Gradient Symbolic Representations and the Typology of Ghost Segments

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This talk

(1) Ghosts: 'Segments that only surface in certain contexts.' (Yang, 2004, 71)

Ghost segments are best analysed as **weakly active elements.**
(Smolensky and Goldrick, 2016; Rosen, 2016; Zimmermann, to appear)

- Accounts for the fact that **different types of ghost segments** with different markedness thresholds can co-exist within one language.
  (=case study from Welsh)
- Predicts that ghost segments can only **gradiently contribute to markedness** if they surface.
  (=teaser from Nuuchahnulth)
- Predicts that **phonological and lexical factors** can contribute to the (non)realization of a ghost segment.
  (=teaser from Catalan)

Two types of ghost segments

Type I: Appearing ghosts

(2) Example: Yawelmani Yokuts (Zoll, 1996, 182+183), (Newman, 1932)

IND.OBJ /–ni/	talap–ni	'bow'
	xataː-ni	'food'
PRECATIVE /–mi/	amic-mi	'having approached'
	pana-m	'having arrived'

- the precative suffix ends in a ghost /i$_{\text{👻}}$/ that only surfaces if its appearance **avoids** a complex coda (*/amicm/)

(3) *Appearing ghost segments*
surface if their appearance resolves a markedness problem; their **default state is to be unrealized**.

Other examples: Slavic yers (Szypra, 1992; Yearley, 1995), Catalan /u/ (Bonet et al., 2007), Mohawk vowels (Rowicka, 1998), French Liaison (Tranel, 1996*a*,*b*), Nguni (Sibanda, 2011)

Type II: Disappearing ghosts

(4) Example: Nuuchahnulth (Kim, 2003, 178)

a.		waʔitʃ–swi–ʔiʃ	wa.ʔitʃs.wi.ʔiʃ
		to.sleep–beyond.normality-3Sg.Ind	‘S/he slept in’
b.	i.	ʔu–**k**ɬaː–siʃ Eun-Sook	ʔu**k**.ɬaː.siʃ
		it–to.be.called–1Sg.Ind Eun-Sook	‘My name is Eun-Sook’
	ii.	kʷis–**k**ɬaː–k’uk–ʔiʃ	kʷis.ɬaː.k’uk.ʔiʃ
		different–to.be.called–1Sg.Ind	‘It seems like he has a different name’

- the suffix ‘to be called’ begins with a ghost /k◌̻/ that only surfaces if its appearance **does not cause** a complex coda (*/kʷiskɬaːk’ukʔiʃ/)

(5) *Disappearing ghost segments*
surface if their appearance does not cause a markedness problem; their **default state is to be realized**.

Other examples: Yawelmani consonants (Noske, 1985; Zoll, 1996), English /a/n/ (Yang, 2004), Nuuchahnulth consonants (Davidson, 2002; Kim, 2003)

Appearing ghosts in Welsh

(6) Ghost consonant in Welsh (Hannahs and Tallerman, 2006, 798)

a. gudag eraill ‘with others’

b. guda gwên ‘with a smile’

Ghost segments: /gudag$_{\text{ghost}}$/

Several morphemes surface with an unpredictable consonant only if its appearance avoids a vowel hiatus.

(7)

__C	__V	
gyda	gydag	‘with’
tua	tuag	‘towards, about’
a	ac	‘and’
na	nac	‘neither, nor’

Disappearing ghosts in Welsh

(8) Welsh definite allomorphy (Hannahs and Tallerman, 2006, 782+783)

a.	**yr** afon	'the river'	yr (=ər) __ V
b.	**y** llyfr	'the book'	y (=ə) __ C
c.	o'**r** afon	'from the river'	/'r/ (=r) V__, overriding a.+b.
	o'**r** llyfr	'from the book'	

Ghost segments: /y$_{\text{ghost}}$r$_{\text{ghost}}$/

A single underlying form /y$_{\text{ghost}}$r$_{\text{ghost}}$/ and either one of these segments can remain unrealized if it would result in a marked structure (=coda or hiatus).

