English consonants: Phonemes and Allophones

Effects related to aspiration and ‘devoiced’ voiced sounds and a few other issues
Phonemes

- Strict, detailed definitions of the term phoneme are complex
  - Not part of this course
  - Take phonology courses to fight over the details

- Rough and ready idea is indispensable for practical phonetics
  - Must make a distinction between phonemic and allophonic differences
Rough definition of phoneme

- "The smallest distinct sound unit in a given language: e.g. /tɪp/ in English realizes the three successive phonemes, represented in spelling by the letters $t$, $i$, and $p$."

Phonemic differences vs. allophonic differences

- Differences in speech sound that can signal differences between two different words are *phonemic differences*

- Other differences in speech sound that are clearly audible are only *allophonic differences*
  - ‘pronunciation variants’ that cannot signal different words.
Representing allophonic differences

- ‘Broad’ (= coarse-grained) transcription enough for phonemic representation
  - Choose simple symbol for a ‘representative’ (allo)phone
- ‘Narrow’ (= fine-grained) transcription often requires diacritics
- Diacritics for stops
  pʰ - aspirated p
  pʰ - ‘p with inaudible release’ (‘unreleased p’)
  b̥ - ‘(partially) devoiced b’
Examples: ‘pie, spy, buy’

- ‘pie’ [ˈpʰaj]
- spy [ˈspaj]
- ‘buy’ [ˈbʰaj] or [ˈbaj]
- Which of [bʰ] [pʰ] [p] are allophones of the same phoneme?
Answer: ‘pie, spy, buy’

Phonemes in ‘/’ (slash or solidus, pl solidi) marks

```
/p/
  /p/
     [p]  [pʰ]
```

```
/b/
  /b/
     [b]  [b̥]
```

Phones in square brackets
Examples ‘Stop.’, ‘Stop!’, ‘Stop!!’, ‘Stob!’

- ‘Stop.’ [ˈstap]  
- ‘Stop!’ [ˈstap]  
- ‘Stop!!’ [ˈstapʰ]  
- ‘Stob!’ [ˈstab] or [ˈstɑb]  
- Which of [b] [pʰ] [p] are allophones of the same phoneme?
Answer: ‘Stop(!!!) Stob.’

Phonemes in ‘/’ (slash or solidus, pl solidi) marks

```
/p/
[ p ] [ pʰ ]
```

```
/b/
[ b ] [ b̥ ]
```

Phones in square brackets

```
[pH]
[ b ]
```
Rough notation

**Conditioned allophone:** The phoneme /X/ is realized as phone [y] in environment between A and B

/\textit{X}/ \rightarrow [y] / [A] _ [B]

**Allophone in free variation**

/\textit{X}/ \rightarrow [y] or [z] (optionally)
Example allophone rule

\[
\begin{align*}
\{ [p^h] / &\ #_\ \\
/p/ &\rightarrow \{ [p^h] / \tilde{v}_\ #\ V \\
\{ [p'] / &\ __# \ (optionally) \\
\{ [p] / &\ s_\ \\
\{ [p] \ &\text{ elsewhere}
\end{align*}
\]

\# = ‘word boundary’

\tilde{v} = ‘weak stressed’ or ‘unstressed’ or ‘reduced’ vowel

\V = primary- stressed full vowel

\v = secondary-stressed (full)
Translation

• The phoneme /p/ is realized as an aspirated p (the phone [pʰ]) at the beginning of a word or between a weak vowel and a stressed vowel.

