Place assimilation changes its triggers*

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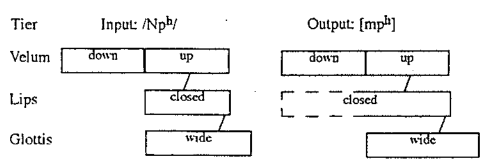
Outline

- Trigger-changing effects in Zulu
- Articulatory Phonology and ALIGN in OT
- A typology of Bantu nasal place assimilation trigger effects

1 Introduction

1. In this paper I present evidence from Bantu languages that place assimilation can result in a structure in which the trigger segment is forced to undergo change, or in which unexpected changes occur to the target.
2. I will argue that an OT instantiation of Articulatory Phonology can predict these changes.
3. Place assimilation in articulatory phonology: gestural overlap between two segments (cf. Browman & Goldstein 1989) or overlap and subsequent gestural reduction–partial or complete–of the target segment (cf. Jun 1995, 1996).
4. On this view, only the oral closure gestures determining place of the trigger are required to overlap gestures of the target.



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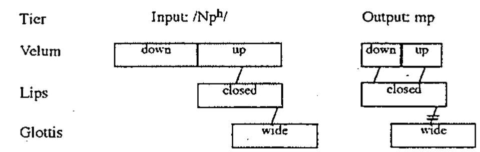
5. Zulu (Bantu) nasal place assimilation, however, exhibits consequences on the trigger segment that are independent of the oral closure gesture, such as loss of laryngeal features:



6. I propose an analysis of Zulu place assimilation that extends this articulatory view by employing gestural ALIGNMENT constraints (Gafos 2002) and a *LONG constraint that together can produce the observed consequences to the trigger C.
7. I will then discuss the wider range of nasal place assimilation phenomena in Bantu, focusing on assimilation of a nasal to a voiceless consonant, and will demonstrate how this analysis can straightforwardly capture the range of changes to the trigger we observe.

2 Trigger effects in Zulu nasal place assimilation

2.1 Background

- Nasal place assimilation is a common phenomenon throughout Bantu, and the processes associated with it have been subject to several analyses (eg. Herbert 1986, Padgett 1994, Hayes and Styvers 1995)

(1) **Zulu**
  a. /iN + ɓuɓe/ ⟶imbuɓe 'lion' (cl. 9)
  b. /iN + daba/ ⟶indaba 'news' (cl. 9)
  c. /iN + goma/ ⟶iŋgoma 'song' (cl. 9)

(2) **Ikalanga** (Mathangwane 1999)
  a. /N + badu/ ⟶mbadu 'ribs' (cl. 10)
  b. /N + dedu/ ⟶ndedu 'beard' (cl. 9)
  c. /N + guluʋe ⟶ŋguluʋe 'pig(s)' (cl. 9,10)

- Zulu exhibits some of the canonical effects of nasal place assimilation, such as postnasal hardening, as well as some more novel ones, such as postnasal deaspiration.
- Zulu has a three-way voicing contrast between voiced stops, voiceless ejectives, and voiceless aspirated stops.

Zulu Consonant Inventory[1]

	labial	alveolar	post-alveolar	palatal	velar	glottal	labial-velar
plosive	p' p^h b ɓ	t' t^h d			k k' k^h g		
nasal	m	n		ɲ	ŋ		
fricative	f v	s z ɬ	ʃ			h ɦ	
affricate		ts dz tɬ d	tʃ dʒ				
approxim.		l		j			w

<table>
<tr><th></th><th>dental</th><th>lateral</th><th>alveolar</th></tr>
<tr><td>click consonants</td><td>|</td><td>||</td><td>!</td></tr>
<tr><td>aspirated</td><td>|^h</td><td>||^h</td><td>!^{h}</td></tr>
<tr><td>voiced</td><td>g|</td><td>g||</td><td>g!</td></tr>
<tr><td>nasalized</td><td>ŋ|</td><td>ŋ||</td><td>ŋ!</td></tr>
</table>

- Consonant clusters are either NC or Cw clusters.

Stem Internal Clusters[2]

Homorganic Clusters			Heterorganic Clusters		
mp' mb mpf mbv mm mw	nt' nd nts ntʃ ndz ntɬ nd	ŋk' ŋg ɲdʒ ɲj	mt' mt^h md ms mʃ mtʃ mz mɬ m mn mɲ mj	mk' mk^h mŋ	tw kw dw gw sw ʃw tʃw zw ɬw w nw ɲw

- The only heterorganic NC clusters are mC clusters.

2.2 Behavior of NC Clusters

- NC clusters in Zulu arise either stem-internally or as the result of prefixal morphology.

(3) **NC origins**
  a. **mɬ**a 'on the day that'
  b. um- + -ɬeli ⟶ u**mɬ**eli 'editor'

- Derived NC clusters result from combining two types of noun class prefixes with stems.
- One prefix, um- (classes 1 and 3), does not undergo place assimilation and does not trigger changes on the stem-initial consonant.

[1]Doke 1969.
[2]Based on a survey of stem initial clusters found in Doke et al. 1990.

- um- combines with stems to produce both the heterorganic and homorganic clusters shown above as well as clusters not attested in stem-inital position: [mp^h], [mɓ], etc.

(4) **Non-assimilating /m/**
  Classes 1 & 3
  um+...
  um-k'ik'ilizo 'insinuating remark'
  um-t^{h}et^{h}o 'law'
  um-p^{h}eki 'a cook'
  um-yeni 'husband'

- The other type of nasal-final prefix, iN/iziN (classes 9 and 10), end in a nasal always undergoes place assimilation with the initial consonant of the root.

(5) **Assimilating N**
  Class 11 ⟶ Class 10
  u(lu)+... ⟶ iziN+...
  u-k'ek'e ⟶ **iziŋ**-k'ek'e 'lopsided object'
  u-p'otʃo ⟶ **izim**-p'otʃo 'enema'
  u-yememe ⟶ **iziɲ**-yememe 'stampede'

- When iN/iziN prefixes combine with a stem, the resulting NC cluster is always of a type found in the inventory of stem internal homorganic NC clusters listed above, despite the range of stem initial consonants in the input.
- The place assimilated NC clusters resulting from noun class prefixation as in (3) display the following properties, all of which are systematically absent in non-assimilated mC clusters of the type shown in (4):

1. Postnasal hardening.
2. Loss of implosion.
3. Loss of aspiration.
4. N+h ⟶ŋk
5. Voicing of non-nasal clicks.

- My analysis focuses on the first three of these changes, illustrated below.

(6) **Postnasal hardening:**
  a. u(lu) + ʃaŋgane ⟶ŭʃaŋgane 'wanderer'
     iziN + ʃaŋgane ⟶izin**t**ʃaŋgane
  b. um + ʃik'sho ⟶umʃik'isho 'friction'

(7) **Loss of implosion:**
  a. iN + ɓali ⟶imbali 'truth'
  b. um + ɓali ⟶umɓali 'color'

(8) **Loss of aspiration:**

a. iN + t^hando ⟶int'ando 'free will'

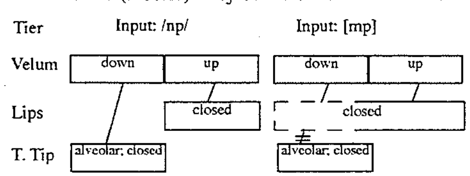
b. um + t^hando ⟶umt^{h}ando 'love, desire'

- These effects mirror the distribution of homorganic NC clusters in stem internal position.
- The absence of such effects in the heterorganic mC clusters and derived homorganic mC clusters indicates that they result from place assimilation rather than general Zulu nasal phonotactics.
- The distribution of derived and underlying NC clusters suggests that while [m] in Zulu does not undergo place assimilation, all other nasals do.
- We can understand the changes to the trigger C brought about by place assimilation as a result of overlap between gestures of the two segments in assimilated NC clusters.

3 Analysis

- My analysis will refer directly to articulatory representations in the input and candidate set.
- The constraint set will include both gesturally- and perceptually-oriented constraints.
- Nasal place assimilation in Zulu is driven by a constraint against two distinct adjacent oral constrictions:

(9) ASSIMILATE (ASSIM): Adjacent distinct oral constrictions are disallowed.



(10) MAX(labial) ≫ ASSIM allows for unassimilated mC clusters.

(11) MAX(place)/__ vocoid[3] ≫ ASSIM ensures that the oral constriction of C_2 is always preserved.

- (9) - (11) will ensure that /m/ will not assimilate, while all other nasals will.
- This basic gestural view of how place assimilation works can straightforwardly capture post-nasal hardening effects (6):
  - Gestural representations cannot separate place from stricture, forcing them to spread as a unit in assimilation.

[3]Vocoids include all vowels and glides; Cj sequences are ruled out by an additional markedness constraint.

- To avoid nasalized fricatives in the output, hardening must occur (See Appendix A for a fuller picture).

- A family of gestural alignment constraints fixes timing relationships between pairs of gestures:

(12) ALIGN(G_1, landmark$_1$, G_2, landmark$_2$): Align landmark$_1$ of Gesture$_1$ with landmark$_2$ of Gesture$_2$ (Gafos 2002).

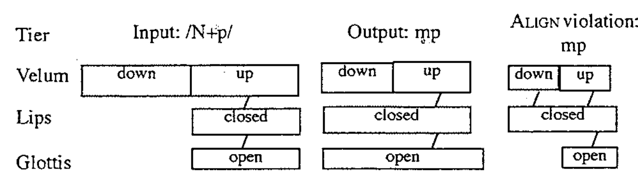
- ALIGN constraints that align the left edge of the oral closure gesture with some other gesture will cause the second gesture to be manipulated whenever the beginning of the oral closure gesture is.
- In nasal place assimilation, ALIGN will force gestures that are aligned with the beginning of C to spread/shift along with the oral closure, resulting in overlap with N.
  - Forced overlap between N and other gestures of C has the potential to create marked structures. Markedness constraints will be employed to prohibit such structures.
  - The presence of MAX(+nas) high in the ranking ensures that nasality is preserved at the expense of conflicting gestures.

3.1 Loss of Implosion and Aspiration

- I argue here that problems with implosives and affricates come from overlap of glottal gestures forced by ALIGN.
- For aspiration and implosion to be perceived, the target of the glottal gesture must be aligned with the offset of the place gesture.
- Moreover, since Zulu voiceless consonants are devoiced throughout, the glottal opening gesture must begin at the beginning of the oral closure, to cut off residual voicing from the previous segment (cf. Hayes and Steriade 2004).

(13) ALIGN(Place, L, Glot, L): Align the left edge of the oral closure gesture with the left edge of the glottal gesture.

- The glottal gesture is thus brought into overlap with N through place assimilation:



- Implosive and voiceless/aspirated nasals are not found in Zulu (see Silverman 1997 for a discussion of such segments' undesirability cross-linguistically).

(14) *ɓ̃: prohibits overlap between N and the glottal lowering gesture.

