Effects of allophonic vowel nasalization on NC clusters: a contrast-based analysis*

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1 Introduction

- Many languages ban sequences of nasal-stop (NC) clusters (*NC_1VNC_2). When NC_1VNC_2 is banned, there are a number of attested repairs.
  - In some systems, NC_1 realized as plain nasal (N) (≈ Meinhof's Law).

    (1) NC_1 nasalization in Ngaju Dayak (Blust 2012)
    a. /ma**N+b**a**nd**o/ → [ma-**m**a**nd**o] 'turn against'
    (cf. [mam-bagi] 'divide')
    b. /ma**N+g**u**nd**ul/ → [ma-**ŋ**u**nd**ul] 'wrap up'
    (cf. [maŋ-gila] 'drive crazy')
  - In others, NC_2 realized as a plain oral (C) (≈ the Kwanyama Law).

    (2) NC_2 oralization in Gurindji (McConvell 1988)
    a. /ka**nyj**u+**mp**al/ → [ka**nyj**u-**p**al] 'across below'
    (cf. [kayirra-mpal] 'across the north')
    b. /ka**nk**a+**mp**a/ → [ka**nk**a-**p**a] 'upstream'
    (cf. [kani-mpa] 'downstream')
  - In still others, NC_1 is realized as a plain oral (C).

    (3) NC_1 oralization in Timugon Murut (Blust 2012)
    a. /ma**N-t**u**mb**uk/ → [ma-**t**u**mb**uk] 'thump'
    (cf. [man-tutu] 'pound')
    b. /sa**N-g**o**ŋg**om/ → [so-**g**o**ŋg**om] 'one fistful'
    (cf. [son-dopo] 'one fathom')
- **Main question:** what is the nature of the markedness constraint that penalizes NC_1VNC_2? What exactly compels the alternations that we see in (1-3)?
  - Meinhof (1932), Blust (2012), others: it's an OCP constraint.
  - Herbert (1977, 1986), Jones (2000): it's a constraint on contrast.

Preview of today's talk…

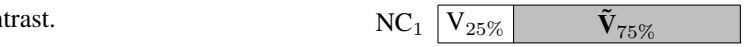
- I will argue, following Herbert and Jones, that the repairs in (1-3) are responses to a constraint that penalizes *insufficiently distinct contrasts*.
  - In NC_1VNC_2, anticipatory nasalization from N_2 renders NC_1 insufficiently distinct from N (more on this in §2).
  - The repairs exemplified in (1-3) are motivated by a desire to avoid insufficiently distinct N/NC contrasts.
- The arguments for this view come from facts about the larger typology of nasal cluster effects (e.g. the kinds of effects in (1-3)).
  - §3: asymmetries in the types of sequences repaired are *predicted.*
  - §4: restrictions on the locality of repairs are *predicted.*
- I will introduce the contrast-based analysis (§2), explore its predictions (§3-§4), and compare it throughout to a OCP-based alternative.

2 Motivating nasal cluster effects

First question: what's so bad about NC_1VNC_2?

- In most (perhaps all) languages, vowels preceding nasals are nasalized.[1]
- So in most (perhaps all) languages, the V in NC_1VNC_2 is nasalized. (Percentages in this diagram are for illustrative purposes only.)

(4) Vowel nasalization in NC_1VNC_2



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[1] The extent of coarticulatory nasality varies by language (see e.g. Jeong 2012) and, to some extent, by consonantal or vocalic context; we'll get back to this latter point in §3.

- Why is this relevant? Because the anticipatory vowel nasalization in (4) reduces cues to the contrast between NC_1 and N.
  - Beddor & Onsuwan (2003): a *very important cue* to the contrast between N and NC is the quality of the following vowel.
    - ≽ Speakers more likely to identify N as N when followed by $\tilde{V}$.
    - ≽ Speakers more likely to identify NC as NC when followed by V.
- **Simplifying hypothesis:** For N and NC to be distinct, N must be followed by a fully nasal vowel ($\tilde{V}$), and NC must be followed by a fully oral vowel.
  - We can formalize this with a MINDIST constraint (Flemming 2002):

    (5) MINDIST N-NC = ΔV: for each contrasting N vs. NC pair, N must be followed by $\tilde{V}$ and NC must be followed by V. Assign one * for each violating pair.
  - In the pair in (6), ΔV is satisfied.

