

# A simple modular approach to environmental shielding

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▲ Dmitri Shostakovich's *The Nose* at the Royal Opera House, 2016 (directed by Barrie Kosky)

## What is environmental shielding?

(Partial) denasalization of nasals adjacent to oral vowels:

$n^d a$

$a^d n^d a$

$a^d n$

The stopping of the nasal 'shields' the vowel from coarticulatory nasalization.

## What is environmental shielding?

Shielding in Karitiâna (Tupian, spoken in **Rondônia**):

(1) *No stopping in the **absence** of oral vowels*

a. /ãmãn/      [ãmãnʔ]      ‘to plant’

b. /ɲõɲõrõɲ/    [ɲõɲõrõɲʔ]    ‘summer’

(data from Storto 1999: §2.3.2.1)



# What is environmental shielding?

Shielding in Karitiâna (Tupian, spoken in **Rondônia**):

(2) ***Pre-stopping after oral vowels***

- |             |                        |              |
|-------------|------------------------|--------------|
| a. /himĩnã/ | [hi <sup>b</sup> mĩnã] | ‘roasted’    |
| b. /osen/   | [ose <sup>d</sup> nʰ]  | ‘to rejoice’ |
| c. /esiŋã/  | [esi <sup>g</sup> ŋã]  | ‘waterfall’  |

(data from Storto 1999: §2.3.2.1)



## What is environmental shielding?

Shielding in Karitiâna (Tupian, spoken in **Rondônia**):

(3) ***Post-stopping before*** oral vowels  
(or total stopping, if word-initial)

- |    |        |                     |            |
|----|--------|---------------------|------------|
| a. | /ãmo/  | [ãm <sup>b</sup> o] | ‘to climb’ |
| b. | /neso/ | [deso]              | ‘mountain’ |

(data from Storto 1999: §2.3.2.1)



## What is environmental shielding?

Shielding in Karitiâna (Tupian, spoken in **Rondônia**):

(4) ***Pre- and post-stopping **between** oral vowels***

a. /apimik/      [api<sup>b</sup>m<sup>b</sup>ik̚] ‘to pierce’

b. /kina/        [ki<sup>d</sup>n<sup>d</sup>a] ‘thing’

(data from Storto 1999: §2.3.2.1)



Stanton (2018) surveys 324 South American languages, finding that:

- ▶ Shielding occurs **only** in systems that **contrast** oral and nasal vowels (with three apparent exceptions, for which she proposes alternative analyses).
- ▶ Shielding is **most likely** to apply in environments that also/otherwise promote **coarticulatory nasalization**:

**More nasalization**

NV, VN]<sub>σ</sub>

**Shielding more likely**

»

**Less nasalization**

V]<sub>σ</sub>N

**Shielding less likely**

- ▶ Stanton: “**Environmental shielding is contrast preservation.**”

## How to account for shielding

Shielding appears to have one foot in phonology (underlying contrasts) and the other in phonetics (coarticulation).

▶ Stanton's (2018) approach:

- Functional
- Phonetically driven phonology
- Dispersion Theory  
(Flemming 2002)

▶ What I propose in this talk:

- Formal
- Modular
- Contrast+Enhancement  
(Hall 2011)

MINDISTV- $\tilde{V}$ =NASDUR<sub>100%</sub>: (Stanton 2018: 47)

“For a contrast in vocalic nasality to be sufficiently distinct,  
the oral vowel must be fully oral and the nasal vowel must be fully nasal.”

Tableau adapted from Stanton (2018: 48):

| /ma/    /mã/                                                                         |                            | MINDISTV- $\tilde{V}$ =NASDUR <sub>100%</sub> | MAX[-nasal] | *CONTOUR |
|--------------------------------------------------------------------------------------|----------------------------|-----------------------------------------------|-------------|----------|
|  a. | [m <sup>b</sup> a]    [mã] |                                               |             | *        |
| b.                                                                                   | [mã]    [mã]               |                                               | *!          |          |
| c.                                                                                   | [m <sup>ã</sup> a]    [mã] | *!                                            |             |          |

Coarticulatory nasalization is also in the constraint grammar:

NASALISE<sub>Type2</sub>

Assign one violation mark for:

- ▶ each NV sequence where V is not at least 80% nasalised;
- ▶ each VN]<sub>σ</sub> sequence where V is not at least 60% nasalised;
- ▶ each V]<sub>σ</sub>N sequence where V is not at least 40% nasalised.

(Type 1 reverses the percentages for NV and VN]<sub>σ</sub>;  
there's no type where V]<sub>σ</sub>N has the most nasalization.)

