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# Week 12 – Phonetics in Phonology I

May 4 and 6, 2008

## 1 The Functional Origin of Constraints?

### 1.1 Overview

- (1) OT research: How do we choose the constraints? McCarthy (earlier readings) emphasizes that this is the main content of phonological theory, testable by factorial typology.
- (2) Everyday working research seems to be guided by the link between typology and analysis: can the data of a language be treated with constraints each of which could be defended by its repeated applicability to other, unrelated languages (ideally, even other phenomena)?
- (3) One approach is to limit the constraints by assigning them to formal families
  - a. Generalized alignment (McCarthy and Prince 1993):  $\text{Align}(X, L/R, Y, L/R)$ .  
“Every left word edge must coincide with the left edge of a syllable Rhyme.”
- (4) Another approach is the construction of constraints from primitive elements by local conjunction: “Don’t violate both constraint A and constraint B in the same domain D”

### 1.2 Appeals to function

- (5) Intuition: constraints solve some sort of problem or avoid difficulty; implying that “optimality” is not just a term for the overall design of the theory, but a characterization of what grammars are like.
  - a. Functionalism has long existed in linguistics; e.g. Chomsky and Halle (1968) suggest that syntactic structure is reparsed into (what later came to be known as) phonological phrases so as to make it more processable on line.
  - b. A large conference volume on functionalism: *Functionalism and Formalism in Linguistics*, ed. Michael Darnell, Edith Moravcsik, Michael Noonan, Frederick J. Newmeyer and Kathleen M. Wheatley (1999, Benjamins)

### 1.3 Three proposed functional goals in phonology

- (6) All involve phonetics in some way.
- a. Articulation: develop output representations that are easily and quickly executable by the articulatory apparatus.
  - b. Perception: develop output representations that yield acoustic representations that are mutually distinct; hence maximally decodable by the perceptual apparatus.
  - c. Morpheme identification: develop output representations in which the morphemes have uniform realization in all appearances, which may be conjectured to facilitate their identification.
- (7) Work by phoneticians on articulation/perception
- a. Such views can be found in the work of phoneticians such as Lindblom and Kohler:
    - Kohler, K. 1990 "Segmental reduction in connected speech in German: phonological facts and phonetic explanation:" in Hardcastle, W.J. and A. Marchal (eds.) *Speech Production and Speech Modeling*, Kluwer, Dordrecht, 69-92.
    - Lindblom, B. 1990 "Explaining phonetic variation: a sketch of the H&H theory", in Hardcastle, W.J. and A. Marchal (eds.) *Speech Production and Speech Modeling*, Kluwer, Dordrecht, 403-439.
    - Lindblom, B. S. Guion, S. Hura, S.-J.Moon, R. Willerman 1995 "Is sound change adaptive?" *Rivista di Linguistica* 7, 5-37.

### 1.4 A simple case of "phonetic explanation" in phonology

- (8) Maddieson (1984) *Patterns of Sounds* (Cambridge) gives several hundred phoneme inventories, remarking on asymmetries
- a. characteristic stop inventory:
 

p	t	k
b	d	g

I.e. the pressure for symmetry is generally rather strong.
  - b. gap-ridden stop inventories:
    - a. often
 

t	k (Arabic)
b	d g
    - b. perhaps
 

p	t k (Dutch)
b	d
    - c. certainly
 

p	t k q (Persian)
b	d g

- (9) These asymmetries plausibly reflect articulatory difficulty, documented with aerodynamic modeling in Westbury and Keating (1986). The crucial mechanism is the amount of yield vocal tract wall.
- (10) The teleologies of articulation and perception characteristically conflict (consider rival forms [aba] and [aβa]), so it seems a fine opportunity to deploy OT...

## 1.5 Opinions about functionalism: Classifying the views

- (11) One extreme: drift and diachrony The system drifts in ways determined by phonetic difficulty, and (usually unspecified) methods learn or mislearn the pattern, from the lexicon, over time. A prominent advocate of this view is John Ohala, e.g. in his famous paper Ohala (1981).
- (12) More recently, the “drift plus mislearning” approach has been elaborated by Juliette Blevins (Blevins 2004).
- (13) Scheme: final devoicing
  - a. Voicing is imperiled in phrase-final position, due to fall-off of subglottal pressure.
  - b. This in turn imperils the acoustic cues, leading to mis-acquisition.
- (14) A grammar-ful variant position
  - a. (Frisch et al. 2004): phonetic change (or preference: what loanwords get adopted?) alters the lexicon, and Junior learns the constraints from the lexicon
- (15) The far opposite position: strong innatism
  - a. If phonology is phonetically effective, it is because our ancestors evolved an innate constraint set that makes it so. Most of the OT work of John McCarthy, and the phonological work of Paul Smolensky, has adopted a strong innatist position.
- (16) An intermediate position: projection of grammar from phonetic experience
  - a. Language learners, tacitly aware of their own phonetic experience, forge constraints from it that make their phonology phonetically sensible. See readings and Hayes (1999), Steriade (2001).