Combinations of appearing and disappearing ghosts

(9) Underlying: /gyda**g**$_{\text{ghost}}$ **y**$_{\text{ghost}}$**r**$_{\text{ghost}}$ nod/ (Hannahs and Tallerman, 2006, 784)

* Option 1:	gyda**g** **y** nod	☹ ☹ ☹	☹ ☹ ☹	☺ ☹
☞ Option 2:	gyda’**r** nod			
		ghost deleted	ghost realized	marked

‘with the aim’

Realization of /r/ takes precedence over the other ghost segments

- one of the reasons Hannahs and Tallerman (2006) reject a phonological account of the definite allomorphy

→ follows in an account based on gradient activity where segment can have different default states: /r/’s **default state is not to be there**

Account: Ghost segments and gradient activity

Background: Gradient Symbolic Representation

1. Embedded in a general **computational architecture for cognition**
   (=Gradient Symbolic Computation Smolensky and Goldrick, 2016)
2. A **unified account** for different exceptional phonological behaviours:
   - liaison consonants in French (Smolensky and Goldrick, 2016)
   - semi-regularity of Japanese Rendaku (Rosen, 2016)
   - allomorphy in Modern Hebrew (Faust and Smolensky, 2017)
   - lexical accent in Lithuanian (Kushnir, 2017)
   - lexical stress in Moses Columbian Salishan (Zimmermann, to appear)
   - tone sandhi in Oku (Nformi and Worbs, 2017)
   - tone allomorphy in San Miguel el Grande Mixtec (Zimmermann, 2017*a*,*b*)
   - …

Assumptions (Smolensky and Goldrick, 2016)

- symbols in a linguistic representation can have **different degrees of presence** or numerical activities
- grammatical computation inside **Harmonic Grammar**
  (Legendre et al., 1990; Potts et al., 2010)
- any **change in activity is a faithfulness violation**

Ghost Segments in GSR

- ghosts are weakly active:
  - it is **costly to realize** them
    (=activity inserted or weakly active element in the output (10))
  - they are **easier to delete** than 'normal' segments
    (=MAX$_S$ violated to a lesser degree)
  - they **violate/satisfy** markedness constraints to a lesser degree

(10) FULL: Assign violation 1-X for every output element with activity X.

(11) Gradient Activity=gradient constraint violations

$b_1a_1t_1$-$p_{0.5}$	FULL 10	MAX$_S$ 10	DEP$_S$ 10	*CC 10	
a. $b_1a_1t_1p_1$			-0.5	-1	-15
b. $b_1a_1t_1p_{0.5}$	-0.5			-0.75	-12.5
c. $b_1a_1p_{0.5}$	-0.5	-1			-15
☞ d. $b_1a_1t_1$		-0.5			-5

Appearing ghosts in GSR

- default is non-realization: DEP$_S$ 👻 ≫ MAX$_S$ 👻
- but realized to avoid markedness: M + MAX$_S$ 👻 ≫ DEP$_S$ 👻
- (and non-ghosts are never not realized: MAX$_S$ ≫ M)

(12) /-m$_1$**i$_{0.5}$**/ in Yawelmani

	FULL 100	DEP$_S$ 20	MAX$_S$ 10	*CC 6	
p$_1$a$_1$n$_1$a$_1$-m$_1$**i$_{0.5}$**					
a. p$_1$a$_1$.n$_1$a$_1$.m$_1$**i$_1$**		-0.5			-10
☞ b. p$_1$a$_1$.n$_1$a$_1$m$_1$			-0.5		-5
a$_1$m$_1$i$_1$c$_1$-m$_1$**i$_{0.5}$**					
☞ a. a$_1$.m$_1$i$_1$c$_1$.m$_1$**i$_1$**		-0.5			-10
b. a$_1$.m$_1$i$_1$c$_1$m$_1$			-0.5	-1	-11

Disappearing ghosts in GSR

- default is realization: MAX$_S$ 👻 ≫ DEP$_S$ 👻
- but not realized to avoid markedness: M + DEP$_S$ 👻 ≫ MAX$_S$ 👻
- (and no true epenthesis: DEP$_S$ ≫ M)

(13) /-**k$_{0.5}$**ɬ$_1$a$_1$/ in Nuuchahnult (not Ahousaht; cf. (30))

