · 0 · 0. Domain: open resonance. Sub-manner: liquid. Place: outermost rank. Laryngeal: voiceless. Glyph U+1D345.

ARTICULATION — *what your mouth does*

You can produce this, though no surveyed language uses it contrastively. Make the rounded *r*-colored sound that Mandarin speakers use, and then produce it without voicing — a whispered version, lips still rounded, tongue still curled or bunched. It is stable and easy to sustain. What appears to be missing is not the ability but the use: languages that acquire rounded liquids seem to acquire the voiced member and stop there.

Producible but unattested: no surveyed language uses this contrastively.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance flowing*

III → *at the outer threshold*

IV → *on breath alone*

Long: a continuum of open resonance, resonance flowing, at the outer threshold, on breath alone

Short: resonance · flowing · outer · breath

Range:

I carrying · dwelling · continuing

II pouring · coursing · running

III lip · boundary · meeting

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Well formed and unattested. No surveyed language fills this cell.

2101 · 𐀮 · /w~/
ADDRESS — *definitional*

2 · 1 · 0 · 1. Domain: open resonance. Sub-manner: liquid. Place: outermost rank. Laryngeal: modal voiced. Glyph U+1D346. Transliterated WR.

ARTICULATION — *what your mouth does*

Round your lips and at the same time make the *r* of *run* — either by curling the tongue tip back or by bunching the tongue body, whichever you do naturally. Both gestures run together from the start rather than one following the other. Mandarin speakers use this. English speakers produce something close in *war*, where the rounding of the vowel reaches into the consonant; the difference here is that the rounding belongs to the consonant itself.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance flowing*

III → *at the outer threshold*

IV → *with voice*

Long: a continuum of open resonance, resonance flowing, at the outer threshold, with voice

Short: resonance · flowing · outer · voice

Range:

I carrying · dwelling · continuing

II pouring · coursing · running

III lip · boundary · meeting

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.0% of surveyed inventories. Mandarin Chinese. Glottocodes pending (Appendix §A.8).

2102 · 𐀮**ADDRESS** — *definitional*

2 · 1 · 0 · 2. Domain: open resonance. Sub-manner: liquid. Place: outermost rank. Laryngeal: marked. Glyph U+1D347.

ARTICULATION — *what your mouth does*

You can produce this, though no surveyed language uses it contrastively. Make the rounded *r* of Mandarin, and let extra air through until the voicing murmurs. Three things run at once — the lip rounding, the curled or bunched tongue, and the slackened folds — and holding

all three steady is the whole difficulty. Nothing about the sound resists being made; it is simply a combination that has not been taken up.

Producible but unattested: no surveyed language uses this contrastively.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance flowing*

III → *at the outer threshold*

IV → *resonant through breath*

Long: a continuum of open resonance, resonance flowing, at the outer threshold, resonant through breath

Short: resonance · flowing · outer · throughvoice

Range:

I carrying · dwelling · continuing

II pouring · coursing · running

III lip · boundary · meeting

IV suffusion · murmur · overlap

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Well formed and unattested. No surveyed language fills this cell.

2110 ·  · /l/

ADDRESS — *definitional*

2 · 1 · 1 · 0. Domain: open resonance. Sub-manner: liquid. Place: middle rank. Laryngeal: voiceless. Glyph U+1D348. Transliterated HL.

ARTICULATION — *what your mouth does*

Put the tip of your tongue against the ridge behind your upper teeth, let the air out around the sides as you would for *lot*, and do it without voicing. The result is a rush of air past the tongue rather than a resonance. Dingri Tibetan and Xumi use this. If you blow harder the sound turns into a hiss and you have made something else entirely — Welsh *ll* — so keep the airflow gentle. The tongue is identical throughout.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance flowing*

III → *at the central point of contact*

IV → *on breath alone*

Long: a continuum of open resonance, resonance flowing, at the central point of contact, on breath alone

Short: resonance · flowing · central · breath

Range:

I carrying · dwelling · continuing

II pouring · coursing · running

III center · handling · address

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Attested band, 2.4% of surveyed inventories. Dingri Tibetan, Xumi, gSerpa.

2111 ·  · /l/

ADDRESS — *definitional*

2 · 1 · 1 · 1. Domain: open resonance. Sub-manner: liquid. Place: middle rank. Laryngeal: modal voiced. Glyph U+1D349. Transliterated L.

ARTICULATION — *what your mouth does*

Touch the tip of your tongue to the ridge behind your upper teeth, seal it along the middle, and let the voice out around the sides. This is the sound at the start of *lot*. Hold it and you can feel that the tip is firmly in contact while air keeps flowing — the only sounds in the frame that combine a real closure with an uninterrupted stream do it this way, by leaving the edges open.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance flowing*

III → *at the central point of contact*

IV → *with voice*

Long: a continuum of open resonance, resonance flowing, at the central point of contact, with voice

Short: resonance · flowing · central · voice

Range:

I carrying · dwelling · continuing

II pouring · coursing · running

III center · handling · address

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

2112 · · /l/
ADDRESS — *definitional*

2 · 1 · 1 · 2. Domain: open resonance. Sub-manner: liquid. Place: middle rank. Laryngeal: marked. Glyph U+1D34A. Transliterated L:, plain LH.

ARTICULATION — *what your mouth does*

Make the sound at the start of *lot* and let more air through than the voicing needs, so the tone acquires a murmur while the air keeps escaping at the sides. Sumi, Bengali, and Nepali use this. The seal at the tip stays exactly where it was. Fingers on your throat: with the ordinary sound you feel a clear steady buzz, with this one a softer and less definite one that never firms up into a pitch.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance flowing*

III → *at the central point of contact*

IV → *resonant through breath*

Long: a continuum of open resonance, resonance flowing, at the central point of contact, resonant through breath

Short: resonance · flowing · central · throughvoice

Range:

I carrying · dwelling · continuing

II pouring · coursing · running

III center · handling · address

IV suffusion · murmur · overlap

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.7% of surveyed inventories. Sumi, Bengali, Nepali. Glottocodes pending (Appendix §A.8).

2120 · · /l̥/
ADDRESS — *definitional*

2 · 1 · 2 · 0. Domain: open resonance. Sub-manner: liquid. Place: innermost rank. Laryngeal: voiceless. Glyph U+1D34B. Transliterated HLR.

ARTICULATION — *what your mouth does*

Curl your tongue tip back toward the roof of your mouth, well behind the ridge, seal it along the middle, let air escape at the sides, and do not voice. Iai, Toda, and Wakhi use this. Reaching it from the whispered *l* is a matter of drawing the tip backward and turning it up

while keeping the sides open and the airflow gentle. If the sound starts to hiss you are pushing too hard.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance flowing*

III → *inward toward the throat*

IV → *on breath alone*

Long: a continuum of open resonance, resonance flowing, inward toward the throat, on breath alone

Short: resonance · flowing · inward · breath

Range:

I carrying · dwelling · continuing

II pouring · coursing · running

III depth · origin · interior

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.1% of surveyed inventories. Iai, Toda, Wakhi. Glottocodes pending (Appendix §A.8).

2121 ·  · /ɹ/

ADDRESS — *definitional*

2 · 1 · 2 · 1. Domain: open resonance. Sub-manner: liquid. Place: innermost rank. Laryngeal: modal voiced. Glyph U+1D34C. Transliterated R.

