Linguistics 219 — Spring 2020
Phonological Theory III — B. Hayes

Class 14, 5/14/2020: Phonetics of Weight III

1. Assignments

- No reading this time; catch up on the Ryan and Gordon readings.
- Homework #4, handed out today, is due on Tuesday, May 26.

EXERCISE: FINDING THE BEST CONSTRAINTS FROM A PHONETIC MAP

2. Exercise

- See spreadsheet on course web site.

3. The phonetic difficulty map for voicing in stops

Source: Hayes, B. (1999) "Phonetically-Driven Phonology: The Role of Optimality Theory and Inductive Grounding" in Michael Darnell, Edith Moravscik, Michael Noonan, Frederick Newmeyer, and Kathleen Wheatly, eds., Functionalism and Formalism in Linguistics, Volume I: General Papers, John Benjamins, Amsterdam, pp. 243-285

4. The phonetic difficulty map

stop:	b	d	g
features:	[+labial,-dorsal]	[-labial,-dorsal]	[-labial,+dorsal]
[-son] ___	43	50	52
# ___	23	27	35
[+son, -nas] ___	10	20	30
[+nas] ___	0	0	0

- Hayes uses a map twice as large, encompassing the voiceless stops as well.

5. Origin of the map

"I obtained this map by using a software aerodynamic vocal tract model. This model was developed originally by Rothenberg (1968) as an electrical circuit model, and is currently implemented in a software version in the UCLA Phonetics Laboratory. This version (or its close ancestors) are described in Westbury (1983), Keating (1984), and Westbury and Keating (1986). Roughly, the model takes as input specific quantitative values for a large set of articulations, and outputs the consequences of these articulations for voicing, that is, the particular ranges of milliseconds during which the vocal folds are vibrating. The units in [the] chart represent articulatory deviations from a posited maximally-easy average vocal fold opening of 175 microns; these deviations are in the positive direction for voiceless segments (since glottal abduction inhibits voicing) and negative for voiced (since glottal adduction encourages it)."

6. Overall strategy

- "good" constraints (= assigned high mu values in learning?) are those which
  - a. separate the map into distinct zones clearly
  - b. use few features to do the job
- (a) is the same criterion as later used by Gordon for syllable weight, where the map is perceptual energy integral
- (b) is the *SPE* evaluation metric, imported from the (idealized, unimplementable) domain of whole grammars to the local domain of constraint design.

7. How to measure separation?

- Hayes (1999) suggests this scheme, where E1 and E2 are entries in the map:

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Correct predictions
E1 violates C and E2 obeys C; E1 is harder than E2.
E1 obeys C and E2 violates C; E1 is easier than E2.

Errors
E1 obeys C and E2 violates C; E1 is harder than E2.
E1 violates C and E2 obeys C; E1 is easier than E2.

Constraint effectiveness
Effectiveness = Correct predictions / (Correct predictions + Errors)
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- Gordon (2005, readings) says: take the mean in each category and subtract
- For this exercise, let us adopt Gordon's criterion.

8. The exercise

- For the map given, and the Gordonian criterion, find the best available constraints in order of increasing complexity, starting with one feature.

9. Gordon doing this on a larger scale: perceptually computed energy integrals for classes of syllables in Pirahã

- The perceptual model:

Schematic example of perceptual energy calculation

Step 1 Step 6

Step 2	Window 1 (0–11 ms)	Window 2 (11–22 ms)	Window 3 (22–33 ms)	Window 4 (33–44 ms)	Total
Intensity average	45.14 dB	40.86	42.57	37.14	
Diff(ave-baseline)	0	−4.28	8.12	−5.43	
Recov/adapt value		4 (Adapt)	2 (Recov)	4 (Adapt)	
Recov/adapt *diff	0	−17.12	16.24	−21.72	
(Recov/adapt *diff) + ave	45.14	23.76	58.81	15.42	143.13
Baseline	45.14	34.45	42.57	35.78	

