Phonemes and allophones

LING 20: Introduction to Linguistic Analysis

UCLA · Winter 2022

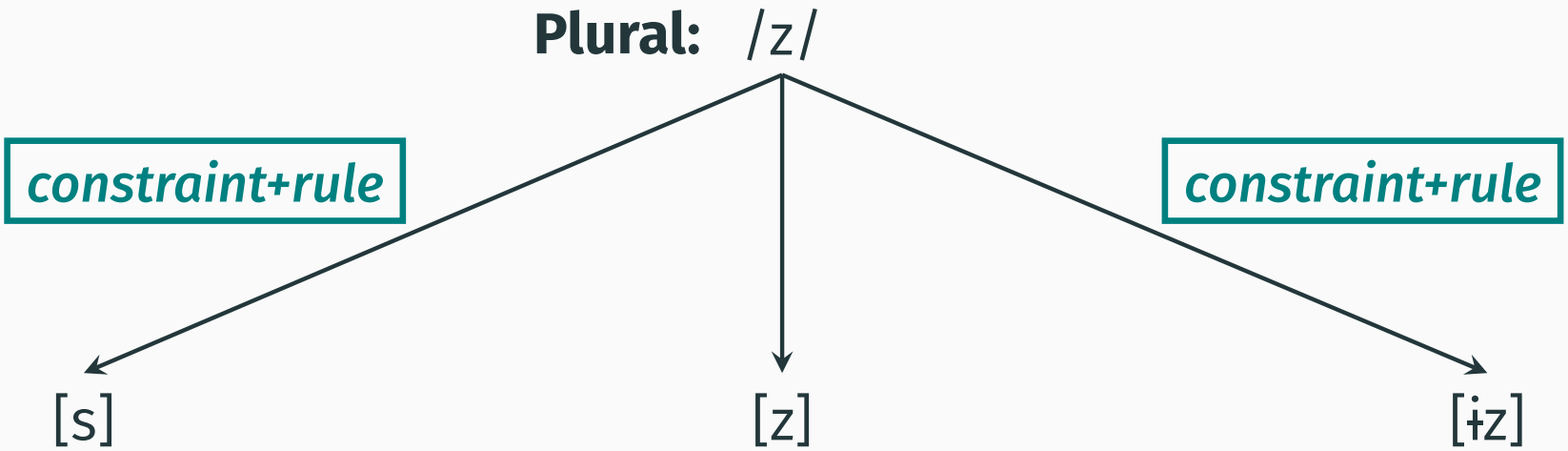
Recap: The English plural

Key observation:
The form of the plural in English varies, but is predictable.

Our analysis:

- **One underlying form**
- This form sometimes gives rise to violations of a **phonotactic constraint**.
- A **rule** is applied to change the sound so that the constraint is no longer violated.

Recap: The English plural



The big picture

- **New observation:**
  Sometimes the distribution of certain **sounds** within a language is entirely predictable:
  - Given two sounds A and B, we can predict at any given point whether it is A or B that will appear.

→ The two sounds are in **complementary distribution** throughout the entire language.

The big picture

We will capture this observation in the same way that we did for the English plural:

- One of the sounds is **underlying** (say, A).
- In some environments, this sounds violates a **phonotactic constraint**.
- A **rule** applies that changes A to B in these environments.

English aspiration

[tɑp]	‘top’	[kɑp]	‘cop’	[pɑp]	‘pop’
[stul]	‘stool’	[skul]	‘school’	[spul]	‘spool’
[it]	‘eat’	[ik]	‘eke’	[ip]	‘eep’

English aspiration

[tʰɑp]	‘top’	[kʰɑp]	‘cop’	[pʰɑp]	‘pop’
[stul]	‘stool’	[skul]	‘school’	[spul]	‘spool’
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English aspiration

[**t**ʰɑp]	‘top’	[**k**ʰɑp]	‘cop’	[**p**ʰɑp]	‘pop’
[s**t**ul]	‘stool’	[s**k**ul]	‘school’	[s**p**ul]	‘spool’
[i**t**]	‘eat’	[i**k**]	‘eke’	[i**p**]	‘eep’

