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Invited lecture @ York University  
Department of Literatures, Languages & Linguistics

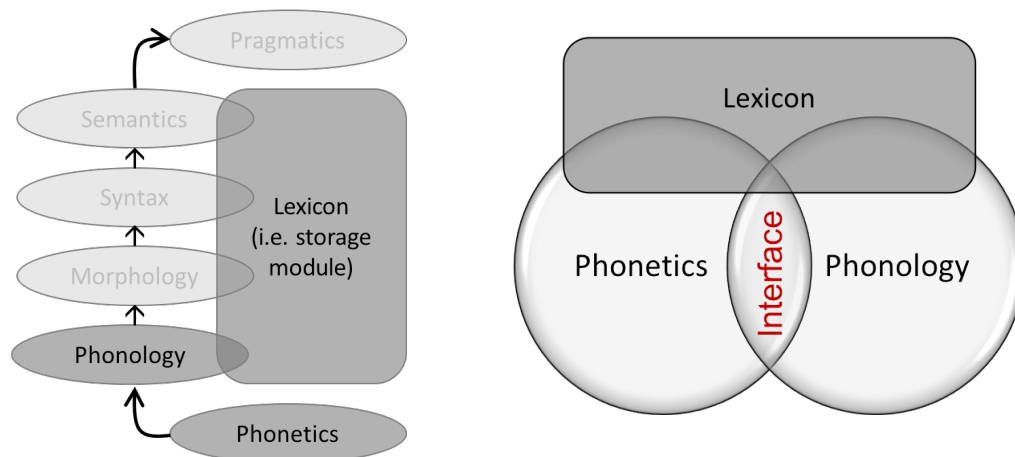
# **The phonetics-phonology interface: Historical sound change, phonetic implementation and word processing**

## PHONETICS

The study of physical properties of speech sounds (acoustics, articulation, perception).

## PHONOLOGY

The study of sound representations and of rules/constraints that govern these representations.



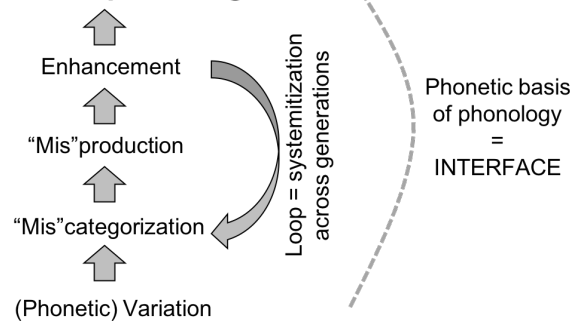
## REPRESENTING PHONOLOGY

- Phonological representations are necessarily linked to their physical realization for both production (phonology → acoustics) and perception (phonology ← acoustics).
- Question 1: How are segments represented?
  - Bundles of features, which are economical, potentially innate, and easily translatable to computational frameworks (e.g. *Optimality Theory*).
  - Exemplar-based, which call on general processing abilities (e.g. statistical learning), and are potentially more universal across individuals and languages.
- Question 2: How is phonology linked to phonetics?
  - The examples of historical sound change, phonetic implementation, and word processing.

## HISTORICAL SOUND CHANGE

- Ohala (2013) hypothesizes that misperceptions constitute the basis of sound change, since (1) phonetic variation (e.g. free variation, coarticulation, constraints on the vocal tract) can be (2) miscategorized during recognition, and in turn (3) misproduced by the listener-turned-speaker. Across generations through language transmission, variation is (4) enhanced and systematized, until (5) large-scale phonologization occurs.

### Large-scale phonologization



- The phonetic basis of phonologization constitutes the interface.

#### COARTICULATORILY NASALIZED VOWELS (VN SEQUENCES)

Oral vowels that are influenced by a following nasal consonant and becomes partially or fully nasalized (i.e. change in vowel quality). A great number of languages display this process, such as English (e.g. *bone* [bɔwn] or [bõŋn]).

