# Phonetic naturalness in phonology

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# Why relevant?

- Are phonetics and phonology separate systems, or not?
- Are natural phonetic explanations directly encoded in the phonology, or not?


- Units *(features, gestures, targets, trajectories…)*


→ Nature of units:

quantitative vs. qualitative

discrete vs. continuous

# Goals

- To what extent is phonology natural?
  General agreement:

  *Most phonological processes "make sense", are natural, from the point of view of speech physiology, acoustics, and perception.*

- Focus on three major views:

(i) Direct encoding of phonetic detail and full integration of phonetic knowledge in phonology *(e.g., **Steriade 2000, 2001**; Flemming 1995, 2001; and others)*

(ii) Indirect reflection of phonetic detail in phonological constraints *(e.g., **Hayes 1999**, Hayes & Steriade 2004)*

(iii) The issue of phonetic naturalness in diachrony *(e.g., Ohala 1981, 1989, 1990; **Hyman 1977, 2001; Blevins 2004**)*

(i) **Phonology is natural**

Sound patterns can be entirely accounted for by principles of production and perception.

Knowledge of quantitative phonetic details

*(unidimensional view; phonetic determinism)*

(ii) **Phonology is natural, but not all of it**

Some constraints are phonetically grounded, but formal symmetry still plays a role in constraint creation.

Speaker/learner generalizes from experience in constructing phonetically grounded constraints.

(iii) **Sound change is natural (but synchronic phonology is not)**

# Constraints

Both (i) and (ii) rely on Optimality Theory (OT) framework

The formal characterization of an OT constraint may include its motivation (unlike rules).

(i) Phonetic and phonological constraints are evaluated the same way – by strict domination *(unlike Cohn 1998, Zsiga 2000).*

(ii) Phonological constraints can be rooted in phonetic knowledge.

Constraints are constructed by speakers based on their knowledge of the physical conditions under which speech is produced and perceived. Constraints may be universal, not necessarily innate.

# Steriade 2001

Asymmetry in loss of place contrasts explained by perceptual cues.

- *Regressive* assimilation

    anpa → a**m**pa        amta → a**n**ta

    aŋpa → a**m**pa        amka → a**ŋ**ka

- *Progressive* assimilation

    anṭa → an**t**a        aɳta → aɳ**ṭ**a

- C place cues in **CV** transitions *(Ohala 1990)*

  $VC_iC_jV$  →  $VC_jC_jV$

                              *$*VC_iC_iV$*

- Cues to apical/retroflex distinction in **VC** transitions *(Ladefoged & Maddieson 1986)*

- P-map     *(Perceptual map)*

  Speaker's knowledge of the discriminability of contrasts:

  - which contrasts are more discriminable

  - the same contrast is more salient in some contexts than in others

  Calculated as *perceived similarity* between two strings

# Formal analysis

- Indexed correspondence constraints

major place contrast:

    IDENT[place]/C_V   >>   IDENT[place]/V_C

apical/retroflex contrast:

    IDENT(anterior)/V[ _, apical, stop]C   >>

        IDENT(anterior)/C[ _, apical, stop]V

See also Flemming (1995, 2001) for OT constraints referring to formant structure.

# Hayes (1999)
## Inductive grounding

- Grounded constraint = phonetically sensible

  i.e., Bans things that are phonetically hard, allows things that are phonetically easy *(to produce)*

- Speaker constructs a phonetic (difficulty) map based on experience *(e.g., for stop voicing in 4 environments)*

- A number of constraints are derived from the phonetic map by inductive grounding

- The effectiveness score of each constraint is calculated by *correct predictions / correct predictions+errors*. Constraints with the highest scores are grounded (the best!), and will be retained in the grammar.

# Stop voicing

- Several constraints emerge as grounded:

  Highest score (1):      *[+nasal][-voice]    *(postnasal voicing)*

*But see Hyman (2001) for postnasal **de**voicing in Bantu.*

  Only .6:          *[LAB, -voice]       *no /p/*

                    *[DORS, +voice]     *no /g/*

  Although these gaps are well attested *(Maddieson 1984)*

  Suggests that phonetic naturalness cannot be the sole criterion in constraint creation.

# Phonetic naturalness in diachrony

- Hyman (1977, 2001)  Phonetic naturalness cannot be a property of synchronic phonologies. It is only relevant in diachrony. A sound change, once *phonologized*, is subject to different principles *(cf. also Anderson 1981)*

- Ohala (1981, 1989, 1990…)  Common sound changes have direct phonetic sources.

