Class the last: Dessert, course review

1 Administrative

(1) Agenda
   a. Harmony dessert
   b. Course review
   c. Course evaluations

(2) Assignments: slides/handouts due at end of today! Book a meeting with me to get feedback
   a. Enjoy your summer!

2 Capstone discussion: ABC+Q (Shih and Inkelas, 2019)

> In this article, we call for a rethinking of the way phonologists approach tone. Despite the appeal and persistence of autosegmental representations, we argue that the ABC framework offers an appropriately modern alternative to AP in the age of surface-optimizing phonology: ABC does as well or better at capturing key tone behaviors, and does not require the specialized autosegmental and feature-geometric representations that have been abandoned in most domains other than tone.
>
> Agreement by Correspondence (ABC) is a theory of string-internal surface correspondence . . . ABC is a radical deconstruction of the idea that assimilation-—-either local or long-distance——should be accomplished not via operational spreading (e.g., Goldsmith 1979, Poser 1982, Archangeli and Pulleyblank 1994, Ní Chiosaín and Padgett 2001) but via syntagmatic agreement constraints (e.g., Baković 2000, Yu 2005). ABC is related to the use of correspondence (and identity) to accomplish reduplication (see, e.g., McCarthy and Prince 1995, Zuraw 2002).
>
> Q Theory takes a different approach to the challenges that inspired AP by returning to the classic null hypothesis of units sequenced in time, but increasing the granularity of units that the grammar can reference. In Q Theory, the most granular level is the subsegment. Each segment Q consists of temporally ordered, featurally uniform, quantized subdivisions (i.e., subsegments) q

Danis and Jardine:

> We use model theory and logical interpretations to systematically compare two competing representational theories in phonology, Q-Theory (Shih and Inkelas, 2014, forthcoming) and Autosegmental Phonology (Goldsmith, 1976). We find that, under reasonable assumptions for capturing tone patterns, Q-Theory Representations are equivalent to Autosegmental Representations, in that any constraint that can be written in one theory can be written in another. This contradicts the assertions of Shih and Inkelas, who claim that Q-Theory Representations are different from, and superior to, Autosegmental Representations.

3 Feature sets and feature geometry

(3) When a phonological process targets not just a single feature but a set of "similar" features cross-linguistically, we may want some way to refer to that set.

Example 3.1 (English nasal place assimilation (McCarthy, 1988; Uffmann, 2011))**.**

in Sussex [ɪn sʌsɪks]	*in Britain* [ɪm bɹɪtn̩]
in Canada [ɪŋ kænədə]	*in Europe* [ɪŋ jʊːɹəp]
in France [ɪŋ fɹæns]	*in theory* [ɪn̪ θɪəɹi]

(4) Here's the nasal place assimilation process expressed as an SPE-style rule:[1]

[1] Note: [anterior] refers to whether articulation is at or in front of the alveolar ridge: [+ant] (alveolars, dentals) or behind: [-ant] (palato-alveolars, retroflexes). The variables $\alpha, \beta, \gamma \in \{+, -\}$

$$[\ +\text{nasal}\ ] \rightarrow \begin{bmatrix} \alpha\text{coronal} \\ \beta\text{anterior} \\ \gamma\text{back} \end{bmatrix} / \_\_ \begin{bmatrix} \alpha\text{coronal} \\ \beta\text{anterior} \\ \gamma\text{back} \end{bmatrix}$$

(5) But what makes that process more "natural" in SPE grammars than a process described by a rule like this:

$$[\ -\text{nasal}\ ] \rightarrow \begin{bmatrix} \alpha\text{coronal} \\ \beta\text{anterior} \\ \gamma\text{back} \end{bmatrix} / \_\_ \begin{bmatrix} \alpha\text{coronal} \\ \beta\text{anterior} \\ \gamma\text{back} \end{bmatrix}$$

(6) or a rule like this?

$$[\ -\text{continuant}\ ] \rightarrow \begin{bmatrix} \alpha\text{coronal} \\ \beta\text{nasal} \\ \gamma\text{sonorant} \end{bmatrix} / \_\_ \begin{bmatrix} \alpha\text{coronal} \\ \beta\text{nasal} \\ \gamma\text{sonorant} \end{bmatrix}$$

(7) or a rule like this?

$$[\ +\text{nasal}\ ] \rightarrow \begin{bmatrix} \alpha\text{back} \\ \beta\text{coronal} \\ \gamma\text{anterior} \end{bmatrix} / \_\_ \begin{bmatrix} \alpha\text{coronal} \\ \beta\text{anterior} \\ \gamma\text{back} \end{bmatrix}$$

(8) That is, why do we see the process described in (4) (or something similar), i.e. nasal place assimilation, so commonly across languages, and not these other processes we can write down with SPE rules?

(9) Representational assumption big change number 1:

a. In SPE style rules, the formal mechanism to express assimilation is to use variables over + and −. But we can see from (7) that it overgenerates.

b. Voila! Autosegmental representations come to the rescue:

> Assimilation is a common process because it is accomplished by an elementary operation of the theory – addition of an association line. A rule like [(7)] is far more complex to state than any true assimilation. Furthermore, the Line-Crossing Prohibition imposes a particular locality requirement on assimilatory processes: assimilation across a segment already specified for the assimilating feature is impossible. (McCarthy, 1988, p. 86)

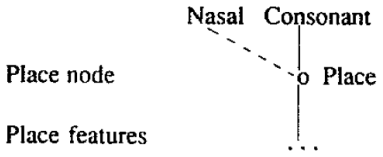
(10) But why does a particular set of features, i.e. place features, frequently appear in phonological rules like ones describing assimilatory processes, but not some other particular set of features?

(11) Representational assumption big change number 2: represent features hierarchically, e.g. with place features as daughters of a single abstract node, Place.

a. So now place assimilation, with this "feature geometry", can be described as the spreading of the Place node (McCarthy, 1988):

(6)

a. Place Assimilation Rule



b. Place assimilation is natural because it's just a single operation: it involves just the insertion of adding an association line on just a single element of the representation, the Place node.

