1. **Introduction**

The special status of coronals

• Relative to other oral place features (labial, dorsal)

**1. Coronals are exceptionally permitted** in some contexts where non-coronals are not.

• Exx. Exemption from place assimilation, phonotactic restrictions, OCP restrictions

**2. Coronals alone capitulate** in some phonological phenomenon.

• Exx. Coronals are targets of place assimilation, neutralization

• Type 1 phenomena suggest that coronals incur a lesser violation of markedness.

• Type 2 phenomena suggest that coronals incur a lesser violation of faithfulness.

Previous constraint-based approach:

• Mirrored markedness and faithfulness constraint sets (de Lacy 2002, 2006).

• Markedness hierarchy for oral place features

[Dorsal] > [Labial] > [Coronal]

<table>
<thead>
<tr>
<th>Markedness constraints</th>
<th>Faithfulness constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>*{Dor}</td>
<td>IDENT-IO{Dor}</td>
</tr>
<tr>
<td>*{Dor, Lab}</td>
<td>IDENT-IO{Dor, Lab}</td>
</tr>
<tr>
<td>*{Dor, Lab, Cor}</td>
<td>IDENT-IO{Dor, Lab, Cor}</td>
</tr>
</tbody>
</table>

Questions

• Why is faithfulness prioritized for more marked features?

• Is it necessary to **duplicate** the Dorsal > Labial > Coronal relationship across sets of M and F constraints?

**Proposal**

Place features have a gradient degree of activation such that

[Dorsal] > [Labial] > [Coronal]

• Employ Gradient Symbolic Representations (GSRs) (Smolensky & Goldrick 2016).

• Weaker activation of [Coronal] causes it to incur a lesser violation of markedness and faithfulness constraints for Place, relative to other oral place features.

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Road map

2. Patterns of special coronal behavior

3. Analysis employing gradient activation for Place features

• Two case studies of place assimilation

4. Discussion of issues surrounding a scale of activation for Place Fs

5. Alternatives

6. Conclusion
2. Patterns: Special Coronal Behavior

Type 1 – Markedness-based: Coronals are exceptionally permitted / inactive relative to labials and dorsals.

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Ex. language(s)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>v. Epenthetic Cs are coronal</td>
<td>Axininca Campa</td>
<td>Payne 1981, McCarthy &amp; Prince 1993</td>
</tr>
<tr>
<td>vi. Only coronals may have a secondary place F (coronals do not block harmony)</td>
<td>Najdi dialect of Bedouin Arabic</td>
<td>Abboud 1979, McCarthy 1994, Gafos &amp; Lombardi 1999</td>
</tr>
</tbody>
</table>

Type 1 patterns have been proposed to reflect a lesser degree of markedness for [Coronal] than [Labial] and [Dorsal].


Type 2 – Faithfulness-based: Coronals alone capitulate.

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Ex. language(s)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>ii. Coronals alone are neutralized</td>
<td>Yamphu</td>
<td>de Lacy 2006</td>
</tr>
</tbody>
</table>

Type 1 patterns have been proposed to reflect a lesser degree of faithfulness for [Coronal] than [Labial] and [Dorsal].

2. Special Coronal Behavior

Illustration type 1 – Markedness: Sri Lankan Portuguese Creole

<table>
<thead>
<tr>
<th>/n/</th>
<th>/sin/</th>
<th>/sin+pa/</th>
<th>/sil+ni/</th>
<th>/sil+ni+ki/</th>
<th>/silono/</th>
<th>/komwan/</th>
</tr>
</thead>
</table>

(De Lacy 2006 compiling data from Smith 1978 and Hume & Tserdanelis 2002)

2. Special Coronal Behavior

Summary

- Two patterns of place assimilation affecting pre-consonantal coda nasals.
- In Sri Lankan Portuguese Creole, coronal /n/ is exceptionally exempted from place assimilation that affects /m/ and /n/.
- Suggests that coronal nasal codas that do not share place with a following onset are less marked than labial and dorsal counterparts.
- In Catalan, coronal /n/ is the sole target of place assimilation; /m/, /n/ and /n/ are not affected.
- Suggests that coronal nasal codas are more susceptible to a violation of faithfulness for place than labial and dorsal counterparts.

