Gradient Symbolic Representations
in the Output

A typology of lexical exceptions

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Main Claim

- the assumption of **Gradient Symbolic Representations in the Output** predicts a typology of attested lexical exception patterns
- the presence of elements with **more then two different grades of activity** predicts the complex stress system in Moses Columbia Salish
- such a representational account correctly predicts that elements with different activity behave **exceptional for more than one process**

1. Gradient Symbolic Representations

2. Case study: Moses Columbia Salish Stress
2.1 Data: Lexical stress in MCS
2.2 Analysis based on gradient activity
2.3 Further evidence: Vowel deletion asymmetries

3. Summary and Conclusion

Gradient Symbolic Representations

Background: Gradient Symbolic Representation

(=GSR; Smolensky and Goldrick, 2016; Rosen, 2016)

- symbols in a linguistic representation can have **different degrees of presence** or numerical activities
- this can predict **lexical exceptions**: elements in the underlying representation of a morpheme can be exceptionally weak
- assumption modifying the original GSR-account: output elements can be weakly active as well (Zimmermann, 2017*a*,*b*): GSRO

  (no explicit argument for this assumption in the MCS analysis)

Gradient Symbolic Representations and HG

- any **change in activity is a faithfulness violation**
- every marked structure M violates a markedness constraint by the number that equals M's activity
- grammatical computation inside **Harmonic Grammar**
  (Legendre et al., 1990; Potts et al., 2010)

(1)

$b_1a_1t_1$-$p_{0.5}$		*CC]$_\sigma$ 3	Dep 2	Max 1	
a.	$b_1a_1t_1p_{0.5}$	-0.5			-1.5
☞ b.	$b_1a_1t_1$			-0.5	-0.5
c.	$b_1a_1p_{0.5}$			-1	-1
d.	$b_1a_1t_1ə_1p_{0.5}$		-1		-2
e.	$b_1a_1t_1p_1$	-1	-0.5		-4

Gradience in the output: Predicted typology of exceptions

Underlying	Phon.	Output	e.g.
1. Exceptional repair: Weak element not realized			
$A_1 + B_{0.6}$ $A_1 + B_1$	*AB	A_1 A_1B_1	Nuuchahnulth unstable C's (Kim, 2003)
2. Exceptional repair: Weak element realized			
$A_1\ B_{0.6} + A_1$ $A_1\ B_{0.6} + C_1$	*AA	$A_1\ B_{0.6}A_1$ A_1C_1	Catalan exceptional u-realization (Bonet et al., 2007)
3. Exceptional non-trigger: Weak element not repaired			
$A_1 + B_{0.6}$ $A_1 + B_1$	*AB	$A_1\ B_{0.6}$ A_1C_1	Cl. Manchu exceptional non-triggers for ATR-harmony (Smith, 2017)
4. Exceptional non-target: Weak element does not change			
$A_1^{A} + B_{0.6}$ $A_1^{A} + B_1$	*X^{A}	$A_1\ B_{0.6}$ A_1A_1	SMG Mixtec exceptional non-hosts for floating tones; GSRO analysis in (Zimmermann, 2017*a*,*b*)
5. Lexical support			
$A_1\ B_{0.6}$ $A_1\ B_{0.6} + B_{0.6}$	*Weak!	A_1 $A_1\ B_{0.6}$	Japanese Rendaku voicing only if stem and suffix trigger it; GSR analysis in Rosen (2016)
6. True competition			
$A_{0.8} + C_1$ $A_{0.8} + B_{0.6}$	1Elem!	C_1 $A_{0.8}$	**→ MCS case study**

Argument 1: More than two grades of activity

- in most accounts that directly implement some concept of strength, only a **binary** division into strong and weak is relevant
  (Inkelas, 2015; Vaxman, 2016*a*,*b*; Sande, 2017)

→ true **gradience** of activity is argued to account for the stress system of Moses Columbia Salish where **feet with 5 different degrees of activity** compete for realization

