Contrastive Hierarchy Theory: An Overview

These are the combined slides presented at talks at the University of Connecticut, February 2015, and at the University of Massachusetts, Amherst, September 2015.

PART 2: Section 7 to end

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University of Toronto
Why Contrast Must be Computed Hierarchically
Consider the typical sub-inventory /p, b, m/ shown below, and suppose we characterize it in terms of two binary features, [±voiced] and [±nasal].

In terms of full specifications, /p/ is [–voiced, –nasal], /b/ is [+voiced, –nasal], and /m/ is [+voiced, +nasal].

Which of these features is contrastive? Many people reason as follows:

<table>
<thead>
<tr>
<th></th>
<th>/p/</th>
<th>/b/</th>
<th>/m/</th>
</tr>
</thead>
<tbody>
<tr>
<td>voiced</td>
<td>–</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>nasal</td>
<td>–</td>
<td>–</td>
<td>+</td>
</tr>
</tbody>
</table>
How do we establish contrasts?

We observe that /p/ and /b/ are distinguished only by [voiced]; so these specifications must be contrastive.

Similarly, /b/ and /m/ are distinguished only by [nasal]; these specifications must also be contrastive.

What about the uncircled specifications? These are predictable from the circled ones:

<table>
<thead>
<tr>
<th></th>
<th>/p/</th>
<th>/b/</th>
<th>/m/</th>
</tr>
</thead>
<tbody>
<tr>
<td>[voiced]</td>
<td>−</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>[nasal]</td>
<td>−</td>
<td>−</td>
<td>+</td>
</tr>
</tbody>
</table>
Since /p/ is the only [–voiced] phoneme in this inventory, its specification for [nasal] is predictable, hence redundant.

Similarly, /m/ is the only [+nasal] phoneme, so its specification for [voiced] is redundant.

This is a still-popular way of thinking about contrastive specifications; we can call it the ‘minimal contrast’ (MC) approach (Padgett 2003, Calabrese 2005, Campos-Astorkiza 2009, Nevins 2010 explicitly, and many others implicitly).

### How do we establish contrasts?

<table>
<thead>
<tr>
<th></th>
<th>/p/</th>
<th>/b/</th>
<th>/m/</th>
</tr>
</thead>
<tbody>
<tr>
<td>[voiced]</td>
<td>—</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>[nasal]</td>
<td></td>
<td>—</td>
<td>+</td>
</tr>
</tbody>
</table>
According to the definition proposed by Nevins (2010: 98), a segment $S$ with specification $[\alpha F]$ is *contrastive* for $F$ if there is another segment $S'$ in the inventory that is featurally identical to $S$, except that it is $[–\alpha F]$.

**Minimal Contrast (MC)**

<table>
<thead>
<tr>
<th></th>
<th>$S$</th>
<th>$S'$</th>
<th>$T$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$[\alpha F]$</td>
<td>$[\alpha F]$</td>
<td>$[–\alpha F]$</td>
<td>$[–\alpha F]$</td>
</tr>
<tr>
<td>$[–\alpha H]$</td>
<td>$[\alpha H]$</td>
<td>$[\alpha H]$</td>
<td>$[–\alpha H]$</td>
</tr>
</tbody>
</table>
According to the definition proposed by Nevins (2010: 98), a segment S with specification \([\alpha F]\) is **contrastive** for F if there is another segment \(S'\) in the inventory that is featurally identical to S, except that it is \([-\alpha F]\).

In our example, the circled specifications are minimally contrastive, by the above definition, but the uncircled ones are not, because there is no voiceless nasal /m̥/ in this inventory.
Halle (1959) argued that phonological features must be ordered into a hierarchy because this is the only way to ensure that segments are kept properly distinct.
Specifically, he proposed (1959: 32) that phonemes must meet the Distinctness Condition:

**The Distinctness Condition**

Segment-type \{A\} will be said to be different from segment-type \{B\}, if and only if at least one feature which is phonemic in both, has a different value in \{A\} than in \{B\}; i.e., plus in the former and minus in the latter, or vice versa.

This formulation is designed to disallow contrasts involving a zero value of a feature, and it disallows specifications derived by MC.
Segment-type \{A\} will be said to be different from segment-type \{B\}, if and only if at least one feature which is phonemic in both, has a different value in \{A\} than in \{B\}; i.e., plus in the former and minus in the latter, or vice versa.

According to the Distinctness Condition, /p/ is ‘different from’ /b/, because /p/ is \([-\text{voiced}]\) and /b/ is \([+\text{voiced}]\).
According to the Distinctness Condition, /p/ is ‘different from’ /b/, because /p/ is [–voiced] and /b/ is [+voiced].

Similarly, /b/ is ‘different from’ /m/, because /b/ is [–nasal] and /m/ is [+nasal].