	FULL 100	MAX$_S$ 20	DEP$_S$ 18	*CC 2	
ʔ$_1$u$_1$-**k$_{0.5}$**ɬ$_1$a$_1$					
☞ a. ʔ$_1$u$_1$**k$_1$**.ɬ$_1$a$_1$			-0.5		-9
b. ʔ$_1$u$_1$.ɬ$_1$a$_1$		-0.5			-10
k^w$_1$i$_1$s$_1$-**k$_{0.5}$**ɬ$_1$a$_1$					
a. k^w$_1$i$_1$s$_1$.**k$_1$**ɬ$_1$a$_1$			-0.5	-1	-11
☞ b. k^w$_1$i$_1$s$_1$.ɬ$_1$a$_1$		-0.5			-10

In a nutshell

/$g_1u_1d_1a_1\mathbf{g}_{0.2}$/ and /$\mathbf{y}_{0.6}\mathbf{r}_{0.6}$/

/$\mathbf{y}_{0.6}$/ and /$\mathbf{r}_{0.6}$/ are realized unless their realization would create a *Cod or *Hiat violation

/$\mathbf{g}_{0.2}$/ is not realized unless it can avoid a *Hiat violation

- if a marked structure is unavoidable, a *Cod violation is tolerated but a violation of *Hiat has to be avoided (=preference for /$\mathbf{r}_{0.6}$)

Constraints

(14)

a. MAX$_S$: Assign violation X for any segmental activity X in the input that is not present in the output.

b. DEP$_S$: Assign violation X for any segmental activity X in the output that is not present in the input.

c. *COD: Assign violation X for every coda consonant with activity X.

d. *HIAT: Assign violation X for every pair of vowels that are adjacent and have the mean activity X.

e. *[CC: Assign violation X for every onset cluster with mean activity X.

Markedness and non-ghosts in Welsh

- non-ghost segments are neither deleted nor inserted to avoid *Hiat and/or *Cod problems

(15)

…V_1 $a_1f_1o_1n_1$ C_1V_1…	Max$_S$ 10	Dep$_S$ 10	*[CC 8	*Hiat 7	*Cod 5	
☞ a. $V_1.a_1.f_1o_1n_1.C_1V_1$				-1	-1	-12
b. $V_1.a_1.f_1o_1.C_1V_1$	-1			-1		-17
c. $V_1.ʔ_1a_1.f_1o_1n_1.C_1V_1$		-1			-1	-15
d. $V_1.ʔ_1a_1.f_1o_1.C_1V_1$	-1	-1				-20

Max$_S$ ≫ *Cod/*Hiat
Dep$_S$ ≫ *Cod/*Hiat

Appearing and disappearing ghosts in Welsh: Default situation

(16)  /$y_{0.6}r_{0.6}$/ is more present than absent: Preferably realized

$y_{0.6}r_{0.6}$	MAX$_S$ 10	DEP$_S$ 10	
☞ a. y_1r_1		-0.8	-8
b.	-1.2		-12

$0.6 \times$ MAX$_S$ $\gg$ $0.4 \times$ DEP$_S$

(17)  /$g_{0.2}$/ is more absent than present: Preferably not realized

$g_1u_1d_1a_1g_{0.2}$	MAX$_S$ 10	DEP$_S$ 10	
a. $g_1u_1d_1a_1g_1$		-0.8	-8
☞ b. $g_1u_1d_1a_1$	-0.2		-2

$0.8 \times$ DEP$_S$ $\gg$ $0.2 \times$ MAX$_S$

Appearing /$g_{0.2}$/: Realized to avoid a problem

(18)

$g_1u_1d_1a_1\mathbf{g_{0.2}}$ V_1…	MAX$_S$ 10	DEP$_S$ 10	*[CC 8	*HIAT 7	*COD 5	
☞ a. $g_1u_1.d_1a_1.\mathbf{g_{0.2}}V_1$		-0.8				-8
b. $g_1u_1.d_1a_1.V_1$	-0.2			-1		-9

*HIAT + 0.2×MAX$_S$ ≫ 0.8×DEP$_S$

Appearing /$g_{0.2}$/: Not realized if no problem is avoided

(19)

$g_1u_1d_1a_1\mathbf{g_{0.2}}$ C_1V_1…	MAX$_S$ 10	DEP$_S$ 10	*[CC 8	*HIAT 7	*COD 5	
a. $g_1u_1.d_1a_1\mathbf{g_{0.2}}.C_1V_1$		-0.8			-5	-13
☞ b. $g_1u_1.d_1a_1.C_1V_1$	-0.2					-2