Argument 2: Exceptionality for more than one process

- such a representational account where exceptionality follows from a property of the underlying representation predicts that **elements can be exceptional for multiple phonological processes**
- → borne out in the case study of MCS where vowel deletion treats the same morpheme types differently as stress assignment

(2)

	Fully active consonant Affix 1: /-k_1/	Exceptional weak consonant Affix 2: /-$p_{0.5}$/
	/$b_1a_1t_1$-k_1/	/$b_1a_1t_1$-$p_{0.5}$/
Epenthesis	[batək]	[batp]
	/$t_1u_1n_1$-k_1-o_1/	/$t_1u_1n_1$-$p_{0.5}$-o_1/
Nasal Ass.	[tuŋko]	[tunpo]

Case study: Moses Columbia Salish Stress

Moses Columbia Salish

(Kinkade, 1982; Czaykowska-Higgins, 1985, 1993*a*,*b*, 2011; Willett, 2003, =MCS)

- a **single main-stressed** syllable in every word
- the default-stress position is the **rightmost** syllable for stems in isolation (3-a+b)
- **prefixes are never stressed**; even if they contain the only full V (3-c)

(3) *Default stress (Czaykowska-Higgins, 1993*a*, 205+225)*

a. hananík
'jackrabbit'

b. q'aláχ
'fence'

c. niʔwəpwápəlqs
niʔ-wp∼wp=lqs
Loc-Red-hair=nose
'hair in nose'

Vowel epenthesis and deletion

- there is vowel **epenthesis**:
  - e.g. weak CC-roots always have an epenthetic V between stem-C's
  - e.g. epenthesis before /ʔ/
  - quality predictable: e.g. i/__j, a/__ʔ, ə elsewhere,...)

(4) nq'ij'apánaʔ
n-q'j'=ap=anʔ
Loc-write=bottom=ear
'branded on the cheek' (215)

- unstressed V's are **deleted** if they follow the stressed V

(5) kaʃħújʧnmncn
kaʃ-ħuj=ʧin-min-t-ʃi-n
unrealized-irritate=mouth-relational-TR-2SG.O-1SG.S
'I'm going to bother you (by mouth)' (202)

(stem=underlined)

Lexically determined stress in Salish

- hierarchy of stress-preferences based on a lexical two-way-distinction for stems and affixes into:
  - dominant 'D' and recessive 'R' suffixes
  - strong 'S' and weak 'W' stems

  ➙ **D-Sfx ≫ S-stem ≫ {R-Sfx, W-stem}**

- very similar systems in all Interior Salishan languages except Lillooet (Idsardi, 1991; Czaykowska-Higgins and Kinkade, 1998)

Lexically determined stress in MCS

(6)

a. p’iʃtɬ’aʔákʃt (S-**Ď**)
p’iʃtɬ’ʔ=akʃt
big.PL=hand
‘big hands’ (229)

b. ʃatʃím’xəx^{w} (**Ś**-R)
ʃatʃ-ʔim’x-mix
IPFV-move-IPFV
‘he’s moving’ (208)

c. ʃatʃím’xəx^{w} (S-**Ď**-R)
kaʃ-p’iq=ʧin-ʧut-mix
unrealized-cook=food-REFL-IPFV
‘he’s going to cook’ (209)

Further distinction for stems: E-stems

- E-stems are stressed if directly followed by one D-suffix
- but loose stress to a D-suffix if at least **one other suffix intervenes**

(7)

a. japkʷánkʃn (**SÉ**-D)
jap-kʷan=akʃt-n-t-ø-n
Loc-grab=hand-Ctrl-Tr-3.O-1Sg.S
'I grab so. by the hand' (229)

b. kɬkʷntʃnákʃn (SE-D-**Ú**)
kɬ-kʷan=tʃin=akʃt-n-t-ø-n
Loc-grab=mouth=hand-Ctrl-Tr-3.O-1Sg.S
'I grab so. by wrist' (231)

c. xatmʃtʃút (SE-R-**Ú**)
xat-min-ʃtu-tʃut
raise-relational-Caus-Refl
'he's raising up' (271)