(15) *N̥: prohibits overlap between N and the glottal opening gesture.

- MAX(imp): keep implosion in the output
- MAX(asp): keep aspiration in the output.

(16) ALIGN, *ɓ̃, *Nʰ, MAX(+nas) ≫ MAX(imp), MAX(asp)

/Nɓ/	ALIGN	*ɓ̃	MAX(+nas)	MAX(imp)
Velum [down][up]; Lips [closed]; Glottis [down]				
mɓ — Velum [down][up]; Lips [closed]; Glottis [down]	*!			
ɓ̃ɓ — Velum [down][up]; Lips [closed]; Glottis [down]		*!		
ɓɓ — Velum [up]; Lips [closed]; Glottis [down]			*!	
☞ mb — Velum [down][up]; Lips [closed]				*

3.1.1 A note on ejectives

- I don't have the full story for why aspirated consonants become ejectives, rather than plain stops (and why ejectives seem to be unproblematic in postnasal contexts).
- We would expect glottal constriction to have the same overlap with the N, and cause the same markedness problems, as glottal opening.

- However, ejection in Zulu is weak in general, and sometimes altogether absent in post-assimilating-nasal contexts, which is in line with what we would expect.
- See Appendix B for more details.

3.2 Durational Differences in Zulu NC

- Though not crucial to the analysis presented here, Zulu mC and assimilated NC clusters display another interesting difference.
- While the unassimilated mC clusters are roughly equal in duration to intervocalic m plus intervocalic C, assimilated NC clusters are quite short–close in duration to a single C.
- This length difference is so far not predicted by anything in the assimilation account.
- What it suggests is that the assimilation in Zulu is occurring not through lengthening the place gesture to spread it onto N, but rather by shifting it over so that it overlaps both N and C without becoming any longer.
- We can capture this aspect of Zulu with a constraint *LONG:

(17) *LONG: The duration of an oral constriction gesture must not exceed the target duration[4] for that gesture.

- Further details on *LONG in Zulu are provided in Appendix C.
- We will see in some of the cross-Bantu cases additional evidence for *LONG and reason to believe that it is active in producing some of the effects observed on triggers.

3.3 Summary

- In this section, I presented an articulatory account of nasal place assimilation effects in Zulu.
- The articulatory representations allow us to straightforwardly capture effects like postnasal hardening.
- Inclusion of gestural ALIGN constraints in the system predict that nasal place assimilation can result the glottal gesture of C overlapping N.
- *N̥ and *ɓ̃ in Zulu prevent overlapped structures from surfacing.
- Because ALIGN is high-ranked, the optimal output involves loss of the glottal gesture.

[4] I do not provide a specific means for obtaining 'target durations' here. Such durations could be calculated through measurement of gestures in intervocalic position during careful speech.

4 Bantu Nasal Place Assimilation Typology

- In this section, I will overview a range of effects found across Bantu nasal place assimilation phenomena, focusing on cases of underlying N+C̥.
- I will argue that, as in Zulu, the correct way to treat these phenomena is as a result of the assimilation process.
- I will demonstrate that the system I developed in the previous section for Zulu can straightforwardly account for the cross-Bantu patterns.

4.1 N+C̥ solutions

- In Bantu, /N+C̥/⟶NC̥ is a rare process (Kadima 1969).
- While in Zulu, we saw changes resulting from nasal place assimilation being realized on the trigger, across Bantu we find cases both of the target nasal and trigger consonant being affected by the assimilation process.
- As discussed above, any changes beyond the place assimilation itself are unexpected on standard accounts of assimilation.
- Typological surveys offer the following range of outputs to the N+C̥ assimilation process:

(18) from Kadima (1969) & Kerremans (1980)

/N+C̥/ ⟶
(i) C̥
(ii) N̥C̥^{h}
(iii) C̥^{h}
(iv) N̥C̥
(v) N̥C̥'
(vi) NC
(vii) N̥
(viii) N̥^{h}
(ix) N

- While some of these processes, such as postnasal voicing (17vi), denasalization (17i), and loss of the oral consonant (17ix), have been argued to be cases of *NC̥, I will argue that, as in Zulu, all of these phenomena should be treated as a result of the assimilation process.
- As we saw in Zulu, many of the outputs of N+C̥ assimilation do nothing to alleviate *NC̥.

(19) **Kitharaka devoicing of nasal** (wa Mberia 2002; cf. (17iv))
(a) N+pongo ⟶m̥pongo proper name
(b) N+tɔŋgɔ ⟶n̥tɔŋgɔ place name
(c) N+kɔrɔ ⟶ŋ̊kɔrɔ 'heart'

(20) **Kongo postnasal aspiration**[5] (Meinhof 1932; cf. (17ii))
(a) N+pele ⟶mp^{h}ele 'eruption' (cl.9)
(b) N+tulu ⟶nt^{h}ulu 'breast' (cl. 9)
(c) N+kaka ⟶ŋk^{h}aka 'elder relative' (cl. 9)

- Furthermore, Zulu also showed that NC̥ problems only seemed to arise in cases of assimilation; non-assimilating NC̥ cases were unproblematic and unaltered.
- While in some Bantu languages, all nasals undergo assimilation, languages which distinguish between assimilating and non-assimilating nasals follow a similar pattern to Zulu:

(21) **Swahili Assimilating nasals: Classes 9 &10** (Meinhof 1932)
N+...
a. **m**-buzi 'goat'
b. **n**-dege 'bird'
c. **ŋ**-guo 'cloth'
d. **ɲ**-oka 'snake'

(22) **Swahili Non-assimilating Nasals: Classes 1 & 3** (Katamba 1993)
m+...
a. **m**-buyu 'baobab tree'
b. **m**-dudu 'insect'
c. **m**-geni 'guest'

- In these languages, only assimilating NC's exhibit changes:

(23) **Swahili N+C̥** (Meinhof 1932)
a. N + tumbili ⟶t^{h}umbili 'a kind of monkey' cl. 9
b. m + toto ⟶mtoto 'child' cl. 1

- Finally, evidence from numerous Bantu languages shows that the oral closure in assimilating NC sequences is quite short, similar to the Zulu cases (Walli-Sagey 1986, Maddieson & Ladefoged 1993, Huffman & Hinnebusch 1998)
- These cases suggest that *LONG is active throughout Bantu.

4.2 Summary

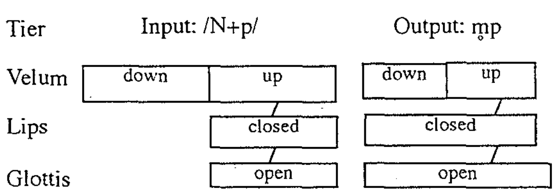
- Bantu shows a range of nasal place assimilation effects to N+C̥ sequences.
- The outputs for N+C̥ sequences often violate *NC̥.
- Assimilated NC sequences are often demonstrated to be short in duration.

[5] Ao 1991 and Carter 1984 note that in some dialects of Kongo, N+C̥ leads to devoicing of the nasal: N+kosi ⟶ŋ̊kosi (lion).

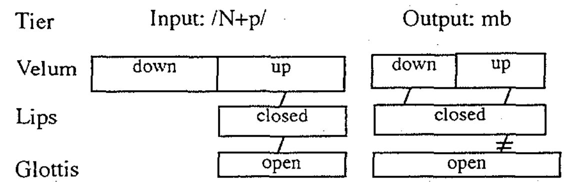
- These effects can be shown in some languages to be explicitly connected to the assimilation process.
- While standard assumptions about place assimilation do not predict that N+C̥ sequences would present a problem, it seems like the assimilation process needs to account for the range of N+C̥ effects.

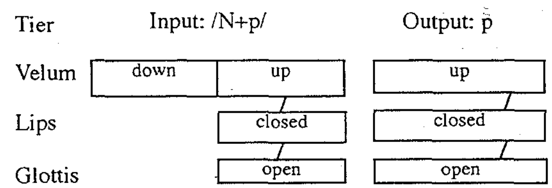
5 Applying the Zulu account across Bantu

- My account for Zulu in section 3 contained 4 main components, beyond the basic constraints for assimilation:
  1. ALIGN:
     - ALIGNL: Align left edges of glottal and oral closure. (as in Zulu)
     - ALIGNR: Align right edges of glottal and oral closure. (relevant for postnasal aspiration)
  2. MARKEDNESS:
     - *N̥ will play the driving role again.
  3. FAITHFULNESS:
     - MAX(+nas) is again important.
     - MAX(-voice) will also play a role.
  4. *LONG: here it will play a crucial role in cases of postnasal aspiration (and perhaps in understanding why N+C̥ ⟶NC̥ is rare).
- My account predicts that place assimilation of N to a following voiceless C̥ will always be problematic: because of the presence of ALIGN in the system, the voicelessness of the C̥ should spread onto N along with place.
- Intuitively, the system allows for 3 basic ways of dealing with the overlap:
  - Accept markedness violations and leave everything intact, allowing the overlapped structure to surface:

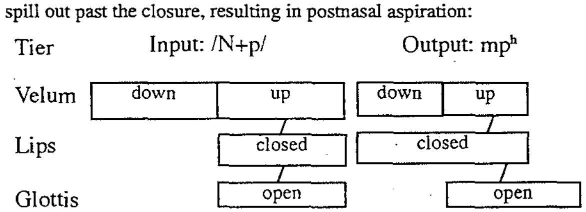


- Avoid markedness at the expense of faithfulness by deleting offending gestures:

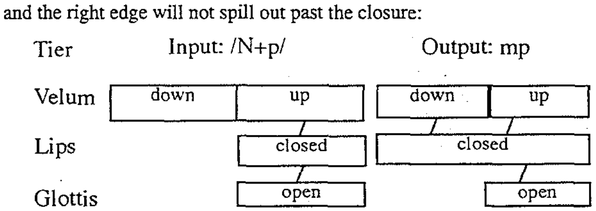




- Avoid markedness at the expense of alignment, by shifting the alignment of the glottal opening gesture so that it doesn't overlap the nasal.
  - ∗ Subcase #1: If *LONG is active, the shifting will cause the glottal opening gesture to spill out past the closure, resulting in postnasal aspiration:



  - ∗ Subcase #2: If *LONG is not active, then the oral closure gesture should be able to lengthen enough so that only the left edge of the glottal opening is misaligned, and the right edge will not spill out past the closure:



- Case #1:

(24) **Kitharaka devoicing of nasal** (wa Mberia 2002)
(a) N+pongo ⟶m̥pongo proper name
(b) N+tɔŋgɔ ⟶n̥tɔŋgɔ place name
(c) N+kɔrɔ ⟶ŋ̊kɔrɔ 'heart'

(25) ALIGNL, ALIGNR, MAX(-voice), MAX(+nas), *Long[6] ≫ *N̥, MAX(+voice)

/N+p/	ALL	AL R	MAX(-voic)	MAX(+nas)	*LONG	*N̥	MAX(+voice)
☞ m̥p						*	*
mp	*!				*		
mpʰ	*!	*					
p				*!			*
mb			*!				