    (6) ΔV satisfied in [NCV] vs. [N$\tilde{V}$]

    a. NC | $V_{100\%}$

    b. N | $\tilde{\mathbf{V}}_{100\%}$
  - But in (7), ΔV is violated: the post-NC vowel is nasalized.

    (7) ΔV violated in [NC$\tilde{V}$NC] vs. [N$\tilde{V}$NC]

    a. NC_1 | $V_{25\%}$ | $\tilde{\mathbf{V}}_{75\%}$ | NC_2

    b. N | $\tilde{\mathbf{V}}_{100\%}$ | NC_2
- **Question:** why don't speakers just avoid nasal coarticulation in NC_1VNC_2?
  - While a lesser degree of nasalization (e.g. 50%) might render N/NC_1 *more* distinct, it would render C/NC_2 *less* so.
  - Beddor & Onsuwan (2003): one of the cues to the C/NC contrast is the quality of a preceding vowel.
    - ≽ Speakers more likely to identify C as C when preceded by V.
    - ≽ Speakers more likely to identify NC as NC when preceded by $\tilde{V}$.

    (8) Enhancing cues to N/NC_1 reduces cues to C/NC_2

    a. NC_1 | $V_{50\%}$ | → | $\tilde{\mathbf{V}}_{50\%}$ | NC_2 — *cues enhanced*

    b. N_1 | $\tilde{\mathbf{V}}_{100\%}$ | NC_2 — *cues enhanced*

    c. NC_1 | $V_{100\%}$ | C_2 — *cues reduced*
  - In NC_1VNC_2 sequences, constraints on contrast conflict: it is impossible to render both NCs maximally distinct from their component parts.
  - **Main point:** these sequences are not optimal under any condition.

Second question: when NC_1VNC_2 is banned, what is the set of possible repairs?

- Given a restriction on NC_1VNC_2, there are many logically possible repairs.

  (9) Examples of possible repairs to marked NC_1VNC_2

Repair	Target	Description (changes bolded)
a. Oralization	NC_1	/NC_1 V NC_2/ → [$\mathbf{C}_1$ V NC_2]
b. Oralization	NC_2	/NC_1 V NC_2/ → [NC_1 V $\mathbf{C}_2$]
c. Nasalization	NC_1	/NC_1 V NC_2/ → [$\mathbf{N}_1$ V NC_2]
d. Nasalization	NC_2	/NC_1 V NC_2/ → [NC_1 V $\mathbf{N}_2$]

- A survey of 63 languages (details provided in the appendix) found that all repairs in (9) are attested, *contra* Jones 2000.
- The typology of attested repairs is consistent with the predictions of both a contrast-based and an OCP-motivated, dissimilation analysis.
  - Under a contrast-based account, all of these repairs alleviate in some way the perceptual problem posed by NC_1VNC_2.[2]
  - Under a OCP-motivated analysis, all repairs get rid of one of the NCs.
- Since our goal is to arbitrate between the two approaches, we'll move onto facts about the typology that distinguish them.

3 Asymmetries in repaired sequences

- **So far:** I've discussed what motivates nasal cluster effects, under a contrast-based approach, and provided a preliminary analysis.
- **Next up:** known phonetic asymmetries correctly predict implicational generalizations regarding which types of NC_1VNC_2 sequences are repaired.

3.1 Asymmetries in the extent of nasal coarticulation

- The MINDIST constraint in (5) claims that, for N/NC to be sufficiently distinct, NC must be followed by *fully oral* V and N by *fully nasal* $\tilde{V}$.

[2] Jones (2000) argues that (9d), NC_2 nasalization, does not help improve perceptibility of N/NC_1, as a vowel preceding N will still be nasalized. This is true, but in many languages vowels preceding prevocalic Ns are *significantly less* nasalized than those preceding NCs, meaning that N/NC_1 will be more distinct pre-NV than pre-NC. On this see §3.1.

- **This section:** not all languages impose such a strict requirement.
  - For example, a language might require N to be followed by a vowel that's only *halfway* nasal, and NC by one that's *halfway* oral.

    (10) MINDIST N-NC = $\Delta V_{50\%}$: for each contrasting N vs. NC pair, N/NC must be followed by a vowel that is at least 50% nasal/oral. Assign one * for each violating pair.
  - So while (11) violates $\Delta V_{50\%}$, (12) does not.