English aspiration

English speakers know where aspiration goes in words that they have never heard before:

‘torble’	‘corble’	‘porple’
‘stib’	‘skib’	‘spib’
‘ort’	‘ork’	‘orp’

English aspiration

English speakers know where aspiration goes in words that they have never heard before:

‘torble’	‘corble’	‘porple’
‘stib’	‘skib’	‘spib’
‘ort’	‘ork’	‘orp’

This shows that the distribution of aspirated and unaspirated sounds is conditioned by a **rule**.

English aspiration

[**t**ʰɑp]	‘top’	[**k**ʰɑp]	‘cop’	[**p**ʰɑp]	‘pop’
[s**t**ul]	‘stool’	[s**k**ul]	‘school’	[s**p**ul]	‘spool’
[i**t**]	‘eat’	[i**k**]	‘eke’	[i**p**]	‘eep’

Generalization:

[tʰ], [kʰ] and [pʰ] occur as the **first sound of a syllable**.

↛ ***Predictable!***

English aspiration

- [t] and [tʰ] are in complementary distribution.
- [p] and [pʰ] are in complementary distribution.
- [k] and [kʰ] are in complementary distribution.

Phonotactic constraints

- **Constraints on English onsets:**
  1. [t] cannot be the first sound of an onset.
  2. [p] cannot be the first sound of an onset.
  3. [k] cannot be the first sound of an onset.

- **Note:**
  These are three separate constraints but they clearly look very similar to each other. We will combine them into a single constraint later on.

The aspiration rule

- Just as in the case of the plural, a rule applies to avoid violating a phonotactic constraint.

- **Underlying sounds:**
  /t/, /k/, /p/

- **Rules:**
  1. Change /t/ to [t^h] when it is the first sound of an onset.
  2. Change /p/ to [p^h] when it is the first sound of an onset.
  3. Change /k/ to [k^h] when it is the first sound of an onset.

Reminder about notation

- We distinguish between a sound's representation in the speaker's memory and how it is actually pronounced.

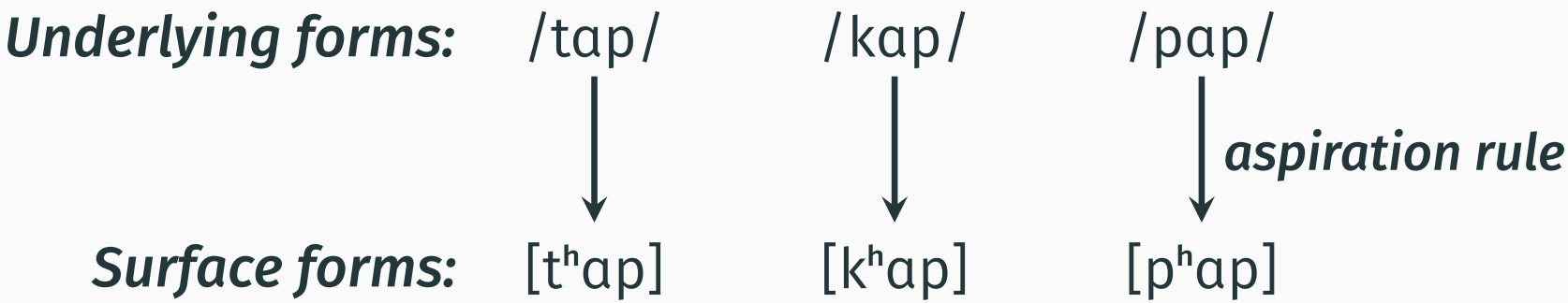
- **Surface form**: Actual spoken sounds are enclosed between square brackets: "[ ]".