3. Analysis:

Gradient Activation for Place Features

3.1 Basics: Place Assimilation

Nasal Place assimilation

- Assumption: Place assimilation involves spreading of a Place feature from onset C to preceding coda C, driven by a coda condition.


<table>
<thead>
<tr>
<th>Root</th>
<th>[som] 'we are'</th>
<th>[son] 'they are'</th>
<th>[aŋ] 'year'</th>
</tr>
</thead>
<tbody>
<tr>
<td>amic(s) 'friend(s)'</td>
<td>[som amiks]</td>
<td>[son amiks]</td>
<td>[aŋ amik]</td>
</tr>
<tr>
<td>pocis 'few-PF, pehit 'short'</td>
<td>[som pəks]</td>
<td>[son pəks]</td>
<td>[aŋ pət]</td>
</tr>
<tr>
<td>veus 'voices'</td>
<td>[som bəus]</td>
<td>[son bəus]</td>
<td></td>
</tr>
<tr>
<td>tontus/sj 'stupid-(N)'</td>
<td>[son tontus]</td>
<td>[aŋ tontus]</td>
<td></td>
</tr>
<tr>
<td>cosins 'cousins'</td>
<td>[som kuzins]</td>
<td>[son kuzins]</td>
<td></td>
</tr>
<tr>
<td>grant/sj 'big-(N)'</td>
<td>[som grants]</td>
<td>[son grants]</td>
<td>[aŋ gran]</td>
</tr>
</tbody>
</table>

- No assimilation of [ɲ]: [təŋ presə] 'I'm in a hurry'
- /p/ does not undergo assimilation; a dorsal component is assumed (Mascaró 1976).
- Before [f], /m/ becomes [n], but /m/ does not show assimilation for major place.


3.1 Basics: Place Assimilation

Constraints

1. CodACond
   - Assign a violation for every Place feature that is solely associated to a coda consonant (Ito 1986, 1989).

2. Max-IO(Place)
   - Assign a violation for every Place feature in the input that does not have a correspondent in the output (McCarty & Prince 1995).

3. Max-IO-Onset(Place)
   - Let S be a segment in an onset in the output. Assign a violation for every Place feature associated with the input correspondent of S that does not have a correspondent in the output (Beckman 1998, framed after Padgett 1995b).
   - (These constraints follow the analysis of Lombardi 2001 on place restrictions in coda in the essentials.)

   Further details
   - Restriction to nasal codas – see (Padgett 1995b)
   - Exemption of word-final codas – see Goldsmith (1990), Padgett (1995b)
3.1 Basics: Place Assimilation

Schematic illustration of place assimilation

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Cor</td>
<td>Lab</td>
</tr>
</tbody>
</table>

- Violates MAX-IO(Place) (here for [Coronal])
- Obeyes MAX-IO-ONSET(Place) and CODACOND

• Framework: Harmonic Grammar
  (Legendre et al. 1990, Smolensky & Legendre 2006)

• Place assimilation
  \( w(\text{CODACOND}) > w(\text{MAX-IO(Place)}) \)

3.1 Basics: Place Assimilation

Assimilation for all Place Fs
- Attested, e.g. in Spanish (Harris 1984, Padgett 1995b)

Problem: Assimilation may be Place-feature specific

Proposal here:
• Differentiation in Place F behavior results from gradient featural representations.
• Constraints like CODACOND, MAX-IO(Place) refer to the entire class of Place.

3.2 Representations

Gradient Symbolic Representations (GSRs)
- Phonological symbolic representations can be gradiently active (Smolensky & Goldrick 2016).
- Gradient activity may be present in outputs (as well as inputs) (Faust 2017, 2019, Faust & Smolensky 2017a, b, Zimmermann 2018, 2019, Jang 2019).

Proposed representations for Place features

\[ \text{[Dor]}_{i_{O}} \text{[Lab]}_{a_{D}} \text{[Cor]}_{a_{a}} \]

• These particular activity values are arbitrary. What matters is that for feature activation \( a \):
  \( \alpha_{\text{Dor}} > \alpha_{\text{Lab}} > \alpha_{\text{Cor}} \)

Implications for constraints
• No stipulation of Place F hierarchy / subsets in constraints. M and F effects follow from gradience in the representation.

