Introduction to Linguistics
LIN101
Lecture 7: Phonemic analysis I

Fall 2024, University of Toronto, St. George

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Announcements

- HW3 is getting posted today.
- The deadline is automatically extended: instead of next week's Tuesday at midnight, you have time until next week's Friday at midnight.
- Elicitation sessions: please do not submit it multiple applications.
- This lecture:
- HW2
- Quiz I
- Phonemes and allophones

Phonemes and allophones

Phonemes and allophones

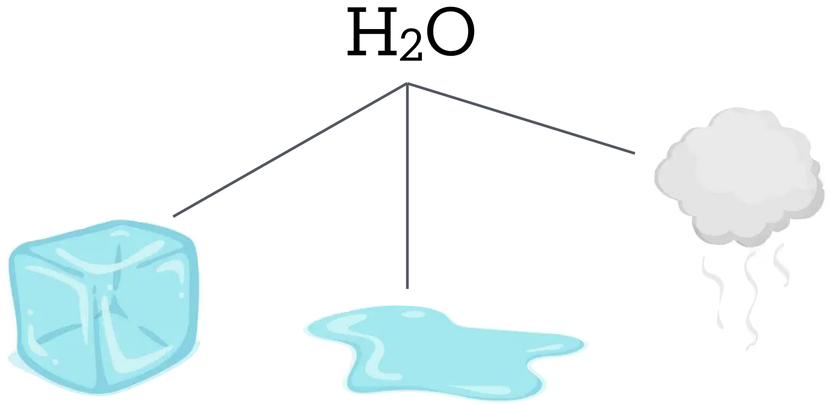
- We have talked about individual sounds and have freely concatenated them, assuming that the invidual sounds are consistently pronounced the same
- But the way we pronounce those sounds is affected by what sounds we pronounce before and after it
- Consider the sound(s) represented by the letter <t> in English orthography in the following words:

atom	['ærəm]
atomic	[ə'tʰomɪk]

- Are [ɾ] and [t] the same sound? They are in the same word…
- Then why this difference?

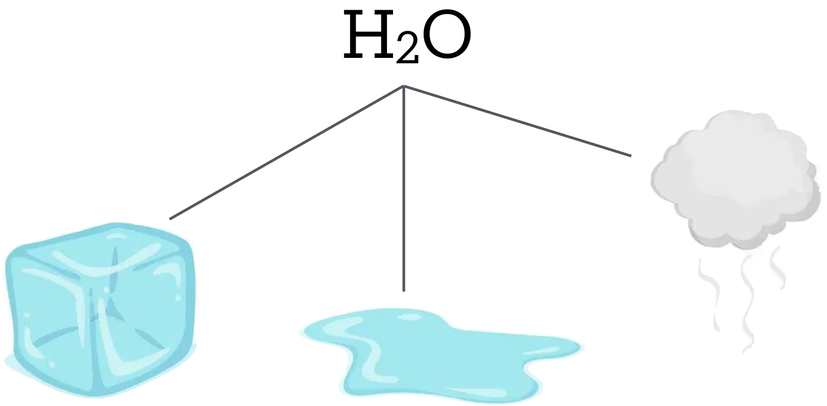
Phonemes and allophones

- Since the sounds [ɾ] and [t^h] are from the same word, it's convenient to treat them as the same object.
- But what is this object? They can't be the variants of the same sound, because they are different sounds!
- This object is called a **phoneme**
- The sounds [ɾ] and [t^h] are **allophones** = various physical realizations of a phoneme
- We can say that {[ɾ], [t^h]} is a phoneme that can appear in different forms in different



Phonemes and allophones

- 'Environments'
  - preceding and/or following phonemes
  - stress
- Notational convention: slashes for phonemes and angled brackets for allophones



/phoneme/

[allophone] [allophone]

/t/

[ɾ] [t^h]

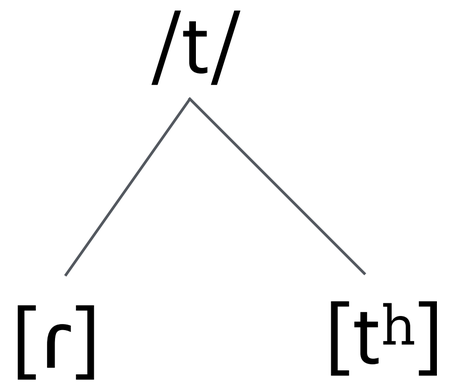
Phonemes and allophones

- What exactly are the environments of each allophone?
- ['æɾəm] = surrounded by vowels
- [ə'tʰomɪk] = surrounded by vowels
- In ['æɾəm], /t/ appears in the onset of an unstressed syllable
- In [ə'tʰomɪk], /t/ appears in the onset of a stressed syllable
- Let's test our hypothesis.

metal	['mɛɾəl]
metallic	[mə'tʰælɪk]