Step 3 Step 5 Step 4

- The effectiveness ranking of constraints

TABLE III

Perceptual energy differences in the rime between heavy and light syllable mean values according to different weight distinctions in Pirahã

	Distinction	Sign.	Wilkes' λ	Diff (heavy–light) (arbitrary units)
Best ↑	Kaa > others	$p = 0.000$	0.861	822.4
	(C)VV > CV	$p = 0.000$	0.770	611.9
	(C)VV, Ka > others	$p = 0.000$	0.820	585.4
	KV(V) > GV(V)	$p = 0.000$	0.882	437.2
	CV(V) > V(V)	$p = 0.009$	0.949	401.3
	(C)V_iV_j > (C)V:	$p = 0.364$	0.990	−139.2 (CV >)
	High T > Low T	$p = 0.204$	0.988	136.1
↓	Low V > High V	$p = 0.307$	0.991	−121.7 (HiV >)
Worst	Ka(a) > others	$p = 0.682$	0.999	53.2

- Outcome:
  - provided we avoid constraints that are complex in a particular sense (combining structural and featural info), then
  - the real Piraha constraints emerge on top

  - ➢ and they emerge in the right order

- and more: a study of non-stress languages indicate that the causality arrow goes phonetics → stress, not stress → phonetics

AN EXERCISE IN PREPARATION FOR THE HOMEWORK

10. Indonesian stress: the monomorphemic cases

- Let us get on the same page with analysis of Indonesian stress by doing the monomorphemic forms together.

1 syllable	[cát]	‘print’
2 syllables	[cári]	‘search’
3 syllables	[bicára]	‘speak’
4 syllables	[bìjaksána]	‘wise’
5 syllables	[kòntinuási]	‘continuation’
6 syllables	[òtobìográfi]	‘autobiography’
7 syllables	[àmerikànisási]	‘Americanization’

11. Thinking about constraints

- Some possibilities:
  - ➢ constraints on foot form (max disyllabic, trochaic)
  - ➢ CULMINATIVITY (every word has a main stress)
  - ➢ FTBIN (*monosyllabic foot)
  - ➢ ALL-FEET-R/L
  - ➢ ALIGN(Word, L/R, Foot, L/R)
  - ➢ *UNFOOTED

12. Thinking about GEN

- Let’s limit ourselves to candidates that obey inviolable constraints

BACK TO SYLLABLE WEIGHT

13. Key concepts so far

- Phonetic functionalism
- Maps as a method of extracting meaning from the variable real phonetic world
- Measures of phonetic effectiveness: separating the heavy from the light, the good from the bad
- Phonetic effectiveness as a way of assigning “principled mu’s” to constraints.

14. Repeating the research questions

- Why do the core criteria CVV > CVC > CV work consistently across languages?
- Why are the core criteria more robust (overriding, better attested) than the peripheral criteria?
- Why is there language specific variation in the choice of Latin vs. Khalkha criteria?

GRADIENCE AND RYAN'S LAW

15. Gradient contexts

- Here, we look at some database:
  - a digital lexicon
  - a body of quantitative verse

  and examine it with statistical tools to find the gradient patterns.

16. Ryan's Law

- Where syllable weight is treated gradiently/statistically, *virtually all criteria get accessed*.
- The Gordonian primordial slime, seen in the maps, does not disappear once the categorical weight criterion is extracted!
  - Stochastic phonology and stochastic metrics still can "see" gradient phonetics.

17. Examples

- Kelly on English, above
- Probably, Nanni on *-ative*, above (since judgments vary a lot in the stressing of these words)
  - Pace Nanni I'm pretty comfortable with *innovative*, *investigative*, and *administrative* with stressless [-əɾəv].

THE PRIMARY TESTING GROUND FOR RYAN'S LAW: CLASSICAL METER

18. Main reference

- Kevin Ryan (2011) Gradient syllable weight and weight universals in quantitative metrics. *Phonology* 28:413–454. (readings)
- This is the journal-distillation of part of his UCLA dissertation:
  - *Gradient Weight in Phonology*, 2011
- … and you can learn more by reading his recent book.