- **Underlying form**: The sounds in memory are represented between slashes: "/ /"

Principle of simplicity

- If something already follows from a general rule, speakers do not memorize it.
- Since the aspiration rule already predicts where aspiration goes, speakers do not put that information into memory.
- Therefore, **only unaspirated sounds are ever memorized**.

Application



A remaining complication

While our analysis works, there is a remaining issue. We have **three separate constraints** and **three separate rules** that look very similar to each other.

- **Constraints on English onsets:**
  1. [t] cannot be the first sound of an onset.
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- **Rules:**
  1. Change /t/ to [t^h] when it is the first sound of an onset.
  2. Change /p/ to [p^h] when it is the first sound of an onset.
  3. Change /k/ to [k^h] when it is the first sound of an onset.

Articulatory features

We can improve on our analysis. The three constraints and the three rules can be collapsed into a **single constraint** and a **single rule** if we make use of **articulatory features**.

- **Feature-based constraint formulation:**
  [–voice, –glottal, +stop, –aspirated] cannot be the first sound of an onset.

- **Feature-based rule formulation:**
  Change /–voice, –glottal, +stop, –aspirated/ to [+aspirated] if it is the first sound in a syllable.

Terminology: Phonemes and allophones

Terminology: Phoneme

A **PHONEME** is a sound (phone) as it is stored in memory (/ /).

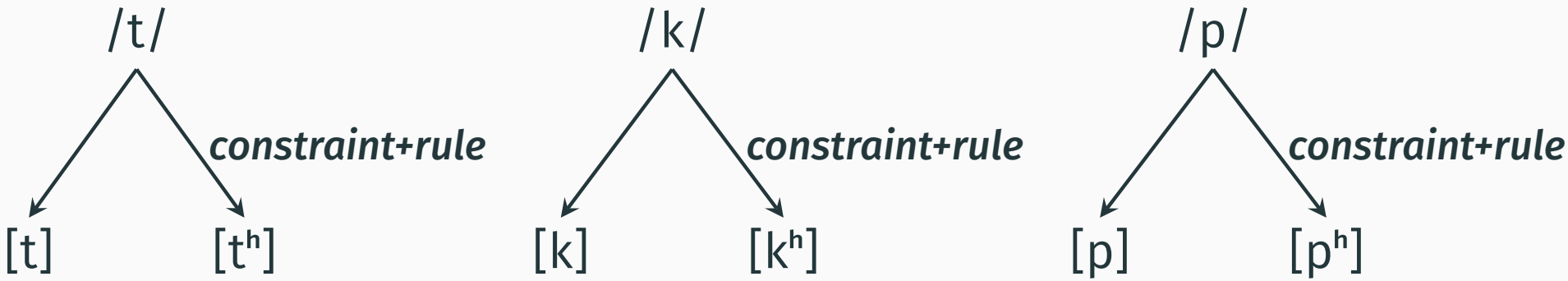
Terminology: Allophone

An **ALLOPHONE** is a sound (phone) as it is pronounced ([ ]).