Phonemes are abstract theoretical constructs

We do not have immediate access to phonemes

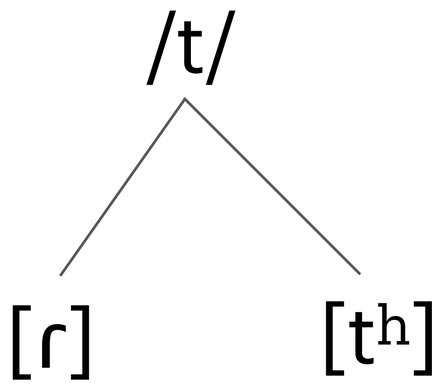


Phones are concrete reality

We have direct access to phones: they can be measured

Phonemes and allophones

- Which sounds are the allophones of the same phoneme and which sounds belong to different phonemes?
- Is ice and vapor the same substance?
- Is ice and metal the same substance?
- Similarity alone is not enough of a criterion.
- We can only base our evidence on
- 1) what environments do the given phones occur in: distribution
- 2) what phonetic properties the given phones have: natural class



Distribution and natural classes

Distribution and natural classes

Natural classes

- Each language has their own phonotactic constraints
- English allows complex onsets
- Other languages do not
- But just because English allows CCCVC syllables, it does not mean that those Cs can be replaced by just about any consonant!
- Phonotactics includes constraints on which Cs can appear in which position in complex margins

aɪskrim
VVC.CCVC

aɪsɨkɨrim
V.V.CV.CV.CVC

aɪsʉkʉrimʉ
V.V.CV.CV.CV.CV

CCVC
k r i m ✔
r k i m ✘

Distribution and natural classes

Natural classes

- In English, up to three consonants are allowed in an onset
- *squeeze* [skwiz], *spray* [spre]
- The first one must be [s]
- The second must be [p] or [t] or [k] voiceless plosives
  The third one must be [r], [l], [j], or [w] approximants

CCVC

k r i m ✔

r k i m ✘

- These groups of consonants form **natural classes**
- These sounds share some phonetic properties and some phonological behavior
- Which groups form a natural class is language-specific

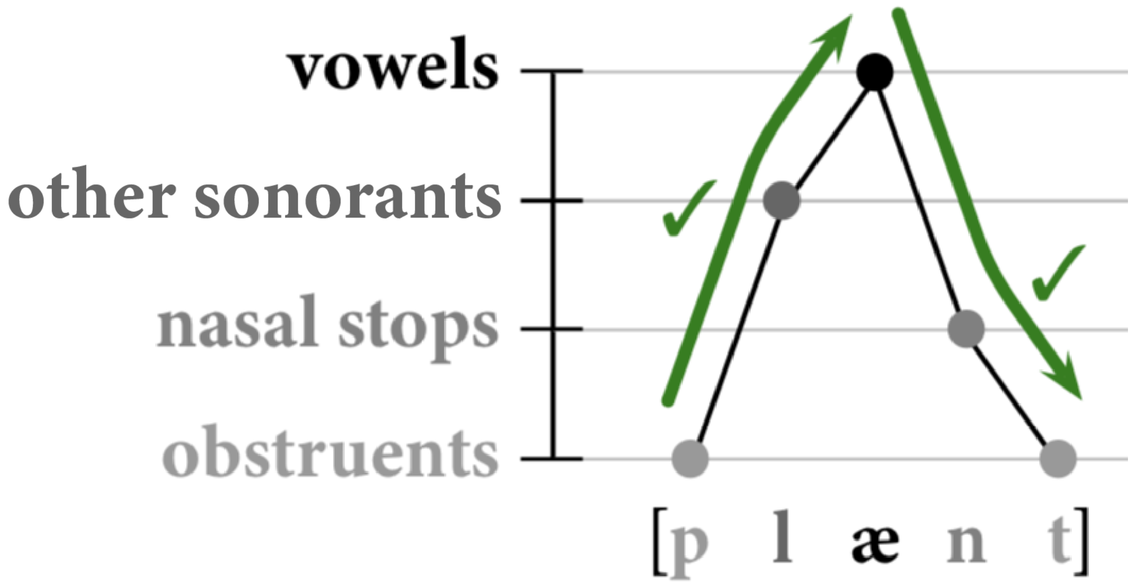
$$s + \begin{Bmatrix} p \\ t \\ k \end{Bmatrix} + \begin{Bmatrix} r \\ l \\ j \\ w \end{Bmatrix}$$

Distribution and natural classes

Phonotactics

- Phonotactic constraints are language-specific, too, but that does not mean they consist of completely arbitrary rules
- Phonotactic constraints of various languages follow certain general universal tendencies and principles:

- the universal tendency to prefer onsets to codas
- obeying the Sonority Sequencing Principle



Distribution and natural classes

Phonotactics

- Even signed languages are subject to phonotactic constraints
- **Symmetry Condition** : in ASL signs where both hands move,
- both hands must have the same handshape
- both hands must move in the same way (not completely different movements
- ASL examples: PRICE, MUCH, HOUSE, MEET
- When hands do different things, only the dominant hand moves, the non-dominant one serves as location
- ASL examples: SLOW, START, WEEK, NICE

Distribution and natural classes

Distribution

- The overall pattern of environments where a given physical unit can occur
- How can we describe the distribution of a sound?
- "Sound X can occur after sounds Y, Z, W ..." > a first step in the analysis but not too elegant itself
- Instead of listing concrete environments, we can make reference to natural classes
- "before nasal stops" or "after high vowels", etc.