19. Some quantitative meters

- Greco-Latin dactylic hexameter

1		2		3		4		5		6
L	B	L	B	L	B	L	B	L	B	L
–	{– / ⏑⏑}	–	{– / ⏑⏑}	–	{– / ⏑⏑}	–	{– / ⏑⏑}	–	{– / ⏑⏑}	– {– / ⏑}

- Some classicist terminology: L = "longum", B = "biceps"[1]
- Example from the *Iliad* (Ryan 2011, discussed below)

a. τριπλῇ τετ[ραπ]λῇ τ᾽ ἀποτείσομεν, αἴ κέ ποθι Ζεὺς 1.128
trip.lɛːj]$_1$ tet.[rap]]$_2$lɛːj • t' a.po]$_3$tej.so.me]$_4$n aj .ke .po]$_5$tʰi z.dews]$_6$
– –]$_1$ – [–]]$_2$ – • ⏑ ⏑]$_3$ – ⏑ ⏑]$_4$ – ⏑ ⏑]$_5$ – –]$_6$

b. εἴ ταρ ὅ γ᾽ εὐ[χω]λης ἐπιμέμφεται ἠδ᾽ ἑκατόμβης 1.065
ej .ta.r ʰo]$_1$ g' ew.[kʰɔː]]$_2$lɛː • s e.pi]$_3$mem.pʰe.ta]$_4$j ɛː.d' ʰe.ka]$_5$tom.bɛːs]$_6$
– ⏑ ⏑]$_1$ – [–]]$_2$ – • ⏑ ⏑]$_3$ – ⏑ ⏑]$_4$ – ⏑ ⏑]$_5$ – –]$_6$

- Persian meters (tradition flourished ca. 600-1900; best ref. is Elwell-Sutton 1976; analysis in Hayes 1979)

a. ⏑ — — — ⏑ — — — ⏑ — — — ⏑ — — —
b. — ⏑ — — — ⏑ — — — ⏑ — — — ⏑ —
c. ⏑ – ⏑ – / {⏑ ⏑ / –} – – / ⏑ – ⏑ – / {⏑ ⏑ / –} –
d. — — ⏑ ⏑ — — ⏑ ⏑ — — ⏑ ⏑ —
e. — — ⏑ ⏑ — ⏑ —⏑ — — ⏑ ⏑ —[2]

- Hausa (Hayes and Schuh 2019, *Language*)

{⏑ ⏑ / —} — {⏑ ⏑ / —} — {⏑ ⏑ / —} — ⏑ —

(and many others)

20. Typology of quantitative verse

- Quantitative meter is a lot like stress-based meter in that it is usually
  - periodic (sequence of parallel constituents)
  - based on hierarchy — e.g. tetrameters are favored

[1] "Biceps" has a nice plural, *bicipitia*.
[2] for Rubaiyat

   - prone to leaving out stuff at the end (catalexis)
   - It tends to require stricter adherence to the template at the end of the line.[3]

- Quantity is "swamped" by stress, and so quantitative meter is largely found in stress-free, or weak-stress languages.

- Yet stress languages can nevertheless use quantity in verse — typically, they regulate only (or principally) the *quantity of stressed syllables*.
   - Old Norse, discussed by Ryan
   - Finnish, discussed by Ryan
   - The English quantitative verse of Gerard Manley Hopkins (Kiparsky 1989; Hayes and Moore-Cantwell, *Phonology* 2011)

- Unlike stress-based meter, quantity is sometime deployed in quite baffling, aperiodic meters.
   - Greek lyric verse, also Sanskrit
   - Perhaps these anchored their irregular quantity patterns to a sung melody?

