

# BBN–ANG–243 Phonological analysis

## Laryngeal contrast in English consonants

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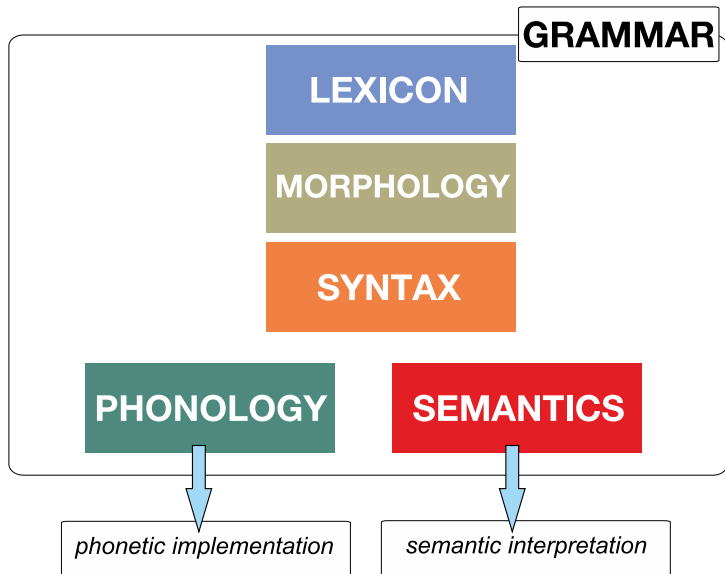
# lecture outline

- ▶ contrast among English obstruents consonants
- ▶ laryngeal (“voicing”) contrast
- ▶ phonological modelling and phonetic implementation of the contrast
- ▶ when contrast disappears: neutralization

# the generative model of language

phonology is one of the **modules** of linguistic competence (“grammar”)

## the typical generative model of language



# units in the mental lexicon

- ▶ the **lexicon** contains any information that needs to be memorized (no rules for them)
- ▶ e.g., it stores a **list** of the words, morphemes of a language
- ▶ what do you know when you “know” a word?
- ▶ 1. the **elements** that the word is **built up from**
- ▶ 2. their meaning
- ▶ these building blocks or **segments** are called **phonemes**
- ▶ the smallest units that can **distinguish** words from one another, responsible for the **contrast**
- ▶ words are represented in the lexicon as strings of phonemes = underlying representation (UR)

# tasks of phonology

- ▶ it defines the **phoneme inventory** of a language
- ▶ it **maps** between phonemes and their surface realizations (allophones)
- ▶ it defines the **phonological rules** that are used to derive surface realizations when there are more than one possible realizations

# phonetics?

- ▶ not part of grammar
- ▶ **implements** the surface representations in speech (= the output of phonology)
- ▶ “translates” the output of phonology to actual speech gestures

what is it exactly that makes the difference between /ʃ/ and /s/, etc,  
possible?



# features

- ▶ /ʃ/ and /s/ are phonemes because e.g., shine  $\iff$  sign
- ▶ we can explicitly express why they contrast with the **distinctive features** they contain

	/ʃ/	$\iff$	/s/
voicing:	[−voice]		[−voice]
nasality:	[−nasal]		[−nasal]
manner:	[−stop]		[−stop]
place:	[+palatal]		[−palatal]

# features

- ▶ a phoneme = **a sum of these features**
- ▶ e.g., /ʃ/ = voiceless + oral + palatal + fricative
- ▶ features are usually defined based on **articulation (phonetics)**
- ▶ they can be thought of as the instructions the brain sends to the speech organs to **implement** sounds

# phonetic implementation of distinctive features

you want to say the word shine:

<u>Phonological representation</u>	⇒	<u>Phonetic implementation</u>
/ʃ/ =		
[-voice]		'do not vibrate vocal folds' +
[-nasal]		'do not lower the velum' +
[+palatal]		'raise tongue to hard palate' +
[-stop]		'do not create complete closure'

# consonant contrasts in English

## the consonant inventory (contrastive consonants)

		Bil.	Lab-den.	Dental	Alveolar	Palatal	Velar	Glottal
O	P	p   b			t   d		k   g	
	F		f   v	θ   ð	s   z	ʃ   ʒ		
	A					tʃ   dʒ		
S	N	m			n		ŋ	
	L				l	r		
	G	w				j		h

Bil. = bilabial, Lab-den. = labio-dental

P = stop/plosive, F = fricative, A = affricate, N = nasal, L = liquid, G = glide

O = obstruent, S = sonorant

| = left of line: “voiceless”, right of line: “voiced”