Distribution and natural classes

Distribution

- **Minimal pairs** were discussed in the lecture on signs: pairs of signs that differ in a single parameter
- Example: SORRY vs. PLEASE differ in handshape alone
- open-A for SORRY, open-B for PLEASE
- In spoken language phonology, minimal pairs are called those pairs of words that differ in a single sound
- *kit* vs. *pit*
- Sometimes it is not easy to find minimal pairs. In this case, we can use **near-minimal pairs** which differ in more than one sound
- [prɛʃ̩] vs. [plɛʒ̩]

Phonemic analysis

Phonemic analysis

- It is not always easy to tell what phoneme a certain allophone represents.
- In the case of /t/, we mentioned [tʰ] and [ɾ].
- However, /d/ also has [ɾ] as its allophone.
- *writer* and *rider* can both be pronounced as [ɹaɪɾɻ]
- To determine which sounds represent which phoneme, we perform **phonemic analysis**
- whereby we can also determine what other potential allophones are and what exact environments those allophones occur in

Phonemic analysis

Georgian laterals

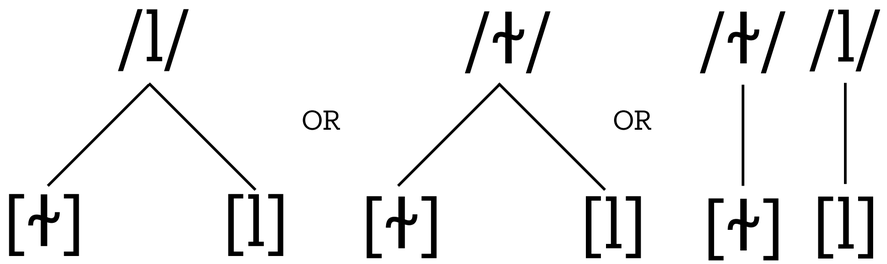
- [x]: a voiceless velar fricative
- [ɬ]: a velarized alveolar lateral approximant
- The phones of interest are [l] and [ɬ]
- [l] 'clear l' as in *leaf*
- [ɬ] 'dark l' as in *feel*

[vxle͡tʃh]	‘I split’	[saxɬʃi]	‘at home’
[t͡ʃet͡ʃxli]	‘fire’	[kaɬa]	‘tin’
[zarali]	‘loss’	[pepeɬa]	‘butterfly’
[t͡ʃoli]	‘wife’	[kbiɬs]	‘tooth’
[xeli]	‘hand’	[ɬxena]	‘joy’
[kleba]	‘reduce’	[erthxeɬ]	‘once’
[leɬo]	‘goal’	[xoɬo]	‘however’
[ɬamazad]	‘prettily’		

Phonemic analysis

Step 1: Identify and organize the phones of interest

- With only two phones to compare, organization is not needed
- The question we ask is: are [l] and [ɬ] allophones of the same phoneme? Options:



[vxletʃ͡h]	‘I split’	[saxɬʃi]	‘at home’
[tʃ͡etʃ͡xli]	‘fire’	[kaɬa]	‘tin’
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[ɬamazad]	‘prettily’		

Phonemic analysis

Step 2: Identify the individual environments of the phones of interest

- List each environment where the phones of interest occur
- preceding sound + target sound + following sound
- target sound: __
- word boundary: #
- Example:
  [l] in [vxleʧh] 'I split': x__e

[vxleʧh]	‘I split’	[saxɬʃi]	‘at home’
[ʧeʧxli]	‘fire’	[kaɬa]	‘tin’
[zarali]	‘loss’	[pepeɬa]	‘butterfly’
[ʧoli]	‘wife’	[kbiɬs]	‘tooth’
[xeli]	‘hand’	[ɬxena]	‘joy’
[kleba]	‘reduce’	[erthxeɬ]	‘once’
[leɬo]	‘goal’	[xoɬo]	‘however’
[ɬamazad]	‘prettily’		

Phonemic analysis

Step 2: Identify the individual environments of the phones of interest

[l]	[ɬ]
x_e	e_o
x_i	#_a
a_i	x_ʃ
o_i	a_a
e_i	e_a
k_e	i_s
#_e	#_x
	e_#
	o_o

[vxlet͡ʃh]	‘I split’	[saxɬʃi]	‘at home’
[t͡ʃet͡ʃxli]	‘fire’	[kaɬa]	‘tin’
[zarali]	‘loss’	[pepeɬa]	‘butterfly’
[t͡ʃoli]	‘wife’	[kbiɬs]	‘tooth’
[xeli]	‘hand’	[ɬxena]	‘joy’
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[leɬo]	‘goal’	[xoɬo]	‘however’
[ɬamazad]	‘prettily’		

Phonemic analysis

Step 3: Determine overlap in environments

[l]	[ɬ]
	e_o
x_e	
	#_a
x_i	
	x_ʃ
a_i	
	a_a
o_i	
	e_a
e_i	
	i_s
	#_x
k_e	
	e_#
#_e	
	o_o

