Class 2
Alternations and Distributions

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Alternations and Rules
German consonants

- Here's some pairs of related words in German. **Tell me what's going on with the consonants.** (Ignore the things that are going on with the vowels.)

[taːk]	'day'	[taːgə]	'days'
[loːp]	'praise' (noun)	[loːbən]	'to praise'
[ʁaːt]	'wheel'	[ʁɛːdɐ]	'wheels'
[laɪt]	'sorry'	[laɪdən]	'to suffer'
[bʊnt]	'league'	[bʊndə]	'league' (dative)
[bʁaf]	'good'	[bʁaːvɐ]	'obedient'
[haʊs]	'house'	[hɔʏzɐ]	'houses'
[niːs]	'sneeze!'	[niːzən]	'to sneeze'

([ə,ɐ,ɛ,ʊ,ɪ,ʏ] are all vowels; [ʁ] is the German *r*; [ː] indicates that the preceding vowel is a long vowel)

Alternations and Rules

Initial observations

▷ **Observations:**

Alternations and Rules
Alternation

- The consonants at the end of the words in the first column **change** when they're in the words in the second column.

[taː**k**]	'day'	[taː**g**-ə]	'days'
[loː**p**]	'praise' (noun)	[loː**b**-ən]	'to praise'
[ʁaː**t**]	'wheel'	[ʁɛː**d**-ɐ]	'wheels'
[laɪ**t**]	'sorry'	[laɪ**d**-ən]	'to suffer'
[bʊn**t**]	'league'	[bʊn**d**-ə]	'league' (dative)
[bʁa**f**]	'good'	[bʁaː**v**-ɐ]	'obedient'
[haʊ**s**]	'house'	[hɔʏ**z**-ɐ]	'houses'
[niː**s**]	'sneeze!'	[niː**z**-ən]	'to sneeze'

Alternations and Rules
Alternation

▷ We call this an **alternation**, because the "same sound" alternates between different forms in different positions.

[taːk]	'day'	[taːg-ə]	'days'
[loːp]	'praise' (noun)	[loːb-ən]	'to praise'
[ʁaːt]	'wheel'	[ʁɛːd-ɐ]	'wheels'
[lait]	'sorry'	[laɪd-ən]	'to suffer'
[bʊnt]	'league'	[bʊnd-ə]	'league' (dative)
[bʁaf]	'good'	[bʁaːv-ɐ]	'obedient'
[haʊs]	'house'	[hɔʏz-ɐ]	'houses'
[niːs]	'sneeze!'	[niːz-ən]	'to sneeze'

Alternations and Rules
Environments

- We can characterize the alternation between the two sets in terms of their **environments**:
  - → What sounds/positions are they adjacent to?

At the end of a word	Before a vowel-initial suffix
(/ _#)	(/ _V)
[**p**]	[**b**]
[**t**]	[**d**]
[**k**]	[**g**]
[**f**]	[**v**]
[**s**]	[**z**]

Alternations and Rules

Describing the alternations

▷ **How can we use these environments to better describe the alternations?**

At the end of a word (/ _#)	Before a vowel-initial suffix (/ _V)
[p]	[b]
[t]	[d]
[k]	[g]
[f]	[v]
[s]	[z]

Alternations and Rules
Phonological rules

- We can describe the alternations by writing **phonological rules** that convert one sound into another.

Rule #1 *or* **Rule #2**

Rule #1			
/p/	→	[b]	/ _V
/t/	→	[d]	/ _V
/k/	→	[g]	/ _V
/f/	→	[v]	/ _V
/s/	→	[z]	/ _V

The sounds {p,t,k,f,s} become the sounds {b,d,g,v,z} when they appear before a vowel.

(applies to righthand column)

Rule #2			
/b/	→	[p]	/ _#
/d/	→	[t]	/ _#
/g/	→	[k]	/ _#
/v/	→	[f]	/ _#
/z/	→	[s]	/ _#

The sounds {b,d,g,v,z} become the sounds {p,t,k,f,s} when they appear at the end of the word.

(applies to lefthand column)

Alternations and Rules
Which rule?

▷ **What kind of evidence would we need in order to pick between the two rules?**

	Rule #1			*or*		**Rule #2**		
/p/	→	[b]	/ _V		/b/	→	[p]	/ _#
/t/	→	[d]	/ _V		/d/	→	[t]	/ _#
/k/	→	[g]	/ _V		/g/	→	[k]	/ _#
/f/	→	[v]	/ _V		/v/	→	[f]	/ _#
/s/	→	[z]	/ _V		/z/	→	[s]	/ _#

The sounds {p,t,k,f,s} become the sounds {b,d,g,v,z} when they appear before a vowel.