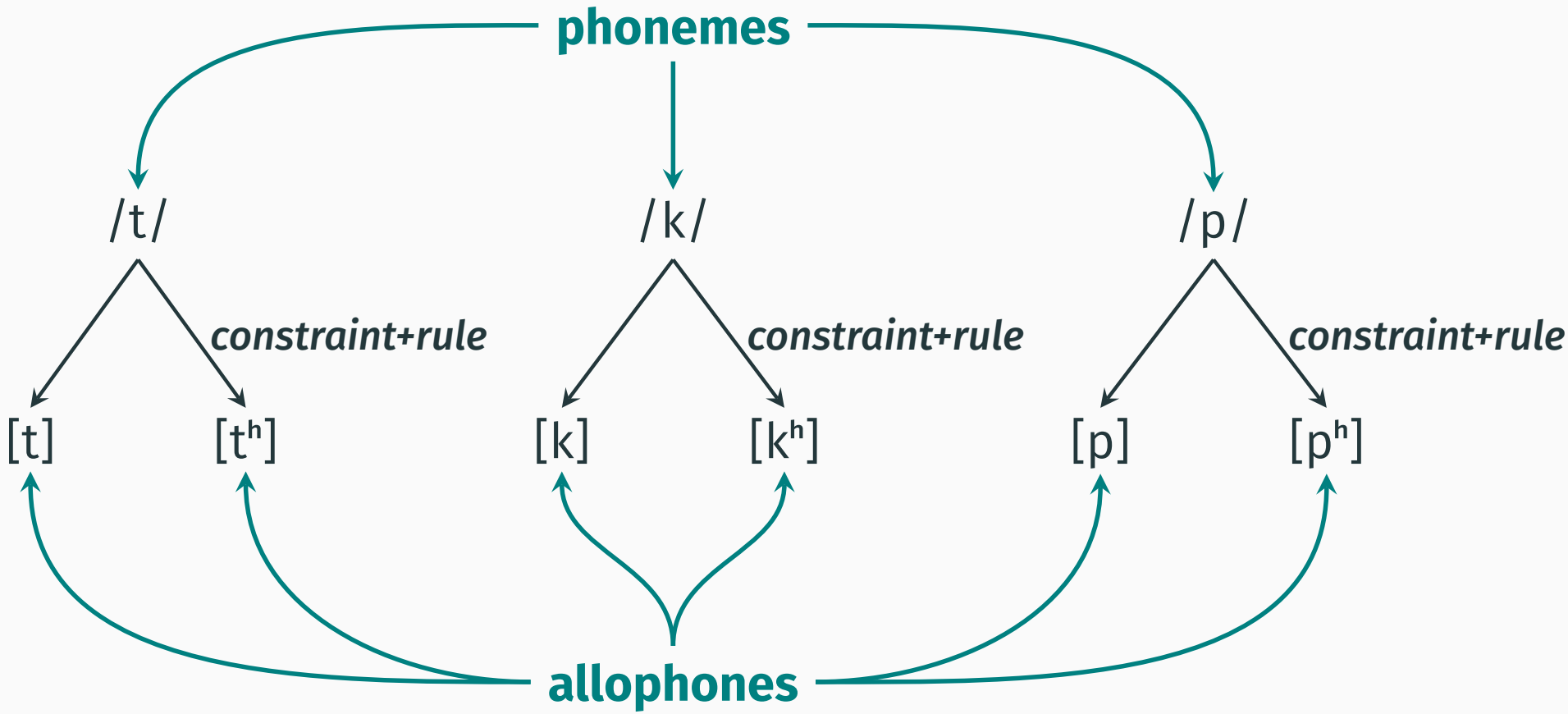
- [X] is an **allophone** of a **phoneme** /Y/ if [X] is one way that speakers pronounce /Y/.

→ [t] and [tʰ] are allophones of the phoneme /t/ in English.

Phonemes and allophones



Phonemes and allophones



Aspiration analysis vs. plural analysis

There are two central differences between our analysis of English aspiration and our analysis of English plurals:

1. With aspiration, the phonotactic conflict does *not* arise from combining elements.
   - ➙ Rather, it is the underlying form of a word itself that violates the constraint.

2. Thus, we are making claims about **all** the words of a language.

Allophones of different phonemes

- **Reminder:**
  Phonotactic constraints differ from language to language.

- **Prediction:**
  If rules are triggered by phonotactic constraints, then rules should differ between languages too.

Allophones of different phonemes

- Whether or not two sounds are allophones of the same phoneme or different phonemes depends on the language.
- In English, [t] and [t^h] are **allophones of the same phoneme**:
  - There is a rule between the two → **predictable**
- In Thai and Hindi-Urdu, [t] and [t^h] are **allophones of different phonemes**.
  - There is no rule → **not predictable**