- A key observation to make at this point is whether the distributions of the two phones are in overlap or not.
- If they are in overlap: the two sounds are in a so-called **contrastive distribution**
- If there is no overlap: the two sounds are in a **complementary distribution**
- If the two sounds are in a contrastive distribution, they are **contrastive** in the given language: they cannot be replaced by each other without changing the meaning of the word
- If the two sounds are allophones of the same phoneme, they appear in a complementary distribution and are not contrastive: replacing one by the other in a word will not change its meaning

Phonemic analysis

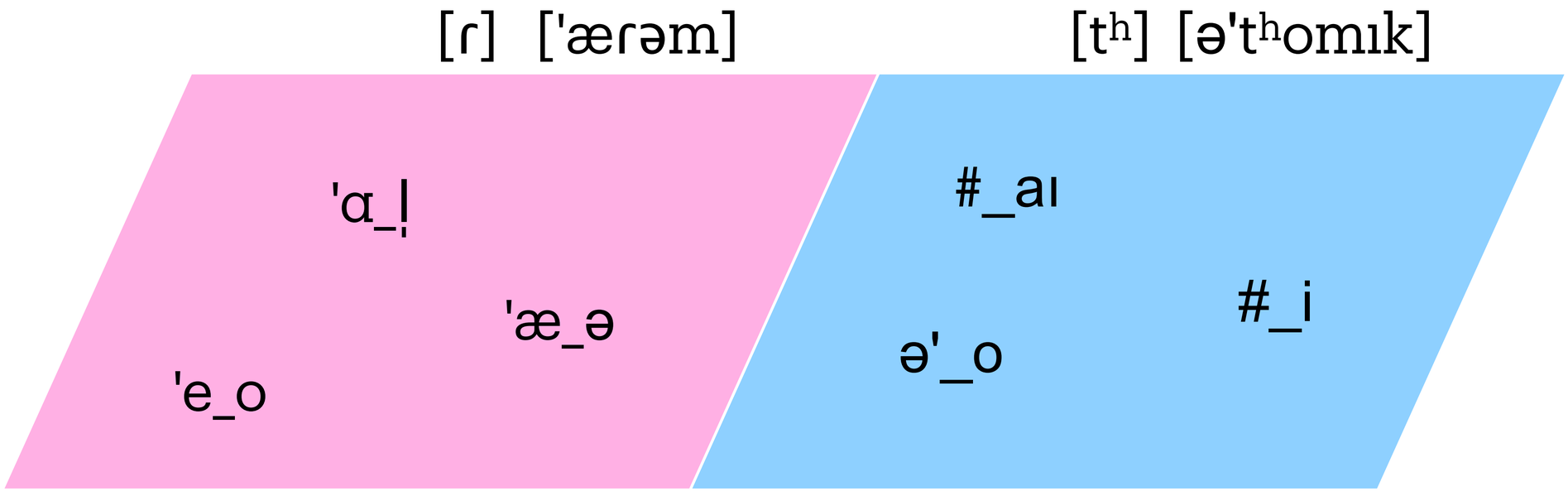
Step 3: Determine overlap in environments

below 0 celsius	between 0 and 100 celsius	above 100 celsius
-1	1	101
-2	2	102
-3	3	103
	99	

- The three sets of degrees are mutually exclusive: each value appears in exactly one cell of the partition
- Together they exhaust all possibilities
- All three cells represent the same substance, H_2O, in different forms due to different environments

Phonemic analysis

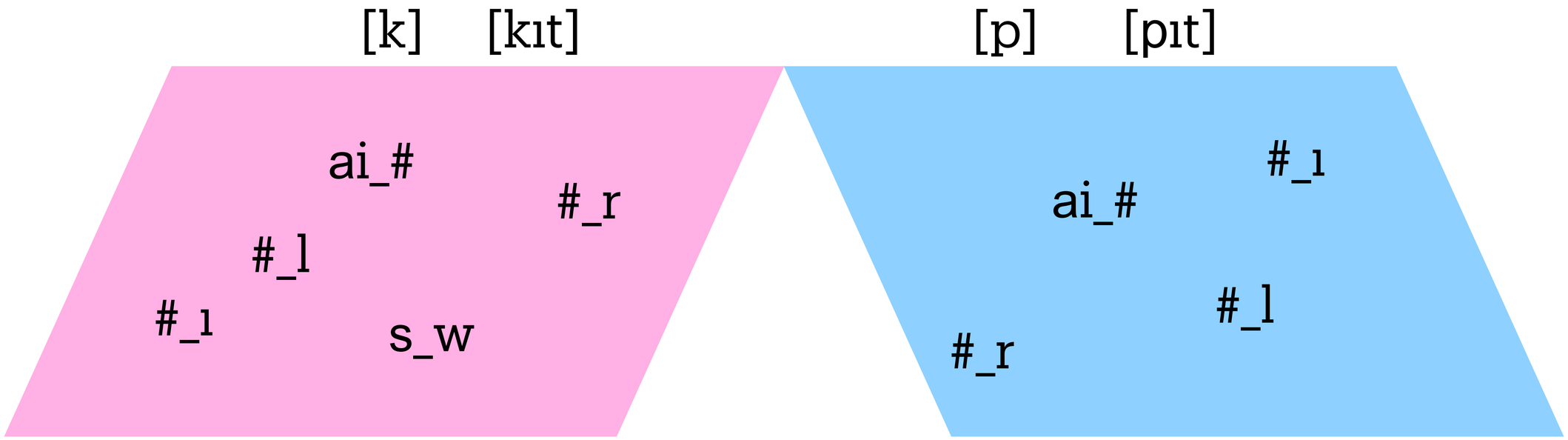
Step 3: Determine overlap in environments