ARTICULATION — *what your mouth does*

Make the *r* of *run*. Most English speakers do this in one of two ways — curling the tongue tip back, or bunching the tongue body upward and pulling the root back — and the two sound almost identical, which is unusual enough to be worth knowing about yourself. Say *run* and then try to feel whether your tip is up or your body is bunched. Whichever you do, the tongue never touches anything.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance flowing*

III → *inward toward the throat*

IV → *with voice*

Long: a continuum of open resonance, resonance flowing, inward toward the throat, with voice

Short: resonance · flowing · inward · voice

Range:

I carrying · dwelling · continuing

II pouring · coursing · running

III depth · origin · interior

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

2122 ·  · /ɾ/**ADDRESS** — *definitional*

2 · 1 · 2 · 2. Domain: open resonance. Sub-manner: liquid. Place: innermost rank. Laryngeal: marked. Glyph U+1D34D. Transliterated RR:, plain RRH.

ARTICULATION — *what your mouth does*

Curl your tongue tip back behind the ridge and produce a brief tap or a held approximation there, letting extra air through so the voicing murmurs. Sindhi, Kharia, and Nepali use this. It is the *r*-colored sound made further back than English makes it, and sighed rather than sounded cleanly. The murmur is what distinguishes it; the curl is what distinguishes it from the sound at the start of *lot*.

DERIVATION — *deterministic; see Chapter 1*I → *a continuum of open resonance*II → *resonance flowing*III → *inward toward the throat*IV → *resonant through breath*

Long: a continuum of open resonance, resonance flowing, inward toward the throat, resonant through breath

Short: resonance · flowing · inward · throughvoice**Range:**

I carrying · dwelling · continuing

II pouring · coursing · running

III depth · origin · interior

IV suffusion · murmur · overlap

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.6% of surveyed inventories. Sindhi, Kharia, Nepali. Glottocodes pending (Appendix §A.8).

2200 · · /m/
ADDRESS — *definitional*

2 · 2 · 0 · 0. Domain: open resonance. Sub-manner: nasal. Place: outermost rank. Laryngeal: voiceless. Glyph U+1D34E. Transliterated HM.

ARTICULATION — *what your mouth does*

Close your lips as though for *my*, drop the soft palate so air can pass through your nose, and let breath through without voicing. What comes out is a whispered hum — quiet, and audible mainly at the nose. Ndonga, Shixing, and Themchen Tibetan use this. Pinch your nostrils while trying and the sound disappears completely, which is the clearest demonstration available that the nose is doing all the work.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance sealed*

III → *at the outer threshold*

IV → *on breath alone*

Long: a continuum of open resonance, resonance sealed, at the outer threshold, on breath alone

Short: resonance · sealed · outer · breath

Range:

I carrying · dwelling · continuing

II enclosing · humming · interior

III lip · boundary · meeting

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Attested band, 2.4% of surveyed inventories. Ndonga (Kolonkadhi), Shixing, Themchen Tibetan.

2201 · · /m/
ADDRESS — *definitional*

2 · 2 · 0 · 1. Domain: open resonance. Sub-manner: nasal. Place: outermost rank. Laryngeal: modal voiced. Glyph U+1D34F. Transliterated M.

ARTICULATION — *what your mouth does*

Close your lips, drop the soft palate at the back of your mouth so the air can escape through your nose, and voice. This is the sound at the start of *my*, and you can hold it as long as your breath lasts even though your lips never part. Now pinch your nostrils and try again: what

comes out is the sound at the start of *by*. The lips did nothing different. Only the soft palate moved.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance sealed*

III → *at the outer threshold*

IV → *with voice*

Long: a continuum of open resonance, resonance sealed, at the outer threshold, with voice

Short: resonance · sealed · outer · voice

Range:

I carrying · dwelling · continuing

II enclosing · humming · interior

III lip · boundary · meeting

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

The only consonant you can produce with your mouth entirely closed, and the only one you can go on making while deciding what to say. That it serves as a sound of assent, hesitation, and pleasure across many unrelated languages follows straightforwardly from that fact, and needs no further explanation to be worth noticing.

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

2202 ·  · /m/

ADDRESS — *definitional*

2 · 2 · 0 · 2. Domain: open resonance. Sub-manner: nasal. Place: outermost rank. Laryngeal: marked. Glyph U+1D350. Transliterated M:, plain MH.

ARTICULATION — *what your mouth does*

Close your lips, lower the soft palate, and voice while letting much more air through the nose than the tone requires, so it murmurs. Sumi, Sindhi, and Korku use this. Compare with the ordinary sound by humming both in succession: the plain one has a definite pitch you could sing, and this one has a breathiness running underneath that blurs it. Nothing at the lips has changed.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance sealed*

III → *at the outer threshold*

IV → *resonant through breath*

Long: a continuum of open resonance, resonance sealed, at the outer threshold, resonant through breath

Short: resonance · sealed · outer · throughvoice

Range:

I carrying · dwelling · continuing

II enclosing · humming · interior

III lip · boundary · meeting

IV suffusion · murmur · overlap

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.8% of surveyed inventories. Sumi, Sindhi, Korku. Glottocodes pending (Appendix §A.8).

2210 ·  · /ŋ/

ADDRESS — *definitional*

2 · 2 · 1 · 0. Domain: open resonance. Sub-manner: nasal. Place: middle rank. Laryngeal: voiceless. Glyph U+1D351. Transliterated HN.

ARTICULATION — *what your mouth does*

Put the tip of your tongue against the ridge behind your upper teeth as though for *no*, drop the soft palate, and let breath through the nose without voicing. Themchen Tibetan, Hopi, and Mah Meri use this. It is quieter than the voiceless lip version and easy to mistake for silence; put a finger under your nose and you will feel the airflow that proves it is there.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance sealed*

III → *at the central point of contact*

IV → *on breath alone*

Long: a continuum of open resonance, resonance sealed, at the central point of contact, on breath alone

Short: resonance · sealed · central · breath

Range:

I carrying · dwelling · continuing

II enclosing · humming · interior

III center · handling · address

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Attested band, 2.0% of surveyed inventories. Themchen Tibetan, Hopi, Mah Meri.

2211 ·  · /n/

ADDRESS — *definitional*

2 · 2 · 1 · 1. Domain: open resonance. Sub-manner: nasal. Place: middle rank. Laryngeal: modal voiced. Glyph U+1D352. Transliterated N.

ARTICULATION — *what your mouth does*

Seal the tip of your tongue against the ridge behind your upper teeth, drop the soft palate, and voice. This is the sound at the start of *no*. Pinch your nostrils and it becomes the sound at the start of *do* — same tongue, same seal, and the whole difference is whether the nose is open. This sound is, by most surveys, the single most widely attested consonant in human language.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance sealed*

III → *at the central point of contact*

IV → *with voice*

Long: a continuum of open resonance, resonance sealed, at the central point of contact, with voice

Short: resonance · sealed · central · voice

Range:

I carrying · dwelling · continuing

II enclosing · humming · interior

III center · handling · address

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

The most widely attested consonant in human speech, present in almost every inventory ever surveyed. A reader looking for significance in ubiquity should consider that the tongue tip is simply the cheapest articulator the body has, and that the nose was already open.

