Gradient symbols and gradient markedness: A case study from Mixtec tones

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Main Claim

Lexical exceptions to phonological processes follow from **Gradient Symbolic Representations**

(Smolensky and Goldrick (2016), Rosen (2016), Faust&Smolensky (this morning))

- gradience not only for segmental alternations but also for exceptions in the **autosegmental** phonology: a case study of **morphological tone**

Extending the original GSR claim, I argue that:

- Phonological representations remain **gradient in the output**: consequences for the evaluation of **markedness constraints**

Exceptional Tones in MIG

Background: MIG (Pike, 1944, 1948; Mak, 1950; Hollenbach, 2003; McKendry, 2013)

- San Miguel el Grande Mixtec (=MIG) is a variety of Mixtec (Otomanguean), spoken in Southern Mexico
- three level tones: H (=á), M (=a), L (=à)
- sequences of two tones only possible on long vowels: μ is the TBU and no true contour tones
- (nasalization is a feature of morphemes (Marlett, 1992), notated as /CVCV/)

Tone 'perturbation' in MIG

- common in Mixtec: 'perturbing' morphemes that trigger a tonal change on a following morphemes (Dürr, 1987; Hollenbach, 2003)
- autosegmental account: floating tones (Goldsmith, 1990; Tranel, 1995*a*,*b*)

(1) *MIG: Floating H-tones* (Mak, 1950; McKendry, 2013)

	Morpheme 1		Morpheme 2		Surface	
a.	kəbə̀$^{(H)}$	'day'	biko	'fiesta'	kəbə̀ bíko	M:83
b.	^{n}deju$^{(H)}$	'food'	bàʔa	'good'	^{n}deju báʔa	M:83
c.	k^{w}aʔà$^{(H)}$	'many'	sùʧí	'children'	k^{w}aʔà súʧí	M:83
d.	ʃiní$^{(H)}$	'head'	ʧìʔí	'skunk'	ʃiní ʧíʔí	McK:85
e.	nuù$^{(H)}$	'face'	nuʧi$^{(H)}$	'beans'	nuù núʧi	McK:84
f.	βáá$^{(H)}$	EMPH	-tɨ̀$^{(H)}$	3.ANIM	βáátɨ́	McK:92

Challenge 1: Exceptional non-hosts

- some morphemes are exceptional **non-hosts for a preceding floating H-tone** if the preceding morpheme ends in H; an example is /-ðe/ 3.MHon (2-a-c) (Pike, 1948, 91)

- (2-d+e) show that this is not a regular phonological ban on *HH: other morphemes host floating H's and create such tone sequences

(2) *Exceptional non-host for floating H* (McKendry, 2013)

	Morpheme 1		Morpheme 2		Surface	
a.	nutʃi$^{(H)}$	'bean'	-ðe	3.MHon	nutʃiðé	McK:92
b.	jee$^{(H)}$	'eat'	-ðe	3.MHon	jeeðé	McK:104
c.	βáá$^{(H)}$	Emph	-ðe	3.MHon	βááðe	McK:92
d.	βáá$^{(H)}$	Emph	-tɨ̀$^{(H)}$	3.Anim	βáátɨ́	McK:92
e.	ʃiní$^{(H)}$	'head'	tʃìʔí	'skunk'	ʃiní tʃíʔí	McK:85

Challenge 2: Exceptional tone allomorphs

- surface forms for /-jo/ 1.INCL and /-ro/ 2 alternate between H, M, and L depending on the preceding morpheme

(3) *Surface realizations of /jo/ro/* (Pike, 1948; McKendry, 2013)

	Preceding morpheme		Surface		
a.	hinì	'know'	hinìjò	L	McK:93
b.	sáʔa	'make'	sáʔajó	H	McK:93
c.	kunu	'run'	kunujó	H	P:90
d.	kee$^{(H)}$	'eat'	keero	M	P:91

Challenge 2: Exceptional tone allomorphs

(4) *Surface realizations of /jo/ro/: Summary* (McKendry, 2013, 93)

following…		Surface
R1.	L#	L
R2.	H#	L
R3.	L (H)#	L
R4.	M (H)#	M
R5.	M#	H
R6.	H (H)#	H

Analysis

Theoretical Background

Weak activation in phonology

- **Gradient Symbolic Representations**
  (Smolensky and Goldrick, 2016; Rosen, 2016)
  - symbols in a linguistic representation have numerical degrees of presence or activity; can be weakly active
  - all output elements are discrete and fully active
- proposed modification: **Gradient Symbolic Representations in the Output (=GSRO)** where output elements can be/remain weakly active
  - consequences for the evaluation of markedness constraints
  - neutralization to desired fully active element penalized by standard faithfulness: interaction with other unfaithful operations
- grammatical computation inside **Harmonic Grammar**
  (Legendre et al., 1990; Potts et al., 2010)

Weak activity in the output: Markedness constraints

- violated by the number

  M! that the desired structure lacks to activity 1.0.
  (=weaker elements don't fulfill them as good)

  ***M** that the penalized structure is active.
  (=weaker elements don't violate them as bad)

Weak activity in the output: Markedness constraints

(5) a. ONS!: Assign violation 1-X for every σ with an onset of activity X.

b. *CC: Assign violation X for a CC in a syllable margin where X is the highest activity that both C share.

(6) *Toy example: weak activation and HG constraint evaluation*

$u_1k_{0.6}t_{0.7}$	ONS! 20	*CC 10	
a. $u_1k_{0.6}t_{0.7}$	-1	-0.6	-26
☞ b. $k_{0.6}u_1t_{0.7}$	-0.4		-8
c. $ʔ_1u_1k_1t_1$		-1	-10

Weak activity in the output: Faithfulness constraints

- any **change in activity is a faithfulness violation**

(7) a. MaxS: Assign violation X for any segmental activity X in the input that is not present in the output.
(vs. rewarding Max (Smolensky and Goldrick, 2016; Rosen, 2016))

b. DepS: Assign violation X for any segmental activity X present in the output but not in the input.

(8) *Toy example: weak activation and HG constraint evaluation*

$p_1a_1k_{0.6}$	Max 3	Dep 2	*Coda 1	
☞ a. $p_1a_1k_{0.6}$			-0.6	-0.6
b. $p_1a_1k_1$		-0.4	-1	-1.8
c. p_1a_1	-0.6			-1.8
d. $p_1a_1k_{0.6}ə_1$		-1		-2

A typology of lexical exceptions predicted by GSRO

Exceptional morphemes=contain weakly active elements

GSR/O	**1)**	Weak elements are only realized…
		A) with lexical support ➙ Smolensky and Goldrick (2016); Rosen (2016) (e.g. Japanese Rendaku (Rosen, 2016))
		B) with phonological support (e.g. Catalan /u/-alternation (Bonet et al., 2007))
GSR/O	**2)**	Weak elements avoided in marked environments ➙ Faust&Smolensky (t.m.) (e.g. Nuuchahnulth unstable consonants (Kim, 2003))
GSRO only	**3)**	Weak output elements are…
		A) avoided since not a good enough solution ➙ This talk (e.g. S.M.G. Mixtec weak tonal hosts (McKendry, 2013))
		B) realized since not a bad enough problem (e.g. Yine non-deleting /–wa/ (Pater, 2006))
GSR/O	**4)**	Elements of different activities compete for realization (e.g. stress in M.-C. Salish (Czaykowska-Higgins, 1993))

Analysis: Avant

Floating tones: Overwriting

- in MIG, floating tones are never deleted (=highest weight for MaxFl)
- there are no contour tones in MIG (9-d): floating tone association results in **overwriting**

(9)
a. MaxT: Assign violation X for any tonal activity X in the input that is not present in the output. (Yip, 2002)

b. MaxFl: Assign violation X for any activity X of a floating tone in the input that is not present in the output. (Wolf, 2007)

c. T>μ: Assign 1-X violations for every tone where X is the activity of TBU's this tone is associated to. (Wolf, 2007)

d. *Cont: Assign X violations for every TBU associated to tones T_1 and T_2 where X is the highest activity that T_1 and T_2 share. (Yip, 2002)

Overwriting

(10)

L_1 H_1 + M_1 | μ_1	MaxFl 200	*Cont 200	T>μ 60	MaxT 10	
a. L_1 H_1 M_1 | | μ_1 μ_1			-1		-60
b. L_1 M_1 | | μ_1 μ_1	-1			-1	-210
c. L_1 H_1 M_1 | \ | μ_1 μ_1		-1			-200
☞ d. L_1 H_1 | | μ_1 μ_1				-1	-10

Analysis I: Exceptional non-hosts

Analysis for exceptional non-hosts in a nutshell

- some μ's have an activity lower than 1: they are **weak hosts for a floating tone** since they don't avoid a T>μ violation fully

- floating H association and preceding H-toned TBU violate the OCP – association to a weak host is not a good enough reason to tolerate this

Analysis for weak hosts: Further constraints

- positional faithfulness constraint (11-b) penalizes new associations of morpheme-final tones (=becomes crucial later)

(11) a. OCP: Assign X violations for every pair of adjacent H-tones where X is the highest activity that both share.

b. $\textsc{Dep}|_{\textsc{Fin}}$: Assign violation 1 for every epenthetic association between a TBU and a tone that is morpheme-final.

- Cf. Krämer (2003); Barnes (2008) on final syllable prominence effects
- faithfulness constraint other than Max/Dep are not scaled to activation (Smolensky and Goldrick, 2016, 17)

Floating H associates to a strong host: OCP irrelevant

ⁿdeju(H)	‘food’	bàʔa	‘good’	ⁿdeju báʔa	M:83
ʃiní(H)	‘head’	ʧìʔí	‘skunk’	ʃiní ʧíʔí	McK:85

(12)

	MaxFL	T>μ	Dep|Fin	OCP	MaxT	
	200	60	19	10	10	
a. H1 H1 + L1 → H1 H1 L1 (μ1 μ1 μ1)		-1				-60
☞ b. H1 + L1 → H1 L1 (μ1 μ1)			-1	-1	-1	-39

Floating H associates to a weak host: No OCP-violation

nuʧi$^{(H)}$	‘bean’	-ðe	3.MHon	nuʧiðé	McK:92

(13)

	MaxFl	T>μ	Dep|Fin	OCP	MaxT	
$M_1\ H_1$ + M_1 | | μ_1 $\mu_{0.5}$	200	60	19	10	10	
a. $M_1\ H_1\ M_1$ | | μ_1 $\mu_{0.5}$		-1				-60
☞ b. $M_1\ H_1$ | | μ_1 $\mu_{0.5}$		-0.5	-1		-1	-59

Floating H association blocked for weak hosts: Fatal OCP-violation

βáá$^{(H)}$	Emph	-ðe	3.MHon	βááðe	McK:92

(14)

	MaxFL	T>μ	Dep|Fin	OCP	MaxT	
	200	60	19	10	10	
☞ a.		-1				-60
b.		-0.5	-1	-1	-1	-69

Weak Hosts: Threshold effects

(15)

Weight of	is greater than	the weight of
T>μ	≫	DEP|FIN + OCP + MAXT
DEP|FIN + OCP + MAXT	≫	0.5xT>μ

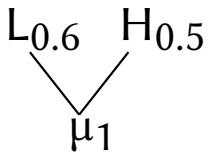
Analysis II: Allomorphy for /jo/ro/

Analysis for /jo/ro/ in a nutshell

(16)

following…		Surface
R1.	L#	L
R2.	H#	L
R3.	L (H)#	L
R4.	M (H)#	M
R5.	M#	H
R6.	H (H)#	H

(17) *Representation for /jo/ro/:*



- the TBU of /ro/jo/ is associated to **both a weakly activated L and a weakly activated H**

(Cf. the French liaison analysis in Smolensky and Goldrick (2016): different 'allomorphs' are all (weakly) activated and part of the same underlying representation)

Preference for realizing $L_{0.6}$

- only one tone can be realized: no contour tones in MIG (*Cont =200)
  (vs. 'blend structures' in Smolensky and Goldrick (2016))

- **realization of $L_{0.6}$ is preferred** since it has a higher activity: lower number of Spec (18) and MaxT violations arise

(18) Spec: Assign 1-X violations for every TBU where X is the tonal activity associated to this TBU. (Yip, 2002)

Preference for realizing $L_{0.6}$

(19)

	*Cont 200	Spec 70	MaxT 10	
H_1 (μ_1) + $L_{0.6}$ $H_{0.5}$ (μ_1)				
a. H_1 (μ_1) $L_{0.6}$ $H_{0.5}$ (μ_1)	-0.5			-100
☞ b. H_1 (μ_1) $L_{0.6}$ (μ_1)		-0.4	-0.5	-33
c. H_1 (μ_1) $H_{0.5}$ (μ_1)		-0.5	-0.6	-41

Ban on ML makes L impossible

- realization of $L_{0.6}$ impossible for bases ending in M due to (20)
- (underlying sequences of ML are preserved: other strategies (deletion and tonal underspecification, deletion and spreading,... are excluded by higher-weighted constraints; cf. Appendix)

(20) *ML: Assign X violations for every sequence of tone M followed by tone L where X is the highest activity that both share.