- Each environment belongs to exactly one of the allophones
- The environments together cover all possibilities in a given language where the phoneme /t/ could appear in
- Each allophone represents the same phoneme /t/, just in somewhat different form, due to the environment they occur in
- If the allophone [ɾ] got replaced by [tʰ] in any of the words, its meaning would not change

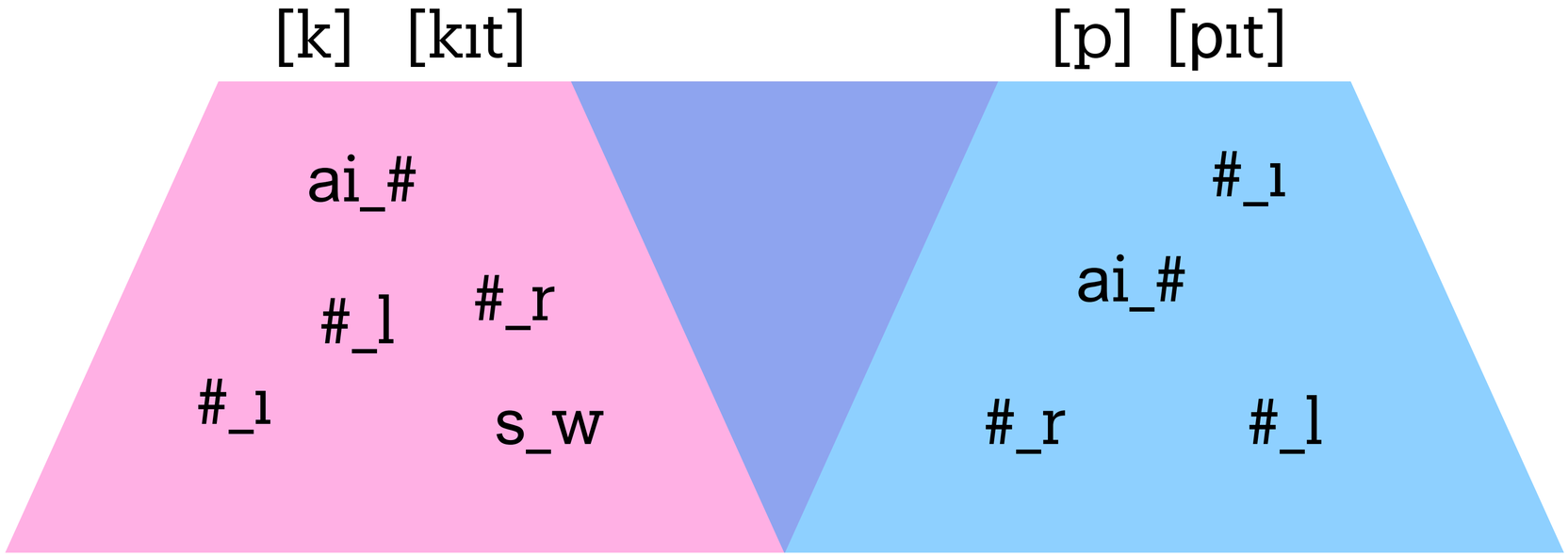
Phonemic analysis

Step 3: Determine overlap in environments



Phonemic analysis

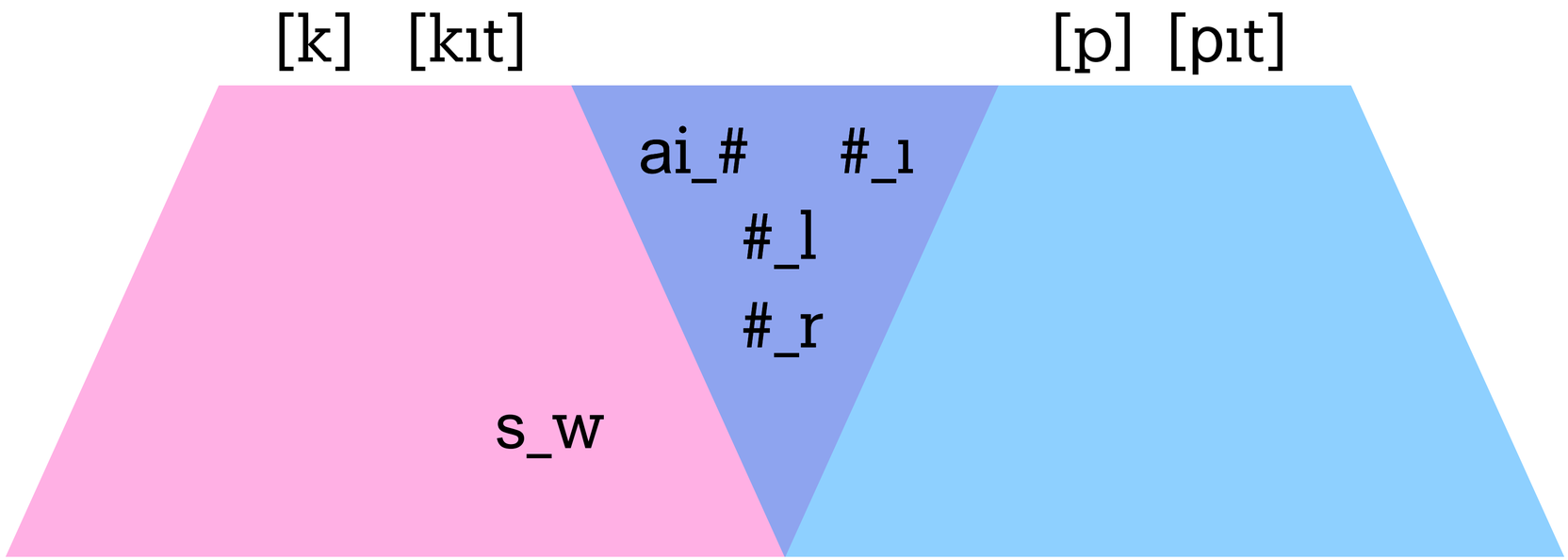
Step 3: Determine overlap in environments



- There is an overlap because both sounds can occur in ai_#, #_r, #_l and #_ɹ
- The list of environments is not comprehensive, but it's enough to make our point

Phonemic analysis