# obstruent contrasts

- ▶ **place** contrast: e.g., /t/ vs. /p/: *tin-pin*; /t/ vs. /k/: *tan-can*
- ▶ **manner** contrast: e.g., /t/ vs. /s/: *tin-sin*
- ▶ **“voicing”** contrast: e.g., /t/ vs. /d/: *time-dime*

## “voicing” contrast in obstruents

## OBSTRUENTS

STOPS		FRICATIVES	
<i>/t/</i>	– <i>/d/</i>	<i>/s/</i>	– <i>/z/</i>
<i>tie</i>	– <i>die</i>	<i>sip</i>	– <i>zip</i>
<i>writer</i>	– <i>rider</i>	<i>missle</i>	– <i>mizzle</i>
<i>beat</i>	– <i>bead</i>	<i>bus</i>	– <i>buzz</i>
‘voiceless’	‘voiced’	‘voiceless’	‘voiced’

# laryngeal contrast in obstruents

- ▶ the phonological contrast of “voicing” is signalled (= **cued**) by a complex of features
- ▶ there are **several correlates** of this contrast = there are many “concomitant” features for the contrast
- ▶ vocal fold vibration is only one of them



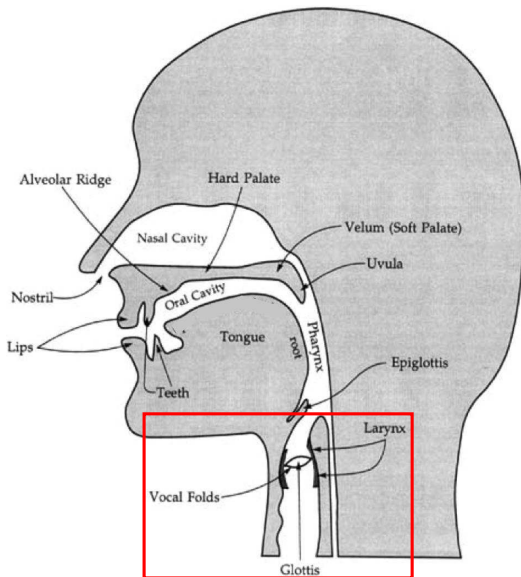
# laryngeal contrast in obstruents

- ▶ let's call the **phonological** contrast between *tie–die*, *writer–rider*, *bus–buzz*, etc. **laryngeal contrast**
- ▶ **voicing** is a narrowly used **phonetic** term: vocal fold vibration (also called: **phonation**)

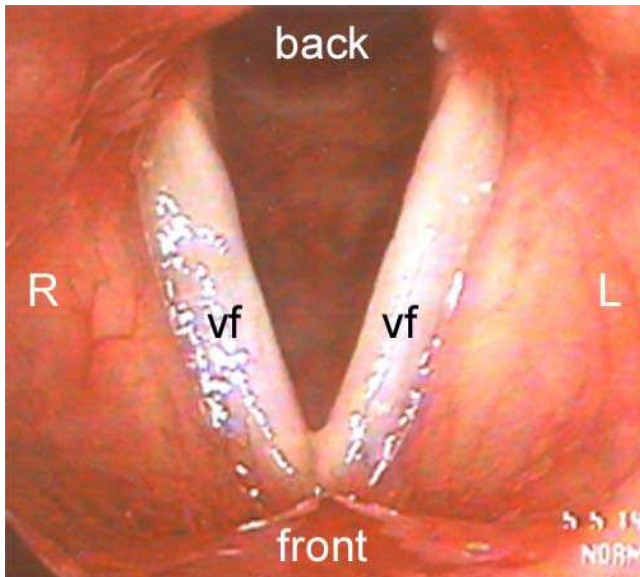
## some phonetic correlates of laryngeal contrast in obstruents

- ▶ **voicing/phonation**: vocal fold vibration
- ▶ **Voice Onset Time (VOT)**
- ▶ relative **length** of preceding vowel
- ▶ **glottalization**
- ▶ **release** noise/burst: intensity & length