$0.8\times$DEP$_S$ $\gg$ $0.2\times$MAX$_S$

(The additional *COD violation of (19-a) is not even crucial)

Disappearing /$y_{0.6}r_{0.6}$/: Realized if no problem arises

(20)

…V_1C_1 $\mathbf{y_{0.6}r_{0.6}}$ V_1…	MAX$_S$ 10	DEP$_S$ 10	*[CC 8	*HIAT 7	*COD 5	
☞ a. $V_1.C_1\mathbf{y_1}.\mathbf{r_1}V_1$		-0.8				-8
b. $V_1.C_1\mathbf{y_1}.V_1$	-0.6	-0.4		-1		-17
c. $V_1C_1.\mathbf{r_1}V_1$	-0.6	-0.4			-1	-15
d. $V_1.C_1V_1$	-1.2					-12

$0.6\times$MAX$_S \gg 0.4\times$DEP$_S$

Disappearing /$y_{0.6}r_{0.6}$/: /r/ not realized to avoid a coda

(21)

…V_1C_1 $\mathbf{y_{0.6}r_{0.6}}$ C_1V_1…	MAX$_S$ 10	DEP$_S$ 10	*[CC 8	*HIAT 7	*COD 5	
a. $V_1.C_1\mathbf{y_1r_1}.C_1V_1$		-0.8			-1	-13
☞ b. $V_1.C_1\mathbf{y_1}.C_1V_1$	-0.6	-0.4				-10
c. $V_1C_1.\mathbf{r_1}C_1V_1$	-0.6	-0.4	-1		-1	-23
d. $V_1.C_1V_1$	-1.2					-12

*COD + 0.4×DEP$_S$ ≫ 0.6×MAX$_S$

Disappearing /$y_{0.6}r_{0.6}$/: /y/ not realized to avoid a hiatus I

(22)

…V_1 $y_{0.6}r_{0.6}$ V_1…	MAX$_S$ 10	DEP$_S$ 10	*[CC 8	*HIAT 7	*COD 5	
a. $V_1.y_1.r_1V_1$		-0.8		-1		-15
b. $V_1.y_1.V_1$	-0.6	-0.4		-2		-24
☞ c. $V_1.r_1V_1$	-0.6	-0.4				-10
d. $V_1.V_1$	-1.2			-1		-19

*HIAT + 0.4×DEP$_S$ ≫ 0.6×MAX$_S$

Disappearing /$y_{0.6}r_{0.6}$/ – Competing Contexts

(23)

a.	**yr** afon	‘the river’	yr (=ər) __ V
b.	**y** llyfr	‘the book’	y (=ə) __ C
c.	o’**r** afon o’**r** llyfr	‘from the river’ ‘from the book’	/’r/ (=r) V__, **overriding a.+b.**

- RealizeMorpheme (=RM) ensures that some portion of /$y_{0.6}r_{0.6}$/ must surface
- in a V__C context, a markedness violation is unavoidable; since *Hiat is higher-weighted than *Cod, there is a preference for /$r_{0.6}$/ after V

Disappearing /$y_{0.6}r_{0.6}$/: /y/ not realized to avoid a hiatus II

(24)

…V_1 $y_{0.6}r_{0.6}$ C_1V_1…	RM 100	MAX$_S$ 10	DEP$_S$ 10	*[CC 8	*HIAT 7	*COD 5	
a. $V_1.y_1r_1.C_1V_1$			-0.8		-1	-1	-20
b. $V_1.y_1.C_1V_1$		-0.6	-0.4		-1		-17
☞ c. $V_1r_1.C_1V_1$		-0.6	-0.4			-1	-15
d. $V_1.C_1V_1$	-1	-1.2					-112

*HIAT ≫ *COD

Combination of appearing and disappearing ghosts

(25)