• It is realized optionally as an unreleased (inaudibly released) p (the phone [p’] word finally

• It is realized as an ordinary voiceless (un- or weakly-aspirated) stop after /s/ and elsewhere.
Allophone rule sheet to follow

• We will examine some important allophones in English Cs and Vs
  – Then I’ll handout rule summary (and post on web)

• For details see Chapter 3 of Rogers and Appendix F (p 292 - 298)
  – Our rules will be much shorter
Allophones of Consonants

• Many important details in English ‘narrow phonetics’ related to voiced/voiceless distinction in obstruents
Allophones of stops: Aspiration and release

• Consider the following words
• Broad and Narrow transcriptions
• ‘Line drawings’ showing relative timings of constrictions at articulators
  – (See Rogers p 25-27 for overview)
Aspiration etc. ‘pit, spit’

‘pit’

/ˈpɪt/ ['pʰɪtʰ], ['pʰɪt'], ['pʰɪt]

‘spit’

/ˈspɪt/ ['spɪtʰ], ['spɪt'], ['spɪt]

/p, t, k/ **always** aspirated at beginnings of words in stressed syllables (always)

Never aspirated after /s/.

Variable word finally, often with inaudible release (‘unreleased’)

Timing of articulator movement

• Many details of English consonant allophones can be illustrated with diagrams
• Very rough sketches of
  • Relative degrees of constriction of supra laryngeal articulators
  • Characterization of lottal activity
  • Relative timing of constrictions of different articulators and of changes in glottal activity
Simple example

• Consider:
  – Voiced, voiceless and voiceless aspirated stops
  – E.g. [d] [t] and [th]
• All involve very similar activity of the supra glottal articulators
• What differs is timing relations to glottal events
• Line diagrams can make this idea clear
Timing diagram Rogers p 51

Graphic unavailable
(see Figure 3.3 of Rogers 2000)
SLVT articulators in Rogers’ line drawings

• Rough cut of major articulatory regions
  – Supralaryngeal articulators
    • Labial - bilabial or labiodental
    • Coronal - tongue tip or blade
    • Dorsal - body of tongue
    • Velic - velo-pharyngeal port
  – Glottal activity (e.g voicing state)
For supra glottal articulators

- Separation of lines relates to degree of constriction at that articulatory region
- Closed:                      stops
- Slightly open:               fricatives
- More open:                   approximants
- Most open:                   vowels
More articulators (assignment 2)
Rogers p 35 Figure 2.5

• Graphic unavailable
My timing drawings: glottal states

- Voiceless states of **glottis**
  
  =:=:=:=: Slightly open (as in aspiration or [h])
  ====== Closed tight as in [?]
  -------- Unknown (either === or :=:=:)

- Voiced state of **glottis** (typing)
  
  vvvvvvvvvv -- voicing (folds buzzing)

- Voice-ready (typing)
  
  xxxxxxx -- vocal folds about ready to voice
  but not buzzing
My timing drawings: articulators

- Rogers’ “velic” = my “VPPort”

- Typing:
  - ———— Closed articulator (as in stops)
  - < Opening articulator (<<<<< longer opening)
  - > Closing articulator
  - :=:=:= Slightly open (as in fricatives)
  - :::::::::: Pretty open articulator (as in approximants)
  - ooooooo Quite open articulators (as in vowels)
**Timing diagrams** See Rogers p. 51 fig 3.3

/d a / \textit{Negative VOT}

Coronal ——<oooooooooooooooooo \textit{Voicing starts before} <
Glottal vvvvvvvvvvvvvvvvv (voicing leads opening)

/ t a / \textit{Near Zero VOT}

Coronal ——<ooooooooooooooooo \textit{Voicing starts at} <
Glottal ::=:=:=:vvvvvvvvvvvv (short voicing lag)

/tʰ a / \textit{Positive VOT}

Coronal ——<ooooooooooooooooo \textit{Voicing starts after} <
Glottal ::=:=:=:=:=:=:vvvvvvvvv (long voicing lead)
English ‘partly voiced’ stops (see Rogers’ p 47.)