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

2212 ·  · /n̥/

ADDRESS — *definitional*

2 · 2 · 1 · 2. Domain: open resonance. Sub-manner: nasal. Place: middle rank. Laryngeal: marked. Glyph U+1D353. Transliterated N̥, plain NH.

ARTICULATION — *what your mouth does*

Make the sound at the start of *no* and let extra air through the nose so the voicing murmurs. Sindhi, Sumi, and Angami use this. The tongue stays sealed against the ridge. Hum the plain sound and then this one: the pitch of the first is clear enough to carry a tune, and the second sounds as though someone is humming and sighing at the same time, which is more or less exactly what is happening.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance sealed*

III → *at the central point of contact*

IV → *resonant through breath*

Long: a continuum of open resonance, resonance sealed, at the central point of contact, resonant through breath

Short: resonance · sealed · central · throughvoice

Range:

I carrying · dwelling · continuing

II enclosing · humming · interior

III center · handling · address

IV suffusion · murmur · overlap

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.4% of surveyed inventories. Sindhi, Sumi, Angami. Glottocodes pending (Appendix §A.8).

2220 ·  · /ŋ/

ADDRESS — *definitional*

2 · 2 · 2 · 0. Domain: open resonance. Sub-manner: nasal. Place: innermost rank. Laryngeal: voiceless. Glyph U+1D354. Transliterated HNG.

ARTICULATION — *what your mouth does*

Raise the back of your tongue against the soft palate as though for the end of *sing*, drop the velum so air passes through the nose, and let breath through without voicing. Aleut, Iai, and Mien use this. English never begins a word with the voiced version, let alone this one, so it takes some deliberate effort to produce it in isolation — start from *sing*, hold the final sound, then cut the voice while keeping the air moving.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance sealed*

III → *inward toward the throat*

IV → *on breath alone*

Long: a continuum of open resonance, resonance sealed, inward toward the throat, on breath alone

Short: resonance · sealed · inward · breath

Range:

I carrying · dwelling · continuing

II enclosing · humming · interior

III depth · origin · interior

IV unvoiced · cool · impersonal

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.9% of surveyed inventories. Aleut, Iai, Mien. Glottocodes pending (Appendix §A.8).

2221 ·  · /ŋ/

ADDRESS — *definitional*

2 · 2 · 2 · 1. Domain: open resonance. Sub-manner: nasal. Place: innermost rank. Laryngeal: modal voiced. Glyph U+1D355. Transliterated NG.

ARTICULATION — *what your mouth does*

Raise the back of your tongue against the soft palate, drop the velum, and voice through the nose. This is the sound at the end of *sing*. English never uses it to start a word, which makes it feel harder to produce alone than it is: hold the end of *sing*, then try to begin a new syllable from there without letting the tongue drop. Pinch your nostrils and it becomes the sound at the end of *sick*.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance sealed*

III → *inward toward the throat*

IV → *with voice*

Long: a continuum of open resonance, resonance sealed, inward toward the throat, with voice

Short: resonance · sealed · inward · voice

Range:

I carrying · dwelling · continuing

II enclosing · humming · interior

III depth · origin · interior

IV sounded · warm · personal

RESONANCE — *not derived; discard freely*

English has this sound and will not let it begin a word — a restriction of English rather than of the mouth, since many languages start words with it freely. Worth knowing when a sound feels difficult: the difficulty may belong to your language rather than to your body.

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

2222 ·  · /ŋ/

ADDRESS — *definitional*

2 · 2 · 2 · 2. Domain: open resonance. Sub-manner: nasal. Place: innermost rank. Laryngeal: marked. Glyph U+1D356. Transliterated NY:, plain NYH.

ARTICULATION — *what your mouth does*

Press the middle of your tongue up against the hard palate — further forward than for the end of *sing*, roughly where you make the sound at the start of *yes* — drop the velum, and voice while letting extra air through so the tone murmurs. Angami, Khezha, and Lotha use this. It is close to the ñ of Spanish *señor*, sighed rather than sounded cleanly.

DERIVATION — *deterministic; see Chapter 1*

I → *a continuum of open resonance*

II → *resonance sealed*

III → *inward toward the throat*

IV → *resonant through breath*

Long: a continuum of open resonance, resonance sealed, inward toward the throat, resonant through breath

Short: resonance · sealed · inward · throughvoice

Range:

I carrying · dwelling · continuing

II enclosing · humming · interior

III depth · origin · interior

IV suffusion · murmur · overlap

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Rare band, 0.2% of surveyed inventories. Angami, Khezha, Lotha. Glottocodes pending (Appendix §A.8).

The vowel tiers and the Center

Thirteen entries: nine digrams, three cardinal monograms, and the Center. The vowel frame runs on its own geometry — two positions rather than four, no laryngeal term because vowels are voiced by definition, and no term for the lips at all (Appendix §A.4). Two of the thirteen do not compose in the ordinary way, and their entries say so.

Tetragram glyphs are computed from the address by arithmetic; the vowel glyphs are not, and come from a lookup table (WP §14). Four of them live in a different Unicode block and are absent from many typefaces — see the front matter on notation.

00 · = · /a/

ADDRESS — *definitional*

0 · 0. Aperture: open. Orientation: central. Glyph U+268C. Transliterated AH. No laryngeal term and no term for the lips; the vowel frame has neither.

ARTICULATION — *what your mouth does*

Drop your jaw as far as it will comfortably go and leave your tongue lying flat, neither pushed forward nor pulled back. Say the vowel of *cat*, then let your tongue settle backward just slightly, into neutral. That is the sound — the vowel of Spanish *casa* and French *patte*. General American does not have it, and it is the most widely attested vowel in the world after the one in *beat*, which is worth sitting with for a moment. Your mouth makes it easily; your language simply never asked for it.

Not phonemic in the reference variety.

DERIVATION — *deterministic; see Chapter 1*

I → *the mouth fully open*

II → *the tongue at rest in the center*

Long: the mouth fully open, the tongue at rest in the center

Short: open · centered

Range:

I wide · unguarded · admitting

II neutral · unweighted · still

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Common band, 86.1% of surveyed inventories. Vacant in the reference variety.

01 · · /æ/**ADDRESS** — *definitional*

0 · 1. Aperture: open. Orientation: front. Glyph U+268E. Transliterated AE. No laryngeal term and no term for the lips; the vowel frame has neither.

ARTICULATION — *what your mouth does*

Drop your jaw wide and push your tongue forward, so the body of it crowds toward your front teeth without touching them. This is the vowel of *cat* and *bad*. Say it, then say the vowel of *bed*, and feel your jaw close by a small but definite amount while the tongue stays forward throughout. That closing is the only thing separating the two — one thing moving against another held still.

DERIVATION — *deterministic; see Chapter 1*

I → *the mouth fully open*

II → *the tongue advanced*

Long: the mouth fully open, the tongue advanced

Short: open · advanced

Range:

I wide · unguarded · admitting

II forward · bright · reaching

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

02 · · /ɑ/**ADDRESS** — *definitional*

0 · 2. Aperture: open. Orientation: back. Glyph U+1D301. Transliterated O. No laryngeal term and no term for the lips; the vowel frame has neither.

ARTICULATION — *what your mouth does*

Drop your jaw wide and pull the body of your tongue back toward your throat. Received Pronunciation makes this in *lot* and *cot*, usually with a little lip rounding; General American merges it with the longer, tenser vowel of *father* and has no separate sound here. Say *father* and then try to make it shorter and slacker without moving your tongue forward. What you get is close to the British vowel.