[t] and [tʰ] in Thai

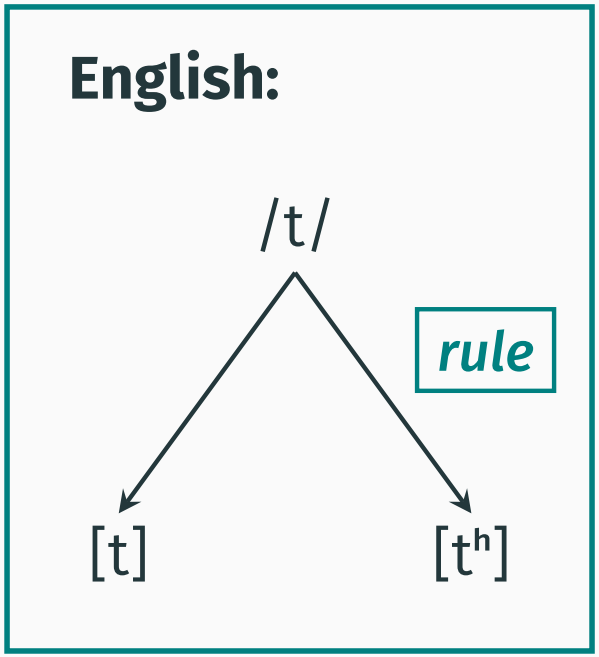
- In Thai (Kra-Dai), the following are **distinct** words:

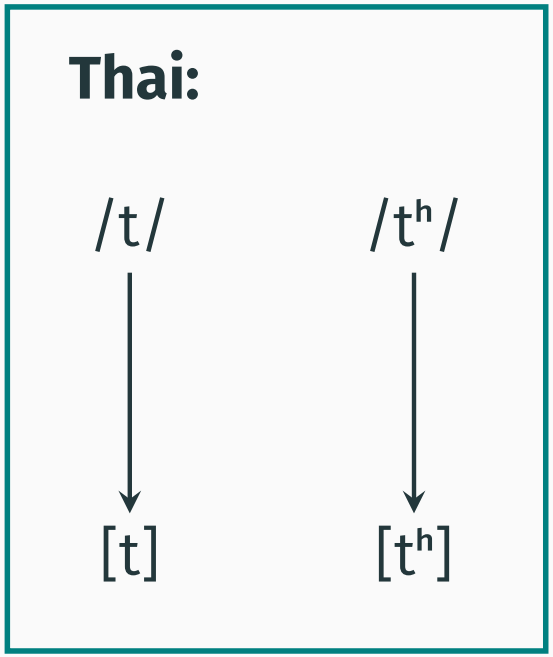
  (1) a. [tam] ‘to pound’
  b. [tʰam] ‘to do’

- Both occur in the **same environment**: [___am]