## Stanton's account

| /ma/     /mã/                                                                        |                               | NASALISE<br>Type 2 | MINDISTV- $\tilde{V}$<br>=NASDUR <sub>30%</sub> | MAX[-nasal] | *CONTOUR |
|--------------------------------------------------------------------------------------|-------------------------------|--------------------|-------------------------------------------------|-------------|----------|
| a.                                                                                   | [ma]<br>0% nas                | [mã]<br>100% nas   | *!                                              |             |          |
| b.                                                                                   | [m <sup>ã</sup> a]<br>20% nas | [mã]<br>100% nas   | *!                                              |             |          |
| c.                                                                                   | [mã <sup>a</sup> ]<br>80% nas | [mã]<br>100% nas   |                                                 | *!          |          |
| d.                                                                                   | [mã]<br>100% nas              | [mã]<br>100% nas   |                                                 | *!          |          |
|  e. | [m <sup>b</sup> a]<br>0% nas  | [mã]<br>100% nas   |                                                 |             | *        |

## Stanton's account

| /am/                                                                                                  | /ãm/             | NASALISE<br>Type 2 | MINDISTV- $\tilde{V}$<br>=NASDUR <sub>30%</sub> | MAX[-nasal] | *CONTOUR |
|-------------------------------------------------------------------------------------------------------|------------------|--------------------|-------------------------------------------------|-------------|----------|
| a. [am]<br>0% nas                                                                                     | [ãm]<br>100% nas | *!                 |                                                 |             |          |
| b. [a <sup>ã</sup> m]<br>20% nas                                                                      | [ãm]<br>100% nas | *!                 |                                                 |             |          |
|  c. [aãm]<br>60% nas | [ãm]<br>100% nas |                    |                                                 |             |          |
| d. [a <sup>a</sup> ãm]<br>80% nas                                                                     | [ãm]<br>100% nas |                    | *!                                              |             |          |
| e. [a <sup>b</sup> m]<br>0% nas                                                                       | [ãm]<br>100% nas |                    |                                                 |             | *!       |

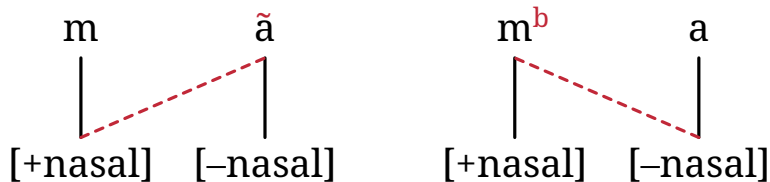
- ▶ ...only seeks to explain shielding, not coarticulatory nasalization itself:

“NASALISE is meant to function as a shorthand for whatever constraints compel nasal coarticulation, and is not meant to function in any way as a claim about how those constraints are defined. [...]ur interest is not in how to derive universals of nasal coarticulation, but in what can be derived from them [...].”  
(Stanton 2018: 56–57)

- ▶ ...refers to arbitrarily fine-grained degrees of phonetic nasality **and** (perhaps not crucially) to  $[\pm\text{nasal}]$  as a categorical phonological feature.
- ▶ ...like other work in Dispersion Theory, requires the grammar to compare surface forms of different inputs.

## Seeking a formal alternative

Could we say that nasalization and ‘shielding’ are just two sides of the same feature-spreading coin (Storto 1999; cf. Anderson 1976)?



Against this, Steriade (1993a,b) argues that:

- ▶ partial denasalization (i.e., shielding) is phonetic
- ▶ [nasal] is inherently privative; there is no [-nasal]

## Some of Steriade's arguments

- ▶ Shielding is phonetic, not phonological:
  - Interorally, shielding can create contours like [<sup>b</sup>m<sup>b</sup>];
  - no languages have **contrastively** medionasal stops;
  - so we shouldn't admit <sup>b</sup>m<sup>b</sup> as a phonological representation.



- ▶ [nasal] is privative:
  - The presence of nasal segments in an inventory implies the presence of their oral counterparts, but not *vice versa*.
  - There is categorical assimilation to nasality, but not to orality.
  - There is no **dissimilation** of [ $\pm$ nasal] between adjacent/nearby segments.

Stanton (2018: 46, footnote 7; emphasis added):

“An anonymous reviewer suggests that the analysis involving constraints like \*NV and \*VN could be saved if [ $\pm$ nasal] is only specified when a V– $\tilde{V}$  contrast is present. To the extent that this proposal is successful, it underscores the major argument of this article: that **any successful analysis of shielding must in some way explicitly reference contrast**. However, the proposal cannot account for the further generalisations outlined in §3” [i.e., the correlation between contexts where shielding and coarticulatory nasalization occur].

An alternative to Dispersion Theory:

- ▶ Features are specified in a contrastive hierarchy (Dresher 2009).
- ▶ In phonetic implementation, specified features may be enhanced by being translated into multiple gestures with similar auditory effects (Stevens & Keyser 2010, etc.).
- ▶ If only contrastive features are specified, their enhancement will increase the distinctness of the surface realizations, with no need for explicit comparison of phonetic forms (by, e.g., MINDIST constraints).