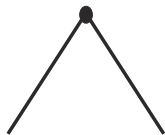
# larynx: vocal folds + glottis



# vocal folds: periodic vibration



# states of the vocal folds



widely open vocal folds  
**breathing**  
no voicing



open vocal folds  
**aspiration**  
no voicing

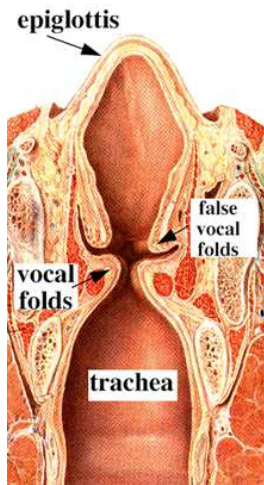


loosely closed  
vocal folds  
**voicing**

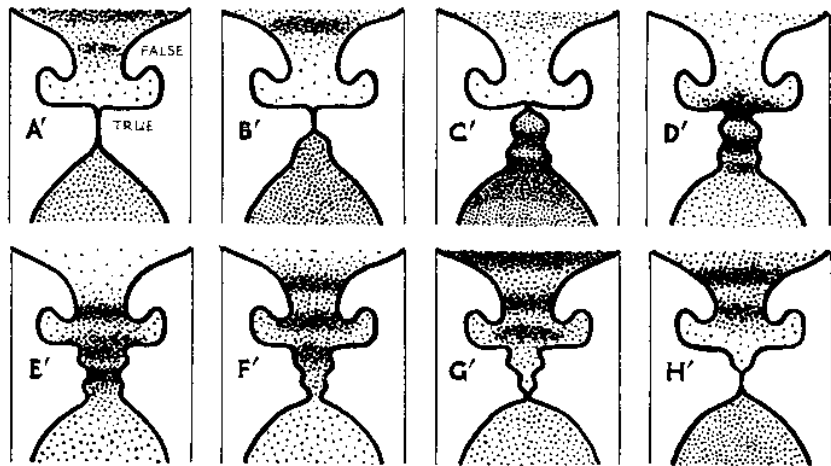


strongly closed vocal folds  
**glottalization**  
no voicing

# cross-section of the larynx



## vocal fold vibration: the Bernoulli effect



## the aerodynamics of voicing: steps of vocal fold vibration

vocal fold vibration happens because of **air pressure changes** (**aerodynamic** reasons):

1. vocal folds loosely close
2. air pressure **increases** below vocal folds
3. air pressure blows vocal folds apart (glottis opens)
4. speed of air particles increases through narrow glottis
5. air pressure **decreases** below/within vocal folds  $\Rightarrow$  vocal folds sucked together (**Bernoulli effect**)
6. vocal folds are closed again, a cycle like this repeats itself approx. 100–300 times/second
7. the cycles last until the state of glottis changes (e.g., opens to produce a voiceless sound)

– phonation can start and can continue when air pressure is **higher below the vocal folds** than above it



## types of voicing & devoicing based on aerodynamics

1. **spontaneous (“modal”) voicing:** open oral cavity – this helps to start and maintain voicing because air pressure will be low in the mouth but high below vocal folds ⇒ **vowels, sonorants**
2. **passive devoicing:** closure/constriction in mouth – this creates high air pressure above vocal folds, which inhibits vocal fold vibration ⇒ **obstruents**

# voicing in obstruents

- ▶ obstruents easily get devoiced
- ▶ but there exist voiced obstruents, how?
  
- ▶ passive voicing
- ▶ active voicing

# passive voicing

- ▶ when obstruents are **between two vowels or sonorants**, voicing from the preceding vowel/sonorant continues throughout the obstruent
- ▶ this is what we call **passive voicing**

**VOWEL or  
SONORANT**

**OBSTRUENT**

**VOWEL or  
SONORANT**



## passive voicing

- ▶ English “voiced” obstruents are **passively voiced**
- ▶ examples: *rider*,  
*bandit*,  
*rabid*,  
*gamble*,  
*begin*,  
*English*,  
*gadget*,  
*nostalgia*,  
*fuzzy*,  
*passy*,  
*Magda*,  
*exam /ɪgzám/...*

# active voicing

- ▶ additional, “extra” voicing articulation-strategies are used to delay devoicing in obstruents
- ▶ e.g., lower the larynx, enlarge the oral cavity
- ▶ Hungarian, French, Russian, etc. obstruents are like this: **actively voiced**

# active devoicing

- ▶ between vowels/sonorants, obstruents are passively voiced
- ▶ to produce voiceless obstruents in such positions, extra articulatory effort is needed
- ▶ this is called **active devoicing**
- ▶ examples from English: *city*, *lucky*, *tempo*, etc.

# types of phonetic voicing

Type	Affected sounds
spontaneous voicing	vowels, sonorant consonants
passive devoicing	obstruents
passive voicing	obstruents between Vs/son. (English, etc.)
active voicing	obstruents (Hungarian, etc.)
active devoicing	voiceless obstruents between Vs/son.