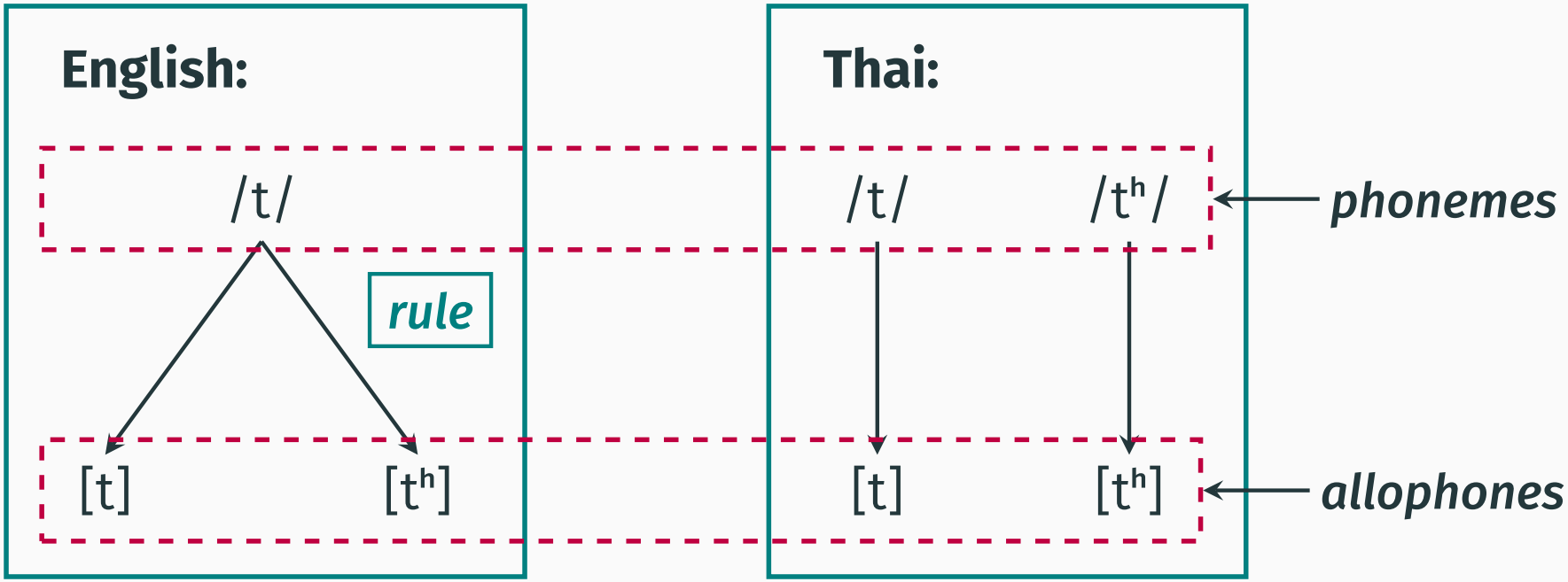
- It is impossible to predict which sound will occur based on the environment. There is **no rule**.

[t] and [tʰ] in English vs. Thai





[t] and [tʰ] in English vs. Thai



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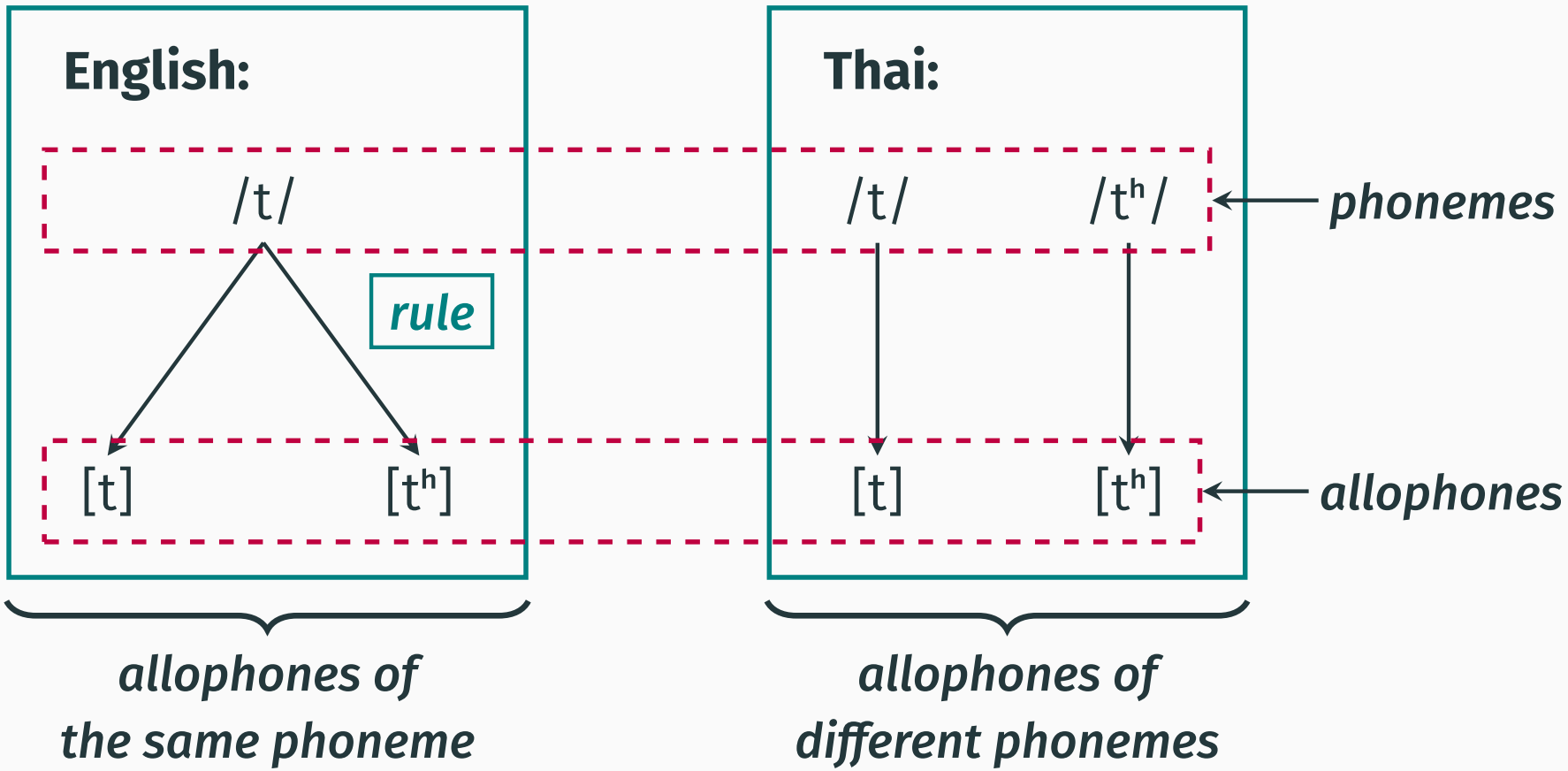