21. Ryan's Law in early scholarly literature

- Earlier students (traditional classics scholars, and even the ancients themselves) had a sense that Ryan's Law is applicable in certain cases.
- But they didn't have statistical testing to prove their point.

22. Longum vs. biceps in Homer

- Ryan downloaded and autoscanned the *Iliad* and the *Odyssey.*
- He compared what *sort of* heavies occur in
   - longum (obligatory —) position
   - biceps (varies with ◡ ◡)
- Here is a simple result:

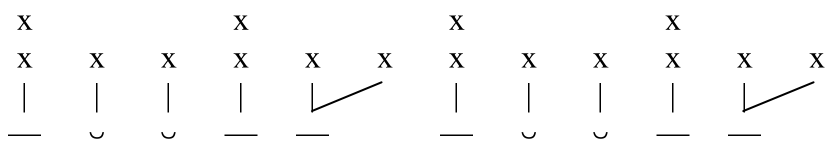
	VV rhyme	VC rhyme	VV : VC ratio
longum	75,931	58,862	1·290
biceps	19,143	8,946	2·140

23. Excursus: Why should *biceps* be the "stronger" position?

- Everyone always recited the dactylic hexameter as "DUM duh-duh DUM duh-duh DUM duh-duh DUM duh-duh DUM duh-duh DUM dum", right?
- This is not just an amateur intuition:

[3] Exception: weight is virtually never enforced in *absolute* final position; perhaps not audible there?

   - In a living tradition (work of Russ Schuh), Hausa musicians tend to sing heavy syllables on the strong beat.
- One option for Hausa singer/poets is to sing "longum" as a single *strong* beat, "biceps" as two weak beats:



   - Perhaps Homer sang thus? This would justify making the "weak" biceps longer than the "strong" longum.

24. A methodological factor that always plagues inferences about meter

- How do we factor out patterns, especially quantitative ones, that might be "inevitable", given the phonology and lexicon of the language?
- There arose a whole school of metrists, the "Russian school", that devoted thought to overcoming this difficulty.[4]

25. A very simple way to control in the case of Homer: just examine second syllables of words with the shape / — — /

	VV rhyme	VC rhyme	VV : VC ratio
longum	6,810	3,999	1·703
biceps	3,829	1,513	2·531

26. Doing it more carefully with modern statistics

- **Mixed-effects regression models** have fully taken over the world of statistical testing for experimental work, at least in linguistics.
   - You can factor out unwanted "noisy" effects from the behavior of individual subjects and test items — these are treated as **random effects**, whereas the general, meaningful things we are interested in are treated as **fixed effects**.
   - The testing returns not just a *p*-value, but a sort of a baby theory, much like maxent, of how the domain under study works.
   - See Ryan p. 419 for references covering these models.
- Jesse Zymet in his 2018 UCLA dissertation suggests we may be headed this way for ordinary phonology — phonological processes may be more sensitive to particular lexical items than we have previously thought; these are his random effect.

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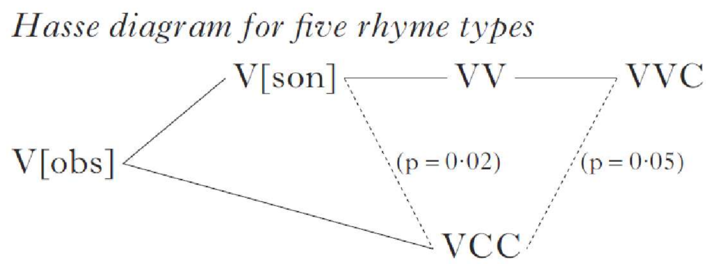
[4] See my "Milton, maxent, and the Russian method", on my web site, for references to, and an example of, this kind of work.