## some consequences of voicing types

- ▶ vowels and sonorants are usually **only voiced** (no voiceless pair)
- ▶ some languages only have voiceless obstruents (“voiceless obstruents are **unmarked**”)
- ▶ if a language has a **voiced** obstruent, it must also have a **voiceless** obstruent

## some consequences of voicing types

- ▶ if an obstruent is passively voiced (as in English), its voicing depends on its environment
  - ▶ passively voiced obstruents are only fully voiced between vowels/sonorants
  - ▶ elsewhere they are usually partially or fully **devoiced**, e.g.:
    - ▶ word-initial position: *back*, *demon*, *game*, *juice*...
    - ▶ word-final position: *rob*, *lead*, *vague*, *bridge*...
    - ▶ next to another obstruent:  
*anecdote*
- ▶ passively voiced obstruents are not predicted to cause regressive voicing assimilation

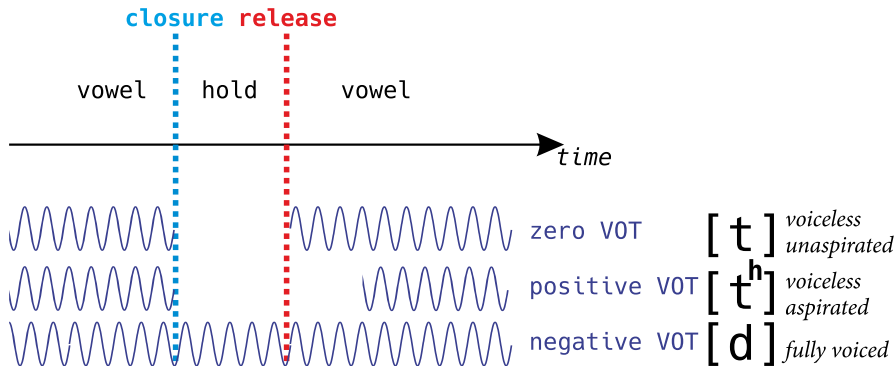
# representational consequences

- ▶ Hungarian obstruents contain the feature [ $\pm$ voice] in their underlying representation
- ▶ English obstruents do **not** contain the feature [ $\pm$ voice] in their underlying representation
- ▶ so what feature makes the contrast possible between English obstruents? for example: *t**ip* – *d**ip*?
  
- ▶ VOT

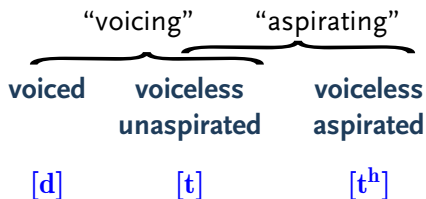
# Voice Onset Time, VOT

- ▶ voicing of stops can be characterized by the **timing between the release and the beginning (“onset”) of voicing** of the next vowel/approximant
- ▶ we call this timing relationship **Voice Onset Time (VOT)**

# three Voice Onset Time options



## voicing and aspirating languages



Hawaiian			[t]
<b>Hungarian</b>	[d]	↔	[t]
<b>English</b>			[t] ↔ [t <sup>h</sup> ]
Thai	[d]	↔	[t] ↔ [t <sup>h</sup> ]
Cl. Greek:	βάς /bás/ – πάς /pás/ – φάς /p <sup>h</sup> ás/		

# voicing and aspirating languages

## **voicing** (zero VOT $\Leftrightarrow$ -VOT) languages

most Romance and Slavic languages (Spanish, Italian, French, Russian, Polish, Slovak, etc.) but also Dutch, Yiddish, Scottish English, and Hungarian

## **aspirating** (+VOT $\Leftrightarrow$ zero VOT) languages

most Germanic (English, German, Danish, Icelandic, Norwegian, Swedish, etc.) but also some Turkic languages

# voicing and aspirating languages

**voicing** (zero VOT  $\Leftrightarrow$  -VOT) languages: [ $\pm$ voice]

- difference between obstruents is due to **voicing**
- e.g., /p/ = **voiceless**, [-voice]; /b/ = **voiced**, [+voice]

**aspirating** (+VOT  $\Leftrightarrow$  zero VOT) languages: [ $\pm$ fortis]

- difference between obstruents is due to **fortisness**
- e.g., /p/ = **fortis**, [+fortis]; /b/ = **lenis**, [-fortis]



## fortis vs. lenis obstruents

Fortis [+fortis]	Lenis [–fortis]
never voiced	have passive voicing, only voiced between Vs/sonorants/lenis obst.'s
can be aspirated	never aspirated
can shorten the preceding vowel (“Pre-Fortis Clipping”)	never shorten preceding vowel
can be glottalized	can never be glottalized