Lexically determined stress: Interim summary

(8)

	S	W	SE	WE
a.	**Ś**(-R)-R	W(-R)-**Ŕ**	**SÉ**(-R)-R	**WÉ**-R
b.	S-**Ď**	W-**Ď**	**SÉ**-D	**WÉ**-D
c.	S-**Ď**-R(-R)	W-**Ď**-R(-R)	**SÉ**-D-R(-R)	
d.	S-D(-D)-**Ď**	W-D(-D)-**Ď**	SE-D(-D)-**Ď**	WE-D(-D)-**Ď**
e.			SE-R-**Ď**	

Asymmetry: Intervening suffix between E-stem and D or not

- hierarchy: **SE/WE ∼ D ≫ S ≫ {R, W}**
- multiple suffixes of the type that should be stressed: the **rightmost** one receives stress

Additional suffix-type R*: Stress-attracting R-suffixes

- two suffixes behave like R-suffixes except that they **attract stress even though they are not the rightmost** in a sequence of R-suffixes

(9)

a. kʷúɬnmn (**Ś**-R*)
kʷuɬn-min-t-ø-n
borrow-relational-CTR-TR-3.O-1SG.S
'I'm borrowing it' (251)

b. ʧqənaʔqímnʧn (W-D-**Ď**-R*)
ʧq=anʔ=qin-min-t-ʃi-n
hear=ear=head-relational-TR-2SG.O-1SG.S
'I heard about you' (251)

c. jərmíʃtm (W-**Ŕ***-R)
jr-min-ʃtu-ø-n
push-relational-CAUS-3.O-1PL.S
'We push him' (252)

Additional suffix-type D*: Stress-attracting D-suffixes

- D*-suffixes behave like D-suffixes except that **they are stressed when adjacent to an SE/WE-stem**

(10)

a. ptχujútija?ʃn (S-**Ď***-R)
ptiχuj=utj?-ʃtu-ø-n
spit=?-CAUS-3.O-1SG.S
'I spittled on them' (270)

b. wak^{w}túɬn (SE-**Ď***)
wak^{w}-tuɬ-t-ø-n
hide-redirective-TR-3.O-1SG.S
'I hid it from s.o.' (256)

c. t'əɬwíl'x (WE-**Ď***)
t'ɬ-wil'x
dirty-inch
'sth. used until it got dirty' (256)

Lexically determined stress: Summary

(11)

	S	W	SE	WE	
a.	**Ś**(-R)-R	W(-R)-**Ŕ**	**SÉ**(-R)-R	**WÉ**-R	(D, R)
b.	S-**Ó**	W-**Ó**	**SÉ**-D	**WÉ**-D	
c.	S-**Ó**-R(-R)	W-**Ó**-R(-R)	**SÉ**-D-R(-R)		
d.	S-D(-D)-**Ó**	W-D(-D)-**Ó**	SE-D(-D)-**Ó**	WE-D(-D)-**Ó**	
e.			SE-R-**Ó**		
f.	**Ś**-R*	W-**Ŕ***			(D, R, R*)
g.		W-**Ŕ***-R			
h.		W(-D)-**Ó**-R*	**SÉ**-D-R*(-R)		
i.		W-R*-**Ó**			
j.			SE-**Ó***	WE-**Ó***	(D, R, D*)
k.			SE-D-**Ó***		
l.	S-**Ó***-R				
m.			SE-**Ó***-R*		(D, R, D*, R*)

D* vs. D and R* vs. R

- hierarchy: **D*** ≫ **SE/WE ∼ D** ≫ **S** ≫ **R*** ≫ **{R, W}**

Summary: The challenges

- lexical stress system with a **preference hierarchy**:
  $D^* \gg \underline{SE/WE \sim D} \gg S \gg R^* \gg \{R, W\}$