(applies to righthand column)

The sounds {b,d,g,v,z} become the sounds {p,t,k,f,s} when they appear at the end of the word.

(applies to lefthand column)

Alternations and Rules
More data

▷ **What do these pairs of words tell us?**

[fɔl**k**]	'people'	[føl**k**-ɐ]	'peoples'
[ʁaː**t**]	'advice'	[ʁaː**t**-ən]	'to advise'
[bʊn**t**]	'colorful' (masc.)	[bʊn**t**-ə]	'colorful' (fem.)
[hɔ**f**]	'courtyard'	[hø**f**-ə]	'courtyards'

Alternations and Rules
Which rule?

- Rule #1 won't work: it would incorrectly change the sounds in the righthand column.

[fɔlk]	'people'	[følk-ɐ]	'peoples'	*[følg-ɐ]
[ʁaːt]	'advice'	[ʁaːt-ən]	'to advise'	*[ʁaːd-ən]
[bʊnt]	'colorful' (masc.)	[bʊnt-ə]	'colorful' (fem.)	*[bʊnd-ə]
[hɔf]	'courtyard'	[høf-ə]	'courtyards'	*[høv-ə]

Rule #1			
/p/	→	[b]	/ _V
/t/	→	[d]	/ _V
/k/	→	[g]	/ _V
/f/	→	[v]	/ _V
/s/	→	[z]	/ _V

Alternations and Rules
Rule #2

- Rule #2 *will* work: it correctly *does not change* the sounds in the lefthand
  column, <u>as long as we assume that the sounds start out as {p,t,k,f,s}.</u>

[fɔl**k**]	'people'	[føl**k**-ɐ]	'peoples'
[ʁaː**t**]	'advice'	[ʁaː**t**-ən]	'to advise'
[bʊn**t**]	'colorful' (masc.)	[bʊn**t**-ə]	'colorful' (fem.)
[hɔ**f**]	'courtyard'	[hø**f**-ə]	'courtyards'

Rule #2 (does not apply)			
/b/	→	[p]	/ _#
/d/	→	[t]	/ _#
/g/	→	[k]	/ _#
/v/	→	[f]	/ _#
/z/	→	[s]	/ _#

Alternations and Rules
Rule #2

- Rule #2 *will* work: it correctly *does not change* the sounds in the lefthand column, **as long as we assume that the sounds start out as {p,t,k,f,s}**.

▷ **What does this tell us about what consonants German words can start out with?**

▷ **And how does that affect our understanding of these alternations?**

Phonemes and Allophones

Alternators and non-alternators

- Compare these two pairs of words:

    [bʊn**t**] 'colorful' (masc.)   [bʊn**t**-ə] 'colorful' (fem.)

    [bʊn**t**] 'league'   [bʊn**d**-ə] 'league' (dative)

▷ Based on what we know so far, **how do we explain why the second one alternates but the first one doesn't?**

Phonemes and Allophones
Different underlying forms

- The two pairs have different **underlying forms** for their roots.
  - The non-alternating root underlyingly has **/t/**.
  - The alternating root underlyingly has **/d/**. This allows Rule #2 to apply to it when that /d/ ends up being at the end of a word.

/bʊn**t**/   =   [bʊn**t**] 'colorful' (m.)   /bʊn**t**-ə/ = [bʊn**t**-ə] 'colorful' (f.)

/bʊn**d**/ $\xrightarrow{\text{Rule #2}}$ [bʊn**t**] 'league'   /bʊn**d**-ə/ = [bʊn**d**-ə] 'league' (dative)

Rule #2			
/b/	→	[p]	/ _#
/d/	→	[t]	/ _#
/g/	→	[k]	/ _#
/v/	→	[f]	/ _#
/z/	→	[s]	/ _#

Phonemes and Allophones
Contrast

- This tells us that German **makes a contrast** between /t/ and /d/.
  - i.e., the difference between having a /t/ and a /d/ in the underlying representation is enough to signal the difference between different words.

- This is true even though sometimes that contrast gets **neutralized** by the application of a phonological rule:
  - [bʊn**d**-ə] 'league' (dat.) vs. [bʊn**t**-ə] 'colorful' (f.)   [contrast maintained]
  - [bʊn**t**] 'league' vs. [bʊn**t**] 'colorful' (m.)   [contrast neutralized]

- The same applies to all the consonants we've been looking at:
  - /p/ vs. /b/, /k/ vs. /g/, /f/ vs. /v/, and /s/ vs. /z/.

