Gradient Feature Activation and the Special Status of Coronals

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1. Introduction

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***.

1. Introduction

Previous constraint-based approach:

- Mirrored markedness and faithfulness constraint sets (de Lacy 2002, 2006).
- Markedness hierarchy for oral place features
  [Dorsal] > [Labial] > [Coronal]

Markedness constraints	**Faithfulness constraints**
*{Dor}	IDENT-IO{Dor}
*{Dor, Lab}	IDENT-IO{Dor, Lab}
*{Dor, Lab, Cor}	IDENT-IO{Dor, Lab, Cor}

1. Introduction

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.

1. Introduction

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

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2. Special Coronal Behavior

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

	Pattern	Ex. language(s)	References
i.	Coronals exempted as target of place assimilation	Sri Lankan Portuguese Creole	Smith 1977, Hume & Tserdanelis 2002, de Lacy 2006
ii.	Coronals exempted as trigger of place assimilation	Korean, Latin	Jun 1995, 2004, Rice 2007
iii.	Coronals exempted from cluster restriction / coda condition	English, German, Finnish	Selkirk 1982, Clements 1990, Yip 1991, Hall 2002
iv.	Coronals exempted from OCP restriction on Place Fs	English, German	Clements & Keyser 1983, Davis 1991, Coetzee 2004
v.	Epenthetic Cs are coronal	Axininca Campa	Payne 1981, McCarthy & Prince 1993
vi.	Only coronals may have a secondary place F (coronals do not block harmony)	Najdi dialect of Bedouin Arabic	Abboud 1979, McCarthy 1994, Gafos & Lombardi 1999

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2. Special Coronal Behavior

Type 1 – Markedness-based

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

(Prince & Smolensky 1993/2004, Smolensky 1993, McCarthy 1994, Gafos & Lombardi 1999, de Lacy 2002, 2006, Lombardi 2001, 2002, Coetzee 2004, cf. Boersma 1998).

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2. Special Coronal Behavior

Place markedness: Further details beyond focus here

- Palatals may pattern distinctly from coronals (de Lacy 2006).
- [Dorsal] > [Labial] has been proposed (de Lacy 2002, 2006; cf. Coetzee 2004).
- In some patterns, lesser marked behavior of coronals may interact with manner (e.g. sonorant vs. obstruent) (McCarthy 1994, Gafos & Lombardi 1999).
- Evidence for a typological preference for coronal C epenthesis is argued to be fragile (Morley 2015).

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2. Special Coronal Behavior

Type 2 – Faithfulness-based: Coronals alone capitulate.

	Pattern	Ex. language(s)	References
i.	Coronals alone are target of place assimilation	Catalan, Dutch	Mascaró 1976, Kiparsky 1985, Boersma 1998, Wheeler 2005, de Lacy 2006
ii.	Coronals alone are neutralized	Yamphu	de Lacy 2006

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

(de Lacy 2002, 2006, Jun 2004)

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2. Special Coronal Behavior

Illustration type 1 – Markedness: Sri Lankan Portuguese Creole

- /m/ and /ŋ/ are targeted in place assimilation in NC clusters

/m/		**/ŋ/**	
/pːam/	[pːa**m**] ‘bread’	/uŋə/	[u**ŋ**ə] ‘one’
/maːm+pə/	[maː**mp**ə] ‘hand-DAT.SG’	/uŋ pæːzu/	[u**m p**æːzu] ‘one pound’
/pərim təsuwaː/	[pəri**nt**əsuwaː] ‘I am sweating’	/uŋ diːjəpə/	[u**n d**iːjəpə] ‘for one day’
/maːm+su/	[maː**ns**u] ‘hand-GEN.SG’	/miːtiŋ+su/	[miːti**ns**u] ‘meeting-GEN.SG’
/rezaːm lej/	[rezaː**nl**ej] ‘reasonably’	/əluŋ dʒeːntis/	[əlu**ɲ dʒ**eːntis] ‘some people’
/maːm+ki/	[maː**ŋk**i] ‘hand-VERBAL N’	/miːtiŋ+ki/	[miːti**ŋk**i] ‘meeting-VERBAL N’