3.3 Calculating the penalty for constraint violation

**Question**
How does gradient feature activity figure into the calculation of the penalty assigned for a constraint pertaining to that feature?

Two possibilities considered here
1. \( w \ast a \): Feature activation \( a \) is multiplied by basic constraint weight \( w \).
   • Problem for differentiating coronal behavior when two conflicting constraints are both multiplied by \( a \).
2. \( w + (s \ast a) \): Feature activation \( a \) is multiplied by a scaling factor \( s \) added to basic constraint weight \( w \).
   • Succeeds in potential to differentiate coronal behavior, even when two conflicting constraints both assign violations to Place Fs.


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   • Succeeds in potential to differentiate coronal behavior, even when two conflicting constraints both assign violations to Place Fs.

3.3 Calculating the penalty for constraint violation

\[ H = w \times a \]

Scenario: Coda Place Assimilation

**Problem:** When two conflicting constraints are each assigned a penalty that is directly proportional to the degree of Place F activation, the behavior of coronals in that conflict cannot be differentiated from non-coronals by activation.

- Depending on \( w \), the penalty assigned for Max(Place) will overtake COdaCONd for no place Fs or for all of them.
  - e.g. for two \( w \): \( x \) and \( y \)
  - If \( x \times .8 > y \times .8 \)
    - Then \( x \times .9 > y \times .9 \)

**Toy example**

\[ 1 + (30 \times \text{activation of } F) \]

1. [Coronal] \( w = .8 \):
   - \( 1 + (30 \times .8) = -10 \)
   - \( 1 + (30 \times .9) = -11 \)
2. [Labial] \( w = .9 \):
   - \( 1 + (30 \times .8) = -10.5 \)
   - \( 1 + (30 \times .9) = -12 \)
3. [Dorsal] \( w = 1 \):
   - \( 1 + (30 \times 1) = -11 \)
   - \( 1 + (30 \times 1) = -13 \)
4. [Labial] \( w = .9 \): [Labial] \( w = .9 \):
   - \( 1 - (30 \times .8) = -21 \)
   - \( 1 - (30 \times .9) = -24 \)

3.3 Calculating the penalty for constraint violation

**Proposal:**

Gradient Place feature activation defines the scale for a *scaling factor* in constraints sensitive to Place features.

- For each violation, the penalty for such constraints is \( w + (s \times a) \)
  - \( w \) = the basic constraint weight, assigned for an offending Place F
  - \( s \) = the scaling factor
  - \( a \) = the activation of \( F \) in Place

- \( w \) and \( s \) are both constraint-specific

Calculation of additive contribution of constraint-specific scaling after Hsu & Jesney (2016, 2017a, 2018), Hsu (to appear)

<table>
<thead>
<tr>
<th>Toy example</th>
<th>Con1(Place)</th>
<th>Con2(Place)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Coronal] ( w = .8 )</td>
<td>( w = 6, s = .5 )</td>
<td>( w = 3, s = 10 )</td>
</tr>
<tr>
<td>[Labial] ( w = .9 )</td>
<td>( w = 6, s = .9 )</td>
<td>( w = 3, s = 10 )</td>
</tr>
<tr>
<td>[Dorsal] ( w = 1 )</td>
<td>( w = 6, s = 1 )</td>
<td>( w = 3, s = 10 )</td>
</tr>
<tr>
<td>[Labial] ( w = .9 ): [Labial] ( w = .9 )</td>
<td>( w = 6, s = .9 )</td>
<td>( w = 3, s = 10 )</td>
</tr>
</tbody>
</table>

3.4 Analysis: Illustration

**Differentiating coronals**

For two Place F-sensitive constraints, Con1 and Con2

- For activation \( a_{\text{Dor}} = 1.0, a_{\text{Lab}} = .9, a_{\text{Cor}} = .8 \)
  - If \( \text{Con1} \): \( w = 18, s = 10 \)
  - \( \text{Con2} \): \( w = 1, s = 30 \)

- For [Dor], [Lab]: \( \mu(\text{Con1}) > \mu(\text{Con2}) \)
  - i.e. Con2 is enforced at the expense of Con1

- For [Cor]: \( \mu(\text{Con2}) > \mu(\text{Con1}) \)
  - i.e. Con1 is enforced at the expense of Con2