(12) Empirical consequences of feature geometry under certain assumptions:

a. Assumption 1: typologically common phonological processes are those that are the most "naturally"/"simply" stated given a particular set of representational assumptions and assumptions about the grammar.

b. Assumption 2: hierarchical organization of features (and the set of features) is universal and fixed

c. then "any subset of the features that appears frequently in phonological rules should be dominated by a single class node of the geometry"

Example 3.2 (Typological evidence for hierarchical organization of Place)**.**

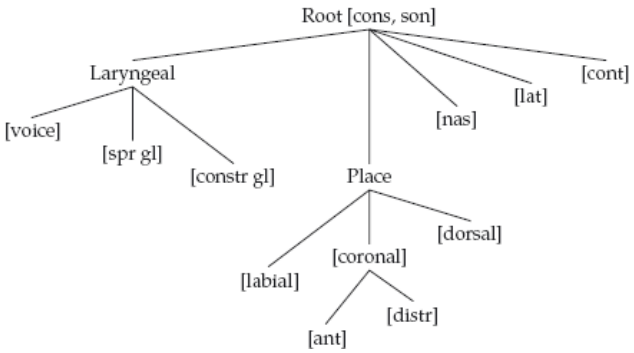
- *[anterior] can spread with all the place features in Malayalam (Dravidian, India, mal)*
  $n \rightarrow$ *m / __ bilabials*
  n̪ / __ *dentals*
  n / __ *alveolars*
  ɳ / __ *retroflexes*
  ɲ / __ *palatals*
  ŋ / __ *dorsals*
- *[anterior] can spread with just other tongue tip/blade features, e.g. English /t,d,n/ [+anterior,-distributed]*[2]
  → *dental* / __ θ,ð *([__ant, __distr])* ← *Fill in* {+, −}*!*
  → *palatoalveolar* / __ tʃ,dʒ,ʃ,ʒ *([__ant, __distr])*
  → *retroflex* / __ ɻ *([__ant, __distr])*

- *[anterior] can spread just on its own, e.g. Navajo sibilant harmony*
  $s \rightarrow ʃ$ / __ X_0 {tʃ, dʒ, ʃ, ʒ}
  $ʃ \rightarrow$ s / __ X_0 {ts, dz, s, z}

Exercise 3.1 (Place hierarchy)**.**
Propose a hierarchy for place features based on the typological evidence just presented.

(13) Here's a pretty standard feature geometry (Uffmann, 2011)

(9) *A basic feature geometry*



(14) Does this also have consequences for a theory of Harmonic Serialism?[3]

> The goal of phonology is the construction of a theory in which cross-linguistically common and well-established processes emerge from very simple combinations of the descriptive parameters of the model. During the last 10 years or so, phonological theory has made great progress toward this goal by adhering to two fundamental methodological premises. The first is that primary emphasis should be placed on studying phonological representations rather than rules. Simply put, if the representations are right, then the rules will follow. (McCarthy, 1988, p. 84)

(15) There is also other evidence for assumptions about feature geometry besides assimilation (spreading) targeting particular groups.

(16) Deletion (delinking):

a. debuccalization in some Spanish dialects: s → h / __]$_{syll}$

b. 3-way laryngeal distinction of Korean obstruents neutralized in codas

(17) OCP effects:

a. Arabic roots can't contain more than one labial, e.g. *fbm, *bfk, *kbm

[2] *[distributed] refers to whether articulation is made with the tongue tip (apical, e.g. t,s) or with the tongue blade (laminal, e.g. ʃ,tʃ)*
[3] Check out McCarthy (2008) `[further-reading/harmony/mccarthy2008.pdf]`

b. Ponapean (Polynesian, Micronesia, pon) clusters: only geminates (*urenna* 'lobster') or homoorganic clusters (*nampar* 'trade-season wind') licit. OCP demands that geminates be represented by a single segment branching to two syllabic positions and for homoorganic clusters to be represented by a single Place node branching to two segments.

4 Privative features

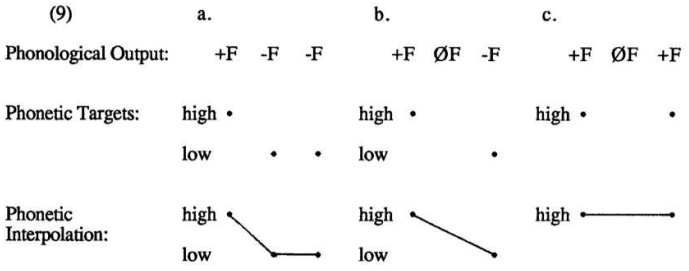
(18) Sometimes features are assumed not to be EQUIPOLLENT, i.e. [+F] vs. [-F] vs. nothing, but PRIVATIVE, i.e. just [+F] (or typically written "[F]") vs. nothing. For a review, see Steriade (1995).

(19) What are the consequences of this? If we say that [nasal] is privative, then there is no [-nasal] to refer to:

a. No autosegmental rules can insert, delete, or move [-nasal]; OCP can't refer to it

b. OT constraints cannot refer to [-nasal], e.g. no MAX([-nas]), DEP([-nas]), ALIGN([-nas]), only MAX([nas]), DEP([nas]), ALIGN([nas])

c. Cohn (1990) argues there are phonetic consequences, and thus empirical data from phonetics can bear on whether features are equipollent or privative:



In (9a) the form is fully specified for the feature F leaving the phonology. Targets are assigned, along some scale for the particular feature. These targets are then hooked up through interpolation, showing a fairly rapid transition between the neighboring high and low targets. In (9b), the first segment is [+F], the second segment is unspecified leaving the phonology and the final segment is [–F]. Only the first and last segments receive phonetic targets. There is interpolation between the targets and the middle segment receives a transitional amount of the scale for the feature F from the phonetic context. In (9c), both the first and last segments are specified as [+F] and the middle segment is again unspecified. Targets are assigned and in this case, there is interpolation straight through the middle segment. The unspecified segment receives a large amount of the scale for the feature F through phonetic context, giving the (erroneous) impression that it had a relatively high target, when in fact it has no target of its own.