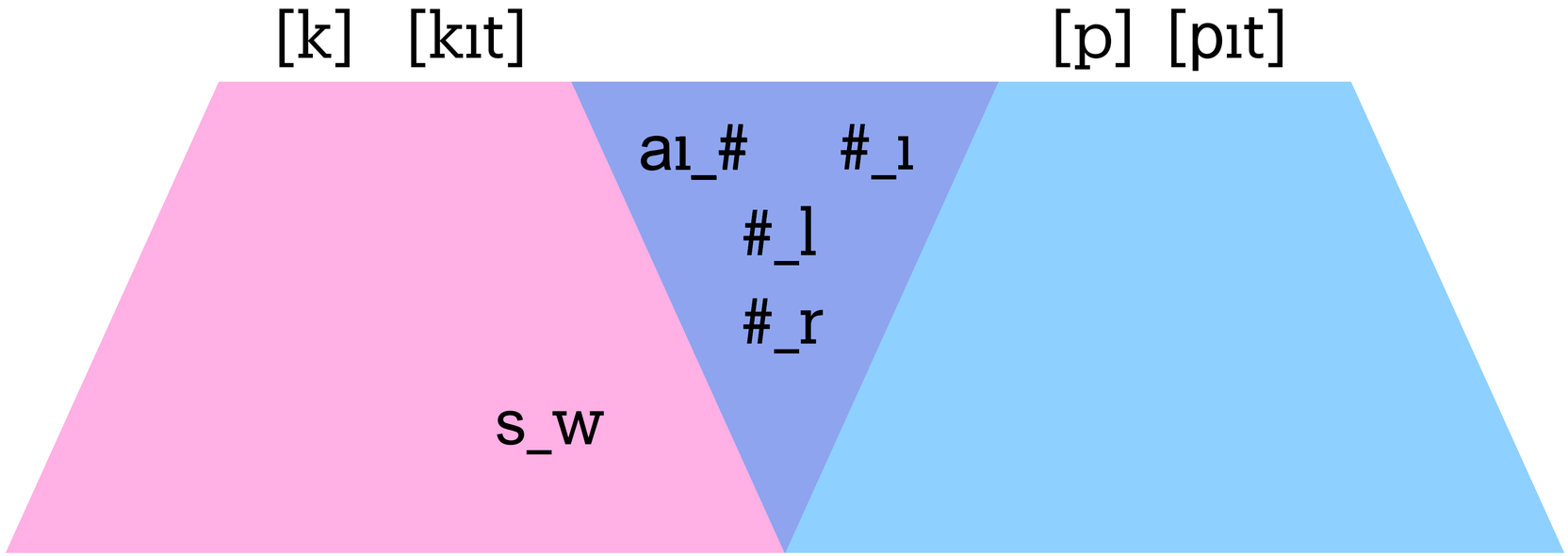
Step 3: Determine overlap in environments



- The shared environments are now represented in the intersection of the two sets of environments
- s_w as in [skwiz] is not shared by [k] and [p], but that does not matter, the two sounds are still contrastive. If we replaced [k] by [p] in this word, it would become an nonce word [spwiz]

Phonemic analysis

Step 3: Determine overlap in environments



- Does each environment belongs to exactly one of the allophones?
- If there is at least one shared environment, the two sounds will likely be contrastive
- Look at the meaning of minimal pairs that differ only in the target sounds: Does their meaning differ? kɪt vs pɪt; haɪk vs haɪp; klin vs. pliz; krez vs. prez; etc.