    (11) NC_1VNC_2 where V is 25% oral

    a. NC_1 $V_{25\%}$ $\tilde{V}_{75\%}$ NC_2

    b. N_1 $\tilde{V}_{100\%}$ NC_2 *

    (12) NC_1VNC_2 where V is 50% oral

    a. NC_1 $V_{50\%}$ $\tilde{V}_{50\%}$ NC_2

    b. N_1 $\tilde{V}_{100\%}$ NC_2 ✓
  - In a language where $\Delta V_{50\%}$ is undominated, only (11) is modified.

    (13) $\Delta V_{50\%}$ violated, $NCV_{25\%}NC$ repaired

$NCV_{25\%}NC$ $N\tilde{V}NC$	$\Delta V_{50\%}$	FAITH
a. $NCV_{25\%}NC$ $N\tilde{V}NC$	*!	
☞ b. $N\tilde{V}NC$ $N\tilde{V}NC$		*

    (14) $\Delta V_{50\%}$ satisfied, $NCV_{50\%}NC$ not repaired

$NCV_{50\%}NC$ $N\tilde{V}NC$	$\Delta V_{50\%}$	FAITH
☞ a. $NCV_{50\%}NC$ $N\tilde{V}NC$		
b. $N\tilde{V}NC$ $N\tilde{V}NC$		*!

  - **Important:** repair of (12) asymmetrically implies repair of (11).
    - ≽ ΔV (requiring fully different vowels) penalizes both.
    - ≽ $\Delta V_{50\%}$ (requiring partially different vowels) penalizes (11).
    - ≽ No MINDIST constraint can penalize *only* (12).
- **Why is this relevant?**: within a language, extent of coarticulatory nasalization varies. Some Ns induce more nasalization than others. Examples:
  - When there is an asymmetry, languages tend to exhibit more extensive nasal coarticulation pre-NT than pre-ND (Beddor 2009).
  - When there is an asymmetry, languages tend to exhibit more extensive nasal coarticulation pre-NC than pre-NV (e.g. Schourup 1973).
- If a language employs a less restrictive MINDIST constraint, like $\Delta V_{50\%}$, we might expect these phonetic asymmetries to be reflected in the typology.
  - The prediction: repairs to NC_1VNC_2 where V is *less* nasalized should asymmetrically imply repairs where V is *more* nasalized.
  - We'll see now that this prediction is correct.

Phonetic asymmetry #1: voicing in NC clusters

- Cross-linguistically, the nasal portion of voiceless NC (NT) clusters is shorter than the nasal portion of voiced NC (ND) clusters.[3]

  (15) N duration and voicing in NC clusters

  a. **N** **D**

  b. **N** **T**
- But: regardless of the duration of the nasal consonant, the duration of the velum lowering gesture remains the same (Beddor 2009).
  - ≽ Extent of nasalization is inversely correlated with N's duration.
  - ≽ *Significance:* more nasalization pre-NT than pre-ND.

  (16) Shifting of velum opening gesture

  a. NC_1 $V_{55\%}$ $\tilde{V}_{45\%}$ **N** **D**

  $V_{25\%}$ *velum gesture*

  b. NC_1 $\tilde{V}_{75\%}$ **N** **T**

  velum gesture
- We might expect an N/NC_1 contrast to be more distinct when it precedes ND: the post-NC vowel is less nasalized in (16a) than it is in (16b).

Typological asymmetry #1: voicing in NC clusters

- *Prediction:* if a language repairs NC_1VND_2 in response to a MINDIST violation, it should also repair NC_1VNT_2.
  - In other words: nasal cluster effects in NC_1VND_2 *asymmetrically implies* those same effects in NC_1VNT_2.
  - This prediction is hard to assess. In most descriptions, the role of NC_2 voicing in nasal cluster effects is not discussed.

[3] For evidence from a variety of languages, see: Maddieson & Ladefoged 1993; Ladefoged & Maddieson 1996: 4.3; Riehl 2008; Coetzee & Pretorius 2010; Cohn & Riehl 2012.

- But in Mori Bawah (Blust 2012), there's an asymmetry that goes in the expected direction: NC_1VNT_1 but not NC_1VND_2 is repaired (17).