- Case #2:

(26) **Yao Postnasal Voicing** (Hyman 2003)
(a) N+peleka ⟶mbeleka 'send me'
(b) N+tuma ⟶nduma 'order me'
(c) N+kweela ⟶ŋgweela 'climb on me'

(27) ALIGNL, ALIGNR, MAX(+voice), MAX(+nas), *Long *N̥ ≫ MAX(-voice)

/N+p/	ALL	AL R	MAX(+voic)	MAX(+nas)	*LONG	*N̥	MAX(-voice)
☞ mb							*
m̥p			*!			*	
mpʰ	*!	*					
p			*!	*			
mp	*!				*		

(28) **Denasalization**: Lunda, Benga, Luhya, Mbagani, and others (Kadima 1969)
ALIGNL, ALIGNR, MAX(-voice), *Long *N̥ ≫ MAX(-voice) MAX(+nas),

/N+p/	ALL	AL R	MAX(-voic)	*LONG	*N̥	MAX(+voice)	MAX(+nas)
☞ p						*	*
m̥p			*!		*		
mpʰ	*!	*					
mb			*!				
mp	*!			*			

- Case # 3

[6] *LONG doesn't really do much work here or in some other cases. However, if we posit it in the system, then in cases were it's not crucial to the output my system predicts that we should always get a short cluster: the long winning candidates will simply violate *LONG in addition to the constraints that the short winner violates.

(29) **Kongo postnasal aspiration** (Meinhof 1932)
(a) N+pele ⟶mpʰele 'eruption' (cl.9)
(b) N+tulu ⟶ntʰulu 'breast' (cl. 9)
(c) N+kaka ⟶ŋkʰaka 'elder relative' (cl. 9)

(30) MAX(-voice), *Long *N̥ MAX(-voice) MAX(+nas) ≫ ALIGNL, ALIGNR

/N+p/	MAX(-voic)	*LONG	*N̥	MAX(+voice)	MAX(+nas)	ALL	AL R
☞ mpʰ						*	*
m̥p			*!	*			
p				*!	*		
mb	*!						
mp		*!				*	

(31) **No Change**: Fipa, Ndonga, and others (Kerremans 1980)
MAX(-voice), *Long *N̥ MAX(-voice) MAX(+nas) ≫ ALIGNL, ALIGNR

/N+p/	MAX(-voic)	AL R	*N̥	MAX(+voice)	MAX(+nas)	ALL	*LONG
☞ mp						*	*
m̥p			*!	*			
p				*!	*		
mb	*!						
mpʰ		*!				*	

- With *LONG in the system, short candidates should be winning in all cases but (31).
- The predictions of *LONG are especially important in the Case #3 examples: the totally unchanged case should always be long, while the postaspiration case should always be short.
- I have no durational information on unchanged cases at this point.
- Initial evidence on the postaspiration cases:
  - Postaspirated assimilated NC is short in Pokomo (Huffman and Hinnebusch 1998).
  - Twana aspirated stops that have undergone nasal place assimilation remain aspirated, but with a shorter closure and longer VOT (Gouskova, p.c.).

5.1 Summary

- Bantu N+Ç assimilating cases are widely problematic.
- Nonassimilating N+Ç does not present problems.
- Using the simple components of the analysis I developed for Zulu, I have shown how many of the major strategies for producing assimilated N+Ç are predicted on my account.

5.2 The Remaining Cases

- Several patterns from the Bantu typology did not emerge from my constraint typology.
- Some of these cases have been characterized as multi-step historical processes. I will put these aside.
- Some of the remaining ones, such as the cases where the oral stop is lost, I believe can be analyzed with a few more assumptions about how nasals in short clusters operate.
- Future work will detail the analysis of these cases.

6 Conclusion

- In this talk, I have demonstrated that nasal place assimilation phenomena in Bantu produce unexpected effects on a theory of assimilation in which only the place of the trigger is implicated.
- I provided an overview of the process in Zulu, showing that these effects are directly tied to assimilation, and independent from general NC phonotactics in the langauge.
- I argued for a gestural analysis of place where ALIGN constraints between the oral constriction and the glottal gesture force overlap between the glottal gesture and the assimilating nasal
- I then showed how this account can be extended to capture similar effects that occur in assimilating NC across Bantu.
- For future research:
  - Developing the account for the appearance of ejection in Zulu nasal place assimilation.
  - Exploring the nature and role of *LONG across Bantu.
  - Developing the remaining aspects of the typological account.

7 References

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8 Appendix A: Postnasal Hardening

Several accounts of postnasal hardening appeal to the inability of place to spread separately from stricture (cf. Padgett 1994).

In Articulatory Phonology, this comes for free: oral closure gestures combine place and degree of closure inseparably.

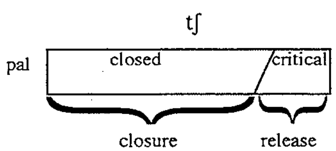
Full assimilation of the oral closure gesture in NF clusters would yield
iziN + ʃangane ⟶iziʃ̃ʃangane.

*ṽ: no nasalized fricatives (see Cohn 1993 for reasons why such segments are cross-linguistically dispreferred).

To satisfy *ṽ in place assimilation, the closure of the place-defining gesture in a fricative must change from critical to closed in order to overlap N.

Here I adapt the notion of affricates as composed of a 'closure' and 'relase' portion from Steriade (1993) to articulatory phonology.

- An affricate can be represented as comprising a single oral closure gesture whose stricture changes from closed to critical at the point of release:



ASSIM, MAX(+nas), *ṽ, MAX(+cont) ≫ DEP(-cont)

/Nf/ — Velum: down | up; Lip: critical; teeth		ASSIM	MAX(vel)	*s̃	MAX(constr)	DEP(clos)
Velum: down | up; Lips: closed | critical; teeth	mf	*!				
Velum: up; Lips: critical; teeth	ff		*!			
Velum: down | up; Lips: critical; teeth	f̃f			*!		
Velum: down | up; Lips: closed	mp				*!	*
☞ Velum: down | up; Lips: closed | crit	mpf					*

9 Appendix B: Ejectives in Zulu

If we could understand why the NC' assimilation cases are unproblematic, we could predict why the aspirates would neutralize to ejectives:

- Voiceless consonants in postnasal position are in danger of being realized as voiced (Hayes and Stivers 1995).
- Simply removing the glottal opening gesture in the Zulu N+Ç^h cases would endanger the perception of voicelessness.
- An increased VOT can help preserve voicing contrasts (Hayes and Stivers 1995, Fallon 2002, Flemming 2008).

Reasons to believe Zulu ejectives are not typical:

- Zulu ejectives are described as being 'weak' (Ladefoged and Maddieson 1996, Fallon 2002...)
- Zulu ejectives have a very short VOT, unlike aspirates in Zulu, which have a long VOT.
- Realization of ejectives in post-assimilating-nasal contexts can be variable; sometimes voicing appears during closure and VOT is negligible.

10 Appendix C: *LONG

In a pilot study, a Zulu speaker was recorded producing C, unassimilated mC, and assimilated NC clusters in intervocalic position in minimal pair words. All tokens were trisyllabic, with clusters occurring between the first and second syllable nuclei. Tokens were recorded in the carrier phrase *Angiboni X encwadini* ("I didn't see X in the book").'

Results indicate a shorter duration of NC compared to mC. In contrast, NC and C exhibited similar durations, within a standard deviation of each other:

	/um+p^h/ [mp^h]	/iN+p^h/ [mp']	/p^h/ [p^h]
Duration	427ms	270ms	237ms
St Dev	36ms	38ms	34ms
n=	15	16	14

Figure 3

In cases with m- or f- initial stems, a similar pattern is observed, with assimilating NC clusters being of similar duration to C, while non-assimilating mC is significantly longer:

	/um+m/ [m]	**/iN+m/ [m]**	**/m/ [m]**
Duration	335ms	**169ms**	**166ms**

Figure 4

	/um+f/ [mf]	**/iN+f/ [mpf']**	/f/ [f]	/um+mf/ [mf']	**/iN+mf/ [mf']**	**/mf/ [mf']**
Duration	359ms	**230ms**	181ms	427ms	**210ms**	**221ms**

Figure 5

Non-/Iterativity in Vata ATR Harmony

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UMMM 4 — November 1st, 2009

1 Introduction

Vata (Kru, Ivory Coast) has two ATR harmony processes with distinct phonological behavior.

i. **Within words** (Domain harmony) ATR harmony is:

   a. Not directionally restricted.
   b. Unblocked.
   c. Obligatory.

ii. **Across word boundaries** (Juncture harmony) ATR harmony is:

   a. Directional (Right to Left only).
   b. Blocked by certain height configurations.
   c. Optional.
   d. Iterative across sequences of monosyllabic words, but non-iterative into a polysyllabic word.

One harmony process (i) is domain-bounded, while the other (ii) occurs at domain junctures.

Domain bounding is a typical characteristic of harmony processes. It has been formalized with domain-specific rules (Selkirk, 1980; Nespor and Vogel, 1986) and more recently within Optimality Theory (OT)(Prince and Smolensky, 1993/2004) with alignment constraints on feature domains (Archangeli and Pulleyblank, 1994; Cole and Kisseberth, 1994, and others).

Because of (iid), Juncture harmony creates disharmonic words. This creates problems for current accounts of domain bounding within OT; both the non-iterativity itself, and the fact that juncture spreading is more restricted than domain spreading (but appears to violate the constraint compelling it) require explanation.

Based on these facts in Vata, I argue that:

a. Constraints on feature spreading that refer to domains refer specifically to the domain where the feature is headed.
b. Spreading is evaluated one link at a time, as in Harmonic Serialism (HS).

Roadmap of the talk:

- Section 2: the facts on the ground in Vata.
- Section 3: the analysis of iterativity and restrictedness.
- Section 4: some typological predictions of the analysis.
- Appendices: discussion of height restrictions (A) and optionality (B).

2 The Facts

Vata has a 10-vowel system, with ATR contrastive for all vowels:[1]

(1) Vata Vowel Inventory

   a. i, e, u, o, ʌ (ATR)
   b. ɪ, ɛ, ɷ, ɔ, a

+ATR is the active feature value; I'll assume privative ATR.

2.1 Within Words

Native monomorphemic words are always harmonic:

(2) Harmonic Roots

a.	lɛtɛ	'iron'
b.	gɔlɷ	'dugout'
c.	menʌ	'nose'
d.	bido	'wash'

In non-monomorphemic words, suffixes bear the ATR value of the root:[2]

(3) Instrumental/locative: lɛ ~ le

a.	kla	'sieze'	klalɛ	(*klale)	'sieze with'
b.	ŋɔŋɷ	'sleep'	ŋɔŋɷlɛ	(*ŋɔŋɷle)	'sleep in'
c.	pi	'prepare'	pile	(*pilɛ)	'prepare with'
d.	su	'crush'	sule	(*sulɛ)	'crush with'

Harmony within words is unblocked, not directionally restricted, and obligatory.

