Phonetics

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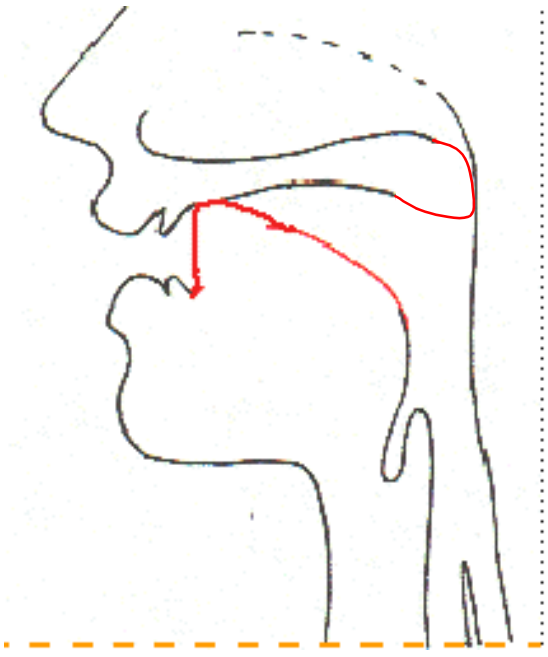
- **place**, **manner**, **voicing**:

	stop	fricative
bilabial	[b], [p]	
labiodental		[v], [f]
interdental		[ð], [θ]
alveolar	[d], [t]	[z], [s]
alveopalatal		[ʒ], [ʃ]
palatal		
velar	[g], [k]	
glottal	[ʔ]	[h]

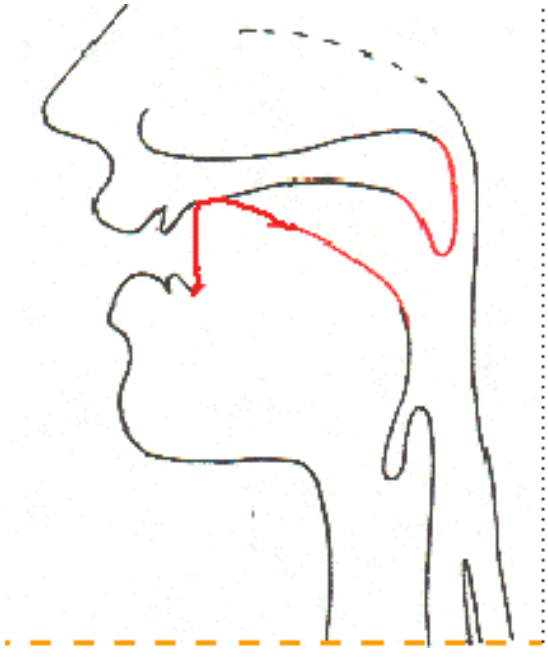
So if [d] is a voiced alveolar stop, and [z] is a voiced alveolar fricative, then what's [n]? it's voiced, and a stop...

...and it's **nasal**.

[t], [d]: airflow stopped (at the alveolar ridge)



[n]: no flow through mouth, but lowered velum allows air to flow through nose



	stop	fricative	nasal (stop)
bilabial	[p], [b]		[m]
labiodental		[f], [v]	
interdental		[θ], [ð]	
alveolar	[t], [d]	[s], [z]	[n]
alveopalatal		[ʃ], [ʒ]	
palatal			
velar	[k], [g]		[ŋ]
glottal	[ʔ]	[h]	

(voiceless, voiced)

This way of classifying the sounds leads us to wonder about gaps:

	stop	fricative	nasal (stop)
bilabial	[p], [b]	[?], [?]	[m], [?]
labiodental		[f], [v]	
interdental		[θ], [ð]	
alveolar	[t], [d]	[s], [z]	[n]
alveopalatal		[ʃ], [ʒ]	
palatal	[?], [?]	[?], [?]	[?]
velar	[k], [g]	[?], [?]	[ŋ]
glottal	[ʔ]	[h]	[?]