(17) NC_1 nasalization in Mori Bawah
  a. *Triggered by NT_2*
    i. /mo**N-s**o**ŋk**a/ → [mo-**s**o**ŋk**a] 'arrange'
    ii. /mo**N-t**a**mp**ele/ → [mo-**t**a**mp**ele] 'hit, smack'
  b. *Not triggered by ND_2*
    i. /mo**N-s**o**mb**u/ → [mo**n-s**o**mb**u] 'connect, join'
    ii. /mo**N-t**o**nd**a/ → [mo**n-t**o**nd**a] 'follow'

Phonetic asymmetry #2: prevocalic vs. non-prevocalic status of N.

- So far, we have focused our attention on repairs to NC_1VNC_2. But we do not need to limit our attention to only those sequences.
  - **The basic insight:** NC_1VNC_2 is dispreferred because nasal coarticulation from N_2 renders N/NC_1 insufficiently distinct.
  - If this is the right approach, NC_1VN_2V should be dispreferred too
- *Note:* N's vocalic context influences the amount of nasalization it induces.
  - In many languages, *non-prevocalic* (≈ coda) nasals induce more anticipatory nasalization than do *prevocalic* (≈ onset) nasals.
    - ⪰ In Pashto, Malagasy, Delware, Gypsy-Telugu, others: more nasalization pre-NC than pre-N (Herbert 1977:348).
    - ⪰ French, Greek: more nasalization before non-prevocalic nasals.

(18) Nasalization in French and Greek (from Jeong 2012)

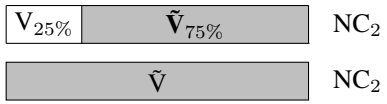
Language	V/¬NV	V/NV
French	33%	17%
Greek	55%	19%

    - ⪰ A. English (Krakow 1993): more $\tilde{V}$ before non-prevocalic nasals.
    - ⪰ Schourup (1973:191), on the basis of a large typological study:

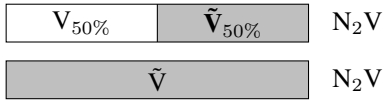
> *"…In no language examined are vowels nasalized before prevocalic nasals when they are not also nasalized before all preconsonantal and word-final nasals."*

  - Some languages will look like (19-20): the intermediate V is more nasalized when N_2 is non-prevocalic than it is when N_2 is prevocalic.

(19) N/NC_1VNC_2: less distinct



(20) N/NC_1VN_2V: more distinct



  - As far as we know, this asymmetry is universal: *no* language allows more nasalization before N_2V than before N_2C.
- We might expect, then, for N/NC_1 to be more distinct when N_2 is prevocalic: the post-NC vowel is less nasalized in (20) than it is in (19).

Typological asymmetry #2: prevocalic vs. non-prevocalic status of N.

- *Prediction:* if a language repairs NC_1VN_2V (20), this asymmetrically implies that it repairs NC_1VN_2C (19).
  - For the most part, this prediction holds (see also Herbert 1977).

(21) Contexts of NC effects (* = effects; ✓ = no effects)

	*N_2	✓N_2
*NC_2	34	27
✓NC_2	1	*n.a.*

  - The sole exception to this generalization is Bolia (Mamet 1960, Meeussen 1963); see the appendix for more details.

3.2 On the role of NC's oral release

- What we saw in §3.1: the identity of NC_2 can play a decisive role in determining whether or not nasal cluster effects are motivated.
- What we'll see now: the identity of NC_1 plays a role, too.

The role of internal cues to the N/NC contrast…

- An additional cue to the N/NC contrast is NC's oral closure and release.
  - Beddor & Onsuwan (2003) show that, as the oral portion of NC increases in duration, listeners become less likely to identify it as N.
  - Therefore, as the oral portion of NC increases in duration and burst amplitude, the N/NC contrast becomes more distinct.

- Since the oral portion of NT is longer than that of ND, we expect N/NT to be more distinct than N/ND (even if external cues to the contrasts are reduced).

(22) N/NT more distinct than N/ND

- How to differentiate between the N/NT and N/ND contrasts in (22)?
  - We can write a disjunctive MINDIST constraint, which requires the presence of one out of a number of cues (see Flemming 2002:57ff).
  - For example: N/NC requires the presence of *either* sufficient external cues *or* a significant difference in the duration of consonantal orality.