[1] All data are from Kaye (1982). Tone markings are not represented here; they do not play a role in the processes under discussion.

[2] There are no prefixes. Could spreading be Left-to-Right, with ATR licensed only in the initial syllable? In a small set of loanwords, /a/ is opaque. In these words, ATR is not positionally restricted (laluku, 'machete'; sika, 'gold').

2.2 Across Word Boundaries

ATR harmony also occurs optionally across word boundaries.

(4) *n la yo*
I called child
'I called a child'

a. n la yo
b. n lʌ yo

Juncture harmony is directionally restricted (Right to Left only):

(5) *n no kɔ*
I hear man
'I hear a man'

a. n no kɔ
b. *n no ko — *cf. (4b)*

Across a sequence of monosyllabic words, Juncture harmony may optionally iterate:[3]

(6) *ɔ ka za pi*
3SG FUT food cook
'He will cook food'

a. ɔ ka za pi
b. ɔ ka zʌ pi
c. ɔ kʌ zʌ pi
d. o kʌ zʌ pi

Into a polysyllabic word, however, Juncture harmony does not iterate:

(7) *ɔ nɪ saka pi*
3SG NEG rice cook
'He didn't cook rice'

a. ɔ nɪ saka pi
b. ɔ nɪ sakʌ pi
c. * ɔ nɪ sʌkʌ pi

[3]See Appendix B for a discussion of how each of these options is possible.

2.3 The Problem

If domain-referencing constraints motivating vowel harmony apply within all domains of the relevant type, the non-iterativity in (7) is surprising.

Since ALIGN must dominate IDENT for normal word-internal spreading, we expect it to force propagation of ATR through the word we've spread into:

(8)

saka pi	Juncture Constraint	ALIGN-L(ATR, WORD)	ID(ATR)
a. saka pi	1		
b. sakʌ pi		1	1
c. ☞ * sʌkʌ pi			2

How can we block iteration of harmony in cases like *sakʌ pi*, but allow it for word-internal harmony and across sequences of monosyllabic words?

If the constraint compelling Juncture harmony can induce violations of ALIGN, it must dominate it. But we would expect any constraints blocking Juncture harmony to also apply to word-internal harmony, by transitivity of ranking. How can we resolve this paradox?

3 Analysis

Following rule-based prosodic phonology (Selkirk, 1980; Nespor and Vogel, 1986), I split the constraint motivating harmony — a modified version of McCarthy (2009)'s SHARE constraint — into a domain-specific version (9) and a juncture-specific version (10).

(9) SHARE[ATR]-DOMAIN$_{(PWd)}$: Assign one violation mark for every pair of segments s_i and s_j that are not linked to the same token of [F], where s_i and s_j, are contained within the same Prosodic Word and s_i is [F]'s head.

Unlike ALIGN and other domain-referencing constraints compelling harmony, SHARE-D doesn't refer to (and apply within) just any domain of the relevant type. Rather, SHARE-D is sensitive to the location of the feature's head.

How do we know where the head is? I'll follow Smolensky (2006, and others) in assuming that the head of [F] is the segment that bears [F] in the underlying representation (though this is not the only way of determining headedness that is compatible with this analysis).

(10) SHARE[ATR]-JUNCTURE$_{(PWd,IP)}$: Assign one violation mark for every pair of adjacent segments s_i and s_j that are not linked to the same token of [F], where s_i and

s_j belong to different Prosodic Words and are contained within the same Intonational Phrase as [F]'s head.

SHARE-J is bounded within a larger domain, and is sensitive to the location of the head with respect to that domain bounding. However, it applies to every juncture of the relevant type within that larger specific domain.

This analysis is situated within Harmonic Serialism (HS), a derivational variant of OT with independent typological advantages (McCarthy, 2002, 2007, 2008b,a; Pater, 2008; Pruitt, 2008; Elfner, 2009; McCarthy, 2009; Kimper, To appear).

In HS, a derivation proceeds as follows:

a. GEN is restricted to producing candidates that differ from the input by a single instance of a single change.

b. This (finite) candidate set is evaluated by the language's constraint hierarchy at EVAL and, like in parallel OT, an optimal candidate is chosen.

c. Instead of exiting as the surface form, the optimal candidate is sent back to GEN — this form serves as the new input.

d. A new candidate set is generated, again differing from the (new) input by one single change, and EVAL chooses an optimum from this candidate set.

e. This loop continues until the single changes produced by GEN are no longer harmonically improving. The derivation *converges* when the input is chosen as optimal.

Because of this, each step in the derivation must be *gradual* and *harmonically improving*.

3.1 Non-Iterativity

In Vata, SHARE-D ≫ IDENT(ATR). This results in word-internal harmony:[4]

(11)

pilɛ	SHARE-D	IDENT(ATR)
a. pilɛ	W_1	L
b. ☞ pile		1

Juncture harmony is the result of SHARE-J ≫ IDENT(ATR). Because SHARE-D is violated only in the domain where the feature is headed, it's not violated by Juncture spreading.[5] We don't iterate into polysyllabic words because no constraint compels us to do so.

[4]For root control, positional faithfulness can eliminate underlying ATR from affixes.

[5]Because ATR is privative, there's no violation for the failure to be harmonic to -ATR. See (McCarthy, 2009) for some other desirable consequences of privativity in autosegmental spreading.

(12) **Step 1**

saka pi	SHARE-D	SHARE-J	IDENT(ATR)
a. saka pi		W_1	L
b. ☞ sakʌ pi			1

Step 2 *Convergence*

sakʌ pi	SHARE-D	SHARE-J	IDENT(ATR)
a. ☞ sakʌ pi			1
b. sʌkʌ pi			W_2

With a sequence of words, Juncture harmony can iterate if they are monosyllabic. This is because SHARE-J compels us to spread across each juncture:

(13) **Step 1**

ɔ ka za pi	SHARE-D	SHARE-J	IDENT(ATR)
a. ɔ ka za pi		W_3	L
b. ☞ ɔ ka zʌ pi		2	1

Step 2

ɔ ka zʌ pi	SHARE-D	SHARE-J	IDENT(ATR)
a. ɔ ka zʌ pi		2	L
b. ☞ ɔ kʌ zʌ pi		1	1

Step 3

ɔ kʌ zʌ pi	SHARE-D	SHARE-J	IDENT(ATR)
a. ɔ kʌ zʌ pi		W_1	L
b. ☞ o kʌ zʌ pi			1

Step 4 *Convergence*

o kʌ zʌ pi	SHARE-D	SHARE-J	IDENT(ATR)
a. ☞ o kʌ zʌ pi			

In (12), we saw a polysyllabic example with only one Juncture to worry about. However, with polysyllabic words, we can't iterate even when there are remaining SHARE-J violations:

(14) **Step 1**

nɪ saka pi	SHARE-D	SHARE-J	IDENT(ATR)
a. nɪ saka pi		W_2	L
b. ☞ nɪ sakʌ pi		1	1

Step 2 *Convergence*

nɪ sakʌ pi	SHARE-D	SHARE-J	IDENT(ATR)
a. ☞ nɪ sakʌ pi		1	
b. nɪ sʌkʌ pi		1	W_2

SHARE-J is unable to compel spreading through the polysyllabic word because the intermediate step required is not harmonically improving — spreading within that word is preferred by neither SHARE-J nor IDENT(ATR), and is therefore harmonically bounded.

Compare this with the situation in Parallel OT:

(15)

nɪ saka pi	SHARE-D	SHARE-J	IDENT(ATR)
a. nɪ saka pi		W_2	L
b. nɪ sakʌ pi		W_1	L_1
c. nɪ sʌkʌ pi		W_1	L_2
d. ☞ * ni sʌkʌ pi			3

If we evaluate all our changes in parallel, we are expected to spread through the polysyllabic word in order to fully satisfy SHARE-J.

Non-iterativity in Vata results from a combination of head-sensitive domain-specificity and the gradual harmonic improvement required by Harmonic Serialism. Iteration of Juncture spreading is blocked only in polysyllabic words, and remains iterative across sequences of monosyllabic words.

3.2 Restrictedness

Because SHARE-D is not violated by Juncture spreading, the fact that Juncture spreading is more restricted is no longer a problem.

In Vata, Juncture harmony occurs only Right to Left, while within-word harmony is not directionally restricted. Directional blocking can be achieved with McCarthy (2009)'s INITIAL(F) and FINAL(F) constraints:

(16) INITIAL(ATR): ("don't spread left")
Let input F tier = $f_1 1 f_2 \ldots f_m$.
Let input segmental tier = $s_1 s_2 \ldots s_n$.
Let output F tier = $f_1 f_2 \ldots f_o$.
Let output segmental tier = $s_1 s_2 \ldots s_p$.
Assign one violation mark for every s_i ? s_j, where:
$f_k \Re f_l$,
f_k is associated with s_i, and there is no s_k that precedes s_i and is also associated with f_k, and
f_l is associated with s_j, and there is some s_y that precedes s_j and is also associated with f_l.

(17) FINAL(ATR): ("don't spread right")
Let input F tier = $f_1 f_2 \ldots f_m$.
Let input segmental tier = $s_1 s_2 \ldots s_n$.
Let output F tier = $f_1 f_2 \ldots f_o$.
Let output segmental tier = $s_1 s_2 \ldots s_p$.
Assign one violation mark for every s_i ? s_j, where:
$f_k \Re f_l$,
f_k is associated with s_i, and there is no s_k that follows s_i and is also associated with f_k, and
f_l is associated with s_j, and there is some s_y that follows s_j and is also associated with f_l.

Ranking SHARE-D ≫ SHARE-J, and ranking a directional blocking constraint between them, produces directionality in Juncture spreading, but no directional restrictions in domain-internal spreading.

Left-to-Right Juncture spreading does not occur:

(18)

no kɔ	SHARE-D	FINAL	SHARE-J	IDENT(ATR)	INITIAL
a. ☞ no kɔ			1		
b. no ko		W_1	L	W_1	

Right-to-Left Juncture spreading does occur:

(19)

la yo	SHARE-D	FINAL	SHARE-J	IDENT(ATR)	INITIAL
a. la yo			W_1	L	L
b. ☞ lʌ ko				1	1

Left-to-Right domain-internal spreading occurs, unaffected:

(20)

pilɛ	SHARE-D	FINAL	SHARE-J	IDENT(ATR)	INITIAL
a. pilɛ	W_1	L		L	
b. ☞ pile		1		1	

Ranking directional blocking constraints below SHARE-D but above SHARE-J restricts juncture spreading while leaving domain-internal spreading unrestricted.