$g_1u_1d_1a_1$**$g_{0.2}$** **$y_{0.6}r_{0.6}$** C_1V_1…	RM 100	MAX$_S$ 10	DEP$_S$ 10	*[CC 8	*HIAT 7	*COD 5	
a. $g_1u_{.1}d_1a_1.$**$g_1y_1r_1$**$.C_1V_1$			-1.6			-1	-21
b. $g_1u_{.1}d_1a_1.$**y_1r_1**$.C_1V_1$		-0.2	-0.8		-1	-1	-22
☞ c. $g_1u_{.1}d_1a_1$**r_1**$.C_1V_1$		-0.8	-0.4			-1	-17
d. $g_1u_{.1}d_1a_1.$**g_1y_1**$.C_1V_1$		-0.6	-1.2				-18

- vs. (25-d): /$g_{0.2}$/ **never shows its non-default state to avoid codas**
  $0.8\times$DEP$_S$ $\gg$ *COD
- vs. (25-a): /$g_{0.2}$/ is an appearing ghost and its **default state is thus to not be there**
  $0.8\times$DEP$_S$ $\gg$ $0.2\times$MAX$_S$

Prediction of a GSR system: Different ghosts within in a language

- elements can have different default states (=present or not)
- and different thresholds for avoiding certain markedness problems

(26)

	default state	non-default state due to	
		*Cod	*Hiat
 $g_{0.2}$ (17)	not present	no (25)	yes (18)
 $y_{0.6}$ (16)	present		yes (22)+(24)
 $r_{0.6}$ (16)	present	yes (21)	

Extending the typology

The typology of ghost segments

1. there are two basic types (in a theoretical account):
   - appearing and disappearing ones
2. there can be different ghosts within one language:
   - of different types
   - that are influenced differently by the phonology
3. ghosts can have special properties:
   - they can only gradiently contribute to markedness (=not be a full-grown problem)
   - lexical and/or phonological facts influence their (non)appearance

Special property I: Gradient markedness

- ghost consonants in Ahousaht appear only after a vowel: Two different marked structures are avoided!

(27) Avoidance of a coda consonant for /–$\mathbf{C}_{\text{👻}}$V/ suffixes

a.	V__	/V-$\mathbf{C}_{\text{👻}}$V/	V.$\mathbf{C}_{\text{👻}}$V		
b.	C__	/VC-$\mathbf{C}_{\text{👻}}$V/	V.CV	*VC.$\mathbf{C}_{\text{👻}}$V	➙ coda avoided

(28) Avoidance of a cluster for /–$\mathbf{C}_{\text{👻}}$CV/ suffixes

a.	V__	/V-$\mathbf{C}_{\text{👻}}$CV/	V$\mathbf{C}_{\text{👻}}$.CV	➙ **a coda is tolerated!**	
b.	C__	/VC-$\mathbf{C}_{\text{👻}}$CV/	VC.CV	*VC$\mathbf{C}_{\text{👻}}$.CV	➙ CC avoided

➙ ghost consonants in codas are tolerated; non-ghost consonants are not!
(GSR account in Zimmermann (2018))

GSR account: Gradient markedness

(29) Ahousaht /-**C**$_{\text{ghost}}$V/: Not realized after a C

tɬ$_1$i$_1$s$_1$-**q$_{0.5}$**u$_1$	MAXS 20	FULL! 12	*CC 10	*COD 7	
a. tɬ$_1$i$_1$s$_1$.**q$_{0.5}$**u$_1$		-0.5		-1-**1**	-13
☞ b. tɬ$_1$i$_1$.s$_1$u$_1$	-0.5				-10

0.5xFULL! + *COD ≫ 0.5xMAXS 0.5xFULL! + *COD ≫ 0.5xMAXS

(30) Ahousaht /-**C**$_{\text{ghost}}$CV/: Realized after a V

ʔ$_1$u$_1$-**k$_{0.5}$**ɬ$_1$aː$_1$	MAXS 20	FULL! 12	*CC 10	*COD 7	
☞ a. ʔ$_1$u$_1$**k$_{0.5}$**.ɬ$_1$aː$_1$		-0.5		-0.5-**0.5**	-9.5
b. ʔ$_1$u$_1$.ɬ$_1$aː$_1$	-0.5				-10

0.5xMAXS ≫ 0.5xFULL! + 0.5x*COD 0.5xMAXS ≫ 0.5xFULL! + **0.5x***COD

Special property II: Lexical and/or phonological factors

- masculine nouns in Catalan realizes an /u/ before plural /s/ if the stem ends in a sibilant (=/u/ avoids a marked structure of two adjacent sibilants)
- some nouns always surface with /u/ in the masculine