(23) MINDIST N/NC = $\Delta V_{50\%}$ OR ΔLONGORALITY
For N/NC to be sufficiently distinct, either (i) N/NC must be followed by a 50% nasal/oral vowel, or (ii) NC's oral portion must be at least 50% of its total duration. One * for each violating pair.

  - (22a) vs. (22c) *satisfies* (23): NT is not followed by a vowel that is 50% oral, but 50% of NT is oral.
  - (22b) vs. (22c) *violates* (23): ND is neither followed by a vowel that is 50% oral nor is 50% of it oral.

- Assuming the phonetics in (22), ND_1VNC_2 but not NT_1VNC_2 is repaired.

(24) $\Delta V_{50\%}$ OR ΔLONGORALITY violated, $NDV_{25\%}NC$ repaired

$NDV_{25\%}NC$ $N\tilde{V}NC$	$\Delta V_{50\%}$ OR ΔLONGORALITY	FAITH
a. $NDV_{25\%}NC$ $N\tilde{V}NC$	*!	
☞ b. $N\tilde{V}NC$ $N\tilde{V}NC$		*

(25) $\Delta V_{50\%}$ OR ΔLONGORALITY satisfied, $NTV_{25\%}NC$ repaired

$NTV_{25\%}NC$ $N\tilde{V}NC_2$	$\Delta V_{50\%}$ OR ΔLONGORALITY	FAITH
☞ a. $NTV_{25\%}NC$ $N\tilde{V}NC$		
b. $N\tilde{V}NC$ $N\tilde{V}NC$		*!

- Under a contrast-based analysis, deriving the opposite asymmetry is impossible: no MINDIST constraint can force only NT_1VNC_2 to be repaired.

Typological asymmetries related to the role of internal cues...

- *Prediction:* if a language repairs NT_1VNC_2 in response to a MINDIST violation, it should also repair ND_1VNC_2.
- This prediction is difficult to assess: not many languages repair NT_1VNC_2.
  - NC_1 nasalization ($\approx$ Meinhof's Rule) never targeted NT_1 in Bantu. Herbert (1977:365) attributes this to the facts discussed above:

> *"Meinhof's Rule never applied to prenasalized voiceless stops or prenasalized fricatives... In a post-nasal environment, the voiced stops evidence the most reduction and are therefore the most susceptible to nasalization... voiceless stops and fricatives are more distinctive in this environment."*

  - In languages that do repair NT_1VNC_2, there are confounding factors:
    - ⩾ Voicing is not distinctive (e.g. Gurindji, McConvell 1988).
    - ⩾ ND banned across morph. boundaries (Mori Bawah, Blust 2012).
- But there is some evidence from Ngaju Dayak (Blust 2012) that duration of the oral component (or something like it) is relevant.
  - NC_1 nasalization targets labials/alveolars more than palatals/velars.

(26) Ngaju Dayak rates of NC_1 nasalization by PoA (after Blust 2012:373)

PoA	Undergo	Faithful	Variation	Rate of application
Bilabial (b-)	63	2	2	94%
Alveolar (d-)	2	2	3	50%
Velar (g-)	16	19	0	46%
Palatal (dʒ-)	2	11	0	15%

  - A fairly uniform cross-linguistic observation is that, the further back a stop's place of articulation, the longer its VOT (Maddieson 1996).
  - In (26), rate of application appears to be correlated with VOT.
    - ⩾ Stops that generally have *shorter* VOTs are more frequent targets.
    - ⩾ The palatals are affricates: they should have the longest VOTs.
  - Assumption: the longer a stop's VOT, the more distinct it is from N.
  - Less distinct N/NC contrasts are targeted more often by NC_1 nasalization. More distinct N/NC contrasts are preserved.[4]

[4] There are also a number of Bantu languages in which only velar NC_1 undergoes NC_1 nasalization; see Meeussen (1963). Without knowing about the phonetics of velar NC clusters in these languages (are they lenited?), it's hard to know what to make of this. Compounding this difficulty is the fact that NC_1 nasalization in most Bantu languages is unproductive, and the set of targets are often limited to a set of clusters whose phonetics have changed since the pattern ceased to be productive.

Some thoughts about homorganicity vs. heterorganicity...

- In some systems, nasal cluster effects only happen when one of NC_1 or NC_2 (which one depends on the language) is homorganic.
  - Nhanda: NC effects with homorganic NC_1 (Blevins 2001, Blust 2012).