Segment-type {A} will be said to be different from segment-type {B}, if and only if at least one feature which is phonemic in both, has a different value in {A} than in {B}; i.e., plus in the former and minus in the latter, or vice versa.
The Distinctness Condition

Segment-type \{A\} will be said to be different from segment-type \{B\}, if and only if at least one feature which is phonemic in both, has a different value in \{A\} than in \{B\}; i.e., plus in the former and minus in the latter, or vice versa.

But /p/ is not ‘different from’ /m/: where one has a feature, the other has no specification.

Therefore, these specifications are not properly contrastive.

<table>
<thead>
<tr>
<th></th>
<th>/p/</th>
<th>/b/</th>
<th>/m/</th>
</tr>
</thead>
<tbody>
<tr>
<td>[voiced]</td>
<td>−</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>[nasal]</td>
<td></td>
<td>−</td>
<td>+</td>
</tr>
</tbody>
</table>
The specifications below violate the Distinctness Condition because no feature hierarchy yields this result.

If we order [voiced] > [nasal], we generate an extra specification on /m/.
The specifications below violate the Distinctness Condition because no feature hierarchy yields this result.

If we order [voiced] > [nasal], we generate an extra specification on /m/.

If we order [nasal] > [voiced], we generate an extra specification on /p/.
Problems with Minimal Contrast

The Distinctness Condition is not some arbitrary formal condition that may be disregarded; as I document in Dresher (2009), MC’s violation of the condition results in a variety of empirical and conceptual problems.

The main problem with MC is that fewer phonemes than we might think are ‘featural identical’ with respect to all features that they might possibly possess.

More usually we ignore ‘small’ or ‘irrelevant’ features when assessing if two phonemes are minimally different.
An example of the shortcomings of MC and how they are often tacitly set aside is Nevins’s discussion of the Turkish vowel system (2010: 26).

In keeping with traditional analyses, Nevins observes that the features [high], [back], and [round] are sufficient to uniquely determine each of the eight vowels of Turkish.
Nevins does not mention the feature [low], though it is one of the features commonly employed in vowel systems.

Limiting Turkish to a single height feature is crucial in achieving the elegant traditional classification of Turkish vowels.

<table>
<thead>
<tr>
<th>[+high]</th>
<th>[+back]</th>
<th>[-back]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[-round]</td>
<td>[-round]</td>
<td>[+round]</td>
</tr>
<tr>
<td>i</td>
<td>ü</td>
<td>i</td>
</tr>
<tr>
<td>u</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>[-high]</th>
<th>[-back]</th>
<th>[+back]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[+round]</td>
<td>[-round]</td>
<td>[+round]</td>
</tr>
<tr>
<td>e</td>
<td>ö</td>
<td>a</td>
</tr>
<tr>
<td>o</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
With just these 3 features, every feature specification is **contrastive** according to MC. Every vowel has 3 counterparts that differ from it with respect to exactly one feature.

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>ü</th>
<th>i</th>
<th>u</th>
<th>e</th>
<th>ö</th>
<th>a</th>
<th>o</th>
</tr>
</thead>
<tbody>
<tr>
<td>[high]</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[back]</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>[round]</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>
For example, consider /i/: it differs from /ü/ only in [round], from /i/ only in [back], and from /e/ only in [high].

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>ü</th>
<th>i</th>
<th>u</th>
<th>e</th>
<th>ö</th>
<th>a</th>
<th>o</th>
</tr>
</thead>
<tbody>
<tr>
<td>[high]</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[back]</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>[round]</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

Turkish Vowels

+ : Present |  - : Absent
If we include [low], the vowel system would look different. Here not all pairs are minimal; MC would not give the desired results. Circled features are noncontrastive.

In particular, /ɨ/ is no longer contrastively [+high], /e/ is not contrastively [−back], and /o/ is not contrastively [+round]. /a/ has no contrastive features at all.

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>ü</th>
<th>i</th>
<th>ɨ</th>
<th>u</th>
<th>e</th>
<th>ö</th>
<th>a</th>
<th>o</th>
</tr>
</thead>
<tbody>
<tr>
<td>[high]</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>[back]</td>
<td>−</td>
<td>−</td>
<td>+</td>
<td>+</td>
<td></td>
<td>−</td>
<td>−</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>[round]</td>
<td>−</td>
<td>+</td>
<td>−</td>
<td>+</td>
<td>−</td>
<td>+</td>
<td>−</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>[low]</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>+</td>
<td>−</td>
</tr>
</tbody>
</table>
Dresher (2009) argues that MC fails in many common situations to yield adequate contrastive representations.

This is hardly a surprise: Archangeli (1988) showed the same. In fact, everybody knows that MC does not really work.
Consider a simple 3-vowel system with the feature specifications as below.

There are no minimal contrasts here at all. The 3 phonemes are too far apart in the \(2^4 = 16\) slot feature space.

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>a</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td>[high]</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>[back]</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>[round]</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>[low]</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>
**A Simple Three-Vowel System**

There are no minimal pairs, so MC would give no contrastive features at all.