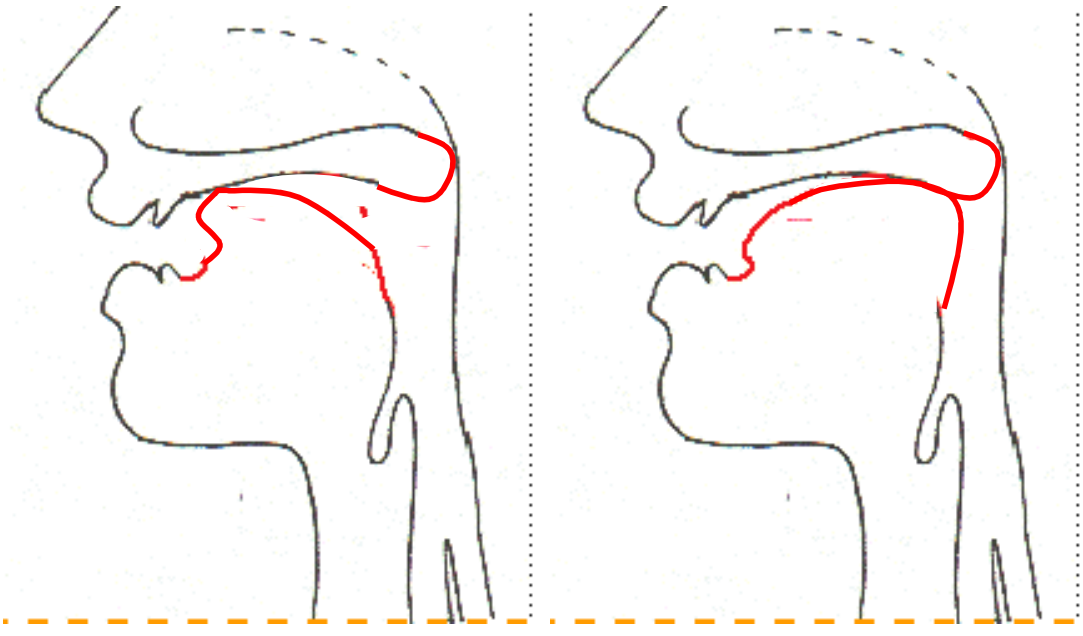
some of the gaps:

	stop	fricative	nasal (stop)
bilabial	[p], [b]	[ɸ], [β]	[m], [m̥]
labiodental		[f], [v]	
(inter)dental	[t̪], [d̪]	[θ], [ð]	[n̪]...
alveolar	[t], [d]	[s], [z]	[n]...
alveopalatal		[ʃ], [ʒ]	
palatal	[c], [ɟ]	[ç], [ʝ]	[ɲ] ([ñ])...
velar	[k], [g]	[x], [ɣ]	[ŋ]...
glottal	[ʔ]	[h]	~~[ʔ̃]~~

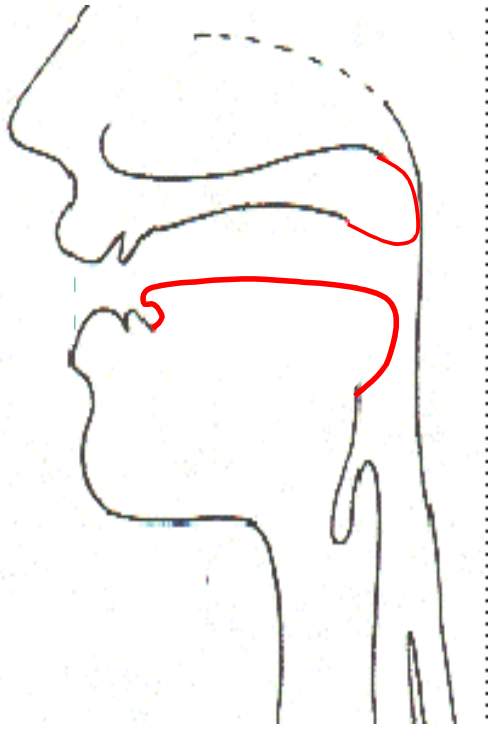
some other gaps:

<u>retroflex</u>: tongue tip on palate: [ʈ] [ɖ] [ʂ] [ʐ] [ɳ]

<u>uvular</u>: tongue body touches near uvula: [q] [ɢ] [χ] [ʁ] [ɴ]



pharyngeal: constriction near pharyngeal wall:
[ħ] [ʕ] (fricatives)



	stop	fricative	nasal (stop)
bilabial	[p], [b]	[ɸ], [β]	[m], [m̥]
labiodental		[f], [v]	
(inter)dental	[t̪], [d̪]	[θ], [ð]	[n̪]...
alveolar	[t], [d]	[s], [z]	[n]...
alveopalatal		[ʃ], [ʒ]	
retroflex	[ʈ], [ɖ]	[ʂ], [ʐ]	[ɳ]...
palatal	[c], [ɟ]	[ç], [ʝ]	[ɲ] ([ñ])...
velar	[k], [g]	[x], [ɣ]	[ŋ]...
uvular	[q], [ɢ]	[χ], [ʁ]	[ɴ]...
pharyngeal		[ħ], [ʕ]	
glottal	[ʔ]	[h]	

some neglected manners of articulation:

Approximants: tongue gestures briefly at another articulatory point, without making contact:

w [w], **y** [j], **l** [l], **r** [ɹ] (sometimes written [r], which we'll use)

These are sometimes divided into **glides**([w], [j])
and **liquids** ([l], [r])

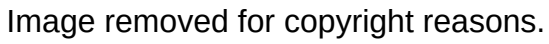
Affricates: like a stop immediately followed by a fricative

ch [tʃ], **j** [dʒ]

	stop	fricative	nasal (stop)	approx.	affr.
bilabial	[p], [b]	[ɸ], [β]	[m], [m̥]	[w]	
labiodental		[f], [v]		[ʋ]	
(inter)dental	[t̪], [d̪]	[θ], [ð]	[n̪]...		
alveolar	[t], [d]	[s], [z]	[n]...	[l]	
alveopalatal		[ʃ], [ʒ]			[tʃ], [dʒ]
retroflex	[ʈ], [ɖ]	[ʂ], [ʐ]	[ɳ]...	[r]	
palatal	[c], [ɟ]	[ç], [ʝ]	[ɲ] ([ñ])...	[j]	
velar	[k], [g]	[x], [ɣ]	[ŋ]...	[ɯ̽]	
uvular	[q], [ɢ]	[χ], [ʁ]	[ɴ]...		
pharyngeal		[ħ], [ʕ]			
glottal	[ʔ]	[h]			

...not that this exhausts the range of possible speech sounds (linguo-labial stops! voiceless liquids!), but it'll do for now...

interlude: what happens to you when you have a cold?



Let's learn some IPA symbols for vowels,
and practice reading IPA:

[ɑ] f**a**ther
[æ] l**a**d
[ɛ] b**e**d
[i] mach**i**ne
[u] n**oo**n
[ə] m**a**chine

Let's learn some IPA symbols for vowels,
and practice reading IPA:

[ɑ] f**a**ther
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ʃi sɛlz si ʃɛlz

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[ə] m**a**chine

ʃi sɛlz si ʃɛlz
su sɛz hiz ə bæd ɛg
ə mæn, ə plæn, ə kənæl, pænəmɑ

Time to go through the vowels systematically.

compare: [i] b**ea**d
[æ] b**a**d

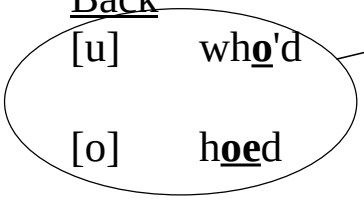
in fact:	[i]	h**ea**t	High
	[e]	h**a**te	Mid
	[æ]	h**a**t	Low