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

2. Special Coronal Behavior

Illustration type 1 – Markedness: Sri Lankan Portuguese Creole

- /n/ is not targeted in place assimilation in NC clusters

/n/	
/siːn/	[siː**n**] 'bell'
/siːn+pə/	[siː**np**ə] 'bell-DAT.SG'
/siloːn+pə/	[siloː**np**ə] 'Sri Lanka-DAT.SG'
/siːn+ki/	[siː**nki**] 'bell-VERBAL N'
/siloːn+ki/	[siloː**nki**] 'Sri Lanka-VERBAL N'
/konwən/	[ko**nw**ən] 'convent'

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

2. Special Coronal Behavior

Illustration type 2 – Faithfulness: Catalan

- Only /n/ is targeted in major place assimilation in NC clusters

Root	**/som/ 'we are'**	**/son/ 'they are'**	**/aɲ/ 'year'**
amic(s) 'friend(s)'	[so**m ə**miks]	[so**n ə**miks]	[a**ɲ ə**mik]
pocs 'few-PL', *petit* 'short'	[so**m p**ɔks]	[so**m p**ɔks]	[a**ɲ p**ətit]
veus 'voices'	[so**m b**ɛus]	[so**m b**ɛus]	
tontu(s) 'stupid-(PL)'	[so**m t**ontus]	[so**n t**ontus]	[a**ɲ t**ontu]
cosins 'cousins'	[so**m k**uzins]	[so**ŋ k**uzins]	
gran(s) 'big-(PL)'	[so**m g**rans]	[so**ŋ g**rans]	[a**ɲ g**ran]

- No assimilation of [ŋ]: [ti**ŋ p**resə] *tinc pressa* 'I'm in a hurry'
- /ɲ/ does not undergo place assimilation; a dorsal component is assumed (Mascaró 1976).
- Before [f], /m/ becomes [ɱ], but /m/ does not show assimilation for major place.

(de Lacy 2006 compiling data from Mascaró 1976, Kiparsky 1985, Hualde 1992, Palmada 1994)

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 /ŋ/.
  - 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/, /ɲ/ and /ŋ/ 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. (Ito 1986, 1989, Ito & Mester 1994, 1999, Goldsmith 1990, Lombardi 2001)

CodaCond (Ito 1989)	$*C]_\sigma$ I F_{Place}	Codas do not license Place features.
Assimilation	$C]_{\sigma\ \sigma}[C$ \ / F_{Place}	CodaCond is obeyed when a Place feature associated with a coda C is also linked to a following onset.

Feature Class Theory (Padgett 1995a, 2002)

- Oral Place: = {Dorsal, Labial, Coronal}
- In this talk, I will use "Place" instead of "Oral Place" to refer to this F class.

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 (McCarthy & 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

Input C C
| |
Cor Lab

Output C]$_{\sigma\ \sigma}$[C
\ /
Lab

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

- Framework: Harmonic Grammar
  (Legendre et al. 1990, Smolensky & Legendre 2006)
- Place assimilation
  w(CODACOND) > *w*(MAX-IO(Place))

3.1 Basics: Place Assimilation

Place assimilation: *w*(CODACOND) > *w*(MAX-IO(Place)); schematic candidates

Input	Output	MAX-IO-Ons (Place) *w* = 10	CODACOND *w* = 7	MAX-IO (Place) *w* = 3	*H*
i. /VmkV/	a. → [VŋkV] *assim. in coda*			–1	–3
	b. [VmkV] *faithful*		–1		–7
	c. [VmpV] *assim. in onset*	–1		–1	–13
ii. /VnkV/	a. → [VŋkV] *assim. in coda*			–1	–3
	b [VnkV] *faithful*		–1		–7
	c. [VntV] *assim. in onset*	–1		–1	–13

Place assimilation in codas, but no difference by Place F.

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

- Previously taken as motivation for sets/hierarchies of place-feature specific constraints (Gafos & Lombardi 1999, Lombardi 2001, de Lacy 2002, 2006).