Not phonemic in the reference variety.

DERIVATION — *deterministic; see Chapter 1*

I → *the mouth fully open*

II → *the tongue withdrawn*

Long: the mouth fully open, the tongue withdrawn

Short: open · withdrawn

Range:

I wide · unguarded · admitting

II back · dark · gathering

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Attested band, 7.4% of surveyed inventories. Vacant in the reference variety.

10 ·  · /ʌ/

ADDRESS — *definitional*

1 · 0. Aperture: mid. Orientation: central. Glyph U+268D. Transliterated UH. No laryngeal term and no term for the lips; the vowel frame has neither.

ARTICULATION — *what your mouth does*

Let your jaw fall about halfway and leave your tongue at rest — not forward, not back, not high, not low. This is the vowel of *cup* and *blood*. It is very nearly the sound your mouth makes when it is doing nothing at all, which is why it is easy to produce and hard to describe. Say *the cup* quickly: the vowel in the second word is this one, and the vowel in the first is the one this system leaves unaddressed.

DERIVATION — *deterministic; see Chapter 1*

I → *the mouth half open*

II → *the tongue at rest in the center*

Long: the mouth half open, the tongue at rest in the center

Short: half · centered

Range:

I poised · partial · between

II neutral · unweighted · still

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

11 · · /ɛ/**ADDRESS** — *definitional*

1 · 1. Aperture: mid. Orientation: front. Glyph U+268F. Transliterated EH. No laryngeal term and no term for the lips; the vowel frame has neither.

ARTICULATION — *what your mouth does*

Let your jaw fall about halfway and push your tongue forward. This is the vowel of *bed* and *set*. Run *bat*, *bet*, *bit* slowly in that order and you will feel your jaw close in two steps while the tongue stays forward the whole time. This is the middle step. Most languages with more than three vowels have something at or near this sound.

DERIVATION — *deterministic; see Chapter 1*

I → *the mouth half open*

II → *the tongue advanced*

Long: the mouth half open, the tongue advanced

Short: half · advanced

Range:

I poised · partial · between

II forward · bright · reaching

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

12 · · /ɔ/**ADDRESS** — *definitional*

1 · 2. Aperture: mid. Orientation: back. Glyph U+1D302. Transliterated AW. No laryngeal term and no term for the lips; the vowel frame has neither.

ARTICULATION — *what your mouth does*

Let your jaw fall about halfway, pull your tongue back, and round your lips a little. This is the vowel of *thought* and *caught* for speakers who keep them distinct from *cot*. Many General American speakers no longer do, and pronounce all three with the open back vowel instead. If *cot* and *caught* sound identical to you, this is a sound your accent has lost, and you can reach it by saying *caught* with the lips pushed forward.

DERIVATION — *deterministic; see Chapter 1*

I → *the mouth half open*

II → *the tongue withdrawn*

Long: the mouth half open, the tongue withdrawn

Short: half · withdrawn

Range:

I poised · partial · between

II back · dark · gathering

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

20 · ɨ · /ɨ/**ADDRESS** — *definitional*

2 · 0. Aperture: close. Orientation: central. Glyph U+1D303. Transliterated IH. No laryngeal term and no term for the lips; the vowel frame has neither.

ARTICULATION — *what your mouth does*

Raise your tongue high, as though for the vowel of *bit*, and then pull it back to the middle without letting your jaw open or your lips round. Russian speakers make this in the word written *ы*. It sits between the vowel of *bit* and the vowel of *put* and is neither. English speakers usually find it easiest by saying *bit*, holding the vowel, and drawing the tongue straight backward.

*Not phonemic in the reference variety.***DERIVATION** — *deterministic; see Chapter 1*I → *the mouth nearly closed*II → *the tongue at rest in the center***Long:** the mouth nearly closed, the tongue at rest in the center**Short:** closed · centered**Range:**

I narrow · focused · fine

II neutral · unweighted · still

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Common band, 16.1% of surveyed inventories. Vacant in the reference variety.

21 · ɪ · /ɪ/**ADDRESS** — *definitional*

2 · 1. Aperture: close. Orientation: front. Glyph U+1D304. Transliterated I. No laryngeal term and no term for the lips; the vowel frame has neither.

ARTICULATION — *what your mouth does*

Raise your tongue high and forward, but stop short of the position for the vowel of *beat* — let it fall slack. This is the vowel of *bit* and *sit*. Say *beat*, then *bit*, then *beat*: your tongue is in nearly the same neighbourhood in both, and what changes is how hard it is working. The slack one is shorter and the tense one can be held.

DERIVATION — *deterministic; see Chapter 1*

I → *the mouth nearly closed*

II → *the tongue advanced*

Long: the mouth nearly closed, the tongue advanced

Short: closed · advanced

Range:

I narrow · focused · fine

II forward · bright · reaching

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

22 · 𐌚 · /ʊ/**ADDRESS** — *definitional*

2 · 2. Aperture: close. Orientation: back. Glyph U+1D305. Transliterated U. No laryngeal term and no term for the lips; the vowel frame has neither.

ARTICULATION — *what your mouth does*

Raise the back of your tongue high, round your lips, and let the tongue fall slack rather than reaching. This is the vowel of *put* and *foot*. Say *boot*, then *put*: the lips round in both, the tongue is high and back in both, and the difference is that one holds its extreme and the other relaxes just short of it.

DERIVATION — *deterministic; see Chapter 1*

I → *the mouth nearly closed*

II → *the tongue withdrawn*

Long: the mouth nearly closed, the tongue withdrawn

Short: closed · withdrawn

Range:

I narrow · focused · fine

II back · dark · gathering

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

Monogram 0 · — · /ɑ/**ADDRESS** — *definitional*

0. The digit is an identity index, not a coordinate — it names the first cardinal, not where that cardinal sits (WP §9). The gloss below therefore derives from this vowel's position in the digram grid, 0 · 2 — aperture open, orientation back — with a tenseness term appended. This monogram and the digram at 02 stand to each other as tense to lax. Glyph U+268A. Transliterated AA.

ARTICULATION — *what your mouth does*

Drop your jaw as wide as it will go and pull the body of your tongue back and down. This is the vowel of *father*, *spa*, and *calm*. It is one of the three corners of the vowel space: you cannot open your mouth further or pull your tongue further back and still be making a vowel. Hold it and try to push past it in either direction — you will find there is nowhere to go.

DERIVATION — *deterministic; see Chapter 1*

I → *the mouth fully open*

II → *the tongue withdrawn*

TENSE → *held at full extension*

Long: the mouth fully open, the tongue withdrawn, held at full extension

Short: open · withdrawn · full

Range:

I wide · unguarded · admitting

II back · dark · gathering

TENSE extremity · cardinal · unreduced

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

Monogram 1 · -- · /i/**ADDRESS** — *definitional*

1. The digit is an identity index, not a coordinate — it names the second cardinal, not where that cardinal sits (WP §9). The gloss below therefore derives from this vowel's position in the digram grid, 2 · 1 — aperture close, orientation front — with a tenseness term appended. This monogram and the digram at 21 stand to each other as tense to lax. Glyph U+268B. Transliterated EE.