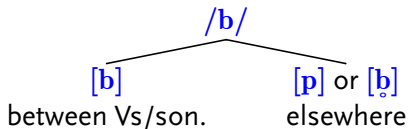
# fortis vs. lenis obstruent contrast in English

## English obstruent phonemes

	Stops	Affr.	Fricatives
Fortis [+fortis]	/p t k/	/tʃ/	/f θ s ʃ/
Lenis [−fortis]	/b d g/	/dʒ/	/v ð z ʒ/

- ▶ lenis phonemes have two allophones: (partially) voiceless and voiced, the voiced allophone is the most limited

- ▶ for example:



- ▶ *bin* /bm/ phonetically: [pm] or [b̥m]
- ▶ *Robin* /róbim/ phonetically: [róbim]

- ▶ fortis phonemes have various allophones (aspirated, unaspirated, glottalized)

# phonetic implementation of [ $\pm$ fortis] in English

example: tip – dip:

	<u>Phonological representation</u>	$\implies$	<u>Phonetic implementation</u>
$/t/ =$	[+fortis] [-nasal] [+alveolar] [+stop]		'aspirate/+VOT' + 'don't lower the velum' + 'raise tongue to alveolar ridge' + 'create complete closure' = [ <b>t<sup>h</sup></b> ]
$/d/ =$	[-fortis] [-nasal] [+alveolar] [+stop]		'don't do anything/ $\emptyset$ VOT' + 'don't lower the velum' + 'raise tongue to alveolar ridge' + 'create complete closure' = [ <b>d</b> ] = [ <b>t</b> ]

# phonetic implementation of [ $\pm$ voice] in Hungarian

example: tél 'winter' – dél 'noon':

	<u>Phonological representation</u>	$\implies$	<u>Phonetic implementation</u>
$/t/ =$	[–voice] [–nasal] [+alveolar] [+stop]		'don't vibrate vocal folds/ $\emptyset$ VOT' + 'do'nt lower the velum' + 'raise tongue to alveolar ridge' + 'create complete closure' = [t]
$/d/ =$	[+voice] [–nasal] [+alveolar] [+stop]		'vibrate vocal folds/–VOT + 'don't lower the velum' + 'raise tongue to alveolar ridge' + 'create complete closure' = [d]

# laryngeal contrast of English **stops** in various positions

- ▶ as we saw, there can be various phonetic implementations of [+fortis] and [–fortis]
- ▶ they depend on the **position** of the obstruent
  1. between sonorants, before a stressed vowel: *repél* – *rebél*
  2. word-initial, before a stressed or unstressed vowel: *tíe* – *díe*,  
*políte* – *Bolívía*
  3. between sonorants, before an unstressed vowel: *wríter* – *ríder*

## 1. between Vs/sonorants, before a stressed vowel

Word in spelling:	<i>rep<u>é</u>l</i>	<i>reb<u>é</u>l</i>
Underlying repr.:	<u>/p/</u>	<u>/b/</u>
	[+fortis]	[-fortis]
	⇓	⇓
Phonetic implem.:	aspirated/+VOT	unaspirated/∅VOT
		<i>plus: passive voicing</i>
	= [p <sup>h</sup> ]	= [b]

– on the surface, both aspiration and phonetic voicing make the contrast possible, we can call it a **strong** position for the obstruent contrast

## 2. word-initial, before vowel (stressed or unstressed)

Word in spelling:	<u>t</u> íe	<u>d</u> íe
Underlying repr.:	/t/	/d/
	[+fortis]	[-fortis]
	⇓	⇓
Phonetic implem.:	aspirated/+VOT	unaspirated/∅VOT
	= [t <sup>h</sup> ]	= [d̥] or [t]

– only aspiration is active in this position for the contrast on the surface

## 3. between sonorants, before an unstressed vowel

Word in spelling:	<i>writer</i>	<i>river</i>
Underlying repr.:	/t̄/	/d̄/
	[+fortis]	[-fortis]
	⇓	⇓
Phonetic implem.:	unaspirated/∅VOT	unaspirated/∅VOT
	= [t]	plus: passive voicing = [d]

- ▶ only voicing is active in this position for the contrast on the surface
- ▶ note: 1. fortis stops may be weakly aspirated in this position, too  
2. length of stops is relatively short here, and voicing may continue throughout the stop: /t̄/ and /d̄/ may become a **flap** [ɾ] in American English, but not /p̄/–/b̄/ or /k̄/–/ḡ/: *rápid* – *rábíd* still contrast



## absolute word final position: *beat* – *bead*

- ▶ in this position, voicing is difficult to maintain
- ▶ since nothing follows the stop, **aspiration is also impossible**

no contrast in *beat* – *bead*?