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).
- GSRs have been applied to features (Rosen 2016, Jang 2019, Lee 2019, McCollum in prep., cf. Boersma 1998, and see Lionnet 2016, 2017, 2019 on gradient subfeatures).
- Gradient activity may be present in outputs (as well as inputs) (Faust 2017, 2019, Faust & Smolensky 2017a, b, Zimmermann 2018, 2019, Jang 2019, McCollum in prep.).

Proposed representations for Place features

$[\mathrm{Dor}]_{1.0}$, $[\mathrm{Lab}]_{.9}$, $[\mathrm{Cor}]_{.8}$

- These particular activity values are arbitrary. What matters is that for feature activation *a:* $a_{Dor} > a_{Lab} > a_{Cor}$

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* * *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* * *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.

   Scaling factor calculation follows Hsu & Jesney (2016, 2017a, 2018), Hsu (to appear); other work on constraint penalty scaling includes Kimper (2011), Zymet (2015), McPherson & Hayes (2016), Pater (2016), Shih & Inkelas 2016, Stanton (2017), Inkelas & Wilbanks (2018), Lionnet 2019, a.o.

3.3 Calculating the penalty for constraint violation

H* = *w* * *a

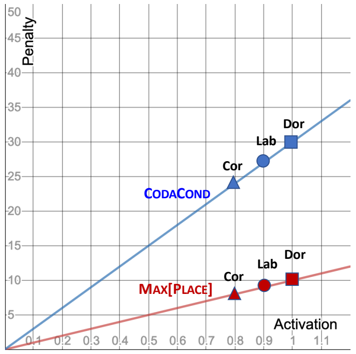
Penalty for violation is directly proportional to degree of activation.

Scenario: Coda Place Assimilation

- Coda Cs assimilate in place to a following onset; coronals are exempted.
- **CODACOND** (*w* = 30): assigns a violation to a Place F that is linked solely to a coda C.

  Calculation: 30 * activation of F.
- **MAX-IO(Place)** (*w* = 10): assigns a violation for every Place F in the input that has no corresponding F in the output.

  Calculation: 10 * activation of F.



- **Red** – Penalty assigned for MAX(Place) violation
- **Blue** – Penalty assigned for CODACOND violation

3.3 Calculating the penalty for constraint violation

H* = *w* * *a

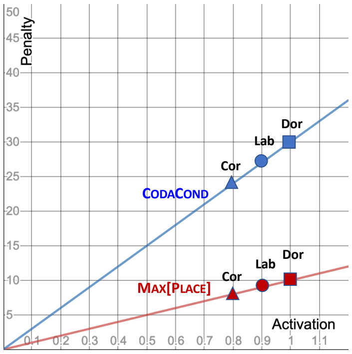
Scenario: Coda Place Assimilation

- **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*'s: *x* and *y*

  If *x* * .8 > *y* * .8
  Then *x* * .9 > *y* * .9



- **Red** – Penalty assigned for Max(Place) violation
- **Blue** – Penalty assigned for CodaCond violation

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* * *a*)**
  - *w* = the basic constraint weight, assigned for an offending **Place** F
  - *s* = the scaling factor, *a* = the **activation of F ∈ 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)

Toy example	Con1(Place) *w* = 6, *s* = 5	Con2(Place) *w* = 3, *s* = 10
[Coronal] *a*=.8	–1(6 + 5*.8) = –10	–1(3 + 10*.8) = –11
[Labial] *a*=.9	–1(6 + 5*.9) = –10.5	–1(3 + 10*.9) = –12
[Dorsal] *a*=1	–1(6 + 5*1) = –11	–1(3 + 10*1) = –13
[Labial] *a*=.9 + [Labial] *a*=.9	–2(6 + 5*.9) = –21	–2(3 + 10*.9) = –24

3.3 Calculating the penalty for constraint violation

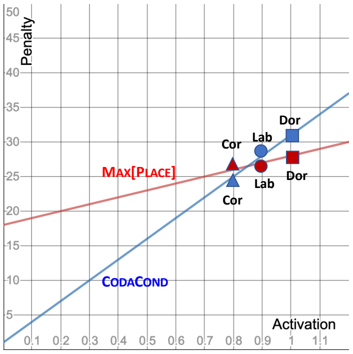
***H* = *w* + (*s* * *a*)**

Penalty for violation increases for Fs with higher activation, but the basic constraint weight holds constant.