This is not a good result. But most phonologists do not try to specify 4 features for a 3-vowel system, so this total failure of MC would not be noticed.

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>a</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td>[high]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[back]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[round]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[low]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A Simple Three-Vowel System

Even if we remove 1 feature MC still gives no results because there are still no minimal pairs.

The features [back] and [round] are getting in each other’s way. We have to remove one of them.

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>a</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td>[high]</td>
<td>+</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>[back]</td>
<td>–</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>[round]</td>
<td>–</td>
<td>–</td>
<td>+</td>
</tr>
</tbody>
</table>
A Simple Three-Vowel System

Now MC *seems* to work: [high] distinguishes /a/ from /u/, and [back] distinguishes /i/ from /u/.

The other features are designated noncontrastive (circled). But I don’t think that this is a proper contrastive specification.

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>a</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td>[high]</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>[back]</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
A Simple Three-Vowel System

Without the noncontrastive features, /i/ and /a/ are not properly in contrast.

Without the /u/, these ‘contrastive’ specifications would look absurd.

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>a</th>
</tr>
</thead>
<tbody>
<tr>
<td>[high]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[back]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Despite these considerable flaws, MC persists because it seems intuitive—there is indeed a sense in which contrast is minimal, almost by definition—and because phonologists tacitly help it out by discreetly removing ‘extra’ features and otherwise papering over awkward results.

Contrastive Hierarchy theory solves these problems, and is always able to arrive at properly contrastive specifications.

Moreover, decisions about the *relative scopes* of features are unavoidable, and are ubiquitous in phonological analyses.
Contrast: Relative Scopes of Features

For example, consider some analyses of Catalan vowel features:

**Eastern Catalan (Crosswhite 2001)**

<table>
<thead>
<tr>
<th>Feature</th>
<th>[+front]</th>
<th>[–front]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[+high]</td>
<td>i</td>
<td>u</td>
</tr>
<tr>
<td>[+ATR]</td>
<td>e</td>
<td>o</td>
</tr>
<tr>
<td>[–ATR]</td>
<td>e</td>
<td>o</td>
</tr>
<tr>
<td>[+low]</td>
<td>a</td>
<td></td>
</tr>
</tbody>
</table>

In Crosswhite’s (2001) analysis, [ATR] in Eastern Catalan is limited to the mid vowels. It has a narrow scope relative to [high] and [low].

**Valencian Catalan (Walker 2005; Lloret 2008)**

<table>
<thead>
<tr>
<th>Feature</th>
<th>[front]</th>
<th>[back]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[+ATR]</td>
<td>i</td>
<td>u</td>
</tr>
<tr>
<td></td>
<td>e</td>
<td>o</td>
</tr>
<tr>
<td>[–ATR]</td>
<td>e</td>
<td>o</td>
</tr>
<tr>
<td>[low]</td>
<td>a</td>
<td></td>
</tr>
</tbody>
</table>

For Walker (2005) and Lloret (2008), Valencian Catalan [ATR] is contrastive over all vowels; it takes wide scope over the height features.
Relative Scope = Ordering

Another way to express this idea is in terms of feature ordering: a feature that is higher in the order takes wider scope than a lower-ordered feature.
The analysis of Eastern Catalan is tantamount to ordering the features [high] and [low] over [ATR].

The tree diagram expresses the ordering:

[high] > [low] > [ATR]
The analysis of Valencian Catalan is tantamount to ordering [ATR] over the height features.

The tree diagram expresses the ordering:

[ATR] > [high], [low]
Ordering is also implicit in the traditional analysis of Turkish vowels.

The features [high], [back], and [round] are ordered ahead of [low] and other possible features.

<table>
<thead>
<tr>
<th>[+high]</th>
<th>[–high]</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>[-back]</td>
<td>[+back]</td>
</tr>
<tr>
<td>[–round]</td>
<td>[+round]</td>
</tr>
<tr>
<td>i</td>
<td>ü</td>
</tr>
<tr>
<td>e</td>
<td>ö</td>
</tr>
</tbody>
</table>
Once the top 3 features have applied, all vowels are contrastive and no further contrastive features can be assigned.

Ordering provides the *rationale* and *justification* for omitting [low] and [ATR] from the analysis of Turkish.
Contrast Shift and Diachrony

The notion that contrast shift is a type of grammar change has proved to be fruitful in the study of a variety of languages.

In a survey of the historical development of Algonquian vowel systems, Oxford (2015) observes that a large set of separate changes can be understood if we posit a single contrast shift.
Contrastive hierarchy for Proto-Algonquian vowels (Oxford 2015)

[round] > [front] > [low]

Oxford (2015) posits this feature hierarchy for Proto-Algonquian (length contrast omitted for ease of exposition).