(31) Ghost vowel in Catalan (Fabra, 1990; Wheeler, 1999; Bonet et al., 2007)

'glass(es)'		'step(s)'		'lad(s)'	
/gɔ́t-**u**$_{\text{ghost}}$/	gɔ́t	/pas-**u**$_{\text{ghost}}$/	pas	/mos-**u**$_{\text{ghost}}$/	mos**u**
/gɔ́t-**u**$_{\text{ghost}}$-s/	gɔ́ts	/pas-**u**$_{\text{ghost}}$-s/	pas**u**s	/mos-**u**$_{\text{ghost}}$-s/	mos**u**s

→ masculine suffix = ghost segment /u/ that only surfaces if it **avoids a marked structure** or is adjacent to certain **lexically marked** nouns

GSR account: Lexical and/or phonological factors

- /-$u_{0.5}$/ in Catalan surfaces if 1) it solves a markedness problem or 2) it is adjacent to a stem that also contains an /$u_{0.5}$/ (=coalescence)

(32) Catalan: Phonological support for /-$\mathbf{u_{0.5}}$/

$p_1a_1s_1-u_{0.5}-s_1$	MAX$_C$ 50	*SS 40	FULL! 30	DEP$_V$ 26	MAX$_V$ 20	INT$_V$ 5	
a. $p_1a_1s_1u_{0.5}s_1$			-0.5				-15
b. $p_1a_1s_1s_1$		-1			-0.5		-50
☞ c. $p_1a_1s_1u_1s_1$				-0.5			-13

(33) Catalan: Lexical support for /-$\mathbf{u_{0.5}}$/

$m_1o_1s_1u^a_{0.5}-u^b_{0.5}$	MAX$_C$ 50	*SS 40	FULL! 30	DEP$_V$ 26	MAX$_V$ 20	INT$_V$ 5	
a. $m_1o_1s_1u^a_{0.5}u^b_{0.5}$			-1				-30
b. $m_1o_1s_1u^a_{0.5}$			-0.5		-0.5		-25
☞ c. $m_1o_1s_1u^{a,b}_1$						-1	-5

Alternatives

Alternative accounts: Autosegmental defectivity

- floating features without prosodic position
  (Hyman, 1985; Noske, 1985; Rubach, 1986; Kenstowicz and Rubach, 1987; Sloan, 1991; Yearley, 1995; Tranel, 1995, 1996*a*; Zoll, 1996)

- empty slots without melodic content
  (Spencer, 1986; Szypra, 1992)

- marked as (optionally) non-syllabifiying
  (Clements and Keyser, 1983; Archangeli, 1984)

→ **a binary contrast** between 'weak' and 'normal'

Alternative accounts: OT implementation

(34) a. HAVE👻 (e.g. MAXF in a floating feature account (Zoll, 1996))

b. *👻 (e.g. DEPRT in a floating feature account (Zoll, 1996))

(35) Appearing ghost in an autosegmental defectivity account

			*CC	*👻	Have👻
pana-mi	a.	pa.na.mi		*!	
	☞ b.	pa.nam			*
amic-mi	☞ a.	a.mic.mi		*	
	b.	a.micm	*!		*

(36) Disappearing ghost in an autosegmental defectivity account

			*CC	Have👻	*👻
ʔu-kɬa	☞ a.	ʔuk.ɬa			*
	b.	ʔu.ɬa		*!	
kʷis-kɬa	a.	kʷis.kɬa	*!		*
	☞ b.	kʷis.ɬa		*	

Alternative accounts: The problem

- the **coexistence of both appearing and disappearing ghosts** within one language is impossible:
  Have👻 ≫ *👻 or *👻 ≫ Have👻

Possible solution

- different types of 'defectivity' and different rankings for Max[place], Max[cont], MaxRt, …as a possible solution
- compatible with the rest of the grammar?

- **gradient markedness** is inherently impossible since constraints are categorically violated

Conclusion

Summary

- typology of ghost segments follows from an account where ghost segments are **weakly active**
  - different types of ghosts within one language
  - phonological or lexical factors influence the realization of ghosts
  - ghosts contribute gradiently to markedness

- this strengthens the argument for **Gradient Symbolic Representations**

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