Coda Place Assimilation revisited

- Coda consonants assimilate in place to a following onset; coronals are exempted.
- **CodaCond** (*w* = 1, *s* = 30)
  Calculation: 1 + (30 * activation of F)
- **Max-IO(Place)** (*w* = 18, *s* = 10)
  Calculation: 18 + (10 * activation of F)

Higher *w* and lower *s* for the constraint (Max(Place)) for which the penalty is overtaken by another (CodaCond) due to scaling factor for Place (Hsu & Jesney 2016, 2017a, 2018).



- **Red** – Penalty assigned for Max(Place) violation
- **Blue** – Penalty assigned for CodaCond violation

3.3 Calculating the penalty for constraint violation

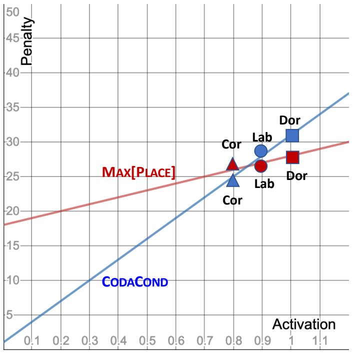
***H* = *w* + (*s* * *a*)**

Coda Place Assimilation revisited

For the values of *w*, *s* and *a* in question

- **Coronal** violation of CodaCond earns a ***lesser*** penalty than Max[Place].
- **Non-coronal** violation of CodaCond earns a ***greater*** penalty than Max[Place].

- When a scaling factor that is proportional to feature activation is added to a basic constraint weight, **it is possible to differentiate the behavior of coronals**. This holds even when both constraints are scaled to Place F activation.



- **Red** – Penalty assigned for Max(Place) violation
- **Blue** – Penalty assigned for CodaCond violation

3.4 Analysis: Illustration

Differentiating coronals

For two Place F-sensitive constraints, Con1 and Con2

For activation a_{Dor} = 1.0, a_{Lab} = .9, a_{Cor} = .8

If **Con1:** *w* = 18, *s* = 10
Con2: *w* = 1, *s* = 30

For [Dor], [Lab]: $_{H}$(**Con1**) > $_{H}$(**Con2**)

i.e. **Con2** is enforced at the expense of **Con1**

For [Cor]: $_{H}$(**Con2**) > $_{H}$(**Con1**)

i.e. **Con1** is enforced at the expense of **Con2**

3.4 Analysis: Illustration

Differentiating coronals in place assimilation

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 [Dor], [Lab]: **CodaCond** (M constraint) is enforced

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-Ons(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.

Input	Output	CodaCond *w* = 1, *s* = 30	Max-IO(Place) *w* = 18, *s* = 10	*H*
i. /V**m**$_{.9}$kV/	a. → [V**ŋ**$_{1}$**k**V] *assim. in coda*		−1 = −1(18 + 10 * .9)	−27
	b. [V**m**$_{.9}$kV] *faithful*	−1 = −1(1 + 30 * .9)		−28
	c. [V**n**$_{.8}$kV] *neutralization to cor*	−1 = −1(1 + 30 * .8)	−1 = −1(18 + 10 * .8)	−52
ii. /V**n**$_{.8}$**p**V/	a. [V**m**$_{.9}$**p**V] *assim. in coda*		−1 = −1(18 + 10 * .9)	−26
	b. → [Vn$_{.8}$pV] *faithful*	−1 = −1(1 + 30 * .8)		−25

Gradient activation of Fs in *output* allows coronal [n] ((iib), *H* = −25) to incur a lesser violation of markedness (CodaCond) than labial [m] ((ib), *H* = −28).

3.4 Analysis: Illustration

Sri Lankan Portuguese Creole

- Nasal place assimilation targets non-coronal /ŋ/ (iii).