*/o/ is [round]: triggers rounding
*/i/ is [front]: triggers palatalization
*/i, ɛ/ sisters: partial neutralization
*/a/ has no marked contrastive features: is never a trigger
Contrastive hierarchy for Proto-Algonquian vowels (Oxford 2015)

[round] > [front] > [low]

The PA hierarchy continues unchanged in the Central Algonquian languages and in Blackfoot.

It accounts for two recurring patterns:
Contrastive hierarchy for Central Algonquian and Blackfoot:

[round] > [front] > [low]

1. Palatalization always includes */i/ as a trigger

PA */t, θ/-palatalization is triggered by */i, iː/

Innu */k/-palatalization is triggered by */i, iː, ɛː/

Betsiamites Innu /t/-palatalization is triggered by /iː/
Contrastive hierarchy for Central Algonquian and Blackfoot

[round] > [front] > [low]

<table>
<thead>
<tr>
<th>syllabic</th>
</tr>
</thead>
<tbody>
<tr>
<td>[round]</td>
</tr>
<tr>
<td>/o/</td>
</tr>
<tr>
<td>[front]</td>
</tr>
<tr>
<td>/ɛ/</td>
</tr>
<tr>
<td>/i/</td>
</tr>
<tr>
<td>[low]</td>
</tr>
<tr>
<td>/ɛ/</td>
</tr>
<tr>
<td>[non-round]</td>
</tr>
<tr>
<td>(non-low)</td>
</tr>
<tr>
<td>/a/</td>
</tr>
</tbody>
</table>

1. Palatalization always includes */i/ as a trigger

Blackfoot */k/-assibilation is triggered by PA */i, iː/

Blackfoot /t/-assibilation is triggered by Blackfoot /i, iː/
Contrastive hierarchy for Central Algonquian and Blackfoot

[round] > [front] > [low]

1. Palatalization always includes */i/ as a trigger

These patterns support the view that palatalization is triggered by a contrastive [front] feature, and favours vowels that are (non-low).
Contrastive hierarchy for Central Algonquian and Blackfoot

[round] > [front] > [low]

2. */ɛ/ regularly merges with */i/

Partial or complete mergers of short */ɛ/ > /i/ occur in Fox, Shawnee, Miami-Illinois, Cree-Innu, Ojibwe, and Blackfoot

Long */ɛː/ > /iː/ in Woods Cree, Northern Plains Cree, and Blackfoot
Contrastive hierarchy for Central Algonquian and Blackfoot

[round] > [front] > [low]

2. */ɛ/ regularly merges with */i/

These mergers are consistent with the idea that merger will tend to involve terminal nodes in the feature tree.
Eastern and Western Algonquian

[round] > [front] > [low]

On the eastern and western edges of the Algonquian area, developments diverge from the predictions of the PA hierarchy.
Map of Algonquian languages

Eastern and Western (Cheyenne-Arapaho) are circled in red
Eastern and Western proto-languages

[round] > [front] > [low]

<table>
<thead>
<tr>
<th>[syllabic]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[round]</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>*/o/</td>
</tr>
<tr>
<td>[front]</td>
</tr>
<tr>
<td>(non-front)</td>
</tr>
<tr>
<td>[low]</td>
</tr>
<tr>
<td>(non-low)</td>
</tr>
<tr>
<td>*/a/</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>*/ɛ/</td>
</tr>
<tr>
<td>*/i/</td>
</tr>
</tbody>
</table>

The high vowels begin to pattern together

**In the east:** Proto-Eastern Algonquian lost the length contrast only in the high vowels (reflexes of */o/, */i/)

**In the west:** Proto-Arapaho-Atsina and Pre-Cheyenne merge */o, o:/ with */i, i:/
Eastern and Western proto-languages

[round] > [front] > [low]

The high vowels begin to pattern together

But under the hierarchy inherited from PA, the high vowels are not a natural class!
If the hierarchy constrains patterning, then the height contrast (reinterpreted as [high]) must have come to outrank place contrasts.

Eastern and Western proto-languages

[round] > [front] > [high]
If the hierarchy constrains patterning, then the **height contrast** (reinterpreted as [high]) must have come to outrank place contrasts. That is, the feature [high] moves to the top of the hierarchy.

Eastern and Western proto-languages

[high] > [round] > [front]
Eastern and Western daughter languages

[high] > [round] > [front]

Subsequent developments in the eastern and western daughter languages follow the predictions of the new hierarchy.

The patterns consistently differ from those of Central Algonquian:
Eastern and Western daughter languages

[high] > [round] > [front]

<table>
<thead>
<tr>
<th>[syllabic]</th>
<th>[high] (non-high)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[round] (non-rnd)</td>
<td>[front] (non-frnt)</td>
</tr>
<tr>
<td>*/o/</td>
<td>*/i/</td>
</tr>
</tbody>
</table>

1. Palatalization is triggered by */ɛ/ but excludes */i/.

Massachusetts */k/-palatalization is triggered by PEA */ɛː/ but not /iː/.