(20) Lombardi (1995) presents arguments within OT that [voice] is privative.
`[further-reading/harmony/lombardi1995.pdf]`

4.1 Harmony basics: spreading

(21) What is "harmony"?

a. A proper subset of **assimilation** (sometimes, harmony is called "non-local assimilation" or "long-distance assimilation")[4]

b. Can affect consonants or vowels (and tones, though that's not usually called "harmony")

c. Assimilation occurs between two or more **non-adjacent** consonants or two or more non-adjacent vowels (where intervening segments are not affected by the assimilating property?)

d. Assimilation involves **feature propagation** (not vowel harmony: a → e / ____C_0i)

e. Assimilation is **iterative**, propagating across a domain (typically, a word), if conditions for assimilation are met

(22) What can get harmonized in vowel harmony?

a. *Backness*: Finnish, Hungarian, and other Uralic languages; Turkic and other Altaic languages; Arapaho

[4] But some people also call assimilation across a continuous string harmony, e.g. in vowel-consonant harmony $C_xV_yC_z \rightarrow C_zV_zC_z$. `[further-reading/harmony/rosewalker2011.pdf]`

b. *Rounding*: Turkic and other Altaic languages; Hungarian (in certain affixes); Yokuts languages (e.g. Yawelmani)

c. *Height*: Bantu languages, "metaphony" in Romance dialects of Italy

   i. It's usually [high] rather than [low] that is the harmonizing feature

d. *ATR (advanced tongue root)*: some West African languages (Tangale, Yoruba, Akan); some Nilotic languages (sometimes accompanied by breathiness or creakiness); some regional dialects of Spanish

   Example 4.1 (ATR in Akan)**.** *Check out the demo from Ladefoged and Maddieson (1996) here and in* `[mat/harmony/akan]`

e. *Nasality*: Austronesian languages spoken in/around Indonesia (Malay, Sundanese); languages of South America (Guaraní, Desano)

f. [long], [stress], diphthongality, and maybe [low] don't seem to be harmonizing features

   Example 4.2 (Sundanese nasal harmony)**.** *Check out the demo from Ladefoged and Maddieson (1996) here and in* `[mat/harmony/sundanese]`

(23) What can get harmonized in consonant harmony? (Following Rose (2011) `[further-reading/harmony/rose2011.pdf]`

a. *Laryngeal features*: voicing, ejectivity, aspiration: Zulu, various Chadic languages (Chaha, Ngizim), Mayan (Chol, Yucatec, Tzutujil)

   i. Usually restricted to roots, sometimes demands complete identity

b. *Coronals*: sibilant harmony (Athabaskan, Chumash; also Basque, Berber, Bantu, Cushitic, Omotic), typically regressive; dental harmony (Nilotic, e.g. Dholuo), retroflex harmony (some Australian languages, Gimira (Omotic), Malto)

   Example 4.3 (Sibilant harmony in Inseño Chumash (California, extinct!))**.**

   (7) *Ineseño Chumash sibilant harmony*

a.	/s-ixut/	[sixut]	'it burns'
b.	/s-ilakʃ/	[ʃilakʃ]	'it is soft'
c.	/ha-s-xintila/	[hasxintila]	'his gentile'
d.	/ha-s-xintila-waʃ/	[haʃxintilawaʃ]	'his former gentile'
e.	/p-iʃ-al-nanʼ/	[piʃanan']	'don't you two go'
f.	/s-iʃ-tiʃi-jep-us/	[sistisijepus]	'they two show him'

c. *Nasality*: mostly in Bantu, progressive from root to suffix

   Example 4.4 (Nasal consonantal harmony in Kikongo (DRC/Congo, Bantu))**.**
   A nasal stop in a verb root causes a [d] in the active perfect suffix (12a) or [l] in the applicative suffix to be realized as [n] (12b); intervening stops/vowels transparent to harmony.

   (12) *Kikongo nasal harmony*

a.	n-suk-idi	'I washed'	tu-nik-ini	'we ground'
	m-bud-idi	'I hit'	tu-sim-ini	'we prohibited'
b.	ku-sakid-il-a	'to congratulate for'	ku-nat-in-a	'to carry for'
	ku-toot-il-a	'to harvest for'	ku-dumuk-is-in-a	'to cause to jump for'

d. *Liquids*: alternations between /r/ and /l/; Bukusu (Bantu), Sundanese, Pohnpeian

e. *Dorsals*: Totanacan languages (in Mexico), Malto (Dravidian, India), Gitksan (Tsimshian, Canada), Aymara (Aymaran, Bolivia); alternations between velar and uvular consonants

f. Absent: harmony for major place features, e.g. [labial],[coronal],[dorsal], or for features that don't tend to assimilate locally, e.g. [sonorant], [continuant], [consonantal]

(24) A set of features may also harmonize, e.g. rounding/backness, [ATR]/height, features with acoustic correlates

(25) Disharmony

Example 4.5 (Quechua laryngeal co-occurrence restrictions)**.** *Check out the demo here and in* `[mat/harmony/quechua]`

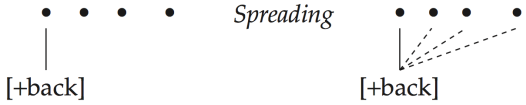
*These kinds of co-occurrence restrictions have been analyzed with markedness constraints like self-conjunction constraints, e.g. *[+constricted glottis]$^2_\omega$ within some prosodic domain (here, a (prosodic?) word), see Doing Optimality Theory, §4.7.2.*

4.2 Challenges in the analysis of harmony[5]

(26) The basic idea: harmony as feature spreading (inserting association lines) goes back to Clements (1980) `[further-reading/harmony/clements1980.pdf]`, the first autosegmental treatment of vowel harmony[6]

Example 4.6 (Spreading of [+back] from root to suffix vowels in Tuvan)**.**

(36) /at-tEr-Im-dEn/ → *Spreading* at-tar-ɯm-dan 'name' PL-1-ABL



- *Bullets represent whatever node dominates [+back] in the segment structure (*FEATURE GEOMETRY*!); harmonizing [+back] feature projected onto its own tier*
- *I: suffix high vowel; E: suffix non-high vowel, unspecified for [±back]*
- *This is called a* FEATURE FILLING RULE

(27) The specification of targets

a. How to express restrictions on targets?

