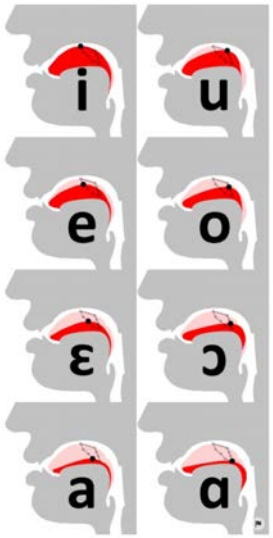


24.901/931, 2026
Introduction to Phonology

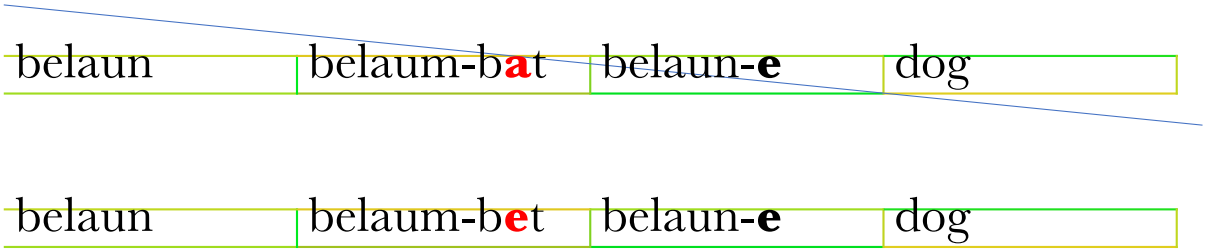
Lecture 2

Work this week and other announcements

- Recitation: Thursdays, beginning today, 4-5pm, room being negotiated.
- Problem set 1 due Tuesday, before class.
- This week read Hayes 2009 chapters 2-3

  in Canvas module: *Features, Contrast, Inventories*
- Chap.1 in Hayes 2009, also included, is an introduction to phonetics.
- DS office hours this week: Thursday 2-3.

Typo in PS1



Thanks, Ro'nikonhkátste!

Notation and IPA sources

- square brackets indicate phonetic transcription: [bʊʃəz], [pæks]
- italics or angle brackets indicate spelling: *bushes*, <bushes>
- can mix them: *bush*[əz]
- slanted lines indicate URs: /bʊʃz/, /pækz/
- you can deviate from this but define any new notation you use.
- More sources of IPA fonts:

https://www.internationalphoneticassociation.org/content/ipa-fonts#

http://wstyler.ucsd.edu/posts/ipa_with_osx.html

https://www.gouskova.com/2016/09/04/international-phonetic-alphabet-fonts-and-keyboards/

Continuing Tuesday's class: Back to detecting ambiguity

How did listeners decide that […rʌmpɪks…] is ambiguous?

Summary of last class

- We argued for the combination below ('H2') in analyzing prefix N-alternations:

  UR: /ɪn/ (in-) (/Xn/ for other prefixes)

  Rule: (informal) an alveolar nasal copies the place features of following C
- Some N-rule is needed in non-prefix contexts (inside roots, between words).
- The rule of H2 generalizes correctly to those other contexts.
- The rules required by alternative URs (H3-5) do not generalize.
- Therefore: this H2 rule yields a simpler grammar.

An argument from implicational universals

- The study of place assimilation across languages reveals a general law:

  If labials (m, ɱ) or velars (ŋ) undergo place assimilation then so do alveolars.

- The converse doesn't hold.
- An *implicational universal*: the presence of X in a language implies that of Y.
- The presence of place assimilation targeting labials or velars in a language implies that of place assimilation targeting alveolars.
- To be consistent with this law, the rules required by the hypotheses H3-H5 would have to include also the possibility of place assimilation targeting /n/.
  H2 is consistent with the law without modification.

Writing place assimilation in English

- alveolar nasal → [α place] / __ $C_{[\alpha\ place]}$

  'alveolar nasal copies the place of articulation of following C'

- $[\alpha F]_i \ldots [\alpha F]_j$ = 'segment$_i$ has the same F value as segment$_j$'
- Assume the feature [place] – the site of an obstruction to airflow – has n values, where n the number of C sites observed in the language.

Back to ambiguity in [ɹʌmpɪks]

- We were in the process of showing that people rely on the assimilation rule of H2 when they decode spoken English.
- Fact: [m#p] (#= word boundary), as in [ɹʌmpɪks],
  is at least 2 ways ambiguous: /…m#p…/ and /…n#p…/.
- The assimilation rule of H2 predicts that [m#p] is indeed ambiguous.
- H3-H5 don't predict this: *their* rules work only if limited to prefixes. No prediction made about word sequences.

How does speech perception lead to judgments of ambiguity?

Analysis by synthesis: Halle and Stevens 1961

1923-2018; Building 20

1924-2013, Building 36

A recognition process that formulates *hypotheses about production* (= *synthesis*) and compares them to input data, until only one hypothesis produces a match. (= between speech signal and lexical items in the message)

To identify lexical items in a surface string Σ, in language L, listeners consider divisions of Σ into substrings $\omega_1\ \omega_2\ \ldots\omega_n$ such that

(i) each one of $\omega_1\ \omega_2\ \ldots\omega_n$ corresponds to a word in L

(ii) when the string $\omega_1\ \omega_2\ \ldots\omega_n$ is an input to the grammar of L, Σ is a possible output.

Alternative: the Similarity Hypothesis

- Fact: *m* and *n* are similar, esp. *not* before V (Hura et al. 1992, Benkí 2003).
- A possible Similarity Hypothesis:

  To find lexical items in a surface string Σ, listeners consider

  (i) divisions of Σ into substrings that correspond to actual words, or

  (ii) divisions of Σ into *substrings similar to actual words*, iff each such substring ω corresponds to an actual word W,
  and the similarity of ω to W meets a specified similarity threshold.

How the Similarity Hypothesis derives our ambiguity

- Parse (i) [əkwɪkrʌmpɪksjuʌp] = [ə] [kwɪk] [rʌm] [pɪks] [ju] [ʌp]
- Parse (ii) [əkwɪkrʌmpɪksjuʌp] = [ə] [kwɪk] **[rʌn]** [pɪks] [ju] [ʌp]
- Suppose [rʌm] and [rʌn] meet the similarity threshold.
- Then both Parse (i) and (ii) are valid under this hypothesis.
- The sentence is 2-ways ambiguous, as observed. This doesn't bear on H2.

Can we distinguish the Analysis by Synthesis vs. Similarity interpretations?
What is a possible test case?
Critical: if x is similar to y, y is similar to x.

Ambiguous?

[əkwɪkrʌndʌzjəgʊd]

…a quick run does you good…

… a quick rum does you good …

Unmbiguous

[əkwɪkrʌndʌzjəgʊd]

…a quick run does you good…

…quick rum does you good …

Comparison

Hypotheses	**Predicted lexical ambiguities**	
	[mp]	[nd]
Analysis by synthesis: grammar guides search for URs	/np/ or /mp/ (a rule n →m/_p)	only /nd/ (no rule turns x →n)

Comparison

Hypotheses	**Predicted lexical ambiguities**	
	[mp]	[nd]
Analysis by synthesis: grammar guides search for URs	/np/ or /mp/ (a rule n →m/_p)	only /nd/ (no rule turns x →n)
Similarity hypothesis: similarity guides search for URs	/np/ or /mp/	/nd/ or /md/

Discussion

- When interpreting a spoken utterance, listeners search for candidate lexical entries corresponding to strings they hear.
- These lexical entries contain URs.
- The URs could differ from the forms they hear in running speech
- To interpret the spoken utterances, listeners experiment with undoing phonological processes,
- only if they know those processes apply in their language.

Possible conclusion

- Place assimilation of /n/ to bilabials exists in English
- Place assimilation of /m/ to alveolars does not exist in English
- Listeners undo only phonological rules *that could have applied in their language*, because they use their phonological grammar to access their lexicon.
- In a language with both rules, perhaps [rʌnteɪks] would be ambiguous.

Implications: how learners choose between analyses

- In Part I we discussed English alternations in prefixes.
  - Many possible analyses
  - A way to choose is to invoke a simplicity standard.
  - That standard favors /ɪn/ over /ɪm, ɪŋ/ etc.
  - Because the rule chosen to map UR to SRs also explains restrictions on NC sequences in simple words.
- But one can wonder if learners reason in this way.
- In Part II we found that the analysis favored by simplicity is used by people who decide if a phrase is ambiguous (< place assimilation).
- The simplicity standard, which chooses H2, is not in the data
- But people apparently use it.