Cheyenne “yodation”, where */k/ > /kj/, is triggered by */ɛ(ː)/ only.
Eastern and Western daughter languages

\[ \text{[high]} > \text{[round]} > \text{[front]} \]

1. Palatalization is triggered by */ɛ/ but excludes */i/

Again, these patterns support the view that palatalization is triggered by a contrastive [front] feature.

Only /ɛ/ is contrastively [front] in these languages.
Eastern and Western daughter languages

\[ \text{[high]} > \text{[round]} > \text{[front]} \]

2. */ɛ/ merges with or shifts to */a/

Partial or complete mergers of PA short */ɛ/ with */a/ occur in Abenaki, Mahican, Mi’kmaq, and Maliseet-Passamaquoddy

PEA long */ɛː/ shifts to /aː/ in Massachusett and merges with */a/ in Western Abenaki
Eastern and Western daughter languages

[high] > [round] > [front]

2. */ɛ/ merges with or shifts to */a/

Long and short */ɛ(:)/ shift to /a(:)/ in Cheyenne

Vowel harmony involves */ɛ(:)/ and */ɑ(:)/ in Arapaho
Eastern and Western daughter languages

[high] > [round] > [front]

2. */ɛ/ merges with or shifts to */a/

This follows from the sisterhood of */ɛ/ and */a/ under the new hierarchy.
A single contrast shift thus accounts for the patterning of a large number of phonological changes across the Algonquian family.

<table>
<thead>
<tr>
<th>PA and Central languages</th>
<th>Eastern and Western languages</th>
</tr>
</thead>
<tbody>
<tr>
<td>[syllabic]</td>
<td>[syllabic]</td>
</tr>
<tr>
<td>[round]</td>
<td>[high]</td>
</tr>
<tr>
<td>(non-round)</td>
<td>(non-high)</td>
</tr>
<tr>
<td></td>
<td><a href="non-rnd">round</a></td>
</tr>
<tr>
<td></td>
<td>[front]</td>
</tr>
<tr>
<td></td>
<td>(non-front)</td>
</tr>
<tr>
<td>*/o/</td>
<td>[front]</td>
</tr>
<tr>
<td></td>
<td>(non-frnt)</td>
</tr>
<tr>
<td>[low]</td>
<td><a href="non-rnd">round</a></td>
</tr>
<tr>
<td>(non-low)</td>
<td>[front]</td>
</tr>
<tr>
<td></td>
<td>(non-frnt)</td>
</tr>
<tr>
<td>*/a/</td>
<td></td>
</tr>
<tr>
<td>*/ɛ/</td>
<td>*/i/</td>
</tr>
<tr>
<td>*/ɛ/</td>
<td>*/ɛ/</td>
</tr>
<tr>
<td>*/i/</td>
<td>*/a/</td>
</tr>
</tbody>
</table>
Harvey (2012) shows that contrastive shifts in the Ob-Ugric Mansi and Khanty languages show clear isoglosses and are borrowed between languages.
The Ob-Ugric languages are found in central Russia, to the east of the Ural mountains along the Ob river system. The two branches of Ob-Ugric are the Mansi languages, in the southwest, and the Khanty languages, to the east and north.

The Ob-Ugric languages inherited a complex vowel system: Proto-Ob-Ugric has been reconstructed to have 19 vowel phonemes (Harvey 2012, based on Sammallahti 1988).

Also characteristic of Ob-Ugric was a pervasive front-back vowel harmony that affected all vowels; we assume that the relevant feature is [front].
Early Western Mansi hierarchy

\[[lg] > [ft] > [rd] > [hi] > [ct]\]

For example, Early Western Mansi has the feature hierarchy below; all vowels are contrastive for \([\text{front}]\) and all participate in vowel harmony.

All vowels have a contrastive \([\text{front}]\) feature.
Later Western Mansi:

\[ [\text{lg}] > [\text{rd}] > [\text{hi}] > [\text{ct}] > [\text{ft}] \]

Subsequently, [front] drops to the bottom of the hierarchy. Front harmony is lost, and phonemes that were previously contrastively (*non-front*) develop front allophones.
Early Northern Mansi

[ft] > [hi] > [rd] > [lg]

A similar development occurred in Northern Mansi.

All vowels have a contrastive [front] feature
Later Northern Mansi:
\([hi] > [rd] > [lg] > [ft]\)

Here, too, [front] drops to the bottom, resulting in the loss of front harmony.

\{*ě, *ő, *ō, *ī, *ũ\} are not contrastive for [front]
Later Northern Mansi:

\([hi] > [rd] > [lg] > [ft]\)

Some phonemes that were previously contrastively [front] merge with back vowels.

Terminal merger from \([+front]\) towards (\(non\-front\))
[front] dropping did not occur early on in the genetic history of Proto Mansi. The shift occurred later in the daughter languages. The red X indicates when the [front]-dropping shift occurred.
Can contrast shifts spread?