Minimal pairs

Terminology: Minimal pair

A **MINIMAL PAIR** is a pair of words that differ in exactly one sound.

- A minimal pair for [X] and [Y] is a minimal pair where one word contains [X] and the other contains [Y].

- Some English examples:

(2)

a.	[miɹ]	vs.	[niɹ]	*minimal pair for [m] and [n]*
b.	[sɪp]	vs.	[ʃɪp]	*minimal pair for [s] and [ʃ]*
c.	[sə͡ʃf]	vs.	[sə͡ʃv]	*minimal pair for [f] and [v]*

Minimal pairs

If a language contains a minimal pair for [X] and [Y], then:

- It is **not** possible to predict whether [X] or [Y] will occur based on the environment.
- [X] and [Y] are **not** in complementary distribution.
- [X] and [Y] are allophones of **different** phonemes.
  - ➙ *[m] and [n] are allophones of different phonemes in English.*
  - ➙ *[s] and [ʃ] are allophones of different phonemes in English.*
  - ➙ *[f] and [v] are allophones of different phonemes in English.*

[d] and [ð] in English

[d] and [ð] in English

Minimal pairs:

[loʊ̯wð] vs. [loʊ̯wd] [ðaɪ̯] vs. [daɪ̯]

[d] and [ð] in English

Minimal pairs:

[loʊ̯wð] vs. [loʊ̯wd] [ðaɪ̯] vs. [daɪ̯]

- Occurrence of [d] vs. [ð] is **not predictable**.
- [d] and [ð] are **allophones of different phonemes** in English.

[d̪] and [ð] in Spanish

[d̪uða]	‘doubts’	[d̪oβlaɾ]	‘to double’
[kond̪uða]	‘with doubts’	[sind̪oβlaɾ]	‘without doubling’
[laðuða]	‘the doubts’	[reðoβlaɾ]	‘redouble’
[miðuða]	‘my doubts’	[oðoβlaɾ]	‘or to double’
[d̪oloɾ]	‘pain’	[puɲaðo]	‘handful’
[kaða]	‘each’		
[oðio]	‘hatred’		