Phonological knowledge has practical value

- It detects ambiguity; and lack of it.
- Knowledge of phonology helps listeners access lexicon *fast.*
- Multi-lingual speakers use it to make foreign words sound *native.*

Dubious vowels

- How many vowels in *Emily, family, homily*? *desperate*? *please*?

In some languages, knowing the grammar tells the speakers that in some context there must *always be a V*; or *never a V*.
(Same for C's. If word begins as [kətæ…], must something follow?)

The information predictable from the grammar makes some acoustic info superfluous. This can speed up lexical access.

Speakers seem to ignore the predictable info in speech perception: could be evidence that they use their grammar.

Phantom vowels in Japanese (Dupoux et al. 1998)

- French and Japanese differ on how predictable Vs are as a function of surrounding Cs. Experiments tests if speakers know this.
- Japanese CC sequences: only NC (nd, mb, ŋg; + nt, mp, ŋk, ns in loans)
- French: lots of diverse CCs.
- The question: do J speakers use this knowledge about their phonology to speed up lexical access?

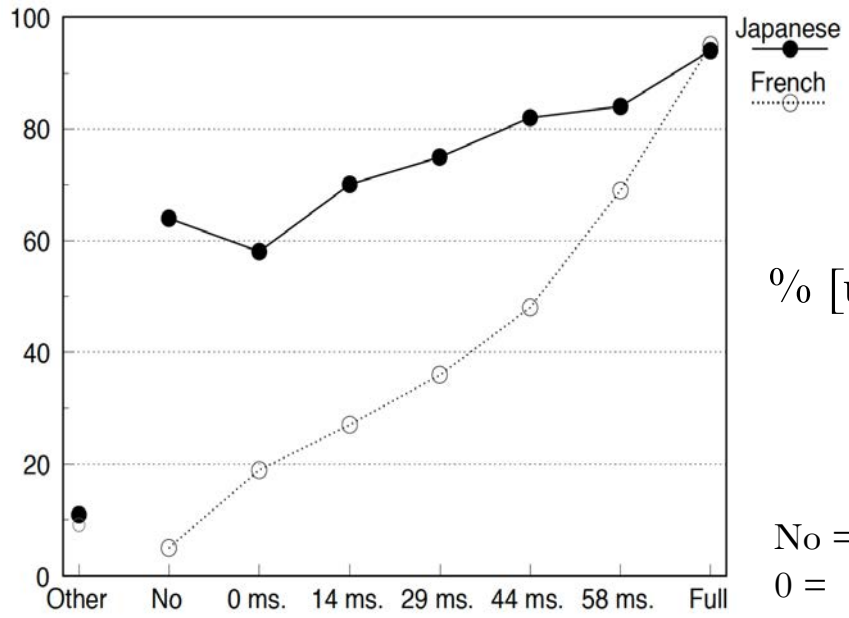
Experiment

- Japanese and French participants listen to VCCV *nonce* words, e.g. [ebzo]. Stimuli are edits of [(C)VCuCV] as spoken by French speaker.
- A continuum of 6 [ebzo]-stimuli, 0-100ms [u]

  [ebzo] ...[eb^{u}zo]...[ebuzo]...[ebuzo]

- Task for all participants is: *did you hear [u]?*

Japanese always hear an [u] in [ebzo]
French reaction based on [u]-duration



% [u] judgments

No = there never was an [u] in the original stimulus
0 = [u] was there, originally; it was completely excised

Discussion: Japanese

- Speakers of J. know that after any C (except after N), there is some V.

  Consequence: they disregard acoustic evidence for CC, if CC ≠ NC
- The grammatical knowledge is helpful: allows speakers to anticipate an upcoming sound.

Discussion: French vs. Japanese

- French allows all sorts of CC, including bC. Plus, all CV sequences.

  abri, abject, abdomen, absent…. bis, abbé, habit

- But there is no [bz] in French words.
- [bz] is non-native to both French and Japanese.
- Japanese subjects 'repair' [bz], but French speakers do not. Why?
- French listeners can't predict there will be a V after *b*. They must process the acoustic information, instead of inferring what comes next.
- Japanese speakers can predict V is coming.
- They can ignore some of the stimulus.

Significance

- The *ebuzo* experiment gives evidence that listeners predict the next sound *based on their grammatical knowledge*.
- These predictions are so confident that they override information in the acoustic stimulus.