If [front] dropping is not a genetic inheritance common to the non-Southern Mansi languages, could it have been spread by areal diffusion?

That is, is can contrast shift show areal patterning, like other elements of linguistic systems?

To investigate this question, Harvey (2012) plotted a number of contrast shifts, and the results are shown on the following map. It is clear that the contrast shifts have occurred in a way that is not at all random.
Innovative dialect
Northern Mansi

Changes follow the rivers (blue arrows, routes of cultural contact.

Red circle is area in which [front] was dropped in the hierarchy.

[front]-dropping jumps language groups, and was borrowed from Mansi languages (M) into some Khanty (K) languages.
Can contrast shifts spread?

We conclude that there is a pattern to these contrastive changes: they follow routes of cultural contact.

Contrast shifts show clear isoglosses and can be borrowed between languages.

It is also important to note that the contrastive analysis of the Ob-Ugric languages presented here is consistent with earlier dialect studies (Steinitz 1955; Honti 1998), and matches earlier observations about which dialects are conservative or innovative.
10.

The contrastive hierarchy and phonetic ‘substance’
Krekoski (2013) constructs contrastive trees for the tone systems of a number of languages that descend from Middle Chinese.

He bases the trees not on the phonetics of the tones, but on the patterns of activity they display in the form of tone sandhi.

Thus, Beijing Mandarin has the 4 tones shown, which participate in 2 robust sandhi rules:

<table>
<thead>
<tr>
<th>Beijing Mandarin tones</th>
<th>Beijing Mandarin tone sandhi</th>
</tr>
</thead>
<tbody>
<tr>
<td>/55/  high level</td>
<td>/214/ → 35/_____/214/</td>
</tr>
<tr>
<td>/35/  rising</td>
<td>/35/ → 55{/35/, /55/}_____T</td>
</tr>
<tr>
<td>/214/ low concave</td>
<td>(T = any tone)</td>
</tr>
<tr>
<td>/51/  high falling</td>
<td></td>
</tr>
</tbody>
</table>
Beijing Mandarin contrastive hierarchy

Krekoski (2013) assumes that, where possible, tones related by a sandhi rule differ minimally, that is by only one feature.

Thus, tone /35/ differs by 1 feature from /214/ and from /55/. Below is a tree satisfying these constraints:

[α] and [β] are placeholders for features which will be given a phonetic interpretation.

Beijing Mandarin tone sandhi

/214/ → 35/_____/214/

/35/ → 55/{/35/, /55/}_____T

(T = any tone)
Pingyao (Jin) tone system

Pingyao is a Jin language with 4 underlying tones. Though two of them have merged at the surface, they can be distinguished by the way they participate in tonal alternations (Chen 2000).

Krekoski identifies 9 tone sandhi rules in Pingyao. Their inputs and outputs are summarized below. I omit alternations that are purely allotonic.

<table>
<thead>
<tr>
<th>Pingyao tones</th>
<th>Pingyao tone sandhi</th>
</tr>
</thead>
<tbody>
<tr>
<td>/13a/ low rising</td>
<td>Input /13a/ Outputs 35</td>
</tr>
<tr>
<td>/13b/ low rising</td>
<td>/35/ 13 [= 13a], 53</td>
</tr>
<tr>
<td>/53/ high falling</td>
<td>/53/ 35, 13 [= 13b]</td>
</tr>
</tbody>
</table>
Following the same procedure as for Beijing, Krekoski arrives at a tree for Pingyao whereby each of the tonal alternations involves a change of only 1 feature.

<table>
<thead>
<tr>
<th>Pingyao tone sandhi</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input</strong></td>
</tr>
<tr>
<td>/13a/</td>
</tr>
<tr>
<td>/35/</td>
</tr>
<tr>
<td>/53/</td>
</tr>
</tbody>
</table>
Krekoski observes that Beijing and Pingyao tones in corresponding positions in the trees are cognates, and descend from the same Middle Chinese tone.

That is, despite extensive changes in their phonetics, the tones retain the same positions in the contrastive hierarchy.
Beijing and Pingyao tone features

Up to here we have not tried to give the features phonetic interpretations; however, features are not purely abstract entities.

Krekoski (2013) suggests correlates for the features; I do not attempt to assign markedness. [extreme] refers to the periphery of a tonal space, [inner] to a more central region of the space.
Substance strikes back: Tianjin Mandarin

Following the same methodology, Krekoski posits the tree below for Tianjin Mandarin.

Surprisingly, these tones do **not** correspond as expected with their cognates in Beijing and Pingyao.

Tones /21/ and /53/ are in the ‘wrong place’ relative to the other dialects that descend from Middle Chinese.
Substance strikes back: Tianjin Mandarin

Tracing the tones from Middle Chinese, Krekoski proposes that an earlier stage of Tianjin (*Proto-Tianjin) must have had the hierarchy on the right.