ARTICULATION — *what your mouth does*

Raise the front of your tongue as high and as far forward as it will go without making friction against the roof of your mouth, and spread your lips slightly. This is the vowel of *beat* and *see*. Push the tongue any higher and the air begins to hiss, at which point you have left the vowels and arrived at the sound that starts *yes*. That boundary is what makes this a corner of the space.

DERIVATION — *deterministic; see Chapter 1*

I → *the mouth nearly closed*

II → *the tongue advanced*

TENSE → *held at full extension*

Long: the mouth nearly closed, the tongue advanced, held at full extension

Short: closed · advanced · full

Range:

I narrow · focused · fine

II forward · bright · reaching

TENSE extremity · cardinal · unreduced

RESONANCE — *not derived; discard freely*

The most widely attested vowel in human language, and one of only three sounds anyone can identify by its limits rather than by its qualities: it is the point past which the tongue cannot rise. A reader inclined to find brightness or clarity here should note that the brightness is acoustic — a high front tongue produces high resonances — and that the metaphor came afterward.

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

Monogram 2 · ' · /u/**ADDRESS** — *definitional*

2. The digit is an identity index, not a coordinate — it names the third cardinal, not where that cardinal sits (WP §9). The gloss below therefore derives from this vowel's position in the digram grid, 2 · 2 — aperture close, orientation back — with a tenseness term appended. This monogram and the digram at 22 stand to each other as tense to lax. Glyph U+1D300. Transliterated 00.

ARTICULATION — *what your mouth does*

Raise the back of your tongue as high as it will go and round your lips firmly. This is the vowel of *boot* and *food*. Like the other two cardinals it sits at a limit: push the tongue higher and you get friction, unround the lips and you slide toward a different vowel entirely. Say *boot* and hold it, then try to make the lips rounder — most people find there is no further to go.

DERIVATION — *deterministic; see Chapter 1*

I → *the mouth nearly closed*

II → *the tongue withdrawn*

TENSE → *held at full extension*

Long: the mouth nearly closed, the tongue withdrawn, held at full extension

Short: closed · withdrawn · full

Range:

I narrow · focused · fine

II back · dark · gathering

TENSE extremity · cardinal · unreduced

RESONANCE — *not derived; discard freely*

—

ATTESTATION — *empirical*

Assigned to the reference variety. No inventory figure available (Appendix §A.9).

The Center · /ə/

ADDRESS — *definitional*

No address. The Center takes no symbol and no digits. A system that addresses sounds by their articulatory commitments has nothing to say about the sound defined by having none (WP §8). Transliterated @, plain UH — the only transliteration in the frame that is not a letter, marking an entry that is not an address.

ARTICULATION — *what your mouth does*

Let your mouth go completely slack. Do not raise or lower the tongue, do not push it forward or pull it back, do not round or spread the lips, and make a sound. That is the whole instruction, and it is the only entry in this book where the instruction is to do nothing. This is the vowel at the start of *about* and the end of *sofa*. Say *sofa* and notice that the second vowel takes almost no effort — the first one is where the work went.

DERIVATION — *deterministic; see Chapter 1*

— *The Center is unaddressed. An unaddressed point has nothing to compose with (WP §8). No derived gloss and no sense range; nothing elsewhere in the frame composes with it.*

RESONANCE — *not derived; discard freely*

The system's one deliberate absence. It is tempting to treat an unaddressed center as a profundity, and worth resisting: the schwa has no address because it has no articulatory commitments to encode, which is a structural fact rather than a mystery. What can be said is narrower and stranger — this is the most frequent vowel in spoken English, and it is the one speakers produce when they stop trying.

ATTESTATION — *empirical*

Not applicable. The Center is a structural position, not a survey result.

Appendix · The Construction Record

Cited from both parts. What is still undecided, what was decided wrongly and repaired, and what checks are run to catch the next one.

Chapters 2 through 10 describe the frame as it stands. This appendix describes how it came to stand that way: what is still undecided, what was decided wrongly and repaired, and what checks are run to catch the next one.

It is kept in one place rather than distributed through the chapters for two reasons. A reader working through a slice should be reading about speech, not about the document. And a construction record is more useful whole than in fragments, because most of its entries bear on more than one slice.

Sections §A.1 through §A.10 correspond one-to-one with the open questions numbered in the Derivation Spec, so a citation in either document resolves in the other. §A.11 records defects that have been closed. §A.12 lists the checks that stay in force.

Sections §A.1 to §A.10 are the open questions, numbered to match the Derivation Spec so a citation resolves in either document.

§A.1 · The value names

Blocks: nothing. Deferred by design.

The three ternary values are provisionally named Hahn (0), Sheen (1), and Yun (2). These names are not final and will be replaced.

Nothing in Part I or Part II may depend on how they sound, how they are spelled, or what they might mean in any other language. No alliteration, no mnemonic built on their phonetics, no sentence of the form *as the name suggests*. Prose that breaks when the names are substituted is a defect, and the check for it is a mechanical one (§A.12).

This rule exists because an earlier version of the system failed it. An audit of the domain-0 glosses found that several had been chosen for how they looked beside a value name rather than for what the articulation warranted — motivation by orthography, dressed as motivation by phonetics. That is a findable class of error and it is worth staying findable.

§A.2 · The affricates

Blocks: nine cells, 0200–0222. Status: quarantined.

Domain 0 sub-manner 2 currently holds the affricates: /pf/, /mjv/, /ts/, /dz/, /tʃ/, /dʒ/ and their aspirated forms. Several are well attested — /ts/ appears in more than a fifth of surveyed inventories — and two of them are ordinary English consonants.

All nine ship as stubs: address and articulation only, no derived gloss, no sense range.

The question is not whether the derivation works. It does; the glosses are complete and correct and are being withheld. The question is whether the addresses are right. An affricate is a stop and a fricative in one segment slot, and the frame already has an operation for that — fusion, which combines two addresses without requiring a third. If affricates are better read as fusions of a domain-0 and a domain-1 address, then sub-manner 2 of domain 0 names nothing, these nine cells are vacant, and their occupants belong elsewhere entirely.

Bound up with this is a second issue, which is why the question has not been settled quickly. The frame appears to encode stop voicing twice — once at Position IV, where it belongs, and once implicitly in the sub-manner assignments — and resolving the affricate question one way or the other changes whether that double encoding is real. The two have to be settled together.

Why quarantine rather than publish and annotate. A formally impeccable derivation from a false premise is worse than an absent gloss, and much harder to detect: nothing on the surface of a gloss reveals whether its address was right. If the addresses turn out to be wrong, nine stubs are discarded. If nine finished entries turn out to be wrong, they have to be found first, and by then they may have been quoted, printed on cards, or built into practice material.

What resolution requires: a decision on whether fusion (Chapter 1 §11.9) subsumes the affricate class, and a determination of whether stop voicing is in fact double-encoded. Neither is a data question.

§A.3 · The marked laryngeal setting

Blocks: wording of three components and their sense-range pools. Selection rule repaired.

This is the frame's most instructive failure, and it happened twice.

The origin. Whitepaper Table 6.4 assigns Position IV value 2 to “aspirated or breathy.” Those are opposite laryngeal configurations — aspiration spreads the glottis, breathy voice slackens it — sharing one cell. A single component phrase cannot honestly describe both, so the frame has to select between them using information from elsewhere in the address.