Input	Output	CodaCond *w* = 1, *s* = 30	Max-IO(Place) *w* = 18, *s* = 10	*H*
iii. /V**ŋ**$_{1}$**p**V/	a. → [V**m**$_{.9}$**p**V] *assim. in coda*		−1 = −1(18 + 10 * 1)	−28
	b. [V**ŋ**$_{1}$**p**V] *faithful*	−1 = −1(1 + 30 * 1)		−31
	c. [V**n**$_{.8}$**p**V] *neutralization to cor*	−1 = −1(1 + 30 * .8)	−1 = −1(18 + 10 * 1)	−53

3.4 Analysis: Illustration

Differentiating coronals in place assimilation

Type 2 – Faithfulness: Catalan

- Coronals alone are target of place assimilation

  CodaCond: *w* = 18, *s* = 10

  Max-IO(Place): *w* = 1, *s* = 30

For [Dor], [Lab]: **Max-IO(Place)** (F constraint) is enforced

For [Cor]: **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 targets /n/ (i) but not non-coronal /m/ (ii).

Input	Output	CodaCond *w* = 18, *s* = 10	Max-IO(place) *w* = 1, *s* = 30	*H*
i. /V**n**$_{.8}$**p**V/	a. → [V**m**$_{.9}$**p**V] *assim. in coda*		−1 = −1(1 + 30 * .8)	−25
	b. [V**n**$_{.8}$**p**V] *faithful*	−1 = −1(18 + 10 * .8)		−26
ii. /V**m**$_{.9}$**k**V/	a. [V**ŋ**$_{1}$**k**V] *assimilation*		−1 = −1(1 + 30 * .9)	−28
	b. → [V**m**$_{.9}$**k**V] *faithful*	−1 = −1(18 + 10 * .9)		−27
	c. [V**n**$_{.8}$kV] *neutralization to cor*	−1 = −1(18 + 10 * .8)	−1 = −1(1 + 30 * .9)	−54

- **Gradient activation of Fs in *input* allows coronal /n/ to incur a lesser violation of faithfulness in place assimilation ((ia), *H* = −25) than labial /m/ ((iia), *H* = −28).**

3.4 Analysis: Illustration

Catalan

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

Input	Output	CodaCond *w* = 18, *s* = 10	Max-IO(Place) *w* = 1, *s* = 30	*H*
iii. /V**ŋ**$_{1}$**p**V/	a. [V**m**$_{.9}$**p**V] *assim. in coda*		−1 = −1(1 + 30 * 1)	−31
	b. → [V**ŋ**$_{1}$**p**V] *faithful*	−1 = −1(18 + 10 * 1)		−28
	c. [V**n**$_{.8}$**p**V] *neutralization to cor*	−1 = −1(18 + 10 * .8)	−1 = −1(1 + 30 * 1)	−57

3.5 Analysis: Summary

Key points

- Place features are represented with scaled activity:

  Dorsal$_{a}$ > Labial$_{a}$ > Coronal$_{a}$

- 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
    → Lesser violation of markedness and faithfulness
  - b) Scaling factors that operate on the Place F activity scale
    → 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$_a$ > Labial$_a$ > Coronal$_a$
  - Loanword nativization: Periphery$_a$ > Intermediate$_a$ > Core$_a$
    - **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 2017a, b, 2018; foundational work on lexical strata from Ito & Mester 1995, 1999, 2001).
  - Prosodic Boundary Strength: Utterance$_a$ > PPh$_a$ > Pwd$_a$ > Syllable$_a$
    - **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$_1$ > Labial$_{.95}$ > Coronal$_{.5}$
- 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

Mismatch Negativities (MMNs)

- MMN measures suggest that the neural code underlying the representation of coronals is **less specific** than that of non-coronals.
- Interpreted as support for coronals having a **sparser phonological representation** than non-coronals.
  - MMN is a component of event-related brain activity that is considered to indicate the brain's reaction to changes in acoustic input.
  - Participants are presented with a passive oddball paradigm, where a deviant stimulus is presented within a series of standard stimuli.
  - Deviant stimulus corresponds to a representation formed from information in the acoustic signal, while repeated processing of the standard stimulus activates structure closer to the mental lexicon.
  - MMN was stronger for deviant coronal stimulus than for deviant non-coronal stimulus, suggesting that the mental lexical representation of the coronal lacked structure that was present in the acoustic form.