Word in spelling:	<i>beat</i>	<i>bead</i>
Underlying repr.:	/t/	/d/
	[+fortis]	[-fortis]
	⇓	⇓
Phonetic implem.:	unaspirated/∅VOT	unaspirated/∅VOT
	= [t]	NO passive voicing here! = [d̥] or [t]

- ▶ has English given up contrast in word-final position? = **neutralization**
- ▶ or maybe there are features other than aspiration or voicing that get activated here to maintain the contrast...

# neutralization: the beer goggle effect



# neutralization

**The disappearance of contrast under a given condition.**

= The local suspension of a phonological opposition between two or more contrastive sound segments; only one segment can appear in that position (but not its contrastive counterpart(s)).

# neutralization: the beer goggle effect

- ▶ *opposition*: the attractiveness of people is perceived differently
- ▶ *condition*: being drunk
- ▶ *output*: the difference in attractiveness disappears (all people are perceived as attractive)

## neutralization example: vowel reduction

- ▶ a wide range of vowels can appear in a stressed syllable but in unstressed syllables, vowel contrast is reduced to a handful of vowels (primarily the schwa)
- ▶ **senténtial** ~ **séntence**     $\varepsilon$  ~  $\ə$
- ▶ **systemic** ~ **sýstem**     $\varepsilon$  ~  $\ə$
- ▶ **moráality** ~ **móral**     $a$  ~  $\ə$
- ▶ **symbolic** ~ **sýmbol**     $\text{ɔ}$  ~  $\ə$
- ▶ **atómic** ~ **átom**     $\text{ɔ}$  ~  $\ə$
- ▶ **harmónious** ~ **hármoney**     $\text{əw}$  ~  $\ə$
- ▶ **mystérious** ~ **mýstery**     $\text{ɪ}$  ~  $\ə$
- ▶ **dráma** ~ **dramátic**     $\text{ɑ}$  ~  $\ə$
- ▶ **sulphúrious** ~ **súlphur**     $\text{jʌ}$  ~  $\ə$
- ▶ *opposition*: full vowels, *condition*: unstressed syllable, *output*: /ə/

# laryngeal neutralization for word-final obstruents?

- ▶ *beat* – *bead*, *back* – *bag*, *loose* – *lose*, *leaf* – *leave*, etc.
- ▶ *opposition*: laryngeal contrast of obstruents,  
*condition*: word-final position,  
*output*: only voiceless-unaspirated obstruents
- ▶ based on this, *beat* and *bead* are supposed to be pronounced the same way:
- ▶ BUT this does **not** seem to be the case!

## “redundant” features to the help

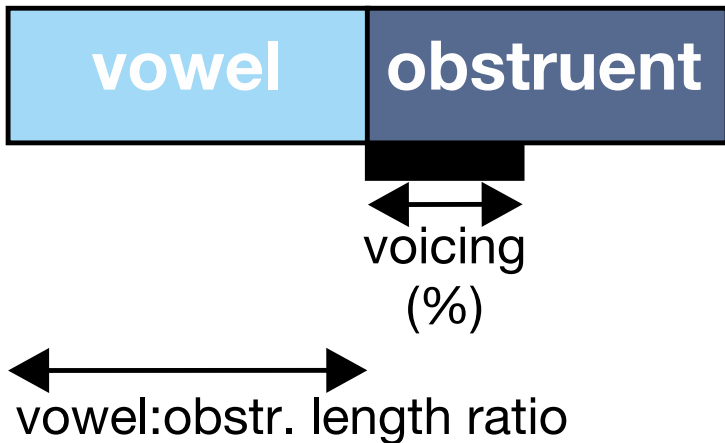
- ▶ correlates of laryngeal contrast so far: **voicing** and **aspiration**
  - **but they are not active in word-final position**
- ▶ however, there are **other correlates** of the laryngeal contrast
- ▶ they do not seem to play a role in other positions (e.g., word-medially), they are “redundant”
- ▶ but they seem to emerge more saliently **when contrast is in danger** (as in word-final position):
  - ▶ **relative length of preceding vowel**
  - ▶ **glottalization**
  - ▶ other features: release noise, articulatory strength/effort/force