4 Typology

In Vata, juncture spreading is (a) non-iterative into polysyllabic words, and (b) subject to more severe restrictions than domain-internal spreading. Must this always be the case?

4.1 Non-iterativity

Under this analysis, juncture spreading is always predicted to be non-iterative. Because the SHARE-J constraint is violated only at domain junctures, and SHARE-D is violated only in the feature's original domain, nothing will compel iterativity.

However, there are languages which have iterative spreading processes which cross word boundaries — for example, Kinande (Mutaka, 1995) and Somali (Saeed, 1993).

This is predicted to be possible if what is compelling spreading across word boundaries is not SHARE-J but rather a SHARE-D constraint bounded to a phonological phrase rather than to a word.

Unlike SHARE-J, SHARE-D_{Phrase} will behave iteratively, but may be ranked below SHARE-D_{PWd} and therefore potentially subject to additional restrictions.

4.2 Restrictedness

If SHARE-D ≫ SHARE-J, blocking constraints can rank between them and impose more severe restrictions on Juncture spreading (as in Vata). However if SHARE-J ≫ SHARE-D, the opposite is predicted to be true — juncture spreading may *less* restricted than domain-internal spreading.

For example, in Shona, (Left-to-Right) tone spreading occurs only across morpheme boundaries (a) not morpheme internally (b). It doesn't propagate into the next morpheme (c), but will propagate along a series of monosyllabic morphemes (d) (Myers, 1997).

(Underline represents underlying host of tone.)

(21) a. í̱ sádza [COP porridge, '(It) is porridge']
cf. sadza ['porridge']
b. bá̱zi ['branch']
*bází
c. ndi-ngá̱ vérеng-e [1SG-potential-read-fv, 'I could read']
d. tí̱-té̱ng-és-é [1PL-SUBJ-buy-CAUS-fv, 'We should sell']

In Shona, domain-internal spreading is in fact so restricted that it doesn't occur. A ranking of SHARE-J(H) ≫ FAITHFULNESS ≫ SHARE-D(H) produces the right results.

Another likely candidate for more permissive juncture spreading is Oroqen (Zhang, 1995), where rounding harmony within a stem is maximally bimoraic, while rounding harmony at the juncture between a stem and a suffix is not subject to such restrictions.

5 Conclusion

In Vata, ATR harmony within words is unrestricted, but spreading across word boundaries is directional, optional, and non-iterative into polysyllables. Because of this non-iterativity, it creates disharmonic words.

Domain bounding that is sensitive to the location of a feature's head, combined with gradual spreading in HS, allow an account of the facts in Vata.

? - does this go to prev. step, or all the way back

Juncture spreading is non-iterative into polysyllabic words because (a) the domain-specific spreading constraint is not violated by disharmony outside a feature's original domain, and (b) spreading through a polysyllabic word to get to a juncture on the other side is not gradually harmonically improving.

Because juncture spreading does not violate the constraint motivating domain-internal spreading, it does not need to outrank it, and stricter restrictions can be imposed on juncture spreading without creating a ranking paradox.

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Appendix A: Height Restrictions and Locality

Juncture harmony is also subject to height restrictions. High vowels can spread onto both high and non-high vowels, but non-high vowels can only spread onto other non-high vowels.

(22) a. **Non-High ← High**

n *sla* *sli*
1SG build house-PL
'I build houses'
n slʌ **sli**

b. **High ← High**

n *nʊ* *kpi*
1SG make-PST stool-PL
'I made stools'
n **nu kpi**

c. **Non-High ← Non-High**

n *dla* *voyo*
1SG kill dog
'I kill a dog'
n dlʌ v**o**y**o**

d. * **High ← Non-High**

n *nʊ* *kpʌ*
1SG make-PST stool
'I made a stool'
* n **nu** kpʌ

These conditions on targets and triggers are *local* — the acceptability of the height configuration is based on the height of the local trigger, regardless of the height of the original initiator of spreading:

(23) ɔnɪ za p**i** ∼ ɔnɪ zʌ p**i** (*ɔn**i** zʌ p**i**)

Something similar is found in Yakut (Krueger, 1962), where rounding harmony is blocked if the local trigger is high and the local target is non-high.

Height restrictions in Vata and Yakut seem to require reference to *local* triggers. But domain bounding in Vata seems to require reference to a *global* trigger, the "head".

Height harmony in Jingulu (Pensalfini, 2002) also seems to require a global trigger — high vowels originating in a suffix trigger height harmony that propagates throughout a root, but high vowels originating in a root do not spread:

(24) a. bardarba → birdirbi-rni 'younger brother / younger sister'
b. ngarrabaja→ ngirribiji-wurru-nu 'dog / dog (f)'
c. mamambiyaka (*mimibiyaka) 'soft'
d. ngamurla (*ngumurla) 'big'

It seems clear that we need both local and global triggers — even within the same language, as in Vata.

Open questions: What phenomena require local triggers, and what phenomena require global triggers? How can we formally account for these relationships?

Appendix B: Iterativity and Variation

In sequences of monosyllabic words, ATR harmony in Vata optionally iterates:

(25) *ɔ* *ka* *za* *pi*
3SG FUT food cook
'He will cook food'

a. ɔ ka za p**i**
b. ɔ ka zʌ p**i**
c. ɔ kʌ zʌ p**i**
d. **o** kʌ zʌ p**i**

Each of the variants in (25a-d) is attested — this is an example of *local optionality* (Riggle and Wilson, 2005).

If we implement a multiple-rankings theory of variation like (Anttila, 1997)'s Partially Ordered Constraints in Parallel OT, this is a problem — either we won't spread across junctures (25a) or we'll spread across all the junctures (25d), but only spreading part of the way (25b-c) is harmonically bounded.

In HS, this is not a problem (Kimper, To appear). Because we undergo multiple passes through EVAL, we have multiple chances to select a total order of partially ordered constraints — with variably ranked constraints, the ranking can change at each step of the derivation.

For example, to derive (6c):

(26) **Step 1**

ɔ ka za pi	Share-D	Share-J	Ident(ATR)
a. ɔ ka za pi		W_3	L
b. ☞ ɔ ka zʌ pi		2	1

Step 2

ɔ ka zʌ pi	Share-D	Share-J	Ident(ATR)
a. ɔ ka zʌ pi		2	L
b. ☞ ɔ kʌ zʌ pi		1	1

Step 3 *Convergence*

ɔ kʌ zʌ pi	Share-D	Ident(ATR)	Share-J
a. ☞ ɔ kʌ zʌ pi			1
b. o kʌ zʌ pi		W_1	L

At each step with a ranking of Share-J ≫ Ident(ATR), we will continue to spread. On a step with a ranking of Ident(ATR) ≫ Share-J, we won't spread — the input will be chosen as the output, and we'll converge.

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Metathesis as Asymmetric Perceptual Realignment

Peter Graff[1] and Gregory Scontras[2]

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2: Harvard Linguistics

Introduction

- CC-Metathesis typology is asymmetric.
- We provide evidence that this asymmetry follows from a perceptual bias optimizing the placement of phonetic cues. (Hume 2001, Steriade 2001)
- We place our study in the wider context of studies on perceptual illusions, where perceptual faithfulness is sacrificed for phonological contrast. (Berent et al. 2007)

Introduction

- Markedness constraints interfere with the mapping of the auditory percept onto the surface representation. (Smolensky 1996)
- Hypothesis:
  In perception, markedness constraints penalizing stops in pre-consonantal position outrank faithfulness constraints preserving linear order.

Typology of CC-Metathesis

- Types of metathesis we ***often*** find (Hume, 2000)

VksV → VskV
#ksV → #skV
Vsk# → Vks#

__Old English__ (Indo-European/Germanic; fiksas~fiskas),
__Cebuano__ (Austronesian/Central Philippine; putus~pustun),
__Modern Hebrew__ (Afro-Asiatic/Semitic; hi-t-Samer~hiStamer),
__Ayacucho Quechua__ (Quechuan; tapsi ~ taspi),
__Udi__ (Lezgian; tadesun ~ tast'un)

Typology of CC-Metathesis

- Types of metathesis we ***hardly*** find (Hume, 2000)

VksV → VskV	**VskV → VksV**
#ksV → #skV	**#skV → #ksV**
Vsk# → Vks#	**Vks# → Vsk#**

Typology of CC-Metathesis

- The same holds for stop-nasal clusters.

VdnV → VndV	**VndV → VdnV**

__Hua__ (Papuan/Trans-New Guinea; aigmeroga~aimgeroga),
__Oromo/Sidamo__ (Afro-Asiatic/Cushitic; habnemmo~hambemmo),
__Old Spanish__ (Indo-European/Romance; dadnos~dandos)

Why this Asymmetry?

- Hypothesis:
  People use CC-Metathesis to maximize perceptibility of place contrast in stops.
  (Hume 2001, Steriade 2001)
- In the case of conflicting place cues in CV and VC transitions, people favor CV transitions.
  (Fujimura et al. 1978)

Place Cues in Consonant Clusters

V k s V

V s k V

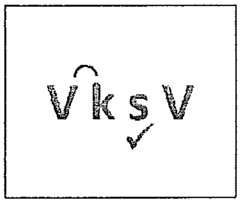
Place Cues in Consonant Clusters

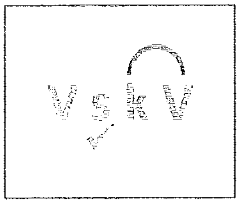
V k s V

V s k V

- Stops ***don't have inherent*** place cues.
- Transitions are much more salient in prevocalic position.

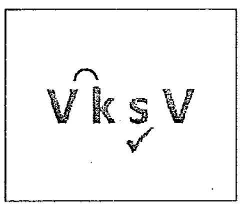
Place Cues in Consonant Clusters

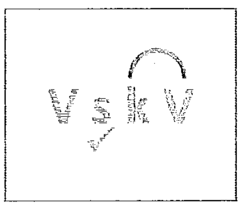




- Fricatives and ***have inherent*** place cues evident from their frequency spectrum.
- Even though they are also relying on transitions...

Place Cues in Consonant Clusters





- Metathesis that places stops in prevocalic position results in a net gain of ***perceptibility of place cues***.

Perceptual Illusions

- English speakers perceive [pnaf] as [pənaf] more than they perceive [ptaf] as [pətaf].
- This is in spite of the fact that they've never heard either. (Berent et al. 2007)

Perceptual Illusions

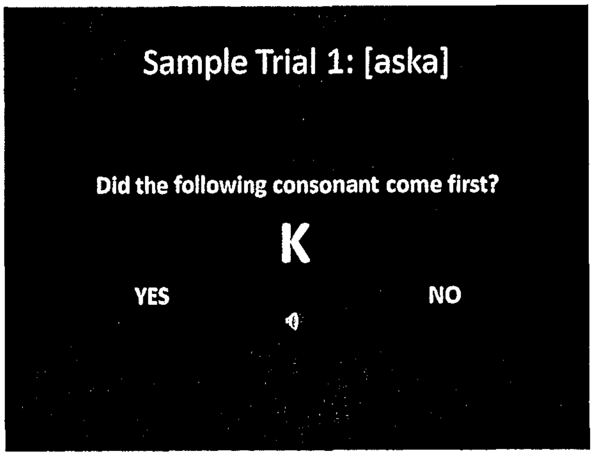
- Hypothesis:
  People are biased against perceiving stops in perceptually suboptimal contexts for place contrast.
- The perceptual system sacrifices accuracy of order perception in favor of perceptibility of place contrast.