**Type 1 – Markedness:** Sri Lankan Portuguese Creole

- Coronals exempted as target of place assimilation
  - Max-Io(Place): \( w = 18, s = 10 \)
  - COdaCONd: \( w = 1, s = 30 \)

- For [Cor]: Max-Io(Place) (F constraint) is enforced
  - Max-Io-Onset(Place) is consistently enforced regardless of Place F in onset or coda
    - Assume \( w = 25, s = 50 \); higher than Max-Io(Place)
    - For ease of exposition, Max-Io-Onset(Place) is henceforth not shown in tableaux and only candidates that obey it are considered.
3.4 Analysis: Illustration

Sri Lankan Portuguese Creole

- Nasal place assimilation targets non-coronal /m/ (i) but not /n/ (ii).
- Candidates are schematic for illustration.

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>CodaCond</th>
<th>Max-IO[Place]</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. /Vm,pV/</td>
<td>a. ( \rightarrow [Vn,kV] ) assim. in coda</td>
<td>( w = 18, s = 10 )</td>
<td>( w = 18, s = 10 )</td>
<td>(-1)</td>
</tr>
<tr>
<td>b. [Vm,kV] faithful</td>
<td>( s = -1(1 + 30 * .8) )</td>
<td>(-1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. [Vn,kV] neutralization to cor</td>
<td>( s = -1(18 + 10 * .8) )</td>
<td>(-1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii. /Vn,pV/</td>
<td>a. [Vm,pV] assim. in coda</td>
<td>( w = 1 ), ( s = 30 )</td>
<td>( w = 1, s = 30 )</td>
<td>(-1)</td>
</tr>
<tr>
<td>b. [Vn,pV] faithful</td>
<td>( s = -1(1 + 30 * .8) )</td>
<td>(-1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{Gradient activation of Fs in output allows coronal [n] (iiib), } H = -25 )</td>
<td>to incur a lesser violation of markedness (( \text{CodaCond} )) than labial [m] (iiib), ( H = -28 ).</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.4 Analysis: Illustration

Differentiating coronals in place assimilation

Type 2 – Faithfulness: Catalan

- Coronas alone are target of place assimilation

  \( \text{CodaCond: } w = 18, s = 10 \)

  \( \text{Max-IO[Place]: } w = 1, s = 30 \)

For [Dor], [Lab]: \( \text{Max-IO[Place]} \) (F constraint) is enforced

For [Cor]: \( \text{CodaCond} \) (M constraint) is enforced

The w and s values for these two constraints are reversed from that for Sri Lankan Portuguese Creole

3.4 Analysis: Illustration

Catalan

- Nasal place assimilation does not target non-coronal /n/ (iii).

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>CodaCond</th>
<th>Max-IO[Place]</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>iii. /Vn,pV/</td>
<td>a. [Vm,pV] assim. in coda</td>
<td>( w = 18, s = 10 )</td>
<td>( w = 18, s = 10 )</td>
<td>(-1)</td>
</tr>
<tr>
<td>b. [Vn,pV] faithful</td>
<td>( s = -1(18 + 10 * .8) )</td>
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<td></td>
<td></td>
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<tr>
<td>c. [Vn,pV] neutralization to cor</td>
<td>( s = -1(1 + 30 * .8) )</td>
<td>(-1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( \text{Gradient activation of Fs in input allows coronal /n/ to incur a lesser violation of markedness in place assimilation ((ii), } H = -25 \) than labial /m/ ((ii), \( H = -28 \)). |

3.5 Analysis: Summary

Key points

- Place features are represented with scaled activity:
  - Dorsal\(_2\) > Labial\(_3\) > Coronal\(_0\)
- Constraints pertaining to Place refer to the entire class of Place features rather than Place-feature specific constraints.
- The potential for special behavior of coronals with markedness and faithfulness derives from
  a) The scale of activity for Place Fs
  b) Lesser violation of markedness and faithfulness
- Scaling factors that operate on the Place F activity scale
  a) Constraint-specific w and s values establish the priority assigned to each Place-referring constraint and the impact of the activity scale
4. Discussion: Scalar Activity

4.1 Scales and scaling factors

Where do scales for scaling factors come from?