[d a] Fully voiced ‘d’

Coronal ——<oooooooooooooooooo
Glottal vvvvvvvvvvvvvvvvvv

Voicing starts **before** <

(voicing leads opening)

[  d a ] **Devoiced** ‘d’

Coronal ——<oooooooooooooooooo
Glottal xxxvvvvvvvvvvvvvvvv

Voicing tries to start at or before <

(voicing leads opening)

[t a] Unaspirated ‘t’

Coronal ——<oooooooooooooooooo
Glottal :=:=:=:=:vvvvvvvvvvvvvvv

Voicing starts **shortly after** <

Devoiced ‘d’ and unaspirated ‘t’ may often be perceptually equivalent
Obstruents weakly voiced in English

• Many languages work hard to keep voicing going during obstruents
  – E.g. French, Russian

• English does not
  – Phonemically voiced stops, fricatives and affricates only likely to show true voicing during constriction when they are between voiced sonorants (approximants and vowels)
Examples

- /'ba'babsə'bəb/ --> ['ba'babsə'bəb] ['ba'babsə'bəb]

- /'za'zazsə'zaz/ --> ['za'zazsə'zaz] ['za'zazsə'zaz']
[d̥] vs. [t] ? Any real difference

- ‘Devoiced’ obstruents can be very similar to voiceless unaspirated sounds with respect to ‘actual’ voicing
- Small differences may remain in ‘excitation’ from larynx
  - Other ‘secondary features’ of ‘devoiced voiced’ sounds resemble ordinary voiced sounds
    - so they may sometimes be perceptually separable
Secondary features of Voiced vs voiceless obstruents

• **Voiced**
  – Lower amplitude of burst or frication
    • (= ‘less loud’)
  – Constriction duration shorter (VCV)
  – **Preceding** vowels longer (VC)

• **Voiceless**
  – Higher amplitude of burst or frication
    • (= ‘louder’)
  – Constriction duration longer (VCV)
  – **Preceding** vowels shorter (VC)
Side effects

• So far we’ve looked mainly at allophones of voiced and voiceless obstruents themselves
  – Some special things happen to things next to obstruents
    • e.g. vowels are shorter before voiceless obstruents

• Next: Effects on approximants next to aspirated obstruents
‘Spill-over’ effects of aspiration

\[ /^{\text{pliz/}} \rightarrow [^{\text{ph}} l_{o} i z ] \]

Lab. \quad \longrightarrow \quad <ooooo00000000000>

Cor. \quad oooo0:::00000:==:

Glot. \quad :=:=:=:=vvvvvvvvvvvv

Open glottis (aspiration) extends through much of /l/
Flapping (tapping)

- Flapping (tapping)
  - /t/ and /d/ often realized as [ɾ] / V__̃v
  - Voiced alveolar flap (or tap) between stressed and ‘weak’ vowel
    - This is ‘opposite’ of one good aspiration environment
      ̃v_ V
      - Roughly speaking
        » aspiration makes stops ‘more devoiced and less sonorant’
        » flapping makes /t,d/ ‘more voiced and more sonornant’

- Example:
  ‘attack’ [ə'tʰæk] vs. ‘attic’ [ˈærɪk]
Flapping more examples

- Example from child’s speech
  - Baby: ‘Daddy’ ['dæᵢdi]
  - Toddler: ‘Daddy’ ['dærᵢ]
  - 5-year old (extra polite): ‘Daddy’ ['dæᵢtʰᵢ]

- More examples
  - ‘buddy’ /'bʌdi/ --> ['bʌdᵢ]
  - ‘butter’ /'bʌtə/ --> ['bʌtᵢ]
  - ‘sitter’ /'sɪtər/ --> ['sɪtᵢᵢ]
  - ‘city’ /'sɪtᵢ/ --> ['sɪrᵢ]
Place assimilation and coarticulation

• Small changes in place of articulation in some consonants
  – Alveolar consonants become dental before θ 郢
    ‘tenth’ /tɛnθ/ --> [tɛnθ]
    • ‘width’ and ‘stealth’ may show similar changes in /d/ and /l/

• Stops
  – Labialized before rounded vowels [w] and [ɹ]
    • ‘dwell’ [d⁶wɛt] ; ‘Gwen’ [g⁶wẽn], ‘twin’; [t⁶wʰwɨn] or (?) [t⁶ʍʔn],
Complex coarticulation in /
\text{stop}+r/

- /t/ and /d/ retroflexed, rounded (and possibly affricated) before /r/
  - ‘train’
    \[ [tʰɛjn] \text{ or } [ts^{\text{w}}rɛjn] \text{ or maybe even } [ts^{\text{w}}rɛjn] \]
    - Kids sometimes spell ‘train’ as ‘chrain’

- ‘drain’
  \[ [dɪɛjn] \text{ or } [dΩ^{\text{w}}rɛjn] \]
'Spill-over' effects aspiration and rounding coarticulation.