- Blevins (2004)  *Evolutionary Phonology*

# Phonetic naturalness in diachrony

- General agreement: sound change is phonetically natural

Common examples:

Tonogenesis *(Hombert et al. 1979)*

Velar palatalization

Final obstruent devoicing

V nasalization before nasals

Nasal place assimilation

……

*Does phonetic naturalness persist in synchronic phonology?*

# Phonologization

Phonetic     →     phonological     →     phonemic

(phonologization)     (phonemicization)

[pa], [ba]     [**p**a], [**b**a]     [pa], [pa]

H    (L)H     H    LH     **H   LH**

(Contrast substitution)

# Evolutionary Phonology

- Blevins (2004) identifies 3 sources of sound change:
*(CCC Model)*

CHANGE

CHANCE

CHOICE

Common sound patterns are phonetically based, can be explained by speech perception and production.

- **CHANGE** – misperception

  |  | *production* | *perception* |
  |---|---|---|
  |  | [anpa] | [ampa] |
  |  | [ki] | [tʃi] |
  |  | [θ] | [f] |

- **CHANCE** – ambiguity of phonetic signal

  /aʔ/ - [ʔa̰ʔ]     [ʔa̰ʔ] - /ʔa/

- **CHOICE** – variation in the phonetic signal (Lindblom 1990, 1998)

  /ka-kata/ 'to laugh'

  hyperarticulated:     [kakata]
  hyparticulated:       [ka̜kata], [kkata]

# Discussion

- Phonologization comes closer to a full model (work subsequent to Hyman 1977: e.g., Barnes 2002)

- Can explain empirical observations

- Addresses the relationship between synchrony and diachrony

  – A sound change which is purely phonetically motivated has consequences which may be exploited by synchronic phonology

# Examples

- iV sequences in Romance languages *(Chitoran & Hualde 2002, 2005; Hualde & Chitoran 2003)*


- Patterns of gestural overlap in Georgian consonant clusters *(Chitoran, Goldstein, Byrd 2002)*
    - natural:  overlap motivated by perceptual salience
    - unnatural:  gesture separation is more than needed to preserve recoverability

# /iV/ sequences in Romance

- Variability in the production of iV sequences

| French | Spanish | Romanian | Catalan, Portuguese |
|--------|---------|----------|---------------------|
| (Italian) | | | |
| [mjɔp] | [miope] | [miopu] 'short-sighted' | |
| [bjɛl] | [bjela] | [biela] 'rod' | |
| [medjan] 'median' | [italjana] | [italj/iana] 'Italian' f. | |

**diphthong**                                    **sequence**

⟵――――――――――――――――――――――――――⟶

**(jV)**                                              **(iV)**

- Variability in syllabification judgments

Standard French:      all tautosyllabic

Castilian Spanish:     mixed (predominantly tautosyllabic, tendency for heterosyllabic wd-initially)

Romanian:      heterosyllabic

Portuguese:     heterosyllabic

# Hypothesis

- The observed difference in variability is related to two factors:


- the presence of the glide [j] in a given language, from other historical sources;

- effects of prosodic structure that affect the realization of the vocalic sequences.

# Historical diphthongs

## Latin /ˈpɛtra/

| French | Spanish | | Romanian | Portuguese |
|--------|---------|--|----------|------------|
| p[**jɛ**]rre | p[**je**]dra | | p[**ja**]trə | p[**ɛ**]dra |
| | | | (with limited distribution) | |