  (Scharinger et al. 2012, Cornell et al. 2013 for German, Cummings et al. 2017 for English; see also Roberts et al. 2013 for ERP and RT study on English)

4.2 Experimental evidence

Speech errors

- Speech error studies suggest that **coronals lack structure that is present in non-coronals**, because coronals interact in speech errors less than non-coronals.
- **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

- Major representational approach to the special status of coronals.

  (e.g. Kiparsky 1985, Avery & Rice 1989, Paradis & Prunet 1989, papers in Paradis & Prunet 1991, Stemberger 1991, Lahiri & Reetz 2002)
- In coronal segments, [Coronal] may be underspecified (absent underlyingly, but possibly acquired at some stage of the derivation).
- Other Place features are not underspecified, allowing for coronals to behave as less marked, less active, or more available as targets of assimilation.
- Underspecification allows for **two** degrees of F presence (present/ absent).
- Special behavior is thus reserved for a single F in a given class, namely, the F that is underspecified.

5.1 Underspecification

Coronal underspecification

- However, Place Fs show ***multiple steps*** on the markedness/ faithfulness scale.
  - [Coronal] is lower on the scale with respect to [Dorsal] and [Labial]
  - [Labial] is lower on the scale with respect to [Dorsal] (de Lacy 2006)
  - Both scalar divisions are evidenced in Korean place assimilation (Jun 1995, 2004, Rice 2007)
- 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.)

5.1 Underspecification

GSRs

- Like underspecification, takes a representational approach, where coronals are weaker.
- In contrast to underspecification, the GSR approach predicts the possibility of scales with **multiple steps**.
- GSRs could be used in place of coronal underspecification, with [Coronal] activity being lowest in the scale for Place Fs, as in the proposed account here. (See Faust & Smolensky 2017a, b, Faust 2017, 2019 on a similar proposal for Vs.)
- In addition, GSR-based scales predict that [Coronal] is **present** in the representation, even if active to a lesser degree.
  - In Sri Lankan Portuguese Creole coronals *trigger* place assimilation.
- Beyond oral place Fs, [Pharyngeal] or [Glottal] may behave as less marked than [Cor] (e.g. Lombardi 2001, Gafos & Lombardi 1999, de Lacy 2002, 2006).
  - Suggests [Pharyngeal]/[Glottal] may have lower activity than [Coronal]

  (Note also potential for "velars", with less specific and weaker articulations than true dorsals, to behave as less marked than coronals Rice 1996.)

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).

Markedness constraints	Faithfulness constraints
*{Dor}	IDENT-IO{Dor}
*{Dor, Lab}	IDENT-IO{Dor, Lab}
*{Dor, Lab, Cor}	IDENT-IO{Dor, Lab, Cor}

- 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} {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

Input	**output**	***{Dor, Lab} {Dor, Lab, Cor}**	**IDENT-IO {Dor, Lab, Cor}**	***{Dor, Lab, Cor} {Dor, Lab, Cor}**
i. /V**mk**V/	a. → [V**ŋk**V] *assim. in coda*		*	
	b. [V**mk**V] *faithful*	*!		*
ii. /V**np**V/	a. [V**mp**V] *assim. in coda*		*!	
	b. → [V**np**V] *faithful*			*

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.

Input	**output**	**IDENT-IO {Dor, Lab}**	***{Dor, Lab, Cor} {Dor, Lab, Cor}**	**IDENT-IO {Dor, Lab, Cor}**
i. /V**np**V/	a. → [V**mp**V] *assim. in coda*			*
	b. [V**np**V] *faithful*		*!	
ii. /V**mk**V/	a. [V**ŋk**V] *assimilation*	*!		*
	b. → [V**mk**V] *faithful*		*	

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

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.)

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