- an apparent **locality threshold** for E-stems: only stressed if no D-suffix follows separated by at least one other suffix

A cyclic account in Czaykowska-Higgins (1993*a*)

- a cyclic account inside the metrical framework of Halle and Vergnaud (1987*a*,*b*)
- crucial contrast: **cyclic (=D) vs. non-cyclic (=R) suffixes**: the former trigger stress deletion and new assignment of stress
- different stress rules assigning **left- or rightmost** stress
- E-stems assign **extrametricality** to an adjacent morphemes
- R*- and D*-suffixes are **lexically accented**

The analysis in a nutshell: Competition

- morphemes have **no or underlying feet of different strengths** in their underlying representation
  (difference between strong/weak stems = underlying V/only epenthetic V)

(12)

Fully active φ		← Weaker φ →				No φ	
SE/WE		D*	D	S	R*	R/W	
φ_1	φ_1	$\varphi_{0.9}$	$\varphi_{0.8}$	$\varphi_{0.6}$	$\varphi_{0.4}$		
SE	WE	D*	D	S	R*	R	W

- competition for φ-realization: **most active one is preferably realized**

(13) MAX-φ:
Assign a violation mark for every input φ without an output correspondent.

Two other (opposing) stress preferences

(14) a. $\acute{V}_{STEM}$ ('Stress the **stem-vowel**!')

Assign a violation mark for every main-stressed vowel that is not preceded and followed by stem-segments.

b. RM_{COL} ('Stress is **rightmost**!')

Assign a violation mark for every morphemic colour α that intervenes between the right word edge and the stressed vowel that is not of morphemic colour α.

c. RM_{V} ('Stress is rightmost!')

Assign a violation mark for every V^{*} that intervenes between the right word edge and the stressed vowel that is not of morphemic colour α.

→ two versions of RIGHTMOST: asymmetry between R- and D-suffixes and abundant V-deletion in Salish

(*Underlying vowel. Modelled in containment theory (Prince and Smolensky, 1993; Zimmermann, 2017*c*)).

→ **gang-effect in HG for E-stems**: stems are preferably stressed but stress can't be too far away from the right word-edge

Realization of the only underlying φ

(15)

φ0.8 W D R	MAX-φ 100	V́STEM 30	RMCOL 30	RMV 16	DEP-φ 5	
a. φ1 W D R	-0.8	-1			-1	-115
☞ b. φ0.8 W D R		-1	-1			-60
c. φ1 W D R	-0.8		-2	-1	-1	-161

(epenthetic=grey background)

Preservation of the φ with the highest activity

(16)

φ0.6 φ0.9 φ0.4 S D* R*	MAX-φ 100	V́STEM 30	RMCOL 30	RMV 16	DEP-φ 5	
a. φ0.4 S D* R*	-1.5	-1				-180
☞ b. φ0.9 S D* R*	-1	-1	-1			-160
c. φ0.6 S D* R*	-1.3		-2	-1		-206

E-stems: A gang effect

- stress on an **E-stem** is more preferred than stress on a D-suffix by both MAX-φ and V́$_{STEM}$
- if, however, more than one suffix intervenes between an E-stem and a D-suffix, stress would be too far away from the right edge and is realized on the **D-suffix** instead

→ a **gang-effect in HG**

…has a higher weight than…			
0.2 x MAX-φ + V́$_{STEM}$	≫	RM$_{COL}$ + RM$_{V}$	Cf. (17)
and			
2 x RM$_{COL}$ + RM$_{V}$	≫	0.2 x MAX-φ + V́$_{STEM}$	Cf. (18)

Gang effect I: Stress on E-stem with one D-suffix

(17)