First attempt (DS v0.1). Select by domain. Aspiration for domains 0 and 1, breathiness for domain 2, on the principle that aspiration falls on obstruents and breathiness on sonorants.

This broke at address 0022. That cell holds /h/, a breathy-voiced glottal fricative, and it sits in domain 0 — so it received *released into breath*, a phrase describing aspiration. The

sound has no aspiration and no closure to aspirate. The gloss was correctly derived and false about its occupant.

Second attempt (DS v0.2). Select by whether a closure release exists to aspirate. This put domain 0 sub-manner 0 with the breathy sounds and repaired /h/.

It left the identical defect one domain over. Addresses 1112 and 1122 hold /s^h/ and /ʃ^h/, aspirated sibilants with no voicing at all, and under the domain-1 default they received *voiced through breath*. The gloss asserted voice of a voiceless segment — a worse error than the first, running in the opposite direction.

Third attempt (DS v0.2.1), current. Select by a set of Position I and II pairs. Aspiration where the manner produces a high-pressure articulation with a discrete release — stops, affricates, and sibilant fricatives. Breathy voice everywhere else, framed to agree with its head. Verified against all sixteen occupied value-2 cells in the frame.

What identified the real rule. Domain 2 was the control. Its component was accurate at every occupied cell under every version of the rule, because that domain is homogeneously sonorant. Two domains failing in opposite directions while a third never failed at all showed that the property being tracked varies *within* domains rather than *between* them — which is a conclusion neither failure could have supported alone.

Three things worth carrying forward.

The repair had to be made at the component table. A note at the affected entries was never available: that would have been a cell-level fact the address does not license, and the defect belonged to the intersection of two slices rather than to any cell.

Both failures were found by comparing generated components against attested occupants, not by reading the rule. The rule looked right twice.

And the general lesson, which belongs to the whole volume: **a derived gloss can be perfectly correct and still false about the sound at its address.** Derivation guarantees that a gloss follows from an address. It guarantees nothing about the address being right.

The cost, recorded deliberately. Position IV is now read conditionally, so two of the four positions branch rather than one. The Whitepaper currently states that only Position II is domain-relative and will need a sentence.

What remains open: the wording of the three components — *released into breath*, *voiced through breath*, *resonant through breath* — and their sense-range pools. The selection is right; the phrasing has never been reviewed. Of the pools, *aftermath* · *escape* · *consequence* for aspiration is the most interpretive vocabulary in the lexicon and the only pool that names a temporal relation rather than a quality.

§A.4 · A fourth position for vowels

Blocks: entry count and notation. **Status:** open. **The Atlas ships digram-based.**

Consonants take four positions; vowels take two, plus a one-digit tier for the cardinals. A fourth vowel position would unify the notation, make every address in the system the same shape, and change the entry count from ninety-four to something larger.

The argument for is symmetry, and it is not trivial — a reader currently has to learn that address length determines tier.

The argument against is that no one has said what the third and fourth positions would encode. Aperture and orientation exhaust the frame's current vowel geometry. Length, nasalization, rhoticity, and tenseness are all candidates, and tenseness is already spoken for as the monogram–digram relation (§6.2 of the Spec). Adding positions without content would produce addresses whose extra digits are always zero, which is worse than an asymmetry.

§A.5 · Secondary articulation as place

Blocks: the class of addresses 0000 and 0002. Status: open.

Position III collapses eight places of articulation into three ranks. The question is whether a secondary articulation — lip rounding on a sound whose primary constriction is elsewhere — counts as place for ranking purposes.

The frame currently says no, and that makes six cells in domain 0 sub-manner 0 formally unreachable. But two of them have plausible occupants under the permissive reading: /ɱ/ and /h^w/ would classify at 0000, and /ɦ^w/ at 0002. The Whitepaper demotes the exclusion to an open question rather than defending it.

The same question arises from the opposite direction in domain 2. /w/ is labial-velar — the lips round and the tongue body raises, simultaneously and inseparably. It is ranked outermost, by its frontmost constriction, and its velar component goes unrecorded. So the restrictive reading excludes sounds that have a secondary articulation, and simultaneously admits a sound whose second articulation is not secondary at all, filing it as though it were simply labial.

The consequence for glosses is real: /w/ and /j/ end up at opposite ends of the place ranking despite sharing a dorsal component, and a reader deriving both will find them further apart than they are in the mouth.

Whichever way this resolves, it should resolve for both cases together. A rule that admits rounding as place at 0000 and ignores it at 2001 is not a rule.

One transliteration is held in reserve against this question. English readers reach for *WH* before any other digraph, and it is what /ɱ/ would want if this question resolves toward admitting secondary articulation and 0000 acquires an occupant. The breathy-voice rule would otherwise assign *WH* to /ɰ/ at 2002 — a South Asian breathy sonorant that no English reader would look for under that spelling. That cell therefore takes *WV* in plain form, as a deliberate exception to the rule, and *WH* stays unassigned. If the question resolves the

other way and 0000 remains empty, the reservation can be released and 2002 can take WH back.

For the reference variety the point is moot in a different way: the Whitepaper excludes /ɹ/ as moribund in most American speech, so the *wh* of *wheel* and *which* is plain /w/ at 2001 and the which/witch distinction is merged. Readers who keep the distinction are using a sound the frame does not currently address.

§A.6 · Reference dialect

Blocks: example words in the ARTICULATION stratum. Status: deferrable.

The Whitepaper’s twenty-four assigned consonants describe a general English inventory without committing to Received Pronunciation or General American. The two differ in ways that matter for worked examples — rhoticity most obviously, and the realization of /t/ between vowels.

This affects nothing in the derivation. It affects which words are used to illustrate a sound in Part II, and it can be settled at any point before those blocks are written.

§A.7 · Glyphs for the vowel tiers

Blocks: nothing. Closed — the assignment exists.

Tetragram glyphs follow from the address by arithmetic: the base codepoint plus the address read as a ternary integer. The vowel tiers do not work that way, and for a time this record listed their notation as undecided. That was an error on the part of this document; Whitepaper Chapter 14 carries the lookup table.

The reason a formula does not serve is worth knowing. The monogram and digram symbols are split across two Unicode blocks — those containing a twice-broken line were encoded with the Tai Xuan Jing set, and the rest were unified with existing Yijing symbols, because a stack of undivided lines is visually identical to the ideographs for one, two, and three. The Yijing digrams follow that tradition’s own bottom-up ordering rather than base-three counting, so four of the twelve cannot be derived arithmetically at all.

What is a live problem is rendering rather than assignment. These characters sit in the Supplementary Multilingual Plane and are missing from most common typefaces, and four of the digrams are absent even from fonts that cover the Tai Xuan Jing block, since they live in Miscellaneous Symbols. Anything intended for distribution should embed the glyphs as artwork rather than trusting font fallback.

§A.8 · Glottocodes

Blocks: the attestation slot for 21 thin-band cells. Status: data blocker.

The Spec requires that any cell attested in under one per cent of surveyed inventories name an attested language *with its Glottocode*, so that a reader can tell a rare sound from a formal possibility.

Neither source document carries Glottocodes. Language names are present; the codes are not, and the Whitepaper asserts they are. Resolving this needs a pull from the source survey, not a decision.

Until then, the thin-band entries name languages without codes, which is weaker than the Spec asks for and should be marked as provisional wherever it appears.