**Phonology:** discrete symbolic features; contrastive underspecification

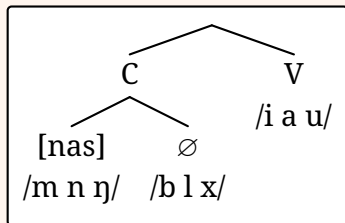
**Phonetics:** some combination of articulatory gestures and acoustic targets

Caveats:

- ▶ The mapping from features to phonetics is not one-to-one.
- ▶ For illustration, I'll use simple gestural instructions here.
- ▶ That looks kind of like Articulatory Phonology (Browman & Goldstein 1986, 1989, 1992), but for me, this part is phonetics.

## Translating phonological features into phonetic instructions

With privative features, we need to traverse the hierarchy to identify where the absence of a feature is contrastive:

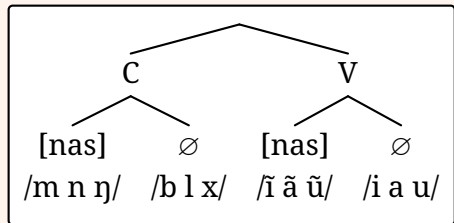


```
If C then {  
  If [nas] then {Velum Down ...}  
  Else {Velum Up ...}  
}  
Else {...}
```

If the absence of [nasal] is non-contrastive on vowels, they get no instructions for the velum.

## Translating phonological features into phonetic instructions

But if vowels contrast for [nasal], they *do* get velic instructions:



```
If C then {  
  If [nas] then {Velum Down ...}  
  Else {Velum Up ...}  
}  
Else {  
  If [nas] then {Velum Down ...}  
  Else {Velum Up ...}  
}
```

## Phonetic implementation

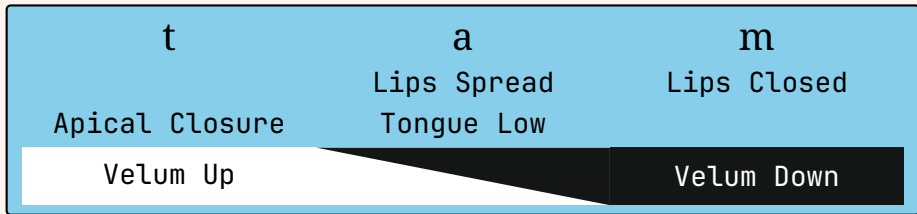
With no nasality contrast on vowels:

| t              | a                         | m           |
|----------------|---------------------------|-------------|
| Apical Closure | Lips Spread<br>Tongue Low | Lips Closed |
| Velum Up       |                           | Velum Down  |

► /a/ has no velic instructions of its own.

## Phonetic implementation

With no nasality contrast on vowels:



- ▶ /a/ has no velic instructions of its own.
- ▶ Its nasality will be determined by interpolation between /t/ and /m/.
- ▶ Coarticulatory nasalization is possible; shielding is not.

## Phonetic implementation

With a contrastively oral vowel:

| a           | m           |
|-------------|-------------|
| Lips Spread | Lips Closed |
| Tongue Low  |             |
| Velum Up    | Velum Down  |

► /a/ and /m/ have opposing velic gestures.

## Phonetic implementation

With a contrastively oral vowel:

| a           | ã | m           |
|-------------|---|-------------|
| Lips Spread |   | Lips Closed |
| Tongue Low  |   |             |
| Velum Up    |   | Velum Down  |

- ▶ /a/ and /m/ have opposing velic gestures.
- ▶ Anticipation of **Velum Down** = nasalization.

## Phonetic implementation

With a contrastively oral vowel:

| a           | b | m           |
|-------------|---|-------------|
| Lips Spread |   | Lips Closed |
| Tongue Low  |   |             |
| Velum Up    |   | Velum Down  |

- ▶ /a/ and /m/ have opposing velic gestures.
- ▶ Anticipation of Velum Down = nasalization.
- ▶ Perseveration of Velum Up = shielding.

## The correlation

Shielding is most likely to apply in environments that also/otherwise promote coarticulatory nasalization:

**More nasalization**

NV, VN]<sub>σ</sub>

**Shielding more likely**

»

**Less nasalization**

V]<sub>σ</sub>N

**Shielding less likely**

- ▶ So, the same environments favour extension of either Velum Down or Velum Up gestures across segment boundaries.
- ▶ The basic pattern seems to be that syllable boundaries reinforce segment boundaries, making gestures less likely to cross them.

The approach described here:

- ▶ is **modular**. Contrast is phonological; coarticulation is phonetic.
- ▶ is compatible with (but not dependent on) Steriade's claim that [nasal] is privative, and concurs with her that shielding is phonetic.
- ▶ is **non-teleological**. Shielding depends on contrast, but doesn't need to be directly motivated by contrast preservation.
- ▶ does not require the grammar to compare outputs for different inputs.
- ▶ is simple.



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