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Some Research Strategies for Feature Theory

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"The Inner Structure of Distinctive Features"

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1. Conjecture: Some Phonologists' Assumptions On Phonetics and Feature Theory

- Phonological representations have a clear relation to phonetic phenomena (e.g. feature definitions; articulator nodes)
- Phonological representations are formally **impoverished** and **schematic**, relative to the phonetic phenomena that they represent.
- The mental computations of phonology take place on these schematized phonological representations.
- A major goal of feature theory is to develop a suitable schematized representation of phonetics, which will fully capture the effects of phonetic substance in phonology.

2. The View Suggested Here

- The physical, physiological, and perceptual systems involved in speech are very complex.
- This complexity includes interactions and trade-offs between various factors (examples below).
- The full complexity of phonetics is indeed reflected, at times, in phonology.
- There is therefore little hope of reflecting phonetic patterning in phonology with a schematized formal representation.
- The current lack of consensus in feature theory is because phonologists are asking more of a feature theory than it is able to give.

3. Promissory Note

This is not a counsel of despair!

4. Coals to Newcastle

Examples of the type to be given have been found before, notably by Ohala (1974, 1978, 1981, 1983, Ohala and Ohala 1993). The more the merrier ...

5. Case To Be Examined: Postnasal Voicing

Full writeup of this is available: Hayes and Stivers (in progress)

6. Phonological Typology of Postnasal Voicing

- A non-negligible proportion of the world's languages ban voiceless obstruents specifically after nasals (perhaps 7-8%, based on Locke 1983's counts)
- The ban results in postnasal voicing; various other "*NC̥" remedies (Pater (forthcoming).
- The ban is specifically one on **postnasal** voicelessness; prenasal position is not different from any other intersonorant position.

A CONJECTURED PHONETIC MECHANISM FOR POSTNASAL VOICING

7. Voicing Control in Obstruents

- Major mechanism of voicing turn-off in obstruents is **build-up of oral pressure**, which cuts off transglottal airflow (Ohala 1983, Westbury and Keating 1986).
- There are other factors, specific to nasal-adjacent obstruents:

8. Nasal Leak

- A nasal neighboring an obstruent induces **velar coarticulation**: part of the obstruent will have a slightly lowered velum. One then obtains **nasal leak**: leakage of air through the velar port, during what is acoustically an oral obstruent (Ohala 1975, 300).
- Nasal leak makes it harder to maintain voicelessness during a nasal-adjacent obstruent (Rothenberg 1968; Kent and Moll 1969).

9. Velar Pumping

a) Some velum positions: (1) open; (2) closed but not all the way up; (3) closed and all the way up. Target position for obstruents = (3) (Bell-Berti 1975; Bell-Berti and Hirose 1975).

b) In Nasal + Obstruent: obstruent shows transition from (2) to (3). This is **rarefactory velar pumping**: expands supraglottal chamber, makes it harder to turn off voicing.

c) In Obstruent + Nasal: obstruent shows transition from (3) to (2). This is **compressive velar pumping**: contracts supraglottal chamber, makes it easier to turn off voicing.

10. Putting It All Together

a) **Nasal + Obstruent**: two factors *combine* to make devoicing harder.

b) **Obstruent + Nasal**: two *opposing* factors result in a neutral context.

Therefore, the raw phonetic mechanisms tend to favor specifically postnasal voicing.

11. Why We Think This is Right

- **Modeling**: across a wide array of parameter values, the pressure/flow vocal tract model of the UCLA Phonetics Lab (Westbury and Keating 1986, Keating 1984) produces considerably more closure voicing in postnasal stops than for other environments.
- **Experiment**: five English speakers saying multiple repetitions of [ˈtampə] and [ˈtaɹpə] produce considerably more voicing-into-closure for [p] in [ˈtampə] than in [ˈtaɹpə].[1]

12. Local Conclusion

A collection of *utterly accidental* aerodynamic factors makes it harder to turn off obstruent voicing in a rather specific environment: after (and only after) nasals.

13. Phonology as Schematic Rendition of the Phonetics: The Features That Would Be Needed

* [–sonorant
–voice
+minor nasal leak
+rarefactive velar pumping]

- The last two features, I think, are of no phonological relevance, other than in making possible a schematic representation for expressing postnasal voicing.
- In particular, they define no natural classes.

14. General Point

No impoverished, schematic rendition of phonetic form with (reasonable) phonological features is likely to be rich enough to schematize all the complexities that the phonetic system involves.

15. Some Sound Bites Making the Same Point

(a) **Madurese** requires vowels to be [+Advanced Tongue Root] after voiced obstruents (Trigo 1991); some Armenian dialects require vowels to be **front** in the same context (Vaux 1994). Are voiced obstruents simultaneously inherently [+ATR] and [-back]?

(b) **English** /t/ → [t͡ʃ] / ___ w, as in *twin*. Does /w/ (but not vowels) share features with palato-alveolars, or with affricates?

[1] But not as much voicing as in [ˈtambə], included as a control. The process is near-neutralizing in fast speech, but never actually neutralizing.

(c) **Madimadi** i → y / ___ retroflexes (Hercus 1969, Flemming 1995). Are retroflexes rounded, or are front rounded vowels retroflex?