Adapting L2 words to L1

Adapting L2 words to L1

- Bilingual speaker English (L2)-Japanese (L1)

Speaking to L2 listener	Speaking to L1 listener
[wɒ́ʃɪŋtən]	[waʃ́ɪ**nt**o**ŋ**]
[ǽndəˌsən]	[andá**:**so**ŋ**]
[bǽdmɪntən]	[bad**o**mínto**ŋ**]
[mæsəʧ́úsəʦ]	[masaʧ́usétt**ʦu**]

Adaptation reflects knowledge of properties of L1 grammar. In Japanese:

- no CC except nasal+stop with identical place of articulation (*mb, nd, ŋg*)
- no final C other than *ŋ*
- no *du tu*: *dzu, tsu* instead
- accent typically on penultimate syllable if the final or penult ends in C

Loan adaptation as rule application

- n → ŋ / _# (# = word boundary sign)
- Ø → o / {t, d} _{C, #} (Ø → o = 'insert o')
- Ø → u / C_{C, #} ({x, y} = 'x or y')
- Stress penultimate syllable

[ándəˌsən]	→	[andá:soŋ]
[bádmɪntən]	→	[badomíntoŋ]
[mæsəʧúsəʦ]	→	[masaʧusétːsu]

None of these are rules of L1 Japanese.
But all apply in L2 → L1 adaptation.
How come Japanese adapters converge on these rules?

2 kinds of knowledge in loan adaptation

1. What sound sequences are excluded in L1 (= grammar of L1)
2. How to turn excluded sequences into acceptable ones.

• Some options in making L2 words sound L1.

[bǽdmɪntən] → [badomintoŋ],[badamintoŋ] [baminto], [badzumintonu]

[mæsəʧúsəʦ] → [masaʧusettsu],[masaʧusettso] [masaʧuse]…

Selection is probably based on the perceived similarity between the sequence forbidden in L1 and modified versions of it.
The most similar version wins.

- One can think about L1 rules in the same terms.
- Some sound sequence is excluded:
  it poses a difficulty for speakers, or uncertainty for listeners.
- The grammar records the prohibition.
- The grammar also selects a substitute for that sequence.
- Selection of the substitute involves finding an output that is maximally similar to the original

Appendix1: tests of (non)ambiguity

Testing ambiguity (Gaskell & Marslen-Wilson 2001)

- Is *ru*[mp]*icks* actually ambiguous?
  Is *ru*[nd]*oes* actually unambiguous?
- A way to tell: *priming* experiments

Priming

- *Prime*: earlier occurrence of a stimulus.
  Later presented in a task. Some primes facilitate the task.
- A lexical decision task: "is X a word?"
  {*...dog, find, bzark, nut, mask, sphey, crank,...*}

Lexical decision, primed stimulus

- (i) *masks*; (ii) {...*dog*, *find*, *bzark*, *nut*, *mask*, *sphey*, *crank*,...}
  prime primed stimulus
- A primed stimulus can yield a faster or more accurate response.
- Compare responses to primed vs. unprimed stimuli.

Gaskell & Marslen-Wilson's 2001 experiments

Lexical task: *is X a word*?

Prime	Stimulus
… run does …	*run*
…rum picks…	*rum*
…rum picks…	*run*
…run does…	*rum*

Gaskell & Marslen-Wilson's 2001 experiments

Prime	Stimulus	Analysis by Synthesis predictions
…*rum picks*…	*run*	[mp] can come from /np/. Then *rum* can prime *run*
…*run does*…	*rum*	[nd] can't come from /md/. Then *run* can't prime *rum*

Gaskell & Marslen-Wilson's 2001 experiments

Prime	Stimulus	Similarity Hypothesis predictions
…*rum picks*…	*run*	[mp] is similar to [np]. Then *rum* can prime *run*
…*run does*…	*rum*	[nd] is similar to [md]. Then *run* can prime *rum*

Gaskell & Marslen-Wilson's 2001 results

Prime	Stimulus	Reaction Time (ms)	Error rate
… *run does* …	*run*	513 (25)	2.5
…*rum picks*…	*rum*	512 (26)	1.6
…*rum picks*...	*run*	522 (16)	
…*run does*...	*rum*	561 (2)	11.0
Control	*run*	538	4.2
	rum	563	5.3

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