    (27) NC_2 oralization in Nhanda
    a. *Repaired when NC_1 is homorganic*
    i. mi**njdʒ**u-**g**u 'purse-ERG'
    ii. wu**mb**a-**g**ula 'hide-AMB'
    b. *Not repaired when NC_1 is heterorganic*
    i. thu**rnb**a-**ŋg**u 'dove-ERG'
    ii. wu**ŋjb**a-**ŋg**ula 'whistle-AMB'

  - Bilinara, others in McConvell (1988): NC_2 must be homorganic.
- There's some evidence that heterorganic NCs are longer than homorganic NCs (Slis 1974; please tell me if you know of other relevant work!).
  - I know nothing about the relative durations of their component parts.
  - One plausible scenario is that the Ns and Cs of homorganic clusters are shorter than the Ns and Cs of heterorganic ones.
- Speculation: if this is true, then we can say something about the above.
  - C in NC_1 short in homorganic clusters: N/NC_1 less distinct.
  - N in NC_2 shorter in homorganic than heterorganic clusters: more anticipatory nasalization, and cues to N/NC_1 are more reduced.

3.3 Are there alternatives?

- A contrast-based analysis correctly predicts several implicational generalizations regarding the types of NC_1VN_2 sequences repaired.

  (28) Predictions of the contrast-based account:
  a. Repair of NC_1VND_2 implies repair of NC_1VNT_2.
  b. Repair of NC_1VN_2V implies repair of NC_1VNC_2.
  c. Repair of NT_1VNC_2 implies repair of ND_1VNC_2.

- It's not clear that an OCP-motivated analysis can account for *any* of these.
  - For a OCP-motivated analysis, (28b) would be particularly difficult.
  - NC_1VN_2 is not an OCP violation, and needs no repair.

4 Locality

- Another area where the contrast-based account makes testable predictions regards the *locality* of repairs.
  - In NC_1VNC_2, N/NC_1 threatened by nasalization from NC_2.
  - If something intervenes between the two NCs to *block* the spread of nasality, we don't expect to find nasal cluster effects.
  - *Prediction:* if there are non-local NC effects, the set of possible interveners should be segments that nasality spreads through.
- In most languages, this is vacuously true: NC effects are *only* transvocalic.
- But in Gurindji (McConvell 1988), other material can intervene...

Gurindji: the basics.

- Reminder: in Gurindji, there is NC_2 oralization (data from (2) repeated).

  (29) Repairs in Gurundji (McConvell 1988)
  a. /ka**nyj**u+**mp**al/ → [ka**nyj**u-**p**al] 'across below'
  (cf. [kayirra-mpal] 'across the north')
  b. /ka**nk**a+**mp**a/ → [ka**nk**a-**p**a] 'upstream'
  (cf. [kani-mpa] 'downstream')

- When certain consonants intervene, NC_2 oralization can apply non-locally.
  - Non-local application happens across approximants and glides:

    (30) Non-local NC_2 oralization
    a. pa**rnk**u-wu**j**a 'with a paternal cross-cousin'
    (cf. ngaji-wunyja 'with father')
    b. ya**ngk**i-wu**p**alng 'to avoid asking'
    (cf. jalngak-kumpalng 'to avoid riding')
    c. jawurra-**ny-k**ari-wu**j**a 'with another thief'
    (cf. ngaji-wunyja 'with father')

  - McConvell 1988:144, on these facts:

    > *"It seems that the domain of [NC_2 oralization] is not restricted to any particular number of syllables but that any number of syllables may intervene... provided the intervening material contains only such segments as w, y, and rl..."*

- In addition: in some dialects of Gurindji, /p/ and /k/ lenite. In these dialects, lenited /p/ and /k/ can intervene in NC_2 oralization.

Claim: NC_2 oralization in Gurindji is local.

- Although McConvell does not address the phonetics of nasality, the set of interveners mirrors generalizations about the typology of nasal spreading.
  - In (31): spreading through a segment class with some value *x* implies spreading through all segment classes with values lower than *x*.