Now compare:

[i] h**e** [u] wh**o**

	Front		Back	
High	[i]	h**e**'d	[u]	wh**o**'d
Mid	[e]	h**a**te	[o]	h**oe**d
Low	[æ]	h**a**d	[ɑ]	h**o**t

	Front		Back		
High	[i]	h**e**'d	[u]	wh**o**'d	**rounded**
Mid	[e]	h**a**te	[o]	h**oe**d	
Low	[æ]	h**a**d	[ɑ]	h**o**t	



What's the difference between...

[u] (wh**o**'d) and [ʊ] (h**oo**d)?
[i] (h**e**'d) and [ɪ] (h**i**d)?
[e] (r**ai**d) and [ɛ] (r**e**d)?
[o] (c**oa**t) and [ɔ] (c**au**ght)?

tense vs. **lax**; no English monosyllables end in lax vowels
[fli], [flu], [fle], *[flɪ], *[flʊ], *[flɛ]

	Front		Back		
High	[i]	he'd,	[u]	who'd,	**rounded**
	[ɪ]	hid	[ʊ]	hood	
Mid	[e]	hate,	[o]	hoed,	
	[ɛ]	head	[ɔ]	hawed	
Low	[æ]	had	[ɑ]	hot	

tense, **lax**

Not all English dialects have all of these vowels.
How do you say **caught** and **cot**?

And not all English dialects have these in the same distribution.
Mary, **merry**, **marry**

one more pair of vowels:

	Front		Central	Back	**rounded**
High	[i]	h**e**'d,		[u]	wh**o**'d,
	[ɪ]	h**i**d		[ʊ]	h**oo**d
Mid	[e]	h**a**te,	[ə] m**a**chine	[o]	h**oe**d,
	[ɛ]	h**ea**d	[ʌ] d**o**ve	[ɔ]	h**aw**ed
Low	[æ]	h**a**d		[ɑ]	h**o**t

tense, **lax**

Not all speakers distinguish between [ə] and [ʌ].

"above"= əbʌv

English has (about) 14 vowels, and 5 letters to spell them with...

	Front		Central	Back	**rounded**
High	[i]	h**e**'d,		[u]	wh**o**'d,
	[ɪ]	h**i**d		[ʊ]	h**oo**d
Mid	[e]	h**a**te,	[ə] m**a**chine	[o]	h**oe**d,
	[ɛ]	h**ea**d	[ʌ] d**o**ve	[ɔ]	h**aw**ed
Low	[æ]	h**a**d		[ɑ]	h**o**t

plus diphthongs:

[aj] m**i**ce [aw] m**ou**se [ɔj] j**oy**

(and several English tense vowels are sort of diphthongal:
[e]=[ej], [o]=[ow])

Again, this categorization has (at least) two benefits:

- leads us to look for gaps
- helps with theories of sound change

	Front		Central	Back	**rounded**
High	[i]	h**e**'d,		[u]	wh**o**'d,
	[ɪ]	h**i**d		[ʊ]	h**oo**d
Mid	[e]	h**a**te,	[ə] m**a**chine	[o]	h**oe**d,
	[ɛ]	h**ea**d	[ʌ] d**o**ve	[ɔ]	h**aw**ed
Low	[æ]	h**a**d		[ɑ]	h**o**t

In English, all and only nonlow back vowels are rounded.

But is that necessary?