Phonemic analysis

Step 3: Determine overlap in environments

[l]	[ɬ]
	e_o
x_e	#_a
x_i	x_ʃ
a_i	a_a
o_i	e_a
e_i	i_s
	#_x
k_e	e_#
#_e	o_o

- Let's look for the most obvious overlap:
- Does the same environment occur in both columns?
- Can we find x_e, or x_i, or ɑ_i, etc. in both columns?
- If yes: two sounds are likely contrastive
- If no: we need to proceed with the analysis
- No obvious overlap

Phonemic analysis

Step 4: Simplify the environments

	[l]
x	x_e
	x_i
a o e	a_i
	o_i
	e_i
k	k_e
#	#_e

	[ɬ]
e a i o	e_o
	#_a
x	x_ʃ
	a_a
	e_a
	i_s
#	#_x
	e_#
	o_o

- Step 4a:
- Let's look at the left side of both sounds
- The left side of both sounds is quite heterogeneous, no natural class can be identified
- There is overlap in terms of what can appear on the left, but that alone does not entail contrastiveness

Phonemic analysis

Step 4: Simplify the environments

[l]		[ɬ]	
x_e		e_o	o
x_i		#_a	a
a_i	e	x_ʃ	ʃ
o_i		a_a	
e_i	i	e_a	
k_e		i_s	s
#_e		#_x	x
		e_#	#
		o_o	

- Step 4b:
- Let's look at the right side of both sounds
- As for [ɬ], there is not a natural class
- But [l] seems to appear only before [e] and [i], which are front vowels
- Front vowels are not present in the right side of the environments of [ɬ]
- There is no overlap between the sounds that can occur to the right of [l] and [ɬ]
- Complementary distribution!

Phonemic analysis

Step 4: Simplify the environments

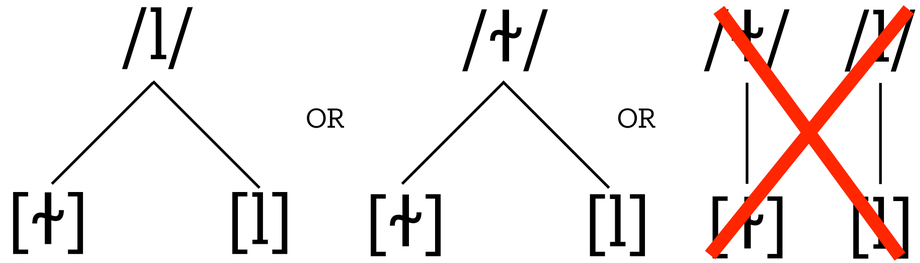
[l]		[ɬ]	
x_e		e_o	o
x_i		#_a	a
a_i	e	x_ʃ	ʃ
o_i		a_a	
e_i	i	e_a	
k_e		i_s	s
#_e		#_x	x
		e_#	#
		o_o	

- The distributions are not unrelated from how these sounds are produced
- There is a contrast between [l] and [ɬ]: the latter is velarized, i.e. the back of the tongue participates in its production
- Relatedly, [ɬ] is followed by central or back vowels, and [l], by front vowels

Phonemic analysis

Step 5: Organize phones into phonemes

- Which of these representations matches our findings?

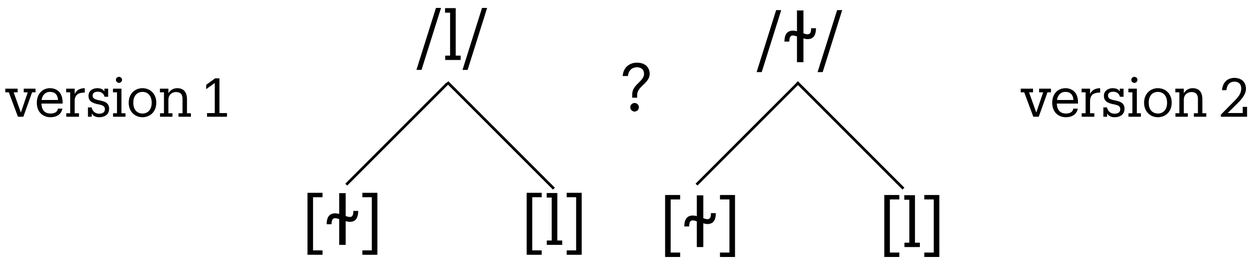


- The two sounds are in complementary distribution
- In addition, [l] and [ɬ] are phonetically similar, so the complementary distribution is likely not an accident
- We can conclude that they are allophones of the same phoneme
- But which one should be the underlying representation, /l/ or /ɬ/?

Phonemic analysis

Step 6: Identify the default allophone and finalize the analysis

- Which of these representations matches our findings?



The underlying representation should be found in more general environments

- **Version 1**: /l/ has two allophones
- [ɬ] which occurs before central and back vowels, consonants and the end of the word, and [l], which appears elsewhere.
- **Version 2**: /ɬ/ has two allophones
- [l] which occurs before front vowels, and [ɬ] which appears elsewhere.