§A.9 · Missing attestation for the assigned cells

Blocks: the attestation slot for 24 entries. Status: data blocker.

The source survey reports inventory counts for candidate segments — the sounds the frame proposes for open cells — and not for the reference variety’s own consonants. So the twenty-four English-assigned cells carry no attestation figure at all.

The effect is perverse and worth stating plainly, because it will mislead anyone scanning the Atlas by column. **The frame’s most ordinary sounds are the ones about which it says least.** /m/, /n/, /ŋ/, /l/, /w/, /j/ and their neighbors carry blanks, while /ɹ/ — recorded in a handful of South Asian languages — carries a precise figure. Domain 2 §10.2 is the extreme case: seven of nine cells blank, in the slice holding the most common consonants on earth.

A blank is a gap in the pipeline. It is not a low number, and it is not a fact about the sound.

§A.10 · Does sub-manner 0 belong in domain 0?

Blocks: potentially the §A.3 repair. Status: open.

Domain 0 is defined by closure and release. Its sub-manner 0 — *breath unobstructed* — has no closure at all, and holds only /h/ and /ɦ/, with six of its nine cells formally unreachable.

That is a strange shape for a sub-manner: a value that negates its own domain head, produces the sparsest region in the frame, and contains the one segment nobody agrees how to classify.

If /h/ and /ɦ/ were relocated — to domain 1 as fricatives without oral constriction, or to a position the frame does not currently have — several things change at once. Six unreachable cells would cease to exist as addresses. The §A.3 repair would need restating, since one of its conditions exists specifically to catch domain 0 sub-manner 0. And the count of unreachable cells, currently nine, would drop to three.

The counter-argument is that /h/ genuinely is an event rather than a channel — it is the release without the closure, which is a coherent thing for a domain of releases to contain, and it does pattern with stops in some phonologies.

This question was raised by the chapters rather than by the Spec, and it has not been examined.

§A.11 · Defects found and closed

The internal comma

Position III value 2 formerly read *inward, toward the throat*. The Spec joins components with commas, so every long form containing it carried four components and five commas and could not be split back into its parts by its own delimiter — twenty-four cells affected, in every domain.

Closed at v0.2.1 by removing the comma. The sense is unchanged, and a generator test now round-trips every long form through its own delimiter on each run.

The excluded position

Position IV formerly contributed nothing to the sense range, on the stated ground that laryngeal state modifies the whole rather than adding a sense. Two consequences followed. Any three cells differing only at the laryngeal position shared an identical sense range — so the range could not distinguish a voiceless segment from its voiced counterpart, in a volume whose whole claim is that every position contributes. And the Spec published pools for the value-0 and value-1 components that no rule could ever reach: vocabulary printed and forbidden in the same document.

Closed at v0.2.1. Every contributing position now prints its pool.

The unmotivated selection

Even where a position did contribute, the Spec named which positions supplied a neighbor without naming which member of the pool to take. The generator took the first and declared the choice a gap. The consequence was visible only in a fully populated domain: because the first neighbor always came from Position I and the generator always took member one, the first word of the sense range was identical at all twenty-seven addresses of domain 1, distinguishing nothing.

Four options were weighed — fixed index, address-driven index, print the pool whole, or drop sense ranges entirely. Printing the pool was adopted because it removes the choice rather than relocating it. An address-driven index would have been better in principle but required first deciding what a pool's internal ordering encodes, which is a question nobody had asked.

Closed at v0.2.1.

The laryngeal selection rule

Recorded at §A.3. Two failed formulations, closed at v0.2.1.

§A.12 · Standing checks

These run against generated output before any typesetting, and again after any change to a component table.

Closure. Every token in every gloss and every sense range must appear in the Spec’s lexicon. Exhaustive, not sampled.

Injectivity. No two addresses may produce the same long or short form. Sense ranges are exempt by design: adjacent cells share most of their range, which is true, and is the same claim Part I spends its length making.

Component against occupant. For every cell with an attested occupant, confirm that each component describes the sound actually there. This is the check that caught the §A.3 defect twice, and neither instance was visible from reading the rule.

Name independence. Substitute arbitrary strings for the three value names and re-read. Any prose that breaks violates §A.1.

Skeleton conformance. Every hand-written articulation block must assert exactly what its generated skeleton asserts. This catches fluent prose that quietly describes the wrong sound.

The shuffle test. Permute the derived glosses across cells and give them, with the composition rules only, to a reader who did not do the drafting. If the permutation is undetectable, Part I is not carrying the derivation and the Atlas is decorative.

This last one is not a formality. An earlier version of this system had roughly four-fifths of its semantic layer shuffled freely without the result becoming detectably wrong — which established that word lists rather than articulatory features had been doing the semantic work, and is the reason the present frame exists at all. The instrument that dismantled the predecessor applies to this volume with undiminished force.

Index of Addresses

Every address in the frame, in order. Entries appear in Part II under these headings.

Address	Glyph	Sound	Class
0000	≡	—	unreachable
0001	≡	—	unreachable

Address	Glyph	Sound	Class
0002		—	unreachable
0010		—	unreachable
0011		—	unreachable
0012		—	unreachable
0020		/h/	reference variety
0021		—	unattested
0022		/h̥/	attested
0100		/p/	reference variety
0101		/b/	reference variety
0102		/p ^h /	common
0110		/t/	reference variety
0111		/d/	reference variety
0112		/t ^h /	common
0120		/k/	reference variety
0121		/g/	reference variety
0122		/k ^h /	common
0200		/pf/	quarantined
0201		/ɱv/	quarantined
0202		/p ^f /	quarantined
0210		/ts/	quarantined
0211		/dz/	quarantined
0212		/ts ^h /	quarantined
0220		/tʃ/	quarantined
0221		/dʒ/	quarantined
0222		/tʃ ^h /	quarantined
1000		/f/	reference variety

Address	Glyph	Sound	Class
1001		/v/	reference variety
1002		/v̥/	rare
1010		/θ/	reference variety
1011		/ð/	reference variety
1012		—	unattested
1020		/x/	common
1021		/ɣ/	common
1022		/ɣ̥/	rare
1100		/s ^w /	attested
1101		/z ^w /	rare
1102		—	unattested
1110		/s/	reference variety
1111		/z/	reference variety
1112		/s ^h /	rare
1120		/ʃ/	reference variety
1121		/ʒ/	reference variety
1122		/ʃ ^h /	rare
1200		/t ^w /	rare
1201		—	unattested
1202		—	unattested
1210		/t/	attested
1211		/k/	attested
1212		/k̥/	rare
1220		—	unattested
1221		/l̥/	rare
1222		—	unattested

Address	Glyph	Sound	Class
2000	𐀀	/w̥/	rare
2001	𐀁	/w/	reference variety
2002	𐀂	/w̥/	rare
2010	𐀃	—	unreachable
2011	𐀄	—	unreachable
2012	𐀅	—	unreachable
2020	𐀆	/j̥/	rare
2021	𐀇	/j/	reference variety
2022	𐀈	/j ^h /	rare
2100	𐀉	—	unattested
2101	𐀊	/w̥/	rare
2102	𐀋	—	unattested
2110	𐀌	/l̥/	attested
2111	𐀍	/l/	reference variety
2112	𐀎	/l̥/	rare
2120	𐀏	/l̥/	rare
2121	𐀐	/ɭ/	reference variety
2122	𐀑	/ɭ̥/	rare
2200	𐀒	/m̥/	attested
2201	𐀓	/m/	reference variety
2202	𐀔	/m̥/	rare
2210	𐀕	/n̥/	attested
2211	𐀖	/n/	reference variety
2212	𐀗	/n̥/	rare
2220	𐀘	/ŋ̥/	rare
2221	𐀙	/ŋ/	reference variety