## 1.6 Teasing apart the positions: drift and diachrony vs. the others

- (17) The general form of the argument
  - a. If phonetic naturalness reflects an active, grammatical ability, it should be manifested in the active, form-creating behavior of adults in novel situations.
  - b. If, by contrast, it is only the result of accumulated phonetic error over time, this should not be so.
- (18) Do speakers generalize in learning based on naturalness?
  - a. Wilson (2006): *Learning Phonology With Substantive Bias: An Experimental and Computational Study of Velar Palatalization*

- b. Learn to reply with a repetition, or a palatalized repetition, of the input. ['gabə] ... ['gabə] OR ['gabə] ... ['dʒabə]
  - c. Includes boring cases like ['mabə] ... ['mabə]
  - d. Generalization task (implicit, hidden by filler items)
    - (i) train on [gi] ~ [dʒi], do they generalize to [ge] ~ [dʒe], missing from training set?
    - (ii) train on [ge] ~ [dʒe], do they generalize to [gi] ~ [dʒi], missing from training set?
- (19) Approximate result, amid considerable experimental noise: A no, B yes.
- (20) The pattern matches crosslinguistic studies of palatalization, which is favored before higher front vowels (Bhat 1978).
- (21) Release of velars is noisier before higher vowels, so [gi] ~ [dʒi] is an undramatic alternation relative to [ge] [dʒe]. The evident basis of alternation is “Substitute [dʒ] for [g], provided the result is a non-dramatic phonetic alternation.”
- a. The pattern has no statistical basis in the existing lexicon of English.
- (22) Child phonology is likewise endogenous and not the creation of drift and diachrony; hence Blevins is up front in saying it isn't phonology, but malperformance

## 2 The role of speech perception

- (23) Preliminary note: All discussion below is neutral between grammar-based and historical/error-based accounts of naturalness in phonology.
- (24) The deceptiveness of the concept “hard to say”
- a. Hard phonological strings feel hard to say, but for a deceptive reason.
  - b. Consider the articulatory difficulty of \*[ktæ] vs. [kæt]
  - c. See Kaye (1989) for a classic statement of the articulation-centered position.
- (25) Articulatory effort. This is modelable, though with difficulty: effort resides in:
- a. extreme displacements of articulators
    - (i) peripheral vowels
    - (ii) fortis stops
  - b. rapid displacements
    - (i) short diphthongs and contour tones
    - (ii) pharyngeals adjacent to high front vowels
  - c. perhaps, requirements of high precision (sibilants, trills)
  - d. See dissertations by Boersma (1998) <http://www.fon.hum.uva.nl/paul/papers/funphon.pdf> and by Kirchner (ROA 276) for attempts to be explicit about articulatory effort, with computational models.
- (26) Sorting out articulatory and perceptual causes can be difficult because hard articulations often lead to bad perceptual cues.

## 2.1 A central principle of perception: cue theory

- (27) Basis: we don't directly hear consonants and vowels, but interpret them from an input waveform.
- (28) Many sounds are (nearly) silent, but are heard through the intermediating factor of coarticulation.

### 2.1.1 Internal cues = heard during the sound

- |                              |   |
|------------------------------|---|
| i. stops                     | none  |
| ii. nasals                   | few, and not particularly distinct for different nasals     |
| iii. non-sibilant fricatives | few, and not particularly distinct for different fricatives |
| iv. sibilant fricatives      | fairly ample  |
| v. vowels                    | very ample, particularly if long and/or stressed            |

### 2.1.2 External cues = heard on neighboring sounds, due to coarticulation

- i. formant transitions on neighboring vowels.  
Every sound except glottals triggers transitions. Even other vowels.
- ii. stops burst at release, VOT
- iii. nasals coarticulatory nasality

## 2.2 Cues and segment distribution

- (29) A subset of the segment inventory “stands alone” with internal cues
- typically high-sonority, esp. vowels
  - typically syllable nuclei (see later)
  - The remainder of the inventory is required to be adjacent to “independent” segments that can bear their external cues.
- (30) Factoring in the asymmetries of the auditory system
- Literature review: Wright (1997); also his chapter in Hayes et al. (2004).
- (31) The auditory system goes wild at sudden increases in amplitude, is indifferent to sudden decreases
- CV transitions are salient, VC transitions are not
  - a preference for consonants in prevocalic position
- (32) Hypothesis:

Phonological grammars tend to arrange sounds so as to place consonants in locations where the least articulatory effort produces the most distinct results.

- (33) What we would expect in phonologies
- Segments which are rich in internal cues are deployed in contexts of **durational abundance**.
  - Segments which are poor in internal cues are deployed in contexts where they will possess good external cues, i.e. adjacent to, and preferably before, high-sonority segments
  - All this in the context of OT, where such principles makes their effects felt more subtly, due to constraint ranking. The real empirical predictions emerge mostly at the level of factorial typology.