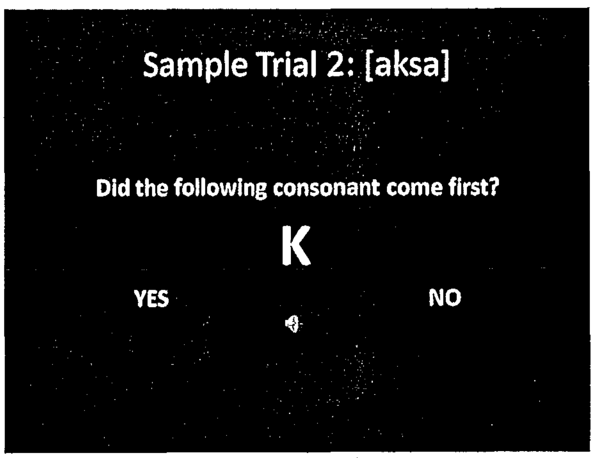
Perceptual Illusions

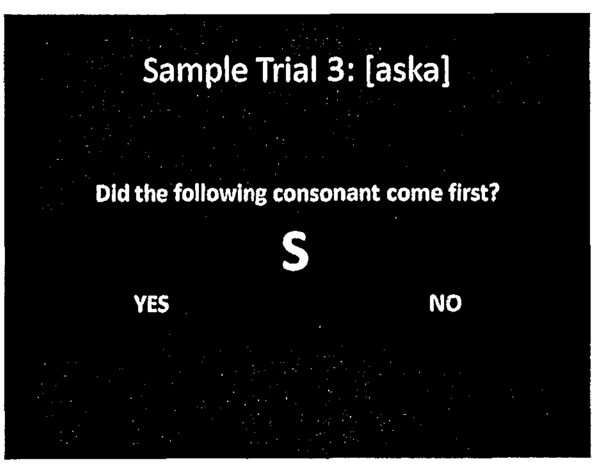
- The current study investigates...
  - whether perception is biased in the direction place cue maximization suggests.
  - whether place cue maximization is a likely explanation for CC-metathesis.

Experiment: Part 1

- ***Subjects***
  24 native speakers of English
- ***Procedure***
  Forced choice task, responses within 1000ms, 200ms ISI


Sample Trial 1: [aska]
Did the following consonant come first?
K
YES
NO


Sample Trial 2: [aksa]
Did the following consonant come first?
K
YES
NO


Sample Trial 3: [aska]
Did the following consonant come first?
S
YES
NO

Sample Trial 4: [aksa]

Did the following consonant come first?

S

YES **NO**

Materials

- *Targets*

[aSTa] [aTSa] [aNTa] [aTNa]

Fricatives	Stops	Nasals
{ʃ, ʒ, s, z, ɣ, x}	{b, d, g, p, t, k}	{m, n, ɲ, ŋ}

- 42 clusters
  (where stops and fricatives always agree in voicing)
- Once in each order = 84 trials +220 distractors

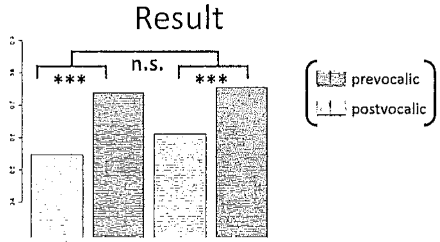
Materials

- Consonants recorded in [aCa] words with initial and final stress
  - ***Produced by native speaker of Austrian German.***
- Spliced together unstressed VC and CV sequences and vice-versa
- Duration standardized
  (vowels 70ms, consonants 90ms)

Question 1:

Are people biased to perceive [aksa] as [aska]?

Result



- ***People mishear [aksa] as [aska] much more than they mishear [aska] as [aksa]***

Faithfulness

- LINEARITY — "No Metathesis"
  (McCarthy and Prince, 1995)
  S_1 *(auditory percept)* is consistent with the precedence structure of S_2 *(surface form)*, and vice versa.
  Let $x, y \in S_1$ and $x', y' \in S_2$.
  If $x\Re x'$ and $y\Re y'$, then
  $x < y$ iff $\neg(y' < x')$.

Markedness

- PERCPLACE(TRANS)
  A stop in the surface form has CV-transitions.

Summary 1

- Bias in favor of the ***output of metathesis.***

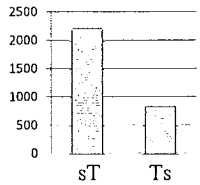
[VksV]	PERCPLACE(TRANS)	LINEARITY
☞ /VskV/		*
/VksV/	*!	

- ***Markedness >> Faithfulness*** in the perception grammar.

Question 2:

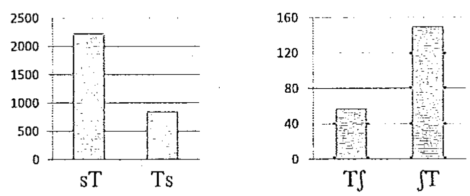
Can this bias be explained by the lexical statistics of English?

Intervocalic Biphone Frequencies



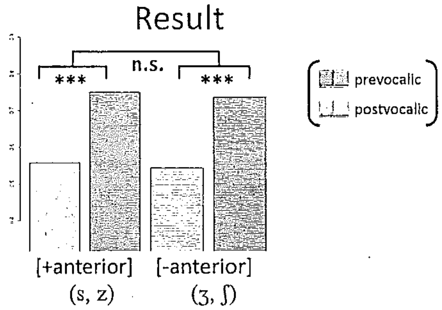
- Overwhelmingly biased towards stops in prevocalic positions. (Baayen et al., 1993)

Intervocalic Biphone Frequencies



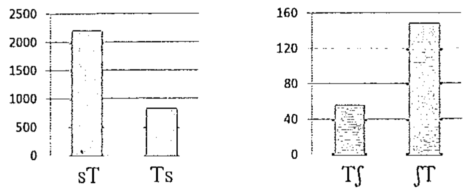
- Overwhelmingly biased towards stops in prevocalic positions. (Baayen et al., 1993)
- ***Except for [-anterior] fricatives (ʃ, ʒ)***

Result



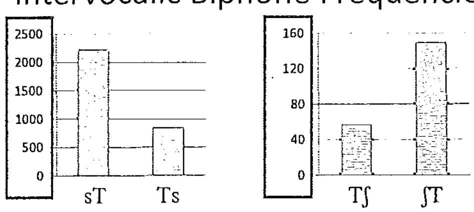
- People show ***the same*** bias for clusters involving [ʃ] and [ʒ]

Intervocalic Biphone Frequencies



- No straightforward statistical explanation in terms of frequencies based in ***phones*** or ***specific natural classes***.

Intervocalic Biphone Frequencies



- No straightforward statistical explanation in terms of frequencies based in ***phones*** or ***specific natural classes***.
- Since [s] and [z] are much more frequent, frequencies based on ***all fricatives*** could still have caused the effect.

Summary 2

- Even though [akʃa] is more frequent than [aʃka], people are biased to perceive [aʃka].
  - ***Native language statistics cannot straightforwardly explain the effect.***
- This bias extends to clusters involving foreign sounds.
  - ***People are also biased to perceive [axka] over [akxa].***

Back to Perceptual Illusions

- People misperceive ST-TS and NT-TN clusters in accordance with linguistic typology and beyond native language statistics.
- Do perceptual illusions target particular linguistic structures or are they a direct function of the availability of phonetic cues?

Place Cues on Stops

- Cues to the place of articulation of stops are most salient in vowel transitions.

Place Cues on Stops

- Cues to the place of articulation of stops are most salient in vowel transitions.
- ***Stop bursts also carry information about the place of articulation of stops.*** (Ohala and Ohala, 1998)

Back to Perceptual Illusions

- Hypothesis:
  If perceptual illusions are a direct function of the availability of phonetic cues, the absence of additional cues should amplify the perceptual bias.

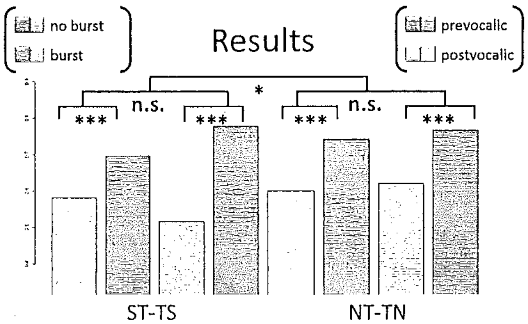
Experiment: Part II

- Half of the subjects (N=12) were exposed to clusters where the stop burst was removed.
- The other half (N=12) heard clusters with a place-appropriate unaspirated prevocalic stop burst added after each stop closure.

Question 4:

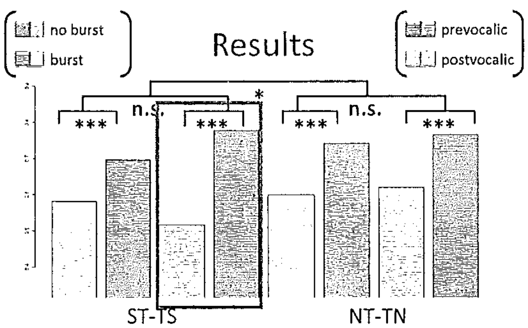
Are people more likely to perceive [aksa] as [aska] when [k] lacks a burst?

Results



- The absence of a burst ***increases*** the bias towards perceiving stops in prevocalic position.
- The absence of a burst ***does not*** lead to an overall increase in confusion.

Results



- This holds ***only for fricatives***.
- Burstless stops in pre-fricative position are most desperately in need of cues!

Markedness

- PERCPLACE(BURST)
  A stop in the underlying representation has a place-appropriate burst

Faithfulness

- DEP-BURST
  Do not insert a burst into the surface representation that is not present in the auditory percept.

Derivation for Stops *with* Burst

[Vk$^{<}$sV]	DEP-BURST	PERCPLACE(TRANS)∧ PERCPLACE(BURST)	PP(TRANS)	FAITH
/Vsk'V/				**!
/Vk'sV/		*!	*	*
☞ /Vsk$^{<}$V/				*
/Vk$^{<}$sV/			*!	

Derivation for Stops *without* Burst

[Vk'sV]	DEP-BURST	PERCPLACE(TRANS)∧ PERCPLACE(BURST)	PP(TRANS)	FAITH
☞ /Vsk'V/				*
/Vk'sV/		*!	*	
/Vsk$^{<}$V/	*!			*
/Vk$^{<}$sV/	*!		*	

- We can explain the ***interaction with burst presence*** when we consider the additive effect of markedness constraints.