Address	Glyph	Sound	Class
2222	⋮⋮	/p̥/	rare
00	=	/a/	common
01	=	/æ/	reference variety
02	≡	/ɑ/	attested
10	=	/ʌ/	reference variety
11	=	/ɛ/	reference variety
12	≡	/ɔ/	reference variety
20	≡	/i/	common
21	≡	/ɪ/	reference variety
22	≡	/ʊ/	reference variety
0	—	/ɑ/	reference variety
1	--	/i/	reference variety
2	...	/u/	reference variety
—	—	/ə/	unaddressed

Index of Sounds

By IPA symbol, for a reader who has a sound and wants its address. Sorted by symbol.

Strict transliteration is unique across the frame and safe for reference and indexing: ' marks aspiration, : marks breathy voice, a leading H marks a voiceless sonorant. **Plain** is letters only, for names and running text, and cannot be unique — four pairs collide (TH, KH, SH, UH), each an aspirated sound against something English also spells with a following H. WH is deliberately unassigned and held in reserve (Appendix §A.5).

Sound	Address	Glyph	Strict	Plain	Short form
/a/	00	=	AH	AH	open · centered
/b/	0101	≡	B	B	release · complete · outer · voice
/d/	0111	≡	D	D	release · complete · central · voice
/dz/	0211	≡	DZ	DZ	<i>withheld</i>
/dʒ/	0221	≡	J	J	<i>withheld</i>

Sound	Address	Glyph	Strict	Plain	Short form
/f/	1000		F	F	channel · diffuse · outer · breath
/h/	0020		H	H	release · unobstructed · inward · breath
/i/	1		EE	EE	closed · advanced · full
/j/	2021		Y	Y	resonance · moving · inward · voice
/j̥/	2020		HY	HY	resonance · moving · inward · breath
/j ^h /	2022		Y:	YH	resonance · moving · inward · throughvoice
/k/	0120		K	K	release · complete · inward · breath
/k ^h /	0122		K'	KH	release · complete · inward · released
/l/	2111		L	L	resonance · flowing · central · voice
/l̥/	2112		L:	LH	resonance · flowing · central · throughvoice
/l̥̥/	2110		HL	HL	resonance · flowing · central · breath
/m/	2201		M	M	resonance · sealed · outer · voice
/m̥/	2202		M:	MH	resonance · sealed · outer · throughvoice
/m̥̥/	2200		HM	HM	resonance · sealed · outer · breath
/n/	2211		N	N	resonance · sealed · central · voice
/n̥/	2212		N:	NH	resonance · sealed · central · throughvoice
/n̥̥/	2210		HN	HN	resonance · sealed · central · breath
/p/	0100		P	P	release · complete · outer · breath
/p ^h /	0102		P'	PH	release · complete · outer · released
/pf/	0200		PF	PF	<i>withheld</i>
/p ^h /	0202		PF'	PFH	<i>withheld</i>
/s/	1110		S	S	channel · concentrated · central · breath
/s ^h /	1112		S'	SH	channel · concentrated · central · released
/s ^w /	1100		SW	SW	channel · concentrated · outer · breath
/t/	0110		T	T	release · complete · central · breath
/t ^h /	0112		T'	TH	release · complete · central · released

Sound	Address	Glyph	Strict	Plain	Short form
/ts/	0210		TS	TS	<i>withheld</i>
/ts ^h /	0212		TS'	TSH	<i>withheld</i>
/tʃ/	0220		CH	CH	<i>withheld</i>
/tʃ ^h /	0222		CH'	CHH	<i>withheld</i>
/u/	2	...	OO	OO	closed · withdrawn · full
/v/	1001		V	V	channel · diffuse · outer · voice
/v̥/	1002		V:	VH	channel · diffuse · outer · throughbreath
/w/	2001		W	W	resonance · moving · outer · voice
/w̥/	2101		WR	WR	resonance · flowing · outer · voice
/w̥̥/	2002		W:	WV	resonance · moving · outer · throughvoice
/w̥̥̥/	2000		HW	HW	resonance · moving · outer · breath
/x/	1020		KH	KH	channel · diffuse · inward · breath
/z/	1111		Z	Z	channel · concentrated · central · voice
/z ^w /	1101		ZW	ZW	channel · concentrated · outer · voice
/æ/	01		AE	AE	open · advanced
/ð/	1011		DH	DH	channel · diffuse · central · voice
/ŋ/	2221		NG	NG	resonance · sealed · inward · voice
/ŋ̥/	2220		HNG	HNG	resonance · sealed · inward · breath
/ɑ/	0	—	AA	AA	open · withdrawn · full
/ɑ/	02		O	O	open · withdrawn
/ɔ/	12		AW	AW	half · withdrawn
/ə/	—	—	@	UH	<i>withheld</i>
/ɛ/	11		EH	EH	half · advanced
/g/	0121		G	G	release · complete · inward · voice
/ɣ/	1021		GH	GH	channel · diffuse · inward · voice
/ɣ̥/	1022		GH:	GHH	channel · diffuse · inward · throughbreath
/h/	0022		H:	HH	release · unobstructed · inward · throughbreath

Sound	Address	Glyph	Strict	Plain	Short form
/i/	20	⠠	IH	IH	closed · centered
/ɪ/	21	⠡	I	I	closed · advanced
/ɬ/	1210	⠠⠠	SL	SL	channel · lateral · central · breath
/ɬʷ/	1200	⠠⠠⠠	SLW	SLW	channel · lateral · outer · breath
/ʋ/	2120	⠠⠠⠠	HLR	HLR	resonance · flowing · inward · breath
/ʋ̥/	1221	⠠⠠⠠	ZLR	ZLR	channel · lateral · inward · voice
/ɓ/	1211	⠠⠠	ZL	ZL	channel · lateral · central · voice
/ɓ̥/	1212	⠠⠠	ZL:	ZLH	channel · lateral · central · throughbreath
/m̥v/	0201	⠠⠠⠠	BV	BV	<i>withheld</i>
/ɲ̥/	2222	⠠⠠⠠	NY:	NYH	resonance · sealed · inward · throughvoice
/ɹ/	2121	⠠⠠⠠	R	R	resonance · flowing · inward · voice
/ɹ̥/	2122	⠠⠠⠠	RR:	RRH	resonance · flowing · inward · throughvoice
/ʃ/	1120	⠠⠠	SH	SH	channel · concentrated · inward · breath
/ʃʰ/	1122	⠠⠠	SH'	SHH	channel · concentrated · inward · released
/ʊ/	22	⠠	U	U	closed · withdrawn
/ʌ/	10	⠠	UH	UH	half · centered
/ɜ/	1121	⠠⠠	ZH	ZH	channel · concentrated · inward · voice
/θ/	1010	⠠⠠	TH	TH	channel · diffuse · central · breath

Addresses per WP Alpha v1.2; glosses per DS v0.2.1.