- Restriction to segments lacking a preexisting specification for harmony feature (FEATURE FILLING)
- Restriction to nodes that immediately dominate spreading feature (more when we discuss FEATURE GEOMETRY)
- Restrictions via feature specification: e.g. round harmony in Turkish only affects high vowels, so restrict targets to [+high]

(28) Interveners

a. BLOCKER: segment that stops harmony, usually does not undergo assimilation itself (sometimes also called an OPAQUE or BLOCKING segment)

- How to account for which interveners block and which don't?
  1. Blockers pre-specified with non-spreading feature value, e.g. [+back] if [-back] is spread
  2. If pre-specified, a segment has an association line to feature value
  3. NO-CROSSING constraint (NCC) forbids feature from spreading over a feature specified on same tier

Example 4.7 (Blocking in Sundanese nasal harmony)**.**

(37) m o e k ɣ n → m õ ẽ k ɣ n 'to dry'

b. TRANSPARENT segment: segment that does not block harmony and does not undergo assimilation itself

- How to account for which segments are transparent?
  1. Feature spreading skips transparent segment, which is both unspecified for the harmonizing feature/target node and GAPPED

     Example 4.8 (Gapping analysis in Halh (Altaic, Mongolia) vowel harmony)**.**

     (39) poːr-ig-E → poːr-ig-o 'kidney' ACC-REFL

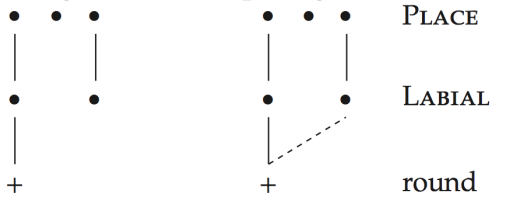
  2. Markedness constraint preventing vowel that would be formed if feature spreading applied
  3. TIER-BASED LOCALITY: trigger and target must be "local", e.g. adjacent within some tier; segments not specified on relevant tier don't enter into computation of locality

[5] **Based on Rose and Walker (2011) `[further-reading/harmony/rosewalker2011.pdf]`**

[6] In articulatory phonology, harmony is analyzed as an extension of a gesture over the temporal interval of harmonizing.

Example 4.9 (Tier-based [labial] locality in Halh vowel harmony).

(40) po:r-ig-E → po:r-ig-o 'kidney' ACC-REFL



(29) *Directionality* of spreading

a. Leftward (regressive); rightward (progressive); or bidirectional

b. Directionality bias (regressive): speech planning?

c. Directionality epiphenomenal from morphological structure, e.g. "stem-control"? (Baković), e.g. regressive harmony in Yoruba because it only has prefixes

d. Directionality from tropism of ALIGN constraints? (Kirchner 1993)

e. Directionality from positional faithfulness? "Strong positions(root-initial, stressed) preserve features". (Kaun 1995, Beckman 1997, Walker 2001b)

(30) A little on consonant harmony

a. Current ideas: feature spreading account cannot account for typological characteristics of consonant harmony which are distinct from consonant-vowel/vowel harmony:

- participation of intervening segments: no blocking, interveners are transparent!
- similarity of target and trigger: e.g. voicing harmony usually restricted to stops and excludes fricatives; some laryngeal and nasal harmonies occur only between homoorganic segments (segments that have the same place)

b. Solution: AGREEMENT-BY-CORRESPONDENCE (ABC), see Rose and Walker (2004) et seq. ; this has also be applied to vowel harmony

Example 4.10 (Sibilant harmony in Sidaama with ABC).

(24)

/ʃalak-is/	IDENT-CC[ant]	CORR-s↔ʃ	IDENT-OI[ant]	CORR-t↔ʃ
☞ a. $ʃ_x$alak-i$ʃ_x$			*	
b. $ʃ_x$alak-is_y		*!		
c. $ʃ_x$alak-is_x	*!			

- *Implicational hierarchy of* CORR-C↔C *constraints from most to least similar*
- IDENT-CC *constraints require corresponding consonants to agree for some feature*
- *Interleaving of* FAITH-IO/OI *to drive harmony of different similarities*

4.3 Overview of constraint-based analyses of vowel harmony

(31) The harmony imperative: spread!

> Mr. McGuire: I want to say one word to you. Just one word.
> Ben: Yes, sir.
> Mr. McGuire Are you listening?
> Ben: Yes, I am.
> Mr. McGuire: Plastics. (The Graduate)

a. ALIGN-R([F],domain): Align features to a domain edge! (Kirchner 1993) `[further-reading/harmony/kirchner1993]`; a generalization of Generalized Alignment