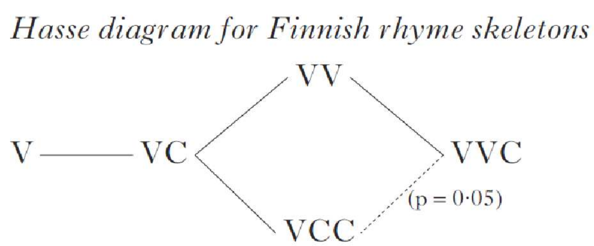
- Ryan applies the method to his Greek data: the random effect here is "word context".
  - e.g., "I am a syllable preceded by ◡ and followed by one single — in my word"
- The payoff is rigorous statistical testing, which ends up justifying an **extensive hierarchy** of weight criteria, which is quite sensible from a Gordonian point of view.
- For the Homer data:

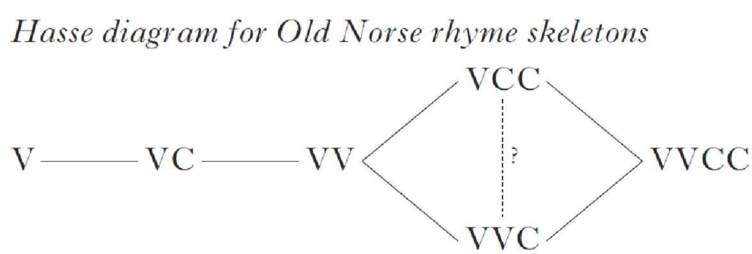


27. What about onsets?

- These appear only in Ryan's dissertation, not the paper, but the result is the same:
  - with statistical significance, onset CC makes greater weight than onset C than onset null.

28. Other quantitative systems studied

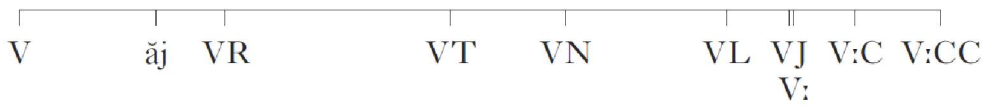




29. Tamil (poetry of Kamban, ca. 1200)

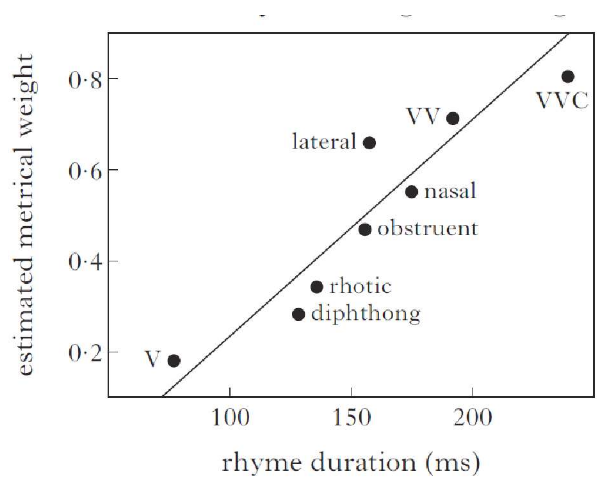
- This is by far the messiest, but nevertheless has a gradient orderliness:

Estimated weights of the rhyme types in Table IX



30. Tamil and phonetics

- Tamil is highly diglossic (acrolect, basilects).
- The acrolectal variety is phonologically very conservative.
- Amazingly, modern prestige speech, when measured by Ryan, provides syllable durations that match Kamban's scansions rather well.
- These rationalize the otherwise-baffling behavior of coda [j] and [r].



31. Why is Ryan's Law true?

- I see two possibilities:
- Standard stochastic constraint-based theory
  - As before, we inspect the p-map for structural possibilities
  - Many constraints emerge
  - All are used!
  - But usually (Latin, Greek, Sanskrit) one single criterion comes to dominate the system.
  - The others lurk in the background, visible only in the corners, as immediately above.

- Skip the constraints
  - The system somehow consults the P-map directly, and penalizes syllables on the basis of their predicted energy integral, based on the P-map.
  - This predicts that there will be no language-specific variation, other than that determined by language-specific phonetics, in the "fuzzy" portions of the metrical system.