# Prosodic effects

- ## Position in the word

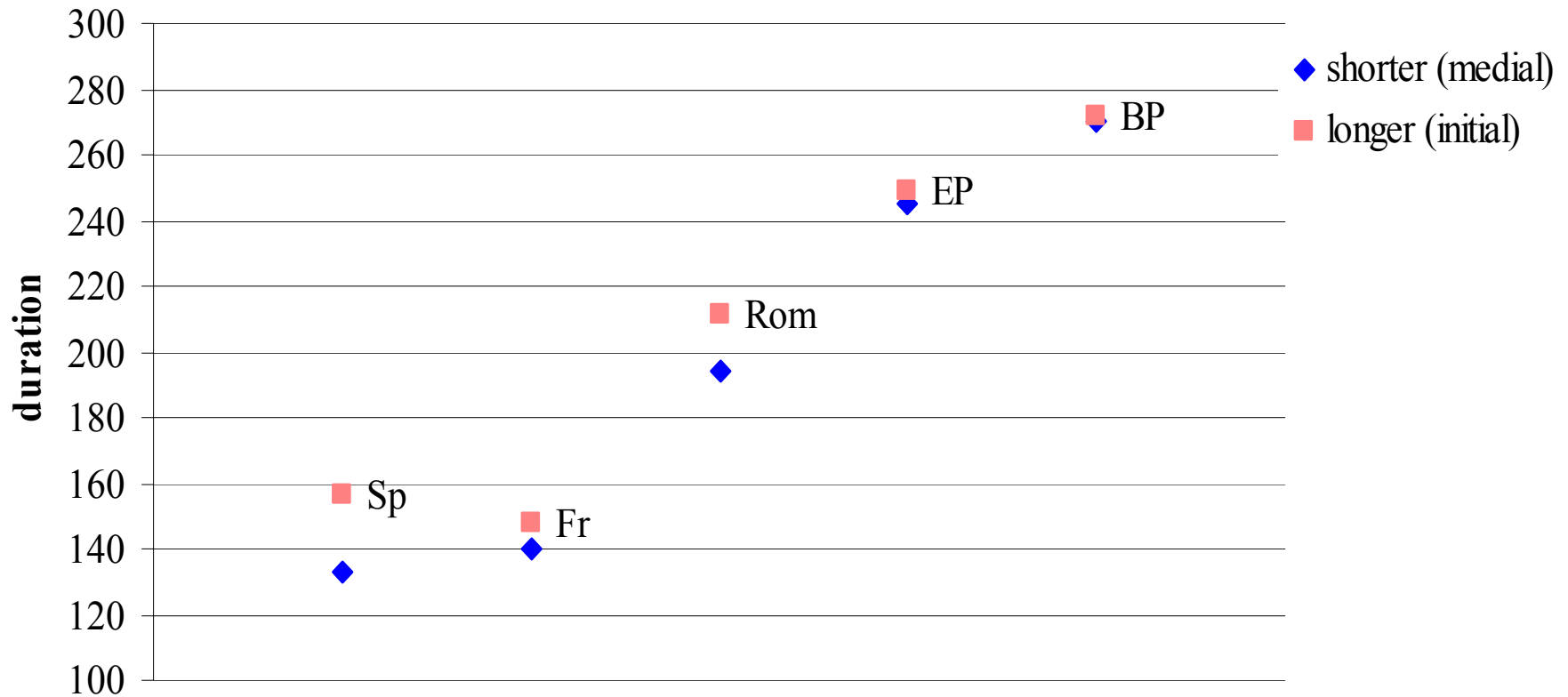  - Vocalic sequences are longer word-initially than word-internally

    [din#d**ia**na]  >  [med**ia**na]


- ## Position with respect to stress

  - Vocalic sequences are longer the closer they are to the main stress syllable, preceding it

    [d**iá**konu]  >  [d**ia**mántu]  >  [d**ia**gonál]

# Distribution of 5 Romance languages with respect to the acoustic duration of iV sequences (means)

The 5 languages are at different stages of variability.

- Phonetic variability is enhanced in Spanish, where we see the contrast between diphthongs and sequences in hiatus being lost (change in progress)
- Contrast already lost in French
- Contrast still maintained in Romanian

Importance of studying variability, within and across languages.

# Patterns of gestural overlap in Georgian C1C2 clusters

Affected by

- Position in the word

  **dgeba** vs. **adgeba**

  *less overlap word-initially than word-medially*

- Order of place of articulation

  front-to-back                  back-to-front

  **dgeba**            vs.     **gdeba**
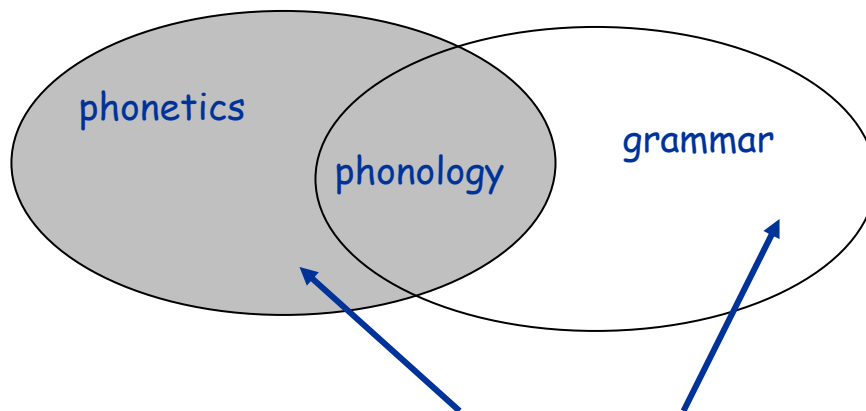
  **p$^h$t$^h$ili**           vs.     **t$^h$bili**

  *less overlap front-to-back than back-to-front*

Perceptual recoverability account

# Conclusion

- Hyman (1977)

"Phonology is the intersection of phonetics and grammar"



Some processes may be closer to *here* or *here*

-in motivation (more or less natural)

-in effect (more categorical or more gradient)

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