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(21)  ALIGN(F,L/R,MCat): For any parsed feature F in morphological category
      MCat (= Root, Word), F is associated to the leftmost/rightmost syllable
      in MCat (violations assessed scalarly).
```

Exercise 4.1 (Feature alignment in Tuvan vowel harmony)**.**
*[at-tar-ɯm-dan] 'name.*PL*-1-*ABL*'*

Not shown: constraint enforcing root faithfulness.

ALIGN*-R([back],word): assign a violation for a [back] feature that is not associated to the rightmost syllable of the word, one violation for each syllable between the associated syllable and the rightmost syllable of the word (gradient violation).*

/at-tEr-im-dEn/ | | + −	ALIGN-R([back], word)	IDENT-IO(back)
☞ a. at-tar-ɯm-dan | +		
b. at-tar-im-den | | + −		
c. at-ter-im-den | | + −		

b. SPREAD-F (Padgett 1995b): a feature specification must be linked to all segments with a given domain. Directionality effects result from other constraints, e.g. positional faithfulness.

c. FEATURE DRIVEN MARKEDNESS (Beckman 1997, 1998, 1999): spreading is epiphenomenal due to the definition of featural markedness constraints on autosegmental representations. *F, e.g. *[back] incurs a violation for each [back] specification in the representation (and crucially, not for each association between a [back] specification and a segment)

d. AGREE(F): adjacent elements must have identical specifications for a feature (but need not *share* a feature specification)

e. What about restrictions on targets? Come from featural co-occurrence constraints, e.g. *[+round, -high] to prevent non-high Turkish vowels from participating in round harmony

4.4 Nasal harmony in Johore Malay (McCarthy, 2010): the data

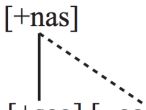
The feature [nasal] spreads rightward to vowels and glides:

(1) Nasal harmony in Johore Malay (Onn 1980)

mãʔãp	'pardon'
pəŋãwãsan	'supervision'
məratappi	'to cause to cry'
baŋõn	'to rise'

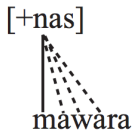
In rule-based autosegmental phonology, we'd say that Nasal spreads L-R from its source (a "trigger") until it encounters a [+consonantal] segment (a "blocker")

(2) Autosegmental spreading rule



Direction: left to right

(3) /mawara/ → [mãwãra]



(32) Check **primary sources** for data!

(33) Cohn (1990) `[further-reading/harmony/cohn1990.pdf]` on Sundanese nasal harmony (see p. 52 for paradigms): the feature [nasal] spreads rightward to vowels but is blocked by liquids [r] and [l] and glides [w] and [j]; [h] and [ʔ] are transparent.[7] Take home: representational assumptions can have consequences!

> "Also, following current views of the representation of /h/ and glottal stop (e.g. Clements 1985), I assume that /h/ and glottal stop are unspecified for the feature Continuant, since they consist of only laryngeal features. The glottal stop is in parentheses, since, although it occurs in the surface phonology, it is predictable and therefore assumed not to be a phoneme of the language. A striking fact about /r/, a trill, is that it appears to pattern with the [-continuant] consonants. For the moment, I assume that /r/ is phonologically specified as [-continuant] in order to account for this fact (Cohn, 1990, p. 55).

[7] Due to limitations of typewriter??? glottal stop appears to be written as its reflection ʕ instead of ʔ, which is confusing since ʕ is the IPA symbol for a pharyngeal fricative!

(1) Nasal harmony in Johore Malay (Onn 1980)

nasalized glottal stop	mãʔãp	'pardon'
	pəŋãw̃ãsan	'supervision'
	mə̃ratappi	'to cause to cry'
	baŋõn	'to rise'

(a) Nasalized glottal stop in 'pardon' in Johore Malay in secondary source (McCarthy, 2010).

(72)

/mewah/	mẽw̃ãh	'to be luxurious'
/mayaŋ/	mãyãŋ	'stalk (palm)'
/maap/	mãʔãp	'pardon'
/məŋ-ayak/	mə̃ŋãyãʔ	'to sift (active)'
/məŋ-tawan/	mə̃nãw̃ãn	'to capture (active)'
/pəŋ-awas-an/	pəŋãw̃ãsan	'supervision'
/pəŋ-təŋah-an/	pənəŋãh̃ãn	'central focus'

no nasalization on glottal stop

(b) Non-nasalized glottal stop in 'pardon' in Johore Malay in primary source (Onn, 1980, p. 45). Wait, but non-nasalized w, too?

The set of examples in (72) shows that nasalization in JM penetrates not only vowels but also other nonconsonantal segments as well, namely *y*, *w*, *h*, and *?*, and proceeds to nasalize the vowel or vowels following these nonconsonantal segments.[1 2] In fact, nasalization continues to spread through the word, to be stopped only when it encounters a consonantal segment that blocks it. Thus in order to account for these facts, Rule (71) has to be reformulated to look something like:

(73) Vowel Nasalization

$$[+\text{syll}] \rightarrow [+\text{nasal}] \;/\; [+\text{nasal}]\ [-\text{cons}]_{0}\text{—}$$

(c) Nasalization on [y,w,h,ʔ]??? (Onn, 1980, p. 46).

Specifically, JM has twenty-four underlying phonemes: six stops, */p, b, t, d, k, g/*; two affricates, */c, j/*; one fricative, */s/*; two liquids, */l, r̃/*; four nasals, */m, n, ñ, ŋ/*; three glides, */w, y, h/*; and six vowels, */i, e, ə, a, o, u/*. All of these segments correspond to their phonetic realizations. The segment */r̃/* represents a voiced, somewhat back, liquid produced with the tongue retracted a little towards the front of the soft palate, but without radical constriction. The voiceless fricative */s/* is underlyingly alveopalatal, and it assimilates with the palatal */ñ/*, and not with the alveolar */n/*. The fricatives, */f, v, z, s, ∅, ɣ, x/*, and */ɤ/*, also occur in the phonetic output of JM, but these are loan segments whose occurrences are limited only to borrowed lexical items, and as such, they will not be considered in the present study (cf. 2.2).