16. The Common Point of the Examples

For all the cases of (15), the relevant phonology serves phonetic ends:

(a) Facilitate obstruent voicing through expansion of a closed supraglottal chamber

(b) Enhance the /tw/ ~ /kw/ contrast by increasing the release noise of the member which has an *a priori* noisier release

(c) Enhance the /it/ ~ /iʈ/ contrast by increasing the F3 difference (crucial cue to retroflexion) during the /i/-to-/ʈ/ transitions

but again, current phonological representations are too schematic to characterize the phonetic basis of the process.

Further, beefing up the feature system to include the requisite detail would introduce segment classifications of no phonological relevance.

WHAT OPTIMALITY THEORY[2] SUGGESTS

17. Let the constraint system do the work.

- Constraint-based solutions are more flexible, accurate, and sensitive to the character of the phenomenon involved than representational solutions.
- Here, the constraint system embodies a phonology that is well-adapted to its phonetic base.

18. Project constraints from phonetic scales (Prince and Smolensky 1993; Steriade 1997)

Start: high sonority
→ phonetic suitability for forming a syllable nucleus
→ a family of constraints forbidding segments of relatively low sonority from appearing as nuclei

19. A More Plainly Phonetic Example

*[+nasal][-voice] (the "*NC̥" constraint; Pater (forthcoming))

- likewise represents the phonological categorization of a phonetic scale
- It singles out a phonological configuration that corresponds to an extreme along a different phonetic scale: articulatory difficulty in producing voicelessness.

[2] Prince and Smolensky (1993).

- Where it differs is in referring to a sequence, not a single segment; but the point is essentially the same.

20. Does work in phonetics illuminate the feature system?

Not necessarily: it illuminates **the role of phonetics in phonology**, but that role should not be limited to defining the feature system.

WHAT ARE FEATURES FOR?

21. The Conundrum

If the real work of expressing phonetic effects in phonology is to be attributed to the constraint system, what evidence do we have for or against any particular feature theory?

22. The Conjecture of Phonological Symmetry (Hayes, in press)

- Phonetic patterns involve extensive trade-offs between different phonetic factors.
- But phonological constraints tend to override these trade-offs, banning symmetrical regions of phonetic space, even at the expense of "phonetic accuracy."

23. Landscape of Difficulty for Voiced Stops: Three Places, Four Environments

	b	d	g	
[-son] ___	43	50	52	
# ___	23	27	35	
[+son, -nas] ___	10	20	30	
[+nas] ___	0	0	0	contour line: 25

- Values calculated, with a lot of arbitrary assumptions, from UCLA aerodynamic vocal tract model (Keating 1984).
- For general typology of voicing difficulty, which the chart faithfully reflects, see Ohala (1983), Westbury and Keating (1986).

24. A Phonological Constraint that Truly Respects the Phonetics

a. *Any voiced stop that characteristically requires more than 25 units of effort
= b. *Post-obstruent voiced stops,
*[d,g] in initial position,
*[g] after oral sonorants

It is unlikely that any language manifests this constraint.

25. Real Phonological Constraints are More Symmetrical

a. *Voiced obstruent word-finally (Polish)
b. *Voiced obstruent after another obstruent (Latin)
c. *Voiced obstruent geminate (Japanese)
d. *Voiced velar obstruents (Dutch)

26. The View Taken Here

- Features define the **categories** on which phonological constraints are stated.
- To find evidence for these categories, find phonological cases that reflect symmetry, resulting in failure to achieve perfect reflection of the phonetic difficulty.
- The features in which the categories are cross-classified can then be justified as authentic phonological features.
- Thus, features defining the classes of obstruents, of geminates, of velars are in principle supported by the cases of (25).

27. What Else Might Test Features as a Theory of Category Formation?

- **"Bach" testing** (Halle 1978):

  plural of *Bach* is [bax**s**] supporting [-voice, -sibilant] as a phonological category
  plural of [toʂ] is [ˈtoʂəz] supporting [+sibilant] as a phonological category

- **Pattern-learning experiments**

  Invented patterns of allomorphy: are featurally-defined classes easier to learn?

- **Examination of morphophonemic patterns when new sounds appear**

  Arabic /l/ Assimilation: $l \rightarrow C_i \ / \_\_\_ \ C_i$ where Ci is [+coronal]

  Comrie (1980, 30-31): dialects that acquire [d͡ʒ] or [ʒ] by borrowing or sound change (from ***g**) characteristically extend /l/ Assimilation to these new coronal sounds (though not instantaneously).

CONCLUSIONS

28. Phonological Features are Classificatory

I.e. they define categories; and the way to study them is to see how phonology refers to categories.

29. What I Hope will Ultimately be Regarded as Naive

Use of features simply to mirror phonetic processes, e.g. "voiced obstruents **must** be [+ATR], because Madurese vowels become [+ATR] after voiced obstruents"

Such arguments

- Fail to see that the same goal is accomplished more effectively and more generally in the constraint system, not the feature inventory.
- Neglect to justify the implicit claim that voiced obstruents and [+ATR] vowels constitute a phonological category.

30. Speculation

- Most existing work on features has been guided, at least in part, by adherence to the "mirroring" approach just castigated.
- Suppose a research program was conducted that considered features as primarily classificatory, defining phonological categories.
- Might such research achieve a greater degree of consensus on feature theory than what we see today?

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