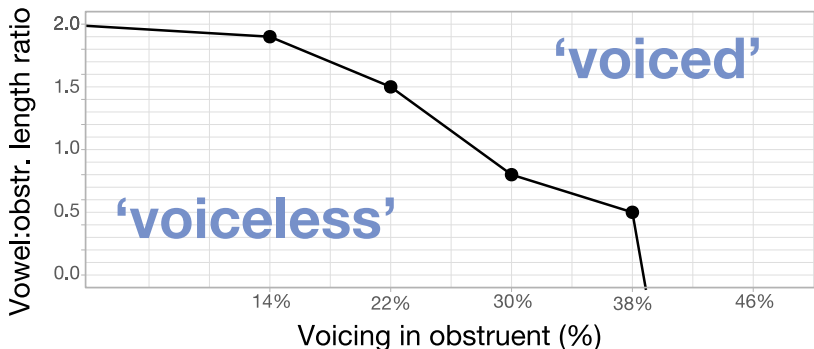
## relative length of preceding vowel

- ▶ experimental evidence: relative length of vowel to the length of the obstruent is an important factor for categorizing the obstruent as ‘fortis/voiceless’ or ‘lenis/voiced’, especially in word-final position
- ▶ generally: short vowel + longer obstr.  $\Rightarrow$  ‘fortis/voiceless’  
long vowel + shorter obstr.  $\Rightarrow$  ‘lenis/voiced’

experiments: manipulating voicing & length



# relation of voicing categorization and voicing amount+vowel length in word-final position



## conclusions

- ▶ if there is little or no voicing in the obstruent, the preceding vowel has to be around twice as long as the obstruent for it to be categorized as ‘lenis/voiced’
- ▶ if this vowel is not this long, the obstruent is categorized as ‘fortis/voiceless’ = **Pre-Fortis Clipping**

## Pre-Fortis Clipping in English in word-final position

- ▶ in English vowels (+ sonorants) are significantly **shorter** (clipped) before fortis obstruents than before lenis obstruents, where they are significantly **longer**
- ▶ Vowel (+ son.) is **shorter** before **fortis** obstr.      Vowel (+ son.) is **longer** before **lenis** obstr.

---

 mate
ropewriterootcapspeaklooseleaffontdensemaderoberiderudecabspeedloseleavefonddens

contrast in *beat* – *bead*

Word in spelling:

*beat**bead*

Underlying repr.:

/t̄/

/d̄/

[+fortis]

[−fortis]

Phonetic implem.:



unaspirated/∅VOT  
 + shorter/clipped vowel  
 = [V<sub>clipped</sub>t̄]



unaspirated/∅VOT  
 + longer vowel  
 = [V<sub>longer</sub>d̄]  
 or [V<sub>longer</sub>t̄]

## pre-glottalization/glottal reinforcement

- ▶ glottal closure quickly closes down the voicing of the vowel, followed by the oral closure of the fortis stops & affricate
- ▶ happens word-finally or when they are followed by another consonant
- ▶ it only happens for the fortis consonants:  
*mate* [mɛjʔt] – *made* [mɛjt],  
*seat* [sɛjʔt] – *seed* [sɛjt]
- ▶ it is another indicator of the fortis – lenis contrast!
- ▶ it happens where the contrast between fortis & lenis stops could potentially disappear (word-finally)
- ▶ note: glottalization may well be just a more salient/forceful version of pre-fortis clipping: the vowel is cut by glottal closure

contrast in *beat* – *bead*

Word in spelling:

Underlying repr.:

Phonetic implem.:

*beat*

/t̄/

[+fortis]



unaspirated/∅VOT

+ shorter/clipped vowel

+ glottalization

= [V<sub>clipped</sub>t̄]*bead*

/d̄/

[-fortis]



unaspirated/∅VOT

+ longer vowel

+ no glottalization

= [V<sub>longer</sub>d̄]or [V<sub>longer</sub>t̄]



## summary

## phonetic implementation of [+fortis] in stops

	Phonetic implementation	In which position?
[+fortis] ⇒	(strong) aspiration	word-initially or before a stressed vowel
⇒	vowel clipping	word-finally
⇒	glottalization	word-finally
⇒	weak/no aspiration	word-medially before an unstressed vowel

## phonetic implementation of [−fortis] in stops

	Phonetic implementation	In which position?
[−fortis] ⇒	voicing	between vowels/son.
⇒	no aspiration, no voicing	elsewhere

## fortis fricative + stop clusters

- ▶ so far we have not seen neutralization of the laryngeal contrast for either stops or fricatives
- ▶ fortis fricative + stop clusters:
  - ▶ /s/ + stop: speak, sport, spring, stéreo, stúpid, string, school, scheme, sketch, discóver, displáy, expláin. . .
  - ▶ /f/ + stop: kaftán, áfter
  - ▶ /ʃ/ + stop: gestált
- ▶ the laryngeal contrast is **completely neutralized** in this position: only an **unvoiced-unaspirated** stop may occur here