Summary 4

- People are more likely to hear [aksa] as [aska] when [k] lacks a stop burst.
  - ***Perceptual Illusions interact directly with the presence of phonetic cues.***
- This effect does not apply to NT-TN clusters
  - ***Nasals have the potential to express transitions and fricatives don't.***

Discussion

- People show a ***perceptual bias*** relative to the ***availability of phonetic cues*** that ***mirrors linguistic typology***.
- Our results support a ***substantively biased*** model of phonology in which speakers' perception is influenced by phonetically driven constraints. (Hayes and Steriade 2004)

Discussion

- Our results indicate that people's perception is biased in favor of maximal perceptibility of cues to ***place of articulation***.
- This is to the detriment of accurately perceiving linear order.

Future Work

- Test initial and final clusters.
- Test the dependence of this bias on the organization of place contrast in a given language.
- Further investigate the nature of and motivation for perceptual illusions.

Thakn you!

UMMM
1 November, 2009

Wug-testing Hebrew denominal verb formation

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Overview

- Strange (phonetically unnatural or morphologically irregular) patterns are often productive
- Hebrew denominal verb formation is an instance of an unusually complex pattern, but one for which there is robust evidence in the lexicon
- Wug-testing denominal verb formation: is the pattern productive?

Productivity of Strange Patterns

1. Strange patterns are often productive

Phonetically unnatural patterns:

- English velar softening (Pierrehumbert, 2006)
- Hungarian vowel harmony (Hayes et. al., to appear)

Morphologically irregular patterns:

- English irregular verbs (Albright and Hayes, 2003)

2. But sometimes not

Phonetically unnatural patterns:

- English vowel shift (Jaeger, 1983)
- Turkish voicing alternations (Becker et. al., to appear)

Morphologically irregular:

- Japanese irregular verbs (Batchelder, 1999)
- Spanish verb paradigms (Albright, in press, Bybee and Pardo, 1981, Shnitzer, 1996)

3. What determines productivity?

- Phonetic naturalness (Hayes et. al., Nevins and Becker)
- Complexity (Moreton)
- Robustness of evidence?
- ???

Hebrew Denominal Verb Formation

4. Semitic Verbal 'Templates'

- Three-consonant 'root' combines with 'template' of {vowel pattern + associated prefixes and suffixes}
- Templates are derivational and inflectional

(1) /gdl/ *'big, tall'*

gadal	'he grew'	godel	'he grows'	yigdol	'he will grow'
gidel	'he raised'	megadel	'he raises'	yegadel	'he will raise'
gadol	(adj.) 'big'				
migdal	(n.) 'tower, turret'				
məgudal	(adj.) 'grown, grown up'				

- Verbs in Hebrew must be exactly long enough to host the vowel pattern (and prefixes and suffixes) without containing illegal syllable margins.
- This means they are bisyllabic unless the template contains a prefix or suffix which forces more syllables (me-, yi-, ye-)

5. Monosyllabic Nouns Becoming Verbs

- Nouns need not follow any particular template, and may be of any size
- The problem: how to associate too many or too few consonants with the verbal template
- The focus here: Too few consonants, nouns with the form CVC
- Denominal verbs appear in the paradigm (binyan) known as *piʕel*, with the vowel pattern (in the past tense) {ie}

6. Data from the Hebrew lexicon

- Data come from a 'corpus' of 58 CVC nouns with verbal counterparts, gathered from Ussishkin(1999), Bolozky & Becker(2006), and Bat-El (1994)
- Denominal verbs can take five shapes[1]: (# examples in
  (in the 3p masc. sing. past) the corpus)

(2)	1. tik 'a file' ~ tijek 'he filed'	C_1ijeC_2	(18)
	2. dam 'blood' ~ dimem 'he bled'	$C_1iC_2eC_2$	(16)
	3. daf 'page' ~ difdef 'he paged through'	$C_1iC_2C_1eC_2$	(10)
	4. ʃuk 'market' ~ ʃivek 'he marketed'	C_1iveC_2	(6)
	5. kod 'a code' ~ koded 'to encode'	$C_1oC_2eC_2$	(5)

- The generalization, according to Ussishkin (1999):
  The verbal form is predicted by the vowel of the noun (a, e[2], i, o, u)

(3)	1. C_1ijeC_2	CiC nouns, and CuC nouns
	2. $C_1iC_2eC_2$	CaC nouns
	3. $C_1iC_2C_1eC_2$	conditioned by a RED morpheme (any noun)
	4. C_1iveC_2	CuC nouns
	5. $C_1oC_2eC_2$	CoC nouns

- High vowels can become glides, filling out the verbal template without violating DEP (([v] is a glide))

(4) $t_1i_2k_3 + i_4e_5 \rightarrow t_1i_4j_2e_5k_3$ *(file → he filed)*

$s_1u_2g_3 + i_4e_5 \rightarrow s_1i_4v_2e_5g_3$ *(kind, sort → he sorted)*

Note: /u/→[j] and /u/→[v] both violate IDENT-PLACE but /i/→[j] doesn't

- Low and mid vowels cannot become glides, so nouns with them must resort to consonant doubling
- OCP-PLACE of the first two verb consonants decided whether a noun with [u] will become CijeC or CiveC: if the first consonant is coronal, it becomes CiveC, otherwise it becomes CijeC
- Ussishkin posits that forms with the {oe} vowel pattern are lexically specified (an indexed constraint MAX-ROOT-VOWEL)

[1] The corpus also contains three nouns which correspond to verbs in binyanim other than piʕel
[2] There are only 5 nouns with [e] in the lexicon: three get pattern 3., one gets pattern 1., one gets pattern 2.

The Wug-test

7. Specs

- 43 wug-nouns, checked by a native speaker for wordhood
  Vowels evenly represented: either 8 or 9 instances of each
- 9 speakers: ages 18-70, varying amounts of time spent in the US

8. Setup

- Novel noun in Hebrew and Roman orthography to avoid vowel confusion
- Noun used in the sentence "He has a ___."
- Speakers presented with five options for filling the blank in "He ___ yesterday."
- Asked to rate each option on a scale of 1-7
- Each verbal form represented for each noun, but order randomized (but the same order for all participants)
- Order of appearance of the nouns also randomized

A section of a completed spreadsheet:

(5)

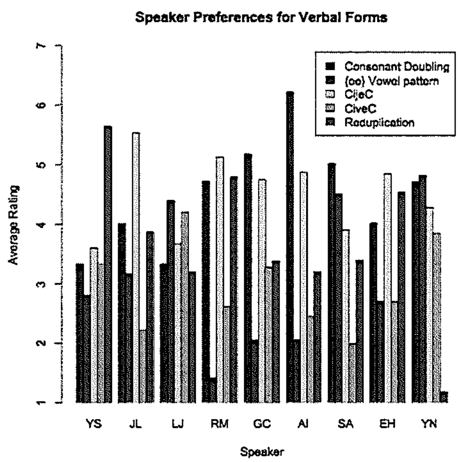
Rating	Forms and Candidates	Form in Roman characters	
He has a goz.	גוז -- יש לו גוז	*goz*	
	הוא ____ אתמול		*He ___ yesterday*
5	גייז	CijeC	*gijez*
7	גיזז	CiCeC	*gizez*
1	גיווז	CiveC	*givez*
1	גיזגז	CiCCeC	*gizgez*
1	גוזז	CoCeC	*gozez*
He has a niz.	ניז -- יש לו ניז	*niz*	
	הוא ____ אתמול		*He ___ yesterday*
1	נוזז	CoCeC	*nozez*
1	נייז	CijeC	*nijez*
3	ניווז	CiveC	*nivez*
5	ניזנז	CiCCeC	*niznez*
7	ניזז	CiCeC	*nizez*
He has a ches.	חֶס -- יש לו חס	*ches*	
	הוא ____ אתמול		*He ___ yesterday*
5	חיסחס	CiCCeC	*χisχes*
7	חיסס	CiCeC	*χises*
4	חייס	CijeC	*χijes*
1	חוסס	CoCeC	*χoses*
1	חיווס	CiveC	*χives*

9. Results

9.1. Accounting for speaker variation

- Speakers use the 1-7 scale differently
- They also have favorite forms
  - in a pilot experiment in which speakers produced the verbs instead of rating them, speakers formed nearly all verbs in their 'favorite' way
  - In assigning ratings, some speakers show marked preference for one form no matter what the base is:

(6)



- The solution: first convert each rating to a Z-score based other scores for that verbal form, then scale back to the 1-7 scale:

(7) For speaker i, verbal form j, and rating x:

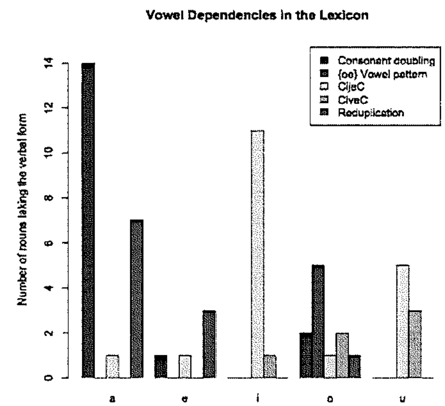
$$Z = \frac{x - \mu_{i,j}}{\sigma_{i,j}}$$

(8)

$$x' = Z\sigma_{all,j} + \mu_{all,j}$$

9.2. Comparative Dependencies:

(9) Vowels and the Lexicon



As predicted by Ussishkin,

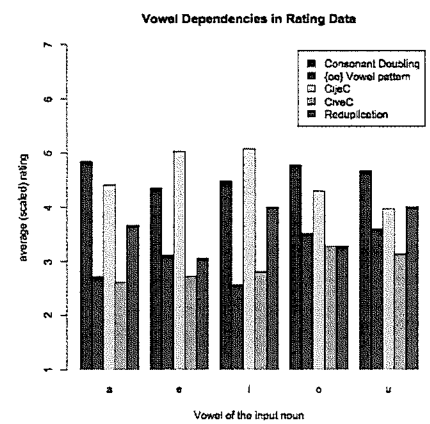
- Consonant doubling goes with [a]
- CijeC goes with [i]
- The {oe} vowel pattern goes with [o]
- About half of nouns with [u] get CijeC, half get CiveC

Not predicted by Ussishkin:

- Reduplication best with [a] and [e]

(10) Vowels and the Rating Data

Much messier than the Lexicon...