(d) Johore Malay [r] as a liquid (Onn, 1980, p. 5).

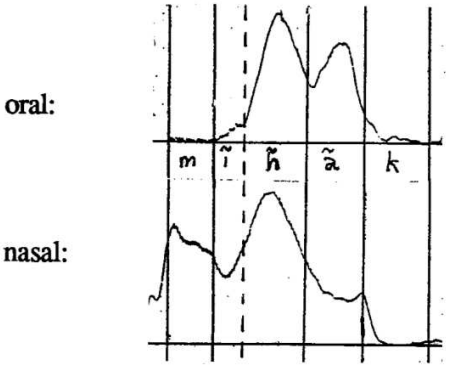
Figure 1: Comparison of primary and secondary source material on nasalization in Johore Malay

(8) Sundanese consonant inventory

p	t	c	k	[-nasal]	[-continuant]
b	d	ɟ	g		
m	n	ɲ	ŋ	[+nasal]	
		s			[+continuant]
	l/r				
w		j			
			h	(ʔ)	

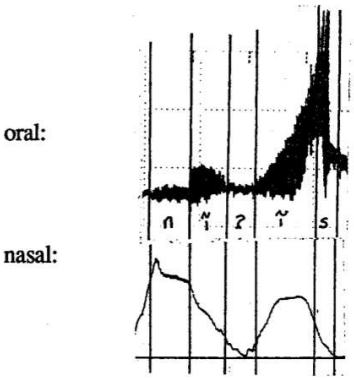
(a) A feature system for Sundanese (Cohn, 1990, p. 54).

(28) /mihak/ [mɪ̃hɪ̃ãk] [S-L 4]



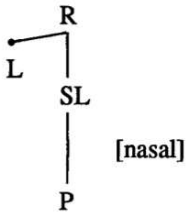
(b) Nasal and oral airflow tracings bearing on the status of Sundanese [h] in nasal spread (Cohn, 1990, p. 69). Why the peak over the [h] for nasal airflow? Check out the oral airflow tracing: overall rate of flow through glottis much greater during [h]!

(26) /niis/ [S-L 2] (raw) oral and (filtered) nasal flow



(c) Nasal and oral airflow tracings bearing on the status of Sundanese [ʔ] in nasal spread (Cohn, 1990, p. 67). Compare to airflow tracings for [h]. What's a glottal stop? Complete closure of the glottis: all airflow is cut off! What does the nasal airflow tracing tell us about velum position?

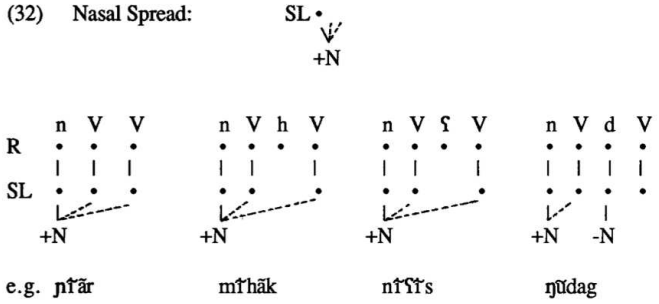
(31) The location of the feature Nasal in the feature geometry



(d) The feature Nasal hanging off of the supralaryngeal node. (SL = supralaryngeal node, P = Place node). If [h] and [ʔ] have no supralaryngeal specification, then they have no nasal specification.

Figure 2: Sundanese nasal harmony (Cohn, 1990)

(32) Nasal Spread:



(a) Nasal spread assuming supralaryngeal underspecification.

Figure 3: Sundanese nasal harmony (Cohn, 1990)

4.5 Nasal harmony in Johore Malay in OT

(34) The simple formulation of unbounded spread as a simple autosegmental rule, which is triggered and blocked by constraints has its roots in Kiparsky (1981) `[further-reading/6/kiparsky1981]`

> This paper is almost 30 years old and was never published. So why am I making you read it? Because many of the proposals in it are still being used, discussed, and rejected today. (JJM)

(35) Can we do any better? Implications for typology of harmony?[8]

(36) The nasalizability constraint hierarchy (Walker 1998 et seq.): "vertical" feature co-occurrence restrictions that penalize nasality in lower-sonority segments
*NasPlo ≫ *NasFric ≫ *NasLiq ≫ *NasGli ≫ *NasVow

a. Example: *NasLiq violated by [r̃]

b. Johore Malay: nasal spreading affects only vowels and glides. How is a pro-spreading constraint ranked relative to the nasalizability hierarchy constraints?

(37) Align as the pro-spreading constraint and overgeneration
Align-R([nasal],word): Align every [+nasal] feature to the right edge of the domain. (Assign a violation mark for every segment intervening between the right edge of the domain and the rightmost segment linked to a nasal feature).

(8) Align-R([nasal], word) illustrated

	/mawara/	*NasLiq	Align-R([nasal], word)	Ident([nasal])
a.	mawara		5 **W**	**L**
b.	mãwara		4 **W**	1 **L**
c.	mãw̃ara		3 **W**	2 **L**
d. →	mãw̃ãra		2	3
e.	mãw̃ãr̃a	1 **W**	1 **L**	4 **W**
f.	mãw̃ãr̃ã	1 **W**	**L**	5 **W**

a. **Problem:** Align says "minimize the number of peripheral segments that are inaccessible to harmony because of an intervening blocker". OK, how can we do that?

b. An example of a problem with Align: if Max is ranked below Align, it can trigger deletion: violations of Align will be repaired by deleting any segments inaccessible to spreading.

/mar/	*NasalLiquid	Align-R(nas)	Max	*NasalGlide	Ident(nas)
a. predicted winner mã			*		*
b. mar		**!|			
c. mãr		*!			*
d. mãr̃	*!				**

(38) Agree and sour grapes
Agree-r([nasal]): In a sequence of adjacent segments xy, if x is associated with [nasal], then y is also associated with [nasal].

[8] For more comparisons of constraint-based theories to rules + constraint-based theories of harmony, see comparison of Archangeli and Pulleyblank rules + constraints to OT in McCarthy (1997) `[further-reading/6/mccarthy1997.pdf]` and to harmonic grammar (HG) in Potts et al. (2010) `[further-reading/6/pottspaterjesney2010.pdf]`.

a. Local AGREE, no blockers. Underlined segments delineate the site of the AGREE violation

/mawa/	*NASALLIQUID	AGREE(NAS)	*NASALGLIDE	IDENT(NAS)
a. ☞ mãw̃ã			*	***
b. mawa		*!		
c. mãwa		*!		*
d. mãw̃a		*!	*	**

b. What happens with local AGREE **with** blockers?

/mara/	*NASALLIQUID	AGREE(NAS)	*NASALGLIDE	IDENT(NAS)
a. intended winner mãra		*		*!!!
b. predicted winner mara		*		
c. mãr̃a	*!	*		**
d. mãr̃ã	*!			***

Desired winner harmonically bounded! SOUR GRAPES: "if I can't spread all the way, I'm not going to spread at all", i.e. the computation of violations accrued by spreading a feature to an adjacent segment is dependent on the computation of violations accrued by spreading the feature to nonadjacent segments.

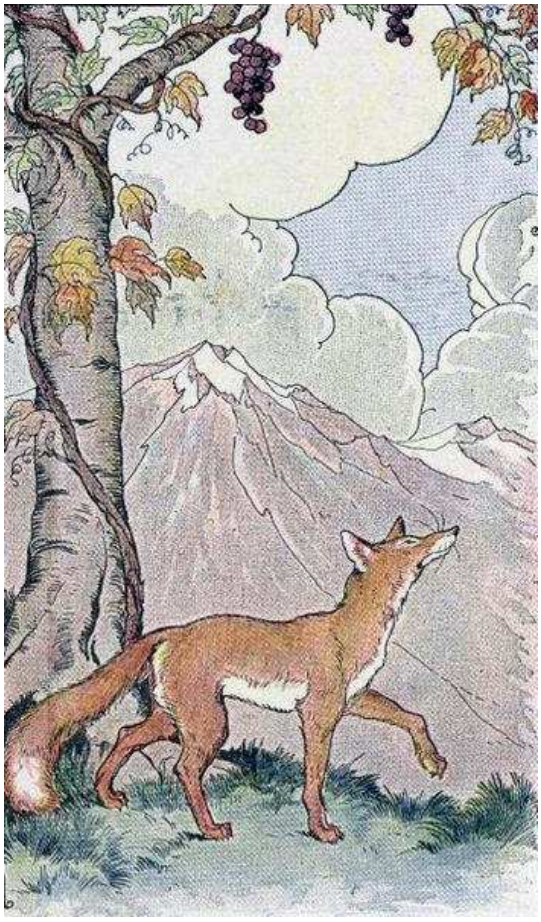


Figure 4: The Fox and the Grapes from Aesop's fables from Project Gutenberg.

(39) So ALIGN overgenerates, and AGREE both undergenerates (can't produce desired winner) and overgenerates (spreading only in the absence of an arbitrarily distant blocker isn't attested).