Why did a contrastive shift occur in the history of Tianjin? An answer can be found in the phonetics of the tones.

Modern

\[
\begin{array}{c}
[+\alpha] \\
[+\beta] & [-\beta] \\
/53/ & /45/ & /21/ & /213/
\end{array}
\]

*Proto

\[
\begin{array}{c}
[+\alpha] \\
[+\beta] & [-\beta] \\
/21/ & /45/ & /53/ & /213/
\end{array}
\]
Krekoski observes that it is difficult to find plausible phonetic correlates for the features in *Proto-Tianjin; whereas the Modern system clearly groups the tones by height. He proposes that “Tonal drift likely accreted changes in height values until the system of contrasts reached some critical inflection point which precipitated the reanalysis of specifications.”
What this example illustrates is that features may be suggested by patterns of phonological activity, but that phonetic substance has a say also.

Contrastive trees for tonal features can remain stable even as the phonetic realizations of the tones change; but the feature tree is restructured when it gets too out of sync with the phonetics.

Without such a mechanism, we would expect a much greater proliferation of ‘crazy rules’ than we actually find.
While phonetic substance influences the contrastive feature hierarchy, the influence is not all in this direction.

I argued above that the contrastive hierarchy serves as an organizing principle for synchronic phonology, and influences the direction of diachronic changes, such as mergers.

The conclusion is that influence runs in both directions.
11. Contrast and OT
It has been claimed that contrasts ‘emerge’ from OT constraint rankings (Itô, Mester & Padgett 1995, Kirchner 1997).

Therefore, no special theory of contrast is necessary.

However, an arbitrary constraint ranking will not express a connection between contrast and phonological activity.

For OT to capture this relation it must incorporate the contrastive hierarchy.

In converting the contrastive hierarchy into an OT constraint set, we must make some assumptions about the output and the input.
The contrastive hierarchy in OT

Output

I will assume that the output of an OT implementation of the contrastive hierarchy is a set of contrastive specifications from which redundant feature specifications are excluded.

Input

I will assume for now that the input consists of fully-specified representations.

The analysis can easily be extended to include underspecified inputs, but we shall not do so here (see Dresher 2009).
The contrastive hierarchy in OT

Constraints

Two basic constraint types are needed to model a contrastive hierarchy:

- **IO-IDENT F**: ‘Correspondent segments must have the same value of the feature F (either + or –)’.

- ***[αF, Φ]**: ‘Exclude αF in the context Φ, where α ranges over + and –, and Φ is the set of features (with wider scope than F) forming the context of F.’
An Example

To illustrate, I will use the Classical Manchu vowel system that was mentioned earlier.

Recall that the feature hierarchy for this language proposed above is:

low > coronal > labial > ATR

For simplicity, I will assume features with both + and – values in this section. We can do the same thing with privative features.
The first feature in the hierarchy is [low]. It has no exclusions.

<table>
<thead>
<tr>
<th>/–low, +cor, –lab, +ATR/</th>
<th>Id [low]</th>
</tr>
</thead>
<tbody>
<tr>
<td>–low, +cor, –lab, +ATR</td>
<td></td>
</tr>
<tr>
<td>+low, +cor</td>
<td>⬠! –low</td>
</tr>
</tbody>
</table>
The second feature is [coronal]. It is excluded with [+low]

<table>
<thead>
<tr>
<th>/–low, +cor, –lab, +ATR/</th>
<th>Id [low]</th>
<th>*[+low cor]</th>
<th>Id [cor]</th>
</tr>
</thead>
<tbody>
<tr>
<td>–low, +cor, –lab, +ATR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>–low, –cor, +ATR</td>
<td></td>
<td></td>
<td>*! –cor</td>
</tr>
</tbody>
</table>
The third feature is [labial]. It is excluded with [–low].

<table>
<thead>
<tr>
<th>/–low, +cor, –lab, +ATR/</th>
<th>ID [low]</th>
<th>*[+low] [cor]</th>
<th>ID [cor]</th>
<th>*[-low] [lab]</th>
<th>ID [lab]</th>
</tr>
</thead>
<tbody>
<tr>
<td>–low, +cor, –lab, +ATR</td>
<td>![lab]</td>
<td>*</td>
<td>! lab</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>–low, +cor, –ATR</td>
<td>![lab]</td>
<td>![lab]</td>
<td></td>
<td>![lab]</td>
<td></td>
</tr>
</tbody>
</table>
The fourth feature is [ATR]. It is excluded with [+cor] and [+lab]

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>–low, +cor, +high</td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>! ATR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>–low, +cor, –ATR</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
All other features are redundant and are excluded.