	Front		Central	Back	**rounded**
High	[i]	h**e**'d,		[u]	wh**o**'d,
	[ɪ]	h**i**d		[ʊ]	h**oo**d
Mid	[e]	h**a**te,	[ə] m**a**chine	[o]	h**oe**d,
	[ɛ]	h**ea**d	[ʌ] d**o**ve	[ɔ]	h**aw**ed
Low	[æ]	h**a**d		[ɑ]	h**o**t

[y], German Gef**üh**l 'feeling'
(high front rounded vowel)

[ɯ], Korean [k**ɯ**nɛ] 'swing'
(high back unrounded vowel)

	Front		Central		Back		**rounded**
High	[i]	h**e**'d,			[u]	wh**o**'d,	
	[ɪ]	h**i**d			[ʊ]	h**oo**d	
Mid	[e]	h**a**te,	[ə]	m**a**chine	[o]	h**oe**d,	
	[ɛ]	h**ea**d	[ʌ]	d**o**ve	[ɔ]	h**aw**ed	
Low	[æ]	h**a**d			[ɑ]	h**o**t	

[y], German Gef**üh**l 'feeling'
(high front rounded vowel)

[ɯ], Korean [k**ɯ**nɛ] 'swing'
(high back unrounded vowel)

[ɛ̃], French [m**ɛ̃**] 'hand' (vs. [m**ɛ**] 'dish')
(front mid lax **nasalized** vowel)

Classification of vowels also helps us in developing theories of phonologically natural sound changes.

Turkish noun plurals:

aslan 'lion'	aslanlar 'lions'
kol 'arm'	kollar 'arms'
kul 'slave'	kullar 'slaves'
kɯz 'daughter'	kɯzlar 'daughters'
yel 'wind'	yeller 'winds'
diʃ 'tooth'	diʃler 'teeth'
gyl 'rose'	gyller 'roses'

this has all been about production...how about perception?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Because a stop causes the acoustic signal, to...well...stop...
...the information about place of articulation, etc. comes from the stop's effects on the nearby vowels:

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other sources of information? **McGurk effect**

...and how much information do we need, really?
Sine Wave Synthesis

let's think more carefully about voicing....

Voice Onset Time: vocal cords start vibrating some time after the stop closure is released....

VOT 0-25 ms-->voiced
VOT 25 ms +-->voiceless

categorical perception: we have an arbitrary dividing line in the continuum of VOT

...categorical perception detected in 1-month-old infants.

chinchillas also have categorical perception...
(Kuhl and Miller 1975)

English VOT actually varies with position...

(Ladefoged sound files)

...so in a sense, English has three bilabial oral stops: b, p, and p^h.

So does Hindi?

pal	'take care of'
p^hal	'knife blade'
bal	'hair'

...so in a sense, English has three bilabial oral stops: b, p, and p^h.

So does Hindi?

pal	'take care of'
p^hal	'knife blade'
bal	'hair'

....seems like we're missing something...

allophones

....English "p" and "p^h" are in **complementary distribution**: there's no environment where you can get either one (unlike Hindi: *pal* 'take care of', *p^hal* 'knife blade').

remember **allomorphs**?

morpheme	**allomorphs**		
"electric" →	electri[k] + "-al"	=	"electrical"
	electri[s] + "-ity"	=	"electricity"

in English, [p] and [p^h] are **allophones** of /p/.

phoneme	**allophones**
/p/ →	[p] between [s] and a vowel
	[p^h] elsewhere

phoneme

/p/ ⟶ [p] / s __ V

becomes

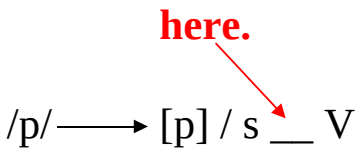
/p/ ⟶ [p] / s __ V

allophone

/p/ ⟶ [p] / s __ V

when it is...

/p/ ⟶ [p] / s __ V



more generally:

A ⟶ B / C __ D

(and C and/or D can be absent...)

English

/p/ → [p] between [s] and a vowel
/p/ → [p^h] elsewhere

Hindi

/p/ → [p]
/p^h/ → [p^h]

How do you know whether two sounds are allophones or distinct phonemes?

- look for **minimal pairs** (like Hindi *pal* and *p^hal*)
- if you can't find any, see if you can find a rule determining when you find which version of the sound.