- Consonant doubling and the CijeC pattern good for any vowel
- The {oe} vowel pattern just as good for [u] as for [o]
- Reduplication best for [i], [u]

9.3. Mixed Effects Modeling

- Ordinary least squares, run in R
- The 'ratings' matched were the scaled ratings averaged across speakers for each form
- Verbal forms predicted as a function of 9 factors - 8 properties of the noun, and also the order in which the form appeared in the survey
- Each noun has a value of 1 or 0 for the noun-properties
- Having a value of 1 for a property 'low vowel' is exactly the same as having 0 for 'high vowel', 'front vowel', and 'back vowel'
- Likewise, having a value of 1 for either '1st consonant velar' or '2nd consonant velar' is equivalent to having a value of 0 for both '1st/2nd consonant coronal' and '1st/2nd consonant labial'.
- 'root OCP' got a value of 1 if both noun consonants had the same place of articulation, 0 otherwise

(11) Ordinary Least Squares significance results

Key:
LEX = that factor is a significant predictor for that verbal form in the lexicon
RAT = that factor is a significant predictor for that verbal form in the rating data
\+ = the factor is positively correlated with the occurrence/rating of that form
\- = the factor is negatively correlated with the occurrence/rating of that form

Factors:	$C_1iC_2eC_2$	C_1ijeC_2	C_1iveC_2	$C_1oC_2eC_2$	$C_1iC_1C_2eC_2$
high vowel		*LEX+*		*LEX-*	*LEX-* RAT+
front vowel	*LEX-*	RAT+			RAT-
back vowel	*LEX-*		RAT+	*BOTH+*	
1st consonant coronal			*LEX+*		RAT-
1st consonant labial					
2nd consonant coronal			*LEX-*		RAT-
2nd consonant labial			*LEX-*		
root OCP		*LEX+*	*LEX-*		
order of appearance		RAT-		RAT-	RAT-

The match is pretty bad:

- There is only one factor that significantly predicts both the lexical occurrences and the rating in the same direction
- One factor significantly predicts both the lexical occurrence and the rating data, but in opposite directions
- Three of the forms were significantly preferred if they appeared earlier in the list

Some Interpretations:

- The only vowel that is [-front] and [-back] is [a], so what the first column is telling us is that nouns with [a] are significantly more likely to take consonant reduplication that other nouns in the lexicon
- In the second column, we can see that while it's high vowels that take CijeC in the lexicon, it's front vowels in the rating data
- CiveC is predicted by several consonant-related factors in the lexicon, but only one vowel-related factor in the rating data
- While the {oe} vowel pattern occurs with only nouns with [o] in the lexicon, it is happy with nouns with both back vowels in the rating data
- In the lexicon, full reduplication is preferred only for nouns with non-hign vowels. In the rating data, reduplication is favored for nouns with high back vowels, and disfavored for nouns with coronal consonants.

9.4. Simple Distribution Matching?

The idea: The overall average rating for verbal forms across all speakers and across all input nouns corresponds to the number of times that verbal form is represented in the lexicon.

(12)

Verbal Form	Avg. rating	Occurrences in the lexicon
$C_1iC_2eC_2$	4.62	16
C_1ijeC_2	4.55	18
C_1iveC_2	2.91	6
$C_1oC_2eC_2$	3.09	5
$C_1iC_1C_2eC_2$	3.62	10

correllation: p = 0.98

- In their ratings, speakers are matching the distribution of verbal forms
- But they don't seem to be matching any relationship between noun properties and verb forms
- a note: It is never the case that more than 6 of 9 speakers agreed on which form they rated the highest of the five

10. Conclusions

- Speakers are not forming novel denominal verbs based on a grammar like Ussishkin's, even though such a grammar accurately models the lexicon
- Nor have they (apparently) learned some other grammar based on the lexicon
- Yet speakers do have intuitions about how to form novel denominal verbs, which lead them to rate more common verbal form types higher than less common ones

11. Questions

- Is there some part of the lexical distribution which is 'natural' and some part which is 'unnatural', and is that what speakers are picking up on?
- If speakers are just mirroring in their ratings the distribution of each verbal form, how do they know this distribution?
- For further exploration: How salient to speakers is the relationship between these noun-verb pairs?
- Also for further exploration: does token frequency as well as type frequency have an effect on ratings?

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Appendix: Ussishkin's analysis of the lexical pattern

12. Ussishkin's analysis

12.5. Word Minimality

(13)

MINWD: Words should be exactly two syllables.

Shorthand for:

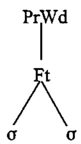
a. FTBIN: Every foot consists of two syllables

b. ALIGN (Ft-R, PrWd-R): The right edge of every foot must be aligned to the right edge of a prosodic word.

c. PARSE-σ: Every syllable must be parsed by a foot

d. IAMB: Feet are right-headed

Together these constraints force the structure:



12.6. Anchor Constraints (McCarthy & Prince 1995: 371)

- Let Edge (X, {L, R}) = the element standing at the Edge = L(eft), R(ight) of X.
- Let S_1 be the input, and S_2 be the output.
- $x\mathfrak{R}y$ stands for 'x and y are in a correspondence relation'

(14) ANCHOR-R: If $x = \text{Edge}(S_1,R)$ and $y = \text{Edge}(S_2,R)$, then $x\mathfrak{R}y$

(15) STRONG-ANCHOR-R: If $x = \text{Edge}(S_1,R)$ and $x\mathfrak{R}y$, then $y = \text{Edge}(S_2,R)$

(16) STRONG-ANCHOR-L: If $x = \text{Edge}(S_1,L)$ and $x\mathfrak{R}y$, then $y = \text{Edge}(S_2,L)$

The difference between ANCHOR and STRONG-ANCHOR constraints:

	ANCHOR-L *satisfied*	ANCHOR-L *satisfied*	ANCHOR-L *violated*
S_1	$[_L b_1 a_2 d_3 u_4 p_5 i_6]_R$	$[_L b_1 a_2 d_3 u_4 p_5 i_6]_R$	$[_L b_1 a_2 d_3 u_4 p_5 i_6]_R$
S_2	$[_L a_2 b_1 d_3 u_4 p_5 i_6]_R$	$[_L b_1 a_2 b_1 d_3 u_4 p_5 i_6]_R$	$[_L a_2 b_1 d_3 u_4 p_5 i_6]_R$

	S-ANCHOR-L *satisfied*	S-ANCHOR-L *violated*	S-ANCHOR-L *violated*
S_1	$[_L b_1 a_2 d_3 u_4 p_5 i_6]_R$	$[_L b_1 a_2 d_3 u_4 p_5 i_6]_R$	$[_L b_1 a_2 d_3 u_4 p_5 i_6]_R$
S_2	$[_L a_2 b_1 d_3 u_4 p_5 i_6]_R$	$[_L b_1 a_2 b_1 d_3 u_4 p_5 i_6]_R$	$[_L a_2 b_1 d_3 u_4 p_5 i_6]_R$

12.7. More Familiar Constraints:

(17) ONSET: (Itô 1989, Prince & Smolensky 1993
Every syllable has an onset.

(18) DEP: (McCarthy & Prince 1995: 370)
Every element in the output has a correspondent in the base.
('No epenthesis')

(19) INTEGRITY: (McCarthy & Prince 1995: 372)
No element of the base has multiple correspondents in the output.
('No copying/doubling')

(20) MAX-C: (McCarthy 1995, McCarthy & Prince 1995: 370)
Every consonant of the base has a correspondent in the output
('No deletion of consonants')

(21) MAX-V-STEM: (McCarthy & Prince 1995: 370, Gafos 1995)
Every base vowel has a correspondent in the output.
('No deletion of stem vowels')

(22) MAX-V-AFFIX: (McCarthy & Prince 1995: 370, Gafos 1995)
Every affixal vowel of the input has a correspondent in the output.
('No deletion of affix vowels')

12.8. What all these constraints do:

(23)

dam + ie	MINWD	S-ANCHOR-L	ANCHOR-R	ONSET	DEP	MAX-V-AFFIX	MAX-V-STEM	INTEGRITY	S-ANCHOR-R
c. damime	*!		*					*	*
e. didem		*!					*	*	
d. dime			*!				*		*
g. diem				*!			*		
f. dijem					*!		*		
a. damem						*!		*	*
b. dimam						*!		*	*
☞ h. dimem							*	*	*

12.9. Desyllabification

The idea: High vowels can become glides, filling out the verbal template without violating DEP

- [v] is the glide-counterpart of [u], and this is enforced by a high-ranked constraint *[w].
- [j] and [v] as medial consonants in verbs correspond with a [u] or [i] in the input noun
- $t_1i_2k_3 + i_4e_5 \rightarrow t_1i_4j_2e_5k_3$
- $s_1u_2g_3 + i_4e_5 \rightarrow s_1i_4v_2e_5g_3$

(24)

ti_1k + ie	MAX-V-STEM	INTEGRITY	S-ANCHOR-R
a. tikek	*	*	*
☞ b. tij_1ek			

(25)

su_1g + ie	MAX-V-STEM	INTEGRITY	S-ANCHOR-R
a. sigeg	*	*	*
☞ b. siv_1eg			

- IDENT-PLACE keeps inputs with [i] from surfacing as CiveC, since [i] is coronal, but [v] is labial

(26) IDENT-PLACE:
Correspondents have identical specification for place features

(27)

ti_1k + ie	MAX-V-STEM	INTEGRITY	S-ANCHOR-R	IDENT-PL
a. tikek	*!	*	*	
a. tiv_1ek				*!
☞ b. tij_1ek				

- IDENT-PLACE can't decide between CijeC and CiveC when the base has [u] because both [j] and [v] differ in place of articulation from [u]

12.10. OCP-Place

- Whether nouns with [u] take CijeC or CiveC depends on the place of articulation of the first consonant of the noun: If it is coronal, they take CiveC, otherwise, they take CijeC.
- Ussishkin explains this as an OCP effect between the first two consonants - a coronal cannot occur with [j] since [j] is also coronal
- He needs three constraints to get this:

(28) *[lab]

(29) *[cor]

(30) OCP-Place
Consonants with identical place specification (labial, coronal, dorsal) are disallowed within a stem.

- The ranking *[lab] ≫ *[cor] forces the CijeC form to be the default, and OCP-PLACE overrides both when the first consonant is coronal

(31)

su_1g + ie	IDENT-PLACE	OCP-PLACE	*[lab]	*[cor]
a. sij_1eg	*	*!		*
☞ b. siv_1eg	*		*	

(32)

xu₁g + ie	IDENT-PLACE	OCP-PLACE	*[lab]	*[cor]
☞ a. xij₁eg	*			*
b. xiv₁eg	*		*!	

12.11. The {oe} vowel pattern

- Nouns which take the {oe} vowel pattern are lexically marked - there is either an indexed constraint or a parallel grammar where something like IDENT-μ outranks MAX-V-AFFIX

12.12. Full Reduplication

- Fully reduplicated forms also contain a reduplicative morpheme, RED

(33) MAX-BR (McCarthy & Prince 1995)
Every element of the base has a correspondent in the reduplicant.

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hip-hop rhyme

seeking evidence that ppl can distinguish ɾ b/w /t/ & /d/ underlyingly