Ban on ML makes L impossible

(21)

M_1 (μ_1) + $L_{0.6}$ $H_{0.5}$ (μ_1)	*Cont 200	Spec 70	*ML 15	MaxT 10	
a. M_1 (μ_1) $L_{0.6}$ $H_{0.5}$ (μ_1)	-0.5		-0.6		-109
b. M_1 (μ_1) $L_{0.6}$ (μ_1)		-0.4	-0.6	-0.5	-42
☞ c. M_1 (μ_1) $H_{0.5}$ (μ_1)		-0.5		-0.6	-41

Providing /jo/ro/ with a fully active tone?

- floating H's can not be realized on /jo/ro/: H's can't associate to TBU's that were underlyingly already H (22-a)
- **spreading** of a preceding tone violates (22-b)

(22) a. DEP|HH: Assign a violation 1 for every new association between a H that is unassociated in the input and a TBU if the TBU was underlyingly associated to a H.

b. *LNGT: Assign * for every tone phonetically associated to more than one TBU. (Yip, 2002)

Spreading of a stem-tone

(23)

	M_1 H_1 + $L_{0.6}$ $H_{0.5}$	DEP|HH	SPEC	*LNGT	MAXT	
		200	70	15	10	
a.	M_1 H_1 $L_{0.6}$		-0.4		-0.5	-33
b.	M_1 H_1 $H_{0.5}$		-0.5		-0.6	-41
☞ c.	M_1 H_1			-1	-1.1	-26
d.	M_1 H_1	-0.5			-1.1	-111

No spreading for stem-final tones

- in the absence of a floating H, stem-final tones are prevented from spreading by DEP|FIN (cf. (11-b)): **only tones that are not the rightmost in the tonal melody of a morpheme can spread**

(24) DEP|FIN: Assign violation 1 for every epenthetic association between a TBU and a tone that is morpheme-final.

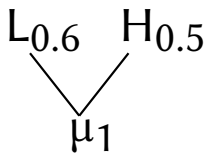
No spreading for stem-final tones

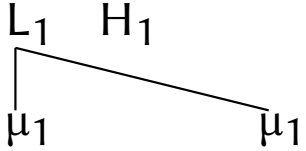
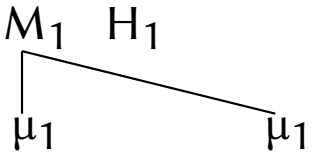
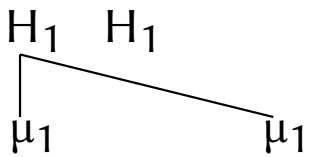
(25) *No spreading without a floating tone*

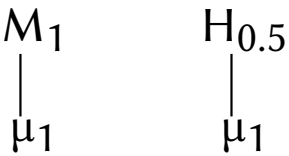
	SPEC 70	DEP|FIN 19	*ML 15	*LNGT 15	MAXT 10	
M_1 μ_1 + $L_{0.6}$ $H_{0.5}$ μ_1						
a. M_1 μ_1 $L_{0.6}$ μ_1	-0.4		-0.6		-0.5	-42
☞ b. M_1 μ_1 $H_{0.5}$ μ_1	-0.5				-0.6	-41
c. M_1 μ_1 μ_1		-1		-1	-1.1	-45

Summary of the analysis

(26)



A. Spreading of non-final stem tone possible			
R3.	L (H)#	L	
R4.	M (H)#	M	
R6.	H (H)#	H	

C. Spreading of stem-final tone impossible			
R1.	L#	L	
R2.	H#	L	
R5.	M#	H	

Alternation of /ro/jo/: Gang effect

(27)

Weight of	is greater than	the weight of
0.4xSpec	≫	*LngT + 0.6xMaxT
Dep|Fin + *LngT + 0.6xMaxT	≫	0.4xSpec

And Dep|Fin is less important than Spec (cf. (15))

Summary of the analysis

(28) *All weights*

MaxFl	*Cont	Dep|HH	Spec	T>μ	Dep|Fin	*ML	*LngT	OCP	MaxT
200	200	200	70	60	19	15	15	10	10

- constraint weights checked with OTHelp (Staubs et al., 2010)
  (and manipulated by hand; e.g. taken times 10 for aesthetical reasons: integers result)

Summary and Conclusion

- **strengthened argument for GSR**: new case study for tonal alternations; adding gradience to **autosegmental** elements
- a unified account for two exceptions of MIG tonology that haven't received any theoretical account
- extended original GSR proposal in assuming **gradience in the output**:
  - **phonologically predictable alternations** of type 3 predicted: weak output elements are avoided since they are not a good enough solution ($\mu_{0.5}$ for T>μ and $L_{0.6}/H_{0.5}$ for Spec)
  - ? phonetic effects for weak elements
  - ? strengthening to full element: interaction with 'normal' epenthesis predicted

References

Barnes, Jonathan (2008), *Strength and Weakness at the Interface : Positional Neutralization in Phonetics and Phonology*, de Gruyter Mouton, Berlin, Boston.