(31) Implicational hierarchy in nasal spreading (from Walker 2000:26)

[1] Vowels [2] Glides [3] Liquids [4] Fricatives [5] Stops [6]

high ⟵ *compatibility with nasalization* ⟶ *low*

  - One interpretation of the facts in (30) is that, in Gurundji, nasality can spread through segment types with a value of [4] and lower.
    - ⩾ Depending on the realization of lenited stops, maybe [5] or lower.
    - ⩾ Crucially, the implicational hierarchy in (31) is obeyed.
  - Under this interpretation, all NC effects in Gurundji are *local*.

But what about the alternative?

- **Major finding:** nasal cluster effects are *exclusively local*. This restriction is naturally predicted by a contrast-based account.
  - Nasal cluster effects are compelled by an NC's local vocalic context.
  - Long-distance effects don't occur because they're not motivated.
- This *cannot* be predicted by an OCP-motivated, dissimilation analysis.
  - It's possible to restrict dissimilatory processes to operate within certain local domains, like adjacent syllables (see e.g. Bennett 2013).
  - But this is a stipulation: there's no reason why they *have* to be local.
  - It's not obvious to me how to account for the Gurindji pattern, where non-local effects only happen when certain consonants intervene.

5 Discussion and conclusions

- If we treat NC effects as perceptually motivated contrast neutralization, many superficially dissimilar facts about the typology fall out.
  - §3: asymmetries in the *types of sequences repaired* are predicted.
  - §4: restrictions on the *locality of repairs* are predicted.
- The true strength of the contrast-based approach is that it provides a unified account of all of these generalizations, based on a small set of phonetic facts.
- **The take-home point:** nasal cluster effects occur in response to a constraint that penalizes *insufficiently distinct contrasts.*
  - This analysis is able to provide a unified explanation for a set of seemingly unrelated typological generalizations.
  - I don't know of another analysis of these facts that can do the same.

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Appendix

List of languages exhibiting NC effects

Repair	Language information		Repaired structures		Restricted to…	Source
	Name	*Major family*	NC_1VNC_2	NC_1VN_2		
NC_1 nasalization	Bangubangu	Niger-Congo	■	■	Velar ND_1	Meeussen (1963)
	Bemba	Niger-Congo	■	■	ND_1	Kim (1999)
	Bobangi	Niger-Congo	■	■	Mostly velar ND_1	Meeussen (1963)
	Bokote	Niger-Congo	■	■	Isolated examples	Meeussen (1963)
	Bolia[1]	Niger-Congo		■	Palatal ND_1	Mamet (1960), Meeussen (1963)
	Budya	Niger-Congo	■	■	Velar ND_1	Meeussen (1963)
	Buyu	Niger-Congo	■	■	Velar ND_1	Meeussen (1963)
	Caga	Niger-Congo	■	■	Mostly velar ND_1	Meeussen (1963)
	Dayak	Austronesian	■		*none listed*	Herbert (1977)
	Ganda	Niger-Congo	■	■	All but alveolar ND_1	Meeussen (1963)
	Gikuyu	Niger-Congo	■	■	All but alveolar ND_1	Meeussen (1963)
	Gwamba-Thonga	Niger-Congo	■	■	Velar ND_1	Meeussen (1963)
	Hemba	Niger-Congo	■		*none listed*	Meeussen (1963)
	Ila	Niger-Congo	■		*none listed*	Meeussen (1963)
	Kami	Niger-Congo	■	■	Mostly velar ND_1	Meeussen (1963)
	Kaonde	Niger-Congo	■	■	Mostly velar ND_1	Meeussen (1963)
	Kerebe	Niger-Congo	■		Certain roots only	Meeussen (1963)
	Kok-Kaper	Pama-Nyungan	■		*none listed*	Jones (2000)
	Kuria	Niger-Congo	■	■	Velar ND_1	Meeussen (1963)
	Lamba	Niger-Congo	■	■	Optional in verbs	Meeussen (1963)
	Luba-Katanga	Niger-Congo	■		Many exceptions	Meeussen (1963)
	Lumasaamba	Niger-Congo	■	■	All but alveolar ND_1	Herbert (1977)
	Makonde	Niger-Congo	■	■	Mostly velar ND_1	Meeussen (1963)
	Matumbi	Niger-Congo	■	■	Mostly velar ND_1	Meeussen (1963)
	Mwanga	Niger-Congo	■	■	Velar ND_1	Meeussen (1963)
	Myene	Niger-Congo	■		Alveolar and velar ND_1	Meeussen (1963)
	Ngaju Dayak	Austronesian	■		Dependent on PoA; see §4.	Blust (2012)
	Nilamba	Niger-Congo	■	■	All ND_1s but palatal and velar	Meeussen (1963)
	Nkore	Niger-Congo	■		Certain roots only	Meeussen (1963)
	Ntomba	Niger-Congo	■	■	*none listed*	Meeussen (1963)
	Nyamwezi	Niger-Congo	■	■	Mostly velar ND_1	Meeussen (1963)
	Nyiha	Niger-Congo	■	■	Mostly velar ND_1	Meeussen (1963)
	Nyoro	Niger-Congo	■		Certain roots only	Meeussen (1963)