Phonemic analysis

Step 6: Identify the default allophone and finalize the analysis

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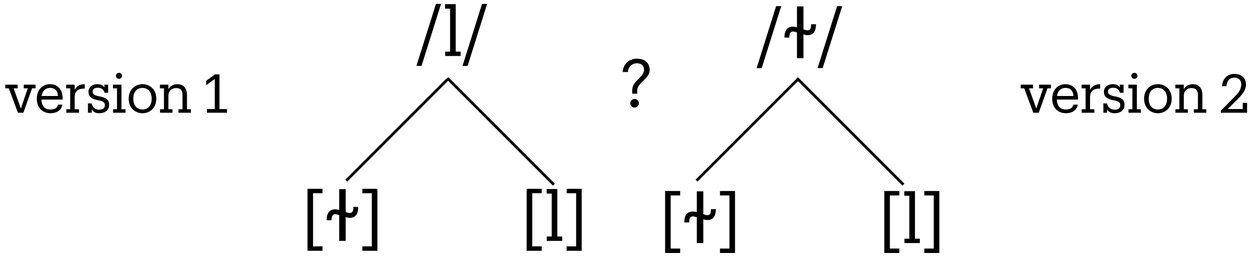


- **Version 1**: /l/ has two allophones
- [ɬ] which occurs before central and back vowels, consonants and the end of the word, and [l], which appears elsewhere.
- **Version 2**: /ɬ/ has two allophones
- [l] which occurs before front vowels, and [ɬ] which appears elsewhere.

😫

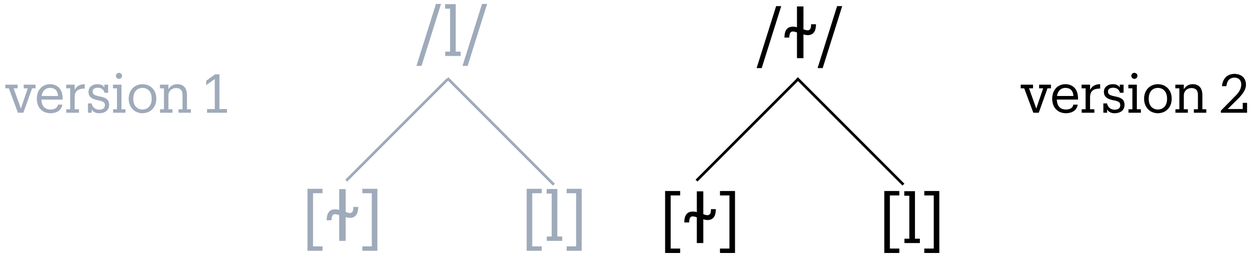
😊

Which of these descriptions is **simpler**?

Phonemic analysis

Step 6: Identify the default allophone and finalize the analysis

- Which of these representations matches our findings?



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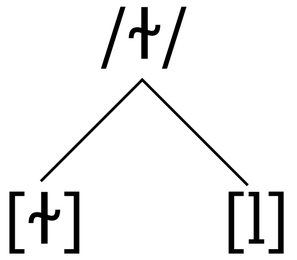
Phonemic analysis

Step 6: Identify the default allophone and finalize the analysis

- /ɬ/ has two allophones
- [l] which occurs before front vowels, and
  [ɬ] which appears elsewhere.



- Compare with the H_2O example:
- H_2O is solid below 0 degrees
- H_2O vaporizes above 100 degrees
- It is liquid otherwise (and is referred to as 'water' otherwise)
- 'Water' is also the neutral term for H_2O, not 'ice' or 'vapor'

Phonemic analysis

- Practice in the book with voiced and voiceless sonorants in French
- In the dataset of chapter 4.6, there are three pairs of phones: [m]-[m̥], [l]-[l̥], and [ʀ]-[ʀ̥]
- Do steps 1–6 for each of these pairs to determine their status in French (allophones of the same vs. different phonemes)
- Check your answers in the book.

[ʀym]	‘cold/flu’	[il]	‘island’
[mɛʀ]	‘mother’	[tabl]	‘table’
[tɛʀm]	‘term’	[kasabl]	‘breakable’
[film]	‘film’	[ɛl]	‘she’
[limite]	‘limited’	[klemã]	‘merciful’
[liʀ]	‘to read’	[simetʀikmã]	‘symmetrically’
[lɛvʀ]	‘lip’	[ɛtʀ̥]	‘to be’
[plɛziʀ]	‘pleasure’	[ʃifʀ̥]	‘number/figure’
[tʀivjal]	‘trivial’	[mɛtʀ̥]	‘to put’
[ʀali]	‘race-meeting’	[mɛkɔnɛtʀ̥]	‘to fail to recognize’
[ʀymatismal]	‘rheumatic’	[pœpl̥]	‘people’
[ʀɔ̃fle]	‘to snore’	[ɔ̃kl̥]	‘uncle’
[ekʀiʀ]	‘to write’	[tãpl̥]	‘temple’
[tɔʀdʀ]	‘to wring’	[ʀitm̥]	‘rhythm’
[pɛʀs]	‘Persian’	[ʀymatism̥]	‘rheumatism’

End of lecture 7

References

- Sanders, Nathan (2022). Introduction to Linguistics: Sounds. Lecture 7 slides.