(40) But wait: what about a more specific version of AGREE, e.g. a "horizontal" feature co-occurrence constraint like *[+nasal][-cons, -nasal]?

4.6 Nasal harmony in Johore Malay in HS

(41) Idea: problems with ALIGN and AGREE stem from overly global nature of OT. We need an approach to harmony that is more "myopic"–less lookahead: spreading a feature to a local segment should be independent of spreading to nonlocal segments.[9]

(42) A new markedness constraint for pro-spreading: SHARE(F). Assign one violation mark for every pair of adjacent segments that are not linked to the same [F] autosegment.

(10) Example: SHARE([nasal]) obeyed

(11) Examples: SHARE([nasal]) violated

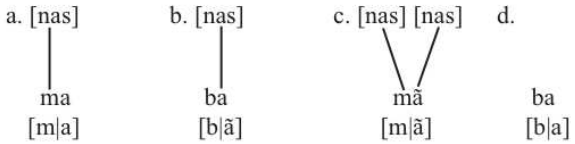


Figure 5: Examples of SHARE in action from McCarthy (2010)

An important aspect of the on-going HS research program is determining what it means to make "one change at a time". Answering this question for the full range of phonological phenomena is beyond the scope of this chapter, but before analysis can proceed it is necessary to adopt *some* assumptions about how GEN manipulates autosegmental structures:

(12) Assumptions about GEN for autosegmental phonology in HS[4]

GEN's set of operations consists of:

a. Insertions:

–A feature and a single association line linking it to some pre-existing structure.

–A single association line linking two elements of pre-existing structure.

b. Deletions:

–A feature and a single association line linking it to some pre-existing structure.

–An association line linking two elements of pre-existing structure.

Under these assumptions, GEN cannot supply a candidate that differs from the input by virtue of, say, spreading a feature from one segment and delinking it from another. This means that feature "flop" processes require two steps in an HS derivation (McCarthy 2007a: 91–93).

Figure 6: GEN for autosegmental representations from McCarthy (2010)

(43) What's the difference? Using HS? The SHARE constraint? What about the assumption that the representations always start out with one feature per segment: start out with the max number of share violations.

(44) What if we ported AGREE or ALIGN into HS?

[9] Really? See Walker (2010) on non-myopic harmony.

(13) SH derivation of /mawara/ → [mãw̃āra] (cf. (8))

Step 1

	m|a|w|a|r|a	*NasLiq	Share ([nasal])	*NasGli	*NasVow	Ident ([nas])
a. →	mã|w|a|r|a		4		1	1
b.	m|a|w|a|r|a		5 **W**		**L**	**L**
c.	b|a|w|a|r|a		5 **W**		**L**	1

Step 2

	mã|w|a|r|a	*NasLiq	Share ([nasal])	*NasGli	*NasVow	Ident ([nas])
a. →	mãw̃|a|r|a		3	1	1	1
b.	mã|w|a|r|a		4 **W**	**L**	1	**L**

Step 3

	mãw̃|a|r|a	*NasLiq	Share ([nasal])	*NasGli	*NasVow	Ident ([nas])
a. →	mãw̃ã|r|a		2	1	2	1
b.	mãw̃|a|r|a		3 **W**	1	1 **L**	**L**

Step 4 – Convergence

	mãw̃ã|r|a	*NasLiq	Share ([nasal])	*NasGli	*NasVow	Ident ([nas])
a. →	mãw̃ã|r|a		2	1	2	
b.	mãw̃ãr̃|a	1 **W**	1 **L**	1	2	1 **W**

Figure 7: HS derivation with Share for Johore Malay, from McCarthy (2010)

a. See Kevin Mullin's 2010 handout `[further-reading/harmony/share-problems/mullin2010.pdf]`, §3.1

(45) Is Share really the *deus ex machina*?

(46) The licensing by spreading problem (this is from a 2014 Sound Workshop handout by Kevin and Joe `[further-reading/share-problems/mullinpater2014.pdf]`): *Share can produce the following pattern: delete a marked feature, except when it would spread.* Further reading: `[further-reading/harmony/share-problems/]`

(47) Typological prediction: languages in which nasal vowels are banned in isolation, but that surface when there are adjacent segments to spread onto.

a. Delete marked feature, except when it would spread: word edge

/oã/	Share(nasal)	*NasalVowel	*Max([nasal])
a. ☞ õã		2	
b. oã	1	1	
c. oa	1		1

/ã/	Share(nasal)	*NasalVowel	*Max([nasal])
a. intended winner ã		1	
b. predicted winner a			1

b. Delete marked feature, except when it would spread: blocker

/wã/	*NasalGlide	Share(nasal)	*NasalVowel	*Max([nasal])
a. intended winner wã		1	1	
b. predicted winner wa		1		1
c. w̃ã	1		1	

(48) See Mullin (2011) `[further-reading/harmony/share-problems/mullin2011.pdf]` for a possible solution.

5 Things you learned this semester

5.1 Empirical phenomena

- Phonetics of tone
- Tonal phonology/long distance processes
- Intonation
- Syntax-prosody mapping

5.2 Theory

- Tonal representations (53, ↓, LH)
- Autosegmental theory
- Metrical theory: the Grid (Hayes, 1995)
- Hierarchical structure in phonological grammar, recursion
- Variable phonetic processes, underspecified targets, semantics/phonology interfaces
- Autosegmental-metrical theory/intonational phonology (foundations: Bruce (1977))
- Theories of the syntax-prosody interface: MATCH theory, direct reference theories
- Formal language theory: Chomsky hierarchy, automata theory, strings and trees and constituency

5.3 Tools

- Recording speech
- Listening to and transcribing tone and intonation
- Fieldwork elicitation
- Basic analysis of fundamental frequency
- Basic use of acoustic analysis software (Praat)
- Implementing phonological grammar fragments in `xfst/foma`
- Preparing talks, giving/receiving feedback (teaching, presentations)

6 Some reflections

(49) **Be clear about your own and other peoples' assumptions underlying hypotheses and claims.**

a. Tonal representations: phonological patterns revealed by working with contour tones as sequences of level tones, e.g. R(ise) as LH, rather than ↗, 25, R, cf. Hakha Lai tonotactics exercise.