φ1 φ0.8 SE D	Max-φ 100	V́Stem 30	RMCol 30	RMV 16	Dep-φ 5	
a. φ0.8 SE D	-1	-1				-130
☞ b. φ1 SE D	-0.8		-1	-1		-126

Gang effect II: Stress on D-suffix if more suffixes intervene

(18)

φ1 SE R φ0.8 D	Max-φ 100	V́Stem 30	RMCol 30	RMV 16	Dep-φ 5	
☞ a. SE R φ0.8 D	-1	-1				-130
b. φ1 SE R D	-1.8	-1	-1	-1	-1	-261
c. φ1 SE R D	-0.8		-2	-1		-156

Interim Summary

- the representations (19) predict the position of main stress: Underlying feet of different activity compete for stress realization

(19)

Fully active φ		← Weaker φ →				No φ	
SE/WE		D*	D	S	R*	R/W	
φ_1	φ_1	$\varphi_{0.9}$	$\varphi_{0.8}$	$\varphi_{0.6}$	$\varphi_{0.4}$		
SE	WE	D*	D	S	R*	R	W

- this representational account predicts **exceptional behaviour of weakly active elements for more than one process**:
  - → evidence from facts about vowel deletion/secondary stress that these is indeed the case

Vowel deletion asymmetry: E-stems and D-suffixes

- unstressed V's are sometimes **deleted if they precede the stressed V**
  - the unstressed V of a D-suffix is deleted between an SE-stem and a stressed D-suffix (20-a)
  - but the unstressed V of a D-suffix is only variably/for some speakers deleted between a W-stem and a stressed D-suffix (20-b)

(20)

a. kɬɬ'awlq^{w}qnákʃtm (SE-D$_{ø}$-D$_{ø}$-**Ď**)
kɬ-ɬ'aw=alq^{w}=qin=akʃt-m
Loc-wash=pole=Top=arm-Mid
'wash wrists' (246)

b. kjər'jər'qnalq^{w}ákʃtn (W-D$_{V/ø}$-D$_{V/ø}$-**Ď**)
k-jr'∼jr'=qin=alq^{w}=akʃt-n-t-ø-n
Loc-RedP∼roll=Top=pole=arm-Ctr-Tr-3.O-1Sg.S
'roll up sleeves' (245)

Secondary stress

- optional secondary stress can be found on:
  - stem vowels
  - suffix vowels preceding the main stress
  - → **in the context where vowel deletion applies optionally**

(21)

a. niʔk'əmàn'kàkst (W-D̀$_{V/ø}$-**Ď**)
niʔ-k'm=ank=akst
Loc-surface.of=flat=hand
'palm of hand' (246)

b. nməq'^{w}àpánaʔ (W-D̀$_{V/ø}$-**Ď**)
n-mq'^{w}=ap=anʔ
Loc-bulge=base=ear
'bulge on side of face' (249)

- → secondary stress is what **saves those vowels from deletion**!

Account: Second foot blocks vowel deletion

- suffix-vowels without main stress can optionally be realized if they are integrated into a foot (=**secondary stress**)

(22)

Underlying form

	φ0.8		φ0.8
	σ	σ	
k'ʷʔ	akʃt	n	ʧut
W	D	C	D

Option 1: D-Vowel realization

	φ0.8	φ0.8
σ	σ	σ
k'ʷa	ʔakʃ	nʧut

Option 2: D-Vowel deletion

	φ0.8
σ	σ
k'ʷaʔ	kʃnʧut

Possibility of a second foot in a word

- implicit assumption so far: feet compete for realization since only a single foot is possible
  (consequence from, for example, ER-L/R (McCarthy, 2003))
- if the responsible constraint is (at least optionally) lower-weighted **two feet in a word are possible**:
  - avoids vowel deletion of unstressed affix-V
  - is better for Max-φ because more feet are realized
  - but is only possible if the secondary-stress φ is not stronger than the main-stress φ (*AsymmetricStrengthφ)
  - and **maximally two feet** in a word are possible