Phonemes and Allophones

Phonemes and allophones

- Sounds that **contrast** in a language are called **phonemes**.
  - Phonemes are the **mental representations** of sounds; the sounds as they are stored in the mind.

- Phonemes can be changed by phonological rules (like Rule #2 in German).
  - The sounds that phonological rules create are called **allophones**.
  - Allophones are the **surface representations** of sounds; the sounds as they are actually pronounced (in the appropriate context).

- We indicate phonemes (underlying representations) with slashes: /X/
- We indicate allophones (surface representations) with brackets: [X]

Phonemes and Allophones

Phonemes and allophones in German

- Recall Rule #2:

Rule #2			
/b/	→	[p]	/ _#
/d/	→	[t]	/ _#
/g/	→	[k]	/ _#
/v/	→	[f]	/ _#
/z/	→	[s]	/ _#

▷ In German, **what sounds are allophones of what phonemes?**

Phonemes and Allophones

Phonemes and allophones in German

- Recall Rule #2:

Rule #2			
/b/	→	[p]	/ _#
/d/	→	[t]	/ _#
/g/	→	[k]	/ _#
/v/	→	[f]	/ _#
/z/	→	[s]	/ _#

$\Rightarrow$

Phonemes and allophones
[p] is an allophone of the phoneme /b/
[t] is an allophone of the phoneme /d/
[k] is an allophone of the phoneme /g/
[f] is an allophone of the phoneme /v/
[s] is an allophone of the phoneme /z/

▷ In German, **what sounds are allophones of what phonemes?**

  ○ The sounds on the righthand side of the rule are allophones of the corresponding sounds on the lefthand side of the rule.

  ○ Because they are *actual pronunciations* of the phonemes.

Phonemes and Allophones

Phonemes and allophones in German

- Recall Rule #2:

Rule #2			
/b/	→	[p]	/ _#
/d/	→	[t]	/ _#
/g/	→	[k]	/ _#
/v/	→	[f]	/ _#
/z/	→	[s]	/ _#

$\Rightarrow$

Phonemes and allophones
[p] is an allophone of the phoneme /b/
[t] is an allophone of the phoneme /d/
[k] is an allophone of the phoneme /g/
[f] is an allophone of the phoneme /v/
[s] is an allophone of the phoneme /z/

▷ **Do the phonemes /b,d,g,v,z/ have any other allophones?**

Phonemes and Allophones

Phonemes and allophones in German

- Recall Rule #2:

		Rule #2		
/b/	→	[p]	/ _#	
/d/	→	[t]	/ _#	
/g/	→	[k]	/ _#	
/v/	→	[f]	/ _#	
/z/	→	[s]	/ _#	

⇒

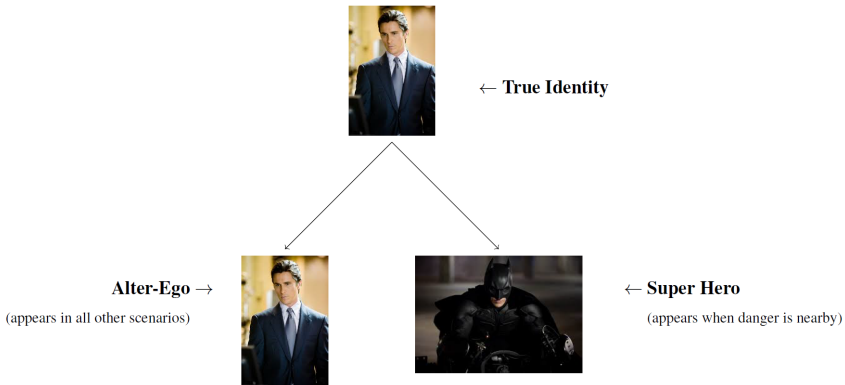| **Phonemes and allophones** |
|---|
| **[p,b]** are allophones of the phoneme /b/ |
| **[t,d]** are allophones of the phoneme /d/ |
| **[k,g]** are allophones of the phoneme /g/ |
| **[f,v]** are allophones of the phoneme /v/ |
| **[s,z]** are allophones of the phoneme /z/ |

▷ **Do the phonemes /b,d,g,v,z/ have any other allophones?**

→ Yes, the allophones of a phoneme are *all the surface sounds that derive from that phoneme*, whether or not they are derived by a rule.