- Hypothesis: They come from GSRs; for example
  - Place features: Dorsal \textsubscript{1} > Labial \textsubscript{1} > Coronal \textsubscript{1}
- Loanword nativization: Periphery \textsubscript{1} > Intermediate \textsubscript{1} > Core \textsubscript{1}
  - Core stratum has potential to show greater range of marked structures (lesser violation of M) or a smaller range of marked structures (lesser violation of F) in comparison to periphery. Modeled with scaling factors (Hsu & Jesney 1997a, b, 2018; foundational work on lexical strata from Ito & Mester 1995, 1999, 2001).
- Prosodic Boundary Strength: Utterance \textsubscript{a} > PPh \textsubscript{a} > Pwd \textsubscript{a} > Syllable \textsubscript{a}
  - Smaller PCats have potential to resist repair (lesser violation of M) or undergo repair (lesser violation of F) in comparison to larger PCats. Modeled with scaling factors (Hsu & Jesney 2016).
  - Scales derived from GSRs could also provide a basis for values.
  - Spacing could potentially be uneven (Pater 2016), e.g. Dorsal \textsubscript{1} > Labial \textsubscript{1} > Coronal \textsubscript{a}
  - Future work could examine whether other scales for scaling factors are amenable to treatment in terms of GSRs.

4.2 Experimental evidence

Weaker activity for coronals

- This account posits that [Coronal] has lower activity than non-coronal Place Fs.
- Experimental evidence points to a less-specific or sparser representation for coronals
  - Mismatch negativities
  - Speech errors

4.2 Experimental evidence

Speech errors

- Speech error studies suggest that coronals lack structure that is present in non-coronal Place Fs.
- Nevertheless, coronals do interact with each other in errors, but to a lesser extent. This could be consistent with an understanding of [Coronal] as active but to a lesser degree than other Place Fs.
  - Source of speech errors: Naturalistic corpus and errors elicited in a laboratory setting.
  - Consonants with greater similarity are expected to show higher participation in errors.
  (Stemberger 1991)

4.3 Possible origins – lesser activation of coronals

Articulation

- Possibly the nature of tongue muscle activation for coronals is such that [Coronal] receives less activation than [Labial] and [Dorsal] in the phonetics-phonology mapping (in the model proposed by Jang 2019).
- Potentially related to the gestures and transition cues for coronals being more rapid than those for non-coronals (Jun 2004).
  - Results in coronals being more confusable and more vulnerable to being obscured by neighboring consonants.
- Transmission noise
  - In learning simulations with transmission noise, more mismatches occurred for coronals than non-coronals, making coronals the least reliable Place F (Seinhorst & Hamann 2017, Seinhorst 2019).
  - Potential for [Coronal] to receive activation overflow from non-coronal Place Fs might contribute to a representation of coronals with a less-specific underlying neural code and less intrinsic activation for [Coronal].

Exploring these possibilities remains for future research

(On sources of scalar activity/strength, see also Inkelas 2015, Faust & Smolensky 2017a, b)
5. Alternatives

5.1 Underspecification

Coronal underspecification
- However, Place Fs show multiple steps on the markedness/faultiness scale.
  - [Coronal] is lower on the scale with respect to [Dorsal] and [Labial] (de Lacy 2006)
  - [Labial] is lower on the scale with respect to [Dorsal] (de Lacy 2006)
- Both scalar divisions are evidenced in Korean place assimilation
- Underspecification does not predict scales beyond a single division; with respect to Place, it predicts special behavior of a single feature. (Yet an enriched hierarchical segmental representation could allow for underspecification of different nodes, such as a terminal Place F versus the Place Class node.)

5.2 Mirrored constraint sets

Place-feature specific markedness and faithfulness constraints
- Mirrored sets of M and F constraints specified for subsets of Place Fs (derived from multi-valued [Place]) have been proposed for special coronal behavior (de Lacy 2002, 2006).