Possibility of a second foot in a word

(23)

SE-D-D	W-D-(C-)D
1. Underlying	
φ1 φ0.8 φ0.8 σ σ σ x'^{w}ir akʃt atk^{w}	φ0.8 φ0.8 σ σ k'^{w}ʔ akʃt n tʃut
2. Option 1: D-Vowel deletion	
φ1 φ0.8 σ σ x'^{w}irkʃ tatk^{w}	φ0.8 σ σ k'^{w}aʔ kʃntʃut
☺ Stronger (stem)-foot realized as secondary stress	☺ Only other foot realized as secondary stress
3. Option 2: D-Vowel realization	
* φ0.8 φ0.8 σ σ σ x'^{w}i rakʃ tatk^{w}	φ0.8 φ0.8 σ σ σ k'^{w}a ʔakʃ ntʃut
☹ Weaker (affix)-foot realized as secondary stress	☺ Stronger (stem)-foot realized as secondary stress

Only the stronger foot can become a secondary stress

- a second foot can 'save' a D-suffix-V following a W-stem but not one following an SE-stem: being able to save a suffix-vowel from deletion is **not a good enough reason to realize the weaker φ**

(24)

φ1 σ x'wir φ0.8 σ akʃt φ0.8 σ atkw	Max-φ 100	Max-V 10	
☞ a. φ1 σ x'wirkʃ φ0.8 σ tatkw	-0.8	-1	-90
b. σ x'wi φ0.8 σ rakʃ φ0.8 σ tatkw	-1		-100

- → again, simple **competition** about which φ is realized; only in another domain (=secondary stress and avoidance of vowel deletion)

Summary and Conclusion

Summary

- lexical stress system in MCS follows from assuming **6 different types of underlying foot structure** for morphemes
  - position of main stress follows from competition about φ-realization
  - exceptionality of E-stems is a threshold-effect in HG

- this representational account also predict exceptional behaviour for vowel deletion: **exceptionality for multiple processes**

  (=argument against lexically indexed constraints (e.g. Alderete, 2001; Pater, 2009; Finley, 2009): It is a coincidence that at least two different constraints are indexed to the same class of (exceptional) morphemes)

- the argument for **GSR(O) is strengthened** in showing that this predicted type of exceptionality is borne out as well

Gradience in the output: Predicted typology of exceptions

Underlying	Phon.	Output	e.g.
1. Exceptional repair: Weak element not realized			
$A_1 + B_{0.6}$ $A_1 + B_1$	*AB	A_1 A_1B_1	Nuuchahnulth unstable C's (Kim, 2003)
2. Exceptional repair: Weak element realized			
$A_1\ B_{0.6} + A_1$ $A_1\ B_{0.6} + C_1$	*AA	$A_1\ B_{0.6}A_1$ A_1C_1	Catalan exceptional u-realization (Bonet et al., 2007)
3. Exceptional non-trigger: Weak element not repaired			
$A_1 + B_{0.6}$ $A_1 + B_1$	*AB	$A_1\ B_{0.6}$ A_1C_1	Cl. Manchu exceptional non-triggers for ATR-harmony (Smith, 2017)
4. Exceptional non-target: Weak element does not change			
$A_1{}^A + B_{0.6}$ $A_1{}^A + B_1$	*X^A	$A_1\ B_{0.6}$ A_1A_1	SMG Mixtec exceptional non-hosts for floating tones; GSRO analysis in (Zimmermann, 2017*a*,*b*)
5. Lexical support			
$A_1\ B_{0.6}$ $A_1\ B_{0.6} + B_{0.6}$	*Weak!	A_1 $A_1\ B_{0.6}$	Japanese Rendaku voicing only if stem and suffix trigger it; GSR analysis in Rosen (2016)
6. True competition			
$A_{0.8} + C_1$ $A_{0.8} + B_{0.6}$	1Elem!	C_1 $A_{0.8}$	**→ MCS case study**

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