## 2.3 Segment sequencing typology in the light of perception

- (34) The Universal Environment of Consonants
- \_\_\_ V, before true vowels<sup>1</sup>
  - Vowels provide the best acoustic backdrop for external cues
  - Prevocalic position benefits from auditory-system asymmetries
  - Prevocalic stops possess bursts
- (35) Differences in Quality of External Cues
- Other than for stop bursts: high-sonority neighboring segments carry better external cues
- (36) Postvocalic Position
- / V \_\_\_ ]word, / V \_\_\_ C
  - best cues are on preceding vowel: /ab/, /abda/
- (37) Postsonorant Position
- / [+sonorant] \_\_\_ ]word, / [+sonorant] \_\_\_ C
  - best cues are on preceding sonorant: /arb/, /arbda/

### 2.3.1 Comparison with An Earlier Approach

- (38) Earlier we saw this analysis: Languages favor forms that obey the following constraints:
- ONSET
  - \*CODA
  - \*COMPLEX ONSET
  - \*COMPLEX CODA
- (39) **Comparison Point I:** 2-Consonant Onsets Whose Second Member is an Obstruent
- Theories that say, “Onset segments are privileged”, should claim that many contrasts are possible here. Probably not right:

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<sup>1</sup>Note that \_\_\_ [+syllabic] does not suffice. Many Bantu languages have word-initial syllabic nasals, which (to my knowledge) never take onsets.

- (i) English: sp, st, sk / marginal ʃp, ʃt, ʃk no others.
  - (ii) Spanish: no consonants may occur in this position
  - (iii) Russian/Polish: lots of weird clusters, but no voicing contrast: ✓[pt], but \*[bt] etc.
- (40) Note that here we have a choice between a hierarchical characterization and a linear one, and the linear one seems to work better.
- (41) **Comparison Point II: Sibilants**
- a. Alone among consonants, these prosper in non-vowel-adjacent position  
English stop vs. \*[ftap] Spanish [toraks] vs. \*[torakp]
  - b. Conjectured reason: their powerful internal cues let them survive better on their own
    - (i) Missing aspect: distribution does not match syllabicity; i.e. [sta] is crosslinguistically common, but [s.ta] is exotic to a Berber-like degree.
    - (ii) Thus: good internal cues alone tend to license distribution, but it is true sonority that licenses syllabicity.
- (42) **Comparison Point III: Consonant Releases and their Distribution**
- a. Medial:
    - (i) Many languages disallow release in consecutive consonant sequences: English *napkin*, *actor* seem \* (at least, for me) with medial releases.  
[ˈnæpˈkɪn] vs. \*[ˈnæpˢkɪn], [ˈækˈtɪ] vs. \*[ˈækˢ tɪ]
    - (ii) Other languages allow optional release: French *acteur*, at least for some speakers An obligatory-release language?: Central Alaskan Yupik (Woodbury 1981)
  - b. Final:
    - (i) Some languages are thought to forbid final release: Korean?
    - (ii) English has optional release in final position: *nap* [næpˈ], [næpˢ]
    - (iii) Conjecture: every language that forbids final release forbids medial release

### 2.3.2 Releases and Audibility

- (43) Demo. Compare:

[ˈa tˈka] vs. [ˈa kˈka] with  
[atˢka] vs. [akˢka]

- (44) Consequences of release for final vs. non-final codas
- a. Final: often final consonant is released, yielding burst
  - b. Non-final: consecutive consonants are virtually always overlapped, covering burst
  - c. Overlap also causes contamination of place cues for VCCV
  - d. Prediction:
    - (i) there should be languages that allow richer codas in final position

- (ii) Cairene Arabic, Diola-Fogny, Majorcan Catalan, English, etc.
- e. Prediction:
  - (i) languages that release the first C of a cluster will have relatively free codas:
  - (ii) true in Yupik Eskimo
- f. Topic: release being underdocumented, the relation between release patterns cross-linguistically and phonological behavior is not well understood.

### 2.3.3 Other interesting cases

- (45) Retroflexes (various work of Steriade; including readings) have a forward tongue movement during them
  - a. at release, almost alveolars
  - b. cues are mostly in preceding vowel [aɖa] [ada]
  - c. characteristic preferred position of retroflexes is **postvocalic**, even in codas
- (46) Pre-Creaked Sonorants
  - a. Creak overlaps with preceding vowel. Creak would overlap with a preceding consonant, which would render it less audible.
  - b. And the characteristic preferred position of pre-creaked sonorants is postvocalic, even in codas
- (47) Reversing the Argument: Extra Faithfulness in certain Codas
  - a. Lithuanian, Greek Sanskrit: contrasts of voicing and aspiration in sonorants require a following sonorant which (as other diagnostics may tell us) may be in the following syllable.
 

ab.na, ap.na, ap<sup>h</sup>.na vs. ap (only), ap.ta (only)
- (48) Hence, the argument goes both ways:
  - a. codas with good cues
  - b. onsets with bad cues

## 2.4 Whither Syllables

- (49) They're still there! But perhaps more relevant to prosodic phenomena:
  - a. docking sites for stress and tone
  - b. counted in metrics

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