<table>
<thead>
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</tr>
<tr>
<td>*(Dor, Lab)</td>
<td>IDENT-IO(Dor, Lab)</td>
</tr>
<tr>
<td>*(Dor, Lab, Cor)</td>
<td>IDENT-IO(Dor, Lab, Cor)</td>
</tr>
</tbody>
</table>

- Anti-heterorganic constraints drive place assimilation (de Lacy 2006: 183)
  *XY: Assign a violation for every pair of adjacent segments such that
  (i) the first segment has a feature $f_1$ from set X and
  (ii) the second segment has a feature $f_2$ from set Y and
  (iii) $f_1 \neq f_2$

Exx. *{Dor, Lab} {Dor, Lab, Cor} *(Dor, Lab, Cor)

5.2 Mirrored constraint sets

Sri Lankan Portuguese Creole
- Nasal place assimilation targets non-coronal /m/ (i) but not /n/ (ii).
- Driven by Place-feature specific markedness:
  - M constraint that penalizes only clusters where the first C is non-coronal

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>*(Dor, Lab)</th>
<th>*(Dor, Lab, Cor)</th>
<th>IDENT-IO(Dor, Lab, Cor)</th>
<th>*(Dor, Lab, Cor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. /Vm/p/</td>
<td>a. (VgkV)</td>
<td>*(Dor, Lab)</td>
<td>*(Dor, Lab, Cor)</td>
<td>IDENT-IO(Dor, Lab, Cor)</td>
<td>*(Dor, Lab, Cor)</td>
</tr>
<tr>
<td></td>
<td>(VgkV) faithful</td>
<td>(\text{assim. in coda})</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. (VgkV) faithful</td>
<td>(\text{assim. in coda})</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii. /Vmp/p/</td>
<td>a. (VnpV)</td>
<td>*(Dor, Lab)</td>
<td>*(Dor, Lab, Cor)</td>
<td>IDENT-IO(Dor, Lab, Cor)</td>
<td>*(Dor, Lab, Cor)</td>
</tr>
<tr>
<td></td>
<td>(VnpV) faithful</td>
<td>(\text{assim. in coda})</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>
5.2 Mirrored constraint sets

Catalan
- Nasal place assimilation targets /n/ (i) but not non-coronal /m/ (ii).
- Driven by **Place-feature specific faithfulness**: 
  - F constraint that enforces identity for non-coronal Cs only.

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>I\textsubscript{ON,I-IO} (Dor, Lab)</th>
<th>*{Dor, Lab, Cor} (Dor, Lab, Cor)</th>
<th>I\textsubscript{ON,I-IO} (Dor, Lab)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. /\textipa{Vnp}/</td>
<td>a. \textipa{[VmpV]} assim. in coda</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. \textipa{[VnpV]} faithful</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii. /\textipa{Vm}/</td>
<td>a. \textipa{[VmpV]} assimilation</td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>b. \textipa{[VmV]} faithful</td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

5.2 Mirrored constraint sets

**GSRs**
- Gradient activation situates the scalar relationship between Place Fs as activity in the representation.
  - Predicts that greater markedness and preservation go hand in hand typologically.
    (see Faust 2017, 2019, Zimmermann 2018, 2019 for related discussion)
  - Eliminates replication of the scale in the M and F constraint sets.
  - In this approach, the simplified constraint set requires constraint-specific scaling factors.

6. Conclusion

**Take-aways**
- GSRs implemented as a scale of activity over Place features sheds new light on a typological duality:
  - Place Fs that exhibit lesser markedness also exhibit lesser faithfulness
- Provides a promising avenue for phonological analysis of scalar phenomena involving place of articulation.
- Lends support to the idea that gradient activity is possible in both input and output.
- Offsets the need for place-feature specific M and F constraints.
- Interaction among Place-sensitive constraints supports using gradient activity to define the scale for constraint scaling factors
- Suggests a possible more general basis for how gradient activity figures into calculation of constraint violation.

6. Conclusion: Future Research

Many open issues remain (more than can be listed here)
- Deeper examination of typological predictions, such as
  - Implications for inventories
  - Treatment of conflation involving Place of Articulation (de Lacy 2006)
  - OCP for Place that is enforced for any co-occurring non-coronals but for coronals only when additional features are shared (e.g. Arabic: McCarthy 1988, Yip 1989, Padgett 1995c, Suzuki 1998; Javanese: Mester 1986, Yip 1989)
- Are all scaling factors calculated in the same fashion?
- How does this approach interact with learning and predictions about the frequency of different grammatical patterns? (e.g. O’Hara 2019, in prep.)