#### PHONOLOGICALLY NASAL VOWELS ( $\tilde{V}$ )

Vowels that are part of a phonological nasal category and are functionally opposed to oral vowels. In the UCLA Phonological Segment Inventory Database, 22.62% of the 451 surveyed language have nasal vowels, such as (Canadian) French (i.e. [ã, ĕ, ð, œ]).

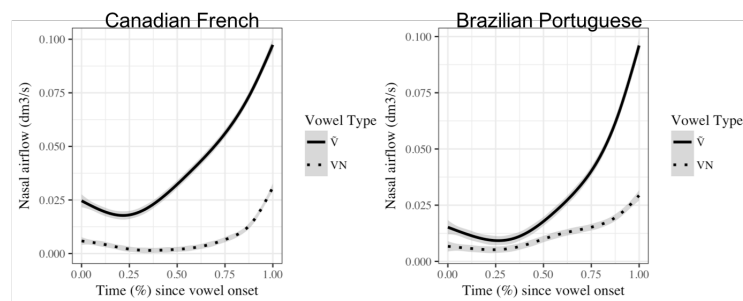
- The example of vowel nasalization:
  - If listeners perceive (1) nasal coarticulation as an (2) intrinsic property of a preceding vowel, they may (3) reproduce it when turned speaker. This has the effect of (4) enhancing the presence of nasalization on the vowel, until the consonant disappears and vowel nasalization (5) enters the phonology of the language. This gives rise to a **nasal vowel category**.

#### PHONETIC IMPLEMENTATION

- The way phonological information (e.g. segments) is implemented in production.

#### Vowel nasalization in French and Portuguese (Desmeules-Trudel & Brunelle, 2018)

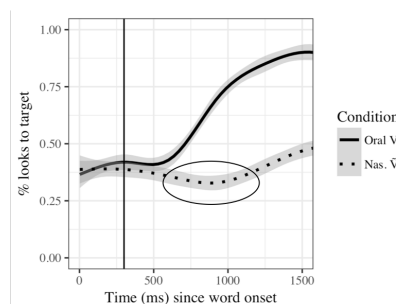
- When the velum is open, such as when nasalized vowels are produced, air coming from the lungs can flow through the nasal tract.
- Measuring nasal airflow:
  - High correlation with vowel nasalization through time.
  - More direct measure of nasalization, given the complexities of the acoustics of vowel nasalization.
- In French, VN sequences and  $\tilde{V}$ s are opposed in the same syllabic contexts.
- In Portuguese, VN sequences and  $\tilde{V}$ s are *never* opposed in the same syllabic contexts.
- The prediction is that the presence of a contrast will motivate better phonetic differentiations in French than in Portuguese overall, due to the presence of a contrast *in context* in French.



- According to the results, the presence of a contrast *in context* conditions airflow patterns, which are not strictly categorical, but rather variable and time-dependent.
  - This is inconsistent with the binary view of phonological features.

### WORD RECOGNITION

- If (real-time) word recognition is mediated by phonology, can we expect this process to be categorical, given the binary character of phonology in traditional representations?
- Beddor et al. (2013) showed that English listeners recognized words with VN sequences earlier when vowels were nasalized for a longer portion of their duration.
- Zamuner et al. (2016) found similar results with 2-3-year-old children.



- These studies suggest that English listeners are able to dynamically use coarticulation, an essentially phonetic phenomenon, for word recognition. They also suggest that coarticulation can be phonological and that the system can be updated in real time.
- Within-category variability (e.g. duration of nasalization on vowels in French) is another phonetic phenomenon that could impact word recognition.
- Desmeules-Trudel and Zamuner (2019) presented native French listeners with variably nasalized vowels (20%, 50%, 80% and 100% of duration) and measured word choices (as well as eye movements).
- We found a *gradient* pattern of recognition, suggesting that French listeners are sensitive to tiny variations in nasalization duration despite the contrast in their native language.
- This shows that fine-grained phonetic details are specified in representations and that word recognition can be gradient, which in turn argues in favour of an integrated view of phonetics, phonology, and the lexicon.

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