## the traditional analysis: exception!

- ▶ spelling suggests that the stop in *speak*, *discover*, etc. is **fortis**, just like in *peak*, *recover*, etc.
- ▶ but then all stops after fortis fricatives and before a (stressed) vowel are **exceptionally unaspirated**
- ▶
 

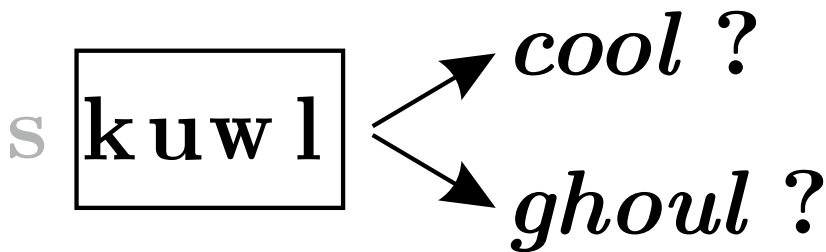
Aspirated	Not aspirated
<u>p</u> éak	sp <u>e</u> ák
rec <u>o</u> ver	disc <u>o</u> ver
att <u>a</u> ín	sust <u>a</u> ín
mát <u>t</u> er	ás <u>t</u> er
- ▶ why?

# syllable-based analysis

- ▶ ‘fortis stops are only aspirated at the beginning of a syllable’
- ▶ so: /p/ in peak is aspirated but not in speak, and /k/ in re.co.ver is aspirated but not in di.sco.ver (. signals syllable boundary)
- ▶ problem: what is special about the syllable-initial position? why in only this “special” position can there be aspiration?
- ▶ problem: putting the fricative and the stop in the same syllable is questionable: a.fter, ka.ftan, ge.stalt. . .

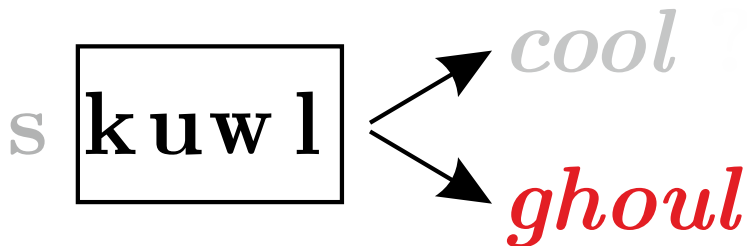
## perception of stops after fortis fricatives

– what do native speakers hear when the /s/ of school is deleted?



stops after /s/ are perceived as lenis

– what do native speakers hear when the /s/ of *school* is deleted?



## alternative analysis: the stop is lenis, not fortis

- ▶ stops after fortis fricatives seem to be lenis and NOT fortis
- ▶ they are not aspirated because they are never aspirated
- ▶ they are not voiced either because they are only (passively) voiced between vowels/sonorants/other lenis obstruents but not next to fortis obstruents
- ▶ if transcription was following this phonological fact, then:  
stop = /sdɒp/, discover = /dɪsgəvə/, etc.
- ▶ why don't we use this transcription then? – probably because it would be very misleading for language learners coming from voicing languages...  
 /sbo:t/, /səsdéjn/, /ásbə:gəz/...
- ▶ = *sport, sustain, Asperger's*...
- ▶ note Welsh spelling: sbecto 'spectacles', sgyrt 'skirt', Sbaen 'Spain', sblasio 'splash'...

# laryngeal contrast of English **fricatives/affricates**

- ▶ similar analysis for fricatives/affricates
- ▶ realization of the laryngeal contrast depends on the position
- ▶ difference: aspiration (VOT) and glottalization do **not** play a role



## correlates of laryngeal contrast of **fricatives/affricates**

- ▶ word-medial position, before vowels: absence/presence of **voicing/phonation**
- ▶ *conffection – convvection, deffied – divvide; míssle – mízzle, rífle – ríval, Confúcian – confúsion*
- ▶ word-initial position: **acoustic intensity** is the main correlate of the contrast
- ▶ fortis fricatives/affricates: more intense; lenis: relatively less intense
- ▶ sip – zip, cellar – Zellar, fain – vein, fault – vault, feel – veal, sheet /ʃi:t/ – gite /ʒi:t/, thigh /θɑj/ – thy /ðɑj/
- ▶ absolute word-final position: **duration & intensity** is the main correlate
- ▶ leaf – leve, bus – buzz, race – raise, ruche /rʊwʃ/ – rouge /rʊwʒ/, teeth /ti:jθ/ – tethe /ti:jð/, loath – lothe