Repair	Language information		Repaired structures		Restricted to…	Source
	Name	*Major family*	NC_1VNC_2	NC_1VN_2		
NC_1 nasalization *(continued)*	Ombo	Niger-Congo	■	■	Certain prefixes only	Meeussen (1963)
	Rundi	Niger-Congo	■		Certain roots only	Meeussen (1963)
	Rwanda	Niger-Congo	■		Certain roots only	Meeussen (1963)
	Sanga	Niger-Congo	■		*none listed*	Meeussen (1963)
	Sango	Niger-Congo	■	■	Mostly velar ND_1	Meeussen (1963)
	Shambala	Niger-Congo	■	■	Velar ND_1	Meeussen (1963)
	Soli	Niger-Congo	■		*none listed*	Meeussen (1963)
	Suthu	Niger-Congo	■	■	Velar ND_1	Meeussen (1963)
	Swahili	Niger-Congo	■	■	Velar ND_1	Iribemwangi (2011)
	Tabwa	Niger-Congo	■		Many exceptions	Meeussen (1963)
	Taita	Niger-Congo	■	■	Mostly velar ND_1	Meeussen (1963)
	Tetela	Niger-Congo	■	■	NC_2 required in nouns	Meeussen (1963)
	Vira	Niger-Congo	■	■	Mostly velar ND_1	Meeussen (1963)
	Yaunde	Niger-Congo	■		Velar NC_1	Meeussen (1963)
	Zande	Niger-Congo	■		ND_1, variably	Herbert (1977)
	Ziba	Niger-Congo	■		Certain roots only	Meeussen (1963)
NC_2 nasalization	Gurindji	Pama-Nyungan	■		Western dialects only	McConvell (1988)
NC_1 oralization	Mori Bawah	Austronesian	■		Voiceless NC_2	Blust (2012)
	Timugon Murut	Austronesian	■		*none listed*	Blust (2012)
NC_2 oralization	Arabana	Pama-Nyungan	■		Retroflex NC_2	Hercus (1994)
	Bilinara[2]	Pama-Nyungan	■		Homorganic NC_2	McConvell (1988)
	Djaru	Pama-Nyungan	■		Palatal or velar NC_2 (some dialects)	McConvell (1988)
	Gurindji	Pama-Nyungan	■		Homorganic NC_2	McConvell (1988)
	Kalkatungu	Pama-Nyungan	■		Certain suffixes	McConvell (1988)
	Kwanyama	Niger-Congo	■		All ND_2s but velar	Herbert (1977)
	Mudbura[3]	Pama-Nyungan	■		Homorganic NC_2	McConvell (1988)
	Ndonga	Niger-Congo	■		Alveolar ND_2s	Herbert (1977)
	Ngarinyman	Pama-Nyungan	■		Homorganic NC_2	McConvell (1988)
	Ngazija	Niger-Congo	■		All ND_2s but velar	Herbert (1977)
	Nhanda	Pama-Nyungan	■		Homorganic NC_1	Blust (2012)

[1]Meeussen (1963:27): "In Bolia the rule is restricted to the palatal series with a single nasal in second position ('assimilation')." Mamet (1960:22): "Au pluriel **m** devant **p, b, w** (cette dernière change en **b**) et **nj** devant voyelle (**ny** si le radical comporte comme première consonne une nasale non combinée)." See these works for relevant examples.

[2]In Bilinara and Gurindji, there's comparative evidence that N was oralized in NC_1VN_2#; however, this process is no longer productive and there are many lexical exceptions.

[3]In Mudbura there is also an isolated example of NC_1 nasalization, in the NC_1VN_2 context. See McConvell 1988:155.