○ These phonemes surface unchanged when a vowel follows:

▪ e.g. /bʊn**d**-ə/ → [bʊn**d**-ə]
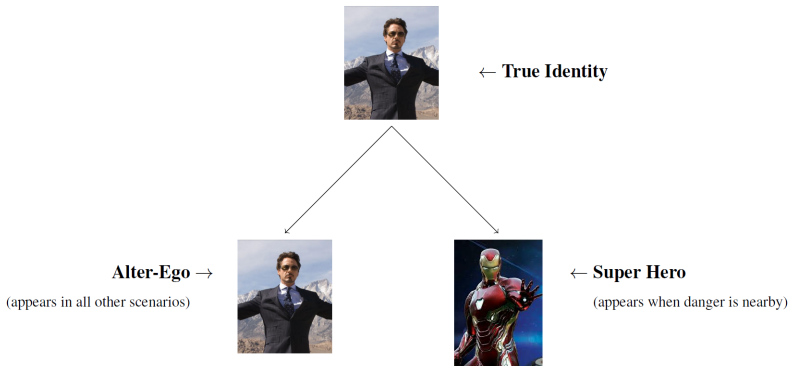
Phonemes and Allophones

Phonemes, allophones, and superheroes

- This is all a little abstract. There's a better way to conceptualize it:
  - $\rightarrow$ Superheroes!

- Many Superheroes have an alter-ego.
  - Their alter-ego is how they present themselves to the world in most cases.
  - But when danger is around, they turn into their superhero persona.

- The fact that they have two different personas doesn't mean they're actually two different people.
  - They still have a single true identity.
  - There are just rules governing which persona appears when.

Phonemes and Allophones
Batman

- Bruce Wayne keeps his Batman identity a secret.

$\leftarrow$ **True Identity**

Alter-Ego $\rightarrow$

(appears in all other scenarios)

$\leftarrow$ **Super Hero**

(appears when danger is nearby)

Phonemes and Allophones
Iron Man

- Tony Stark doesn't hide the fact that he's Iron Man

← **True Identity**

Alter-Ego →

(appears in all other scenarios)

← **Super Hero**

(appears when danger is nearby)

Phonemes and Allophones

Superman

- Superman and Clark Kent are personas of Kal-El (people don't usually get to see the Kal-El persona)

$\leftarrow$ **True Identity**

Alter-Ego $\rightarrow$

(appears when trying to conceal identity)

$\leftarrow$ **Super Hero**

(appears in all other scenarios)
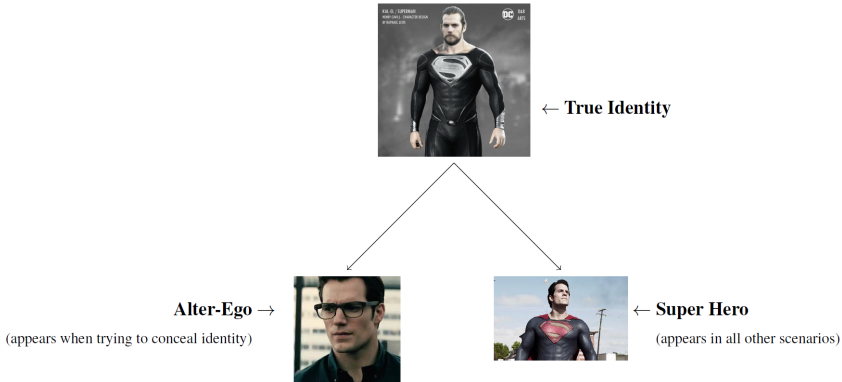
Phonemes and Allophones
Thor

- Some superheroes are just inherently superheroes, and don't hide it.

← **True Identity**

← **Super Hero**
(appears in all scenarios)

Phonemes and Allophones

Superheroes as phonemes

- A superhero's true identity is like a phoneme, in that it is the true (underlying) representation of the superhero (sound).

- A superhero's Super Hero identity and Alter-Ego are like allophones, in that they are different ways that the superhero (sound) is observable (pronounced) in the world.

- The distribution of the Super Hero identity and the Alter-Ego is like the distribution of allophones, in that one of them appears in a **predictable** environment, and the other appears everywhere else.

Phonemes and Allophones

A phoneme and its allophones

- We can draw the same kind of diagram for phonemes and their allophones as we did with the superheroes:

$$/d/ \quad \leftarrow \textbf{Phoneme}$$

Allophone 1 (basic) → [d]   [t]   ← **Allophone 2** (derived)

(appears everywhere else)   (appears at the end of a word)

- When two allophones that belong to the same phoneme appear exclusively in **distinct, predictable environments**, we call that **complementary distribution**.