Bonet, Eulàlia, Maria-Rosa Lloret and Joan Mascaró (2007), 'Allomorph selection and lexical preferences: Two case studies', *Lingua* **117**(6), 903–927.

Czaykowska-Higgins, Ewa (1993), 'Cyclicity and stress in Moses-Columbia Salish (Nxa'amxcin)', *Natural Language and Linguistic Theory* **11**, 197–278.

Dürr, Michael (1987), 'A preliminary reconstruction of the Proto-Mixtec tonal system', *Indiana* **11**, 19–61.

Goldsmith, John, ed. (1990), *Autosegmental and Metrical Phonology*, Oxford: Blackwell.

Hollenbach, Barbara (2003), The historical source of an irregular Mixtec tone-sandhi pattern, *in* M. R.Wise, T.Headland and R.Brend, eds, 'Language and life: essays in memory of Kenneth L. Pike', SIL international, Dallas, pp. 535–552.

Kim, Eun-Sook (2003), *Theoretical issues in Nuu-chah-nulth phonology and morphology (British Columbia)*, UMI, Ann Arbor, MI.

Krämer, Martin (2003), 'What is wrong with the right side? edge (a)symmetries in phonology and morphology', Unpublished paper. University of Ulster. Available on Rutgers Optimality Archive, ROA-576.

Legendre, Geraldine, Yoshiro Miyata and Paul Smolensky (1990), 'Harmonic grammar – a formal multi-level connectionist theory of linguistic well-formedness: Theoretical foundations', *Proceedings of the 12th annual conference of the cognitive science society* pp. 388–395.

Mak, Cornelia (1950), 'A unique tone perturbation in Mixteco', *International Journal of American Linguistics* **16**, 82–86.

Marlett, Stephen A. (1992), 'Nasalization in Mixtec languages', *International Journal of American Linguistics* **58**, 425–435.

McKendry, Inga (2013), Tonal Association, Prominence and Prosodic Structure in South-Eastern Nochixtlán Mixtec, PhD thesis, University of Edinburgh.

Pater, Joe (2006), The locus of exceptionality: Morpheme-specific phonology as constraint indexation, *in* L.Bateman, M.O'Keefe, E.Reilly and A.Werle, eds, 'Papers in Optimality Theory III', GLSA, Amherst, MA, pp. 259–296.

Pike, Kenneth L. (1944), 'Analysis of a Mixteco text', *International Journal of American Linguistics* **10**, 113–138.

Pike, Kenneth L. (1948), *Tone languages*, University of Michigan Press, Ann Arbor, MI.

Potts, Christopher, Joe Pater, Karen Jesney, Rajesh Bhatt and Michael Becker (2010), 'Harmonic grammar with linear programming: From linear systems to linguistic typology', *Phonology* pp. 77–117.

Rosen, Eric (2016), Predicting the unpredictable: Capturing the apparent semi-regularity of rendaku voicing in Japanese through harmonic grammar, *in* E.Clem, V.Dawson, A.Shen, A. H.Skilton, G.Bacon, A.Cheng and E. H.Maier, eds, 'Proceedings of BLS 42', Berkeley Linguistic Society, pp. 235–249.

Smolensky, Paul and Matthew Goldrick (2016), 'Gradient symbolic representations in grammar: The case of French Liaison', *ROA 1286* .

Staubs, Robert, Michael Becker, Christopher Potts, Patrick Pratt, John McCarthy and Joe Pater (2010), 'OT-Help 2.0. software package.', Amherst, MA: University of Massachusetts Amherst.

Tranel, Bernard (1995*a*), On the status of universal association conventions: Evidence from Mixteco, *in* J.Ahlers, L.Bilmes, J.Guenter, B.Kaisse and J.Namkung, eds, 'Proceedings of BLS 21', pp. 299–312.

Tranel, Bernard (1995*b*), 'Rules vs. constraints: a case study', ROA-72.

Wolf, Matthew (2007), For an autosegmental theory of mutation, *in* L.Bateman, M.O'Keefe, E.Reilly, and A.Werle, eds, 'UMOP 32: Papers in Optimality Theory III', GLSA, Amherst, MA, pp. 315–404.

Yip, Moira (2002), *Tone*, Cambridge University Press.

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