/ˈkwɪk/ --> ['k \^[ ] ^[ i k\^] ]

Lab ::::::::::o000000000000000

Vel. __<:::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<::::<:::<
Clear and dark ‘l’ in NA Eng.

• At beginning of syllables in N.A. English, /l/ is relatively ‘clear’ [l]
• At end of syllables, it is relatively ‘dark’ [ɾ]
  – Often described as ‘velarized’ but may more often be pharyngealized
  – Dark [ɾ] often shows up as a ‘syllabic’ l
    • We will not systematically distinguish it from schwa+dark l
• Examples
  – ‘pal’ ['pʰæl] v. ‘lap’ ['læp]
  – ‘little’ ['lɪɾəl] or ['lɪɾəl]
Articulation of some laterals (sagittal MRI tracings)

AK shows mainly pharyngeal constr. in [†]

• Graphic unavailable. See web link below

Laterals from MRI http://www.icsl.ucla.edu/~spapl/projects/mripix/figg3.html
Syllabic nasals and glottal stop

• ‘Mountain’, ’sutton’, ‘sudden’  
  – Broad transcription /'maʊntən/ /'bʌtən/, /'saʊdən/,  
  – Narrow transcription (casual pronunciation)

• ‘Mountain’ ['mawnʔn] or ['mawnʔtn]

• ‘Button’ ['bʌʔn] or maybe ['bʌʔtn]
  – See Rogers p 55 “RP Glottalization”
    • Something much like this may happen frequently in NA English

• ‘Sudden’ ['saʊdən], ‘redden’ ['ɛrən]
Inaudible releases

• Unreleased (inaudible release) stops often occur in stop clusters
  – ‘apt’, ‘act’, ‘abdicate’
  – [ˈæptʰ] [ˈækʰ] [ˈæbdɪkʰjɛtʰ]

• Unreleased stops often occur prepausally (e.g. utterance final)
  – Even possible for word like [ˈækʰtʰ] making final stop very difficult to hear.

• Many languages do not allow inaudible releases of stops
  – Require aspiration or brief vocalic release
    • Compare: [ˈækʰ] [ˈækʰtʰ] [ˈækʰtʰ]
Some additional details

- Most of the things so far might show up on a quiz for ‘moderately narrow’ transcription

- Some additional details will \textbf{not} show up in any live \textit{transcription} quiz ever
  - Some facts discussed might be addressed in multiple choice or short answer questions
‘Inherent’ rounding in some Cs

• N.A. English /ɪ/ is pretty strongly rounded
  – Rogers p 60.
  – *Could* be transcribed most accurately [ɪʷ]

• /ʃ, z, tʃ, dʒ/ are also somewhat rounded
  (compared to /s, z/)
  – These *could* be transcribed /ʃʷ, zʷ, tʃʷ, dʒʷ/

*But we won’t bother in ‘moderately narrow transcription’

?? What would we do with ‘Schreck’, ‘Schwepps’ vs. ‘she’
Special releases (plosions)  
Nasal and lateral releases

- Stops before homorganic nasals (mainly d+n) often result in a ‘nasal release’ or ‘nasal plosion’ (Rogers p 57)
  - Can be transcribed with d + raised n
    - ‘Rodney’ [ˈraudnɪ]
    - ‘kindness’ [ˈkʰajndnəs]
- Similarly, ‘d’ before ‘l’ may lead to ‘lateral release’ or ‘lateral plosion’
  - Can be transcribed as d + raised l
    - ‘sadly’ [ˈsædlɪ]
- What about ‘butler’???
  [ˈbaʊtələ] emphatic [ˈbaʊ tələ]