b. Hidden assumptions in constraint-based analyses using autosegmental theory: e.g., referring to deletion of features

c. Syntax-prosody mapping: "it's a mismatch!" Under what assumptions about prosodic analyses? What assumptions about syntactic analyses? What assumptions about the map between syntactic and prosodic analyses? If you really understand assumptions, you should be able to implement idea; implementing makes you realize where you are making assumptions.

d. Find out what's right about what someone's saying, even if you think their idea has flaws: you'll learn something, maybe a lot.

(50) **Be rigorous and flexible.**

a. Be ready to revise, reject, and generate new hypotheses in the process of discovering linguistic generalizations, cf. Mandarin tone discovery: creating tone "piles" and trying to classify a new elicited item into an existing pile or creating a new one. Emphasis on same vs. different rather than exact transcriptions.

b. Designing experiments: creating spreadsheets with a unique "bar code" for each item, and all manipulated factors and controls for each item indicated in spreadsheet, cf. Bruce (1977)'s experiment unraveling the phonetic contrast between Swedish Accent 1 vs. Accent 2. Works in fieldwork, experiments, gathering acceptability judgments, you name it.

c. When you have hunches, write them down to make them precise and testable—elevate your hunches into hypotheses. Pick up a marker; write things out on the board! Also, rubber ducky.

d. Describe your phenomenon first, you should be able to do this in plain English. And trry different representations!

(51) Giving talks: remember the **jet-lagged audience member principle**. Do everything you can to make things easy for your audience members, e.g. putting page numbers on slides, visually highlighting and annotating important points, using a running example sentence, etc.

7 P-things you can do after 606

1. Come knock on my door
2. Come by the weekly Sound Workshop! Even better, present your work there!
3. Get on the ling-phonology mailing list
4. More on prosody:
   - Get on the ling-prosody mailing list
   - Check out activities of the Five Colleges Prosody Community
   - Fall 2019: 592B (speech processing), 716 (phonetics seminar)
5. More foundations on phonetics/speech processing
   - Come to spectrolunch
   - Come to experimental lab meetings, psycholinguistics workshop
   - 891PR: Speech perception (offered by Alexandra Jesse, Psychology)
   - 614: Introduction to Phonetic Theory (offered by John Kingston)
   - Phonetics lab practicum
6. More on computational/theoretical phonology
   - Join activities of the Computational Phonology Lab
   - Join activities of the NSF grant group

References

Bruce, Gösta. 1977. *Swedish word accents in sentence perspective*. Lund: CWK Gleerup.
Clements, George N. 1980. *Vowel harmony in nonlinear generative phonology*. Indiana University, Bloomington, IN: Indiana University Linguistics Club.
Cohn, Abigail C. 1990. Phonetic and phonological rules of nasalization. *Working Papers in Phonetics, Department of Linguistics, UCLA* 76.
Hayes, Bruce. 1995. *Metrical stress theory: principles and case studies*. University of Chicago Press.
Kiparsky, Paul. 1981. Vowel harmony. Manuscript. MIT.
Ladefoged, Peter, and Ian Maddieson. 1996. *The sounds of the world's languages*. Blackwell Publishing.
Lombardi, Linda. 1995. Why voice and place are different. Manuscript. ROA 105.
McCarthy, John J. 1988. Feature geometry and dependency: a review. *Phonetica* 43:84–108.
McCarthy, John J. 1997. Process-specific constraints in Optimality Theory. *Linguistic Inquiry* 28:231–251.

McCarthy, John J. 2008. The gradual path to cluster simplification. *Phonology* 25:271–319.
McCarthy, John J. 2010. Autosegmental spreading in Optimality Theory. In *Tones and features: phonetic and phonological perspectives*, ed. John A. Goldsmith, Elizabeth Hume, and W. Leo Wetzels, 195–222. Berlin/Boston: De Gruyter Mouton.
Onn, Farid Mohd. 1980. *Aspects of Malay phonology and morphology: A generative approach*. Universiti Kebangsaan Malaysia.
Potts, Christopher, Joe Pater, Karen Jesney, Rajesh Bhatt, and Michael Becker. 2010. Harmonic grammar with linear programming: from linear systems to linguistic typology. *Phonology* 27:77–117.
Rose, Sharon. 2011. Long-distance assimilation of consonants. In *The blackwell companion to phonology*, ed. Marc van Oostendorp, Colin J. Ewen, Elizabeth V. Hume, and Keren Rice. Malden, Massachusetts: Wiley-Blackwell.
Rose, Sharon, and Rachel Walker. 2004. A typology of consonant agreement as correspondence. *Language* 80:475–531.
Rose, Sharon, and Rachel Walker. 2011. Harmony systems. In *Handbook of phonological theory*, ed. John A. Goldsmith, Jason Riggle, and Alan C. L. Yu. Blackwell.
Shih, Stephanie S., and Sharon Inkelas. 2019. Autosegmental aims in surface-optimizing phonology. *Linguistic Inquiry* 50:137–196.
Steriade, Donca. 1995. Underspecification and markedness. In *The handbook of phonological theory*, ed. John A. Goldsmith, 114–174. Oxford: Basil Blackwell.
Uffmann, Christian. 2011. The organization of features. In *The Blackwell companion to phonology*, ed. Beth Hume Marc van Oostendorp, Colin Ewen and Keren Rice. Wiley-Blackwell.
Walker, Rachel. 2010. Nonmyopic harmony and the nature of derivations. *Linguistic Inquiry* 41:169–179.