[d̪] and [ð] in Spanish

[d̪u**ð**a]	‘doubts’	[d̪oβlaɾ]	‘to double’
[kond̪u**ð**a]	‘with doubts’	[sind̪oβlaɾ]	‘without doubling’
[la**ð**u**ð**a]	‘the doubts’	[re**ð**oβlaɾ]	‘redouble’
[mi**ð**u**ð**a]	‘my doubts’	[o**ð**oβlaɾ]	‘or to double’
[d̪olor]	‘pain’	[puɲa**ð**o]	‘handful’
[ka**ð**a]	‘each’		
[o**ð**io]	‘hatred’		

[d̪] and [ð] in Spanish

[d̪u**ð**a]	‘doubts’
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[ka**ð**a]	‘each’
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[sind̪oβlaɾ]	‘without doubling’
[re**ð**oβlaɾ]	‘redouble’
[o**ð**oβlaɾ]	‘or to double’
[puɲa**ð**o]	‘handful’

[ð]: *after vowels*

[d̪]: *after consonants and silence* (#)

Spanish constraint and rule

- **Underlying form / phoneme:**
  /d̪/
- **Phonotactic constraint:**
  *[vowel][d̪]
- **Rule:**
  Change /d̪/ to [ð] if it follows a vowel.
- **Formal rule notation:**
  /d̪/ → [ð] / [vowel] ___

More Spanish: [b] and [β]

[bino]	‘he came ’
[diβino]	‘divine’
[kaβo]	‘end’
[suβteraneo]	‘subterranean’
[bɾotaɾ]	‘sprout’
[imbierno]	‘winter’
[uβa]	‘grape’
[eŋgaɲaβoβos]	‘trick’

More Spanish: [b] and [β]

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[β]: *after vowels*

[b]: *after consonants and silence* (#)

More Spanish: [b] and [β]

- **Underlying form / phoneme:**
  /b/
- **Phonotactic constraint:**
  *[vowel][b]
- **Rule:**
  Change /b/ to [β] if it follows a vowel.
- **Formal rule notation:**
  /b/ → [β] / [vowel] ___

Yet more Spanish: [g] and [ɣ]

[leɣal]	‘legal ’
[golpe]	‘a hit’
[gato]	‘cat’
[aɣo]	‘I do’
[iɣaðo]	‘liver’
[teŋgo]	‘I have’

Yet more Spanish: [g] and [ɣ]

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[teŋgo]	‘I have’

[ɣ]: *after vowels*

[g]: *after consonants and silence* (#)

Yet more Spanish: [g] and [ɣ]

- **Underlying form / phoneme:**
  /g/
- **Phonotactic constraint:**
  *[vowel][g]
- **Rule:**
  Change /g/ to [ɣ] if it follows a vowel.
- **Formal rule notation:**
  /g/ → [ɣ] / [vowel] ___

Spanish: Taking stock

- Right now, we have **three constraints** and **three rules**, all of which look very similar.

- **Constraints:**
  1. *[vowel][d̪]
  2. *[vowel][b]
  3. *[vowel][g]

- **Rules:**
  1. /d̪/ → [ð] / [vowel] ___
  2. /b/ → [β] / [vowel] ___
  3. /g/ → [ɣ] / [vowel] ___

Problem

These rules **miss a generalization**! They are completely separate rules, but they all do essentially the same thing.

- ⇀ All three rules turn a stop into the corresponding fricative if it follows a vowel.

Unification by using features

- **Constraint:**

$$*[+\text{vowel}]\begin{bmatrix} +\text{voice} \\ +\text{stop} \\ -\text{nasal} \end{bmatrix}$$

- **Rule:**

Change $/\begin{matrix} +\text{voice} \\ +\text{stop} \\ -\text{nasal} \end{matrix}/$ to [+fricative] after a vowel.

- **Formal rule notation:**

$$/\begin{matrix} +\text{voice} \\ +\text{stop} \\ -\text{nasal} \end{matrix}/ \rightarrow [+\text{fricative}] \;/\; [\text{vowel}]\ \_\_$$