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>–low, +cor, +high</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
<td>! hi</td>
</tr>
<tr>
<td>–low, +cor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The contrastive hierarchy in OT

General Procedure for Converting a Contrastive Hierarchy to an OT Constraint Hierarchy Given an Ordering of Features

a. Go to the next contrastive feature in the list, $F_i$. If there are no more contrastive features, go to (e).

b. In the next stratum of constraints, place any co-occurrence constraints of the form $*[\alpha F_i, \Phi]$, where $\Phi$ consists of features ordered higher than $F_i$.

c. In the next stratum, place the constraint $IO-IDENT [F_i]$.

d. Go to (a).

e. In the next constraint stratum, place the constraint *[F], and end.
Every contrastive hierarchy can be converted into a constraint hierarchy by the above procedure.

But the converse does not hold: not every constraint hierarchy can be converted into a contrastive hierarchy.

Limiting constraint hierarchies to those that conform to a well-formed contrastive hierarchy captures the relation between contrast and phonological activity and constrains the class of possible grammars.

For more on the contrastive hierarchy in OT, see papers by Sara Mackenzie in *Lingua* (2011) and especially *Phonology* (2013).
12. Conclusions
Conclusions

The approach to phonology I have sketched here is based on a fundamental distinction between a phonetic and phonological analysis of the sound systems of languages.

This view builds on approaches to phonology pioneered by Sapir and the Prague School (Jakobson and Trubetzkoy), instantiated within a generative grammar.

More specifically, it views phonemes as being composed of contrastive features that are themselves organized into language-particular hierarchies.

Because of the hypothesized connection between contrast and activity, we expect languages with similar hierarchies and inventories to exhibit similar patterns.
Conclusions

In some of the language families I have surveyed here, feature hierarchies appear to be relatively stable, as exemplified by the vowel systems of Manchu-Tungusic, Eastern Mongolian, Yupik-Inuit, and branches of Algonquin, and the tonal systems of the Chinese dialects reviewed here.

Contrast shifts can occur, however, for various reasons, and these can result in dramatic differences in patterning, as shown by the modern Manchu languages, Central Algonquin as compared with Eastern and Western, and extensive changes in Ob-Ugric vowel systems (over a long period of time).
Conclusions

Ob-Ugric shows that elements of feature hierarchies can spread and be borrowed, like other aspects of linguistic structure.

The Tianjin Mandarin tone system shows that there is a limit to how far the phonetics can get out of sync with the feature hierarchy before something has to give.

I have also briefly discussed Spahr’s (2014) proposal that the intermediate nodes of a contrastive feature tree can also receive phonetic interpretations, as in the case of neutralizing vowel reduction.
The approach presented here shares with ‘substance-free’ theories the idea that features are emergent (Hale & Reiss 2000a, b, 2008; Morén 2003, 2006, 2007; Odden 2006; Blaho 2008; Samuels 2011, 2012; Iosad 2012; see Hall 2014 for discussion).

Some of these theories go too far, in my view, in shifting the explanation for phonological patterning to external factors.

In this way they resemble phonetics-driven approaches to phonology that they otherwise oppose (e.g., Boersma 1998; Pierrehumbert, Beckman & Ladd 2000; Hayes, Kirchner & Steriade 2004; Steriade 2009).
In his review of Samuels (2011), Hall (2012: 738) comments:

“the substance-free and the substance-based views are alike in that they both posit functional phonetic explanations for substantive phonological patterns… the two lines of thought, in their different ways, both turn away from the practice of constructing formal explanations for substantive patterns.”

The contrastive feature hierarchy restores the balance between functional and formal explanations, to the extent that it serves as a formal organizing principle of the phonology.
Finally, it has been suggested that only syntactic recursion is part of the narrow faculty of language (FLN; Hauser, Chomsky & Fitch 2002), and that phonology is outside FLN.

However, the contrastive hierarchy has a recursive digital character, like other aspects of FLN.

Like syntax, phonology takes substance from outside FLN and converts it to objects that can be manipulated by the linguistic computational system.

The parallels between phonology and syntax may go even further, if it turns out that syntax, too, is in the business of creating contrastive hierarchies of morphosyntactic features (Cowper & Hall 2013).
Readings

For a detailed review of early work in the MCS framework, see Dresher (2009) and the references therein. The readings below and on the next slide are a sampling of more recent publications; see the References for full citations. Please see http://homes.chass.utoronto.ca/~dresher/publications.html for my recent papers and talks.


Readings (continued)


THANK YOU!

For discussions, ideas, and analyses I would like to thank Elizabeth Cowper, Daniel Currie Hall, Paula Fikkert, Ross Godfrey, Christopher Harvey, Ross Krekoski, Will Oxford, Keren Rice, Christopher Spahr, and Zhang Xi, and other members of the project on *Markedness and the Contrastive Hierarchy in Phonology* at the University of Toronto (Drescher and Rice 2007):

http://homes.chass.utoronto.ca/~contrast/
References


Harvey, Christopher. 2012. Contrastive shift in Ob-Ugric Vowel systems. Ms., Department of Linguistics, University of Toronto.


