

A novel three-way prosodic contrast in Amuzgo word-initial NC sequences

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Context: What's in an NC?

- Cross-linguistically, nasal-plosive sequences (NC) reflect a diversity of phonological structures (Browman & Goldstein 1986, Herbert 1986, Maddieson 1989, Maddieson & Ladefoged 1993, Iverson & Salmons 1996, Downing 2005, Durvasula 2009, Riehl & Cohn 2011, Stanton 2017).
- They may be:
 - unary contour segments: prenasalized stops [ⁿd], postoralized nasals [n^d]
 - bisegmental sequences of various prosodic configurations: tautosyllabic or heterosyllabic clusters [nd, n.d]
 - syllabic nasals followed by a simple onset: [ŋ.d]

Amuzgo: An introduction

- A branch of the Oto-Manguean family
 - Spoken in Guerrero and Oaxaca States, southern Mexico, by around 30-40,000 people
 - At least 4 varieties where mutual intelligibility is not straightforward
 - Various word-initial NC sequences in different morphophonological contexts
- What are they, phonologically?
What are they like, phonetically?

Approximate location of Amuzgo in Mexico



Amuzgo: A phonological profile

1. Tonally complex (XA: 3 level & 3 contour tones; SPA: up to 5 level & 3 contour tones)
2. Nasal vowels
3. Diphthongs exist
4. Three-way phonation: modal, laryngealized, “breathy”
5. CCC is maximal initial where C_1 is a nasal, C_3 usually a glide
6. Strong monosyllabic tendency: $(N)(C_2)V(^n)(?)$ with reduction of pretonic syllable (iambic stress in the root)
7. Historically *CVCV (Longacre & Millon 1961)

Consonant inventory

	Bilabial	Apico- dental	(Lamino-) Postalveolar	Velar	Glottal
Plosive	(p)	t	tʃ	k k ^w	ʔ
Affricate		ts	tʃ		
Fricative	(β)	s	ʃ		h
Nasal	m	n	nʃ		
Trill		r			
Tap		ɾ			
Lateral		l			
Glide	w			j	

Vowel qualities

- Monophthongs (7 oral, 5 nasal)

i u
e ã o õ
ɛ ẽ ɔ õ
a ã

- Diphthongs (6 oral, 4 nasal)

	<u>high</u>	<u>mid</u>	<u>low</u>	<u>mid</u>	<u>low</u>
i _—	iu	io	ia	ĩõ	ĩã
u _—	ui	ue	ua	ũẽ	ũã

- Plus 3 phonation types and various level and contour tones

A three-way NC contrast

Previous sources vary widely in their characterizations of NC sequences (Bauernschmidt 1965: 476-480, Smith-Stark & Tapia García 1984: 208, Buck 2000, Herrera Zendejas 2009: 154, Buck 2018, Hernández 2019, Dobui 2021, Kim & Hernández 2021).

However, a critical synthesis of these descriptions and analyses allows us to posit a three-way phonological contrast:

N^C “Shielded” nasal, an allophone of /n^(j)/ before an oral vowel
(1) /nia^H/ [n^dia] ‘clothes’

NC Cluster of nasal + obstruent (gets voiced before diphthongs)
(2) /n-tĩõ^M/ [ndĩõ^M] ‘corral’, pl. (cf. tĩõ^M ‘corral’, sg.)

N.C Syllabic nasal + obstruent onset (gets voiced before diphthongs)
(3) /ṅ^H-tũã^M/ [ṅ^H.tũã^M] ‘wash’, 3pl. fut.

Data from the variety of San Pedro Amuzgos, Oaxaca (SPA)

Outline and preview

- Review of phonological arguments for the three categories of NC
- Acoustic phonetic study: is the three-way distinction just a morphophonological abstraction (cf. Ladefoged & Maddieson 1986), or is it also detectable on the phonetic level?
- *Spoiler:* It is surprisingly non-robust phonetically, at least for the one younger SPA speaker studied in detail, but there are various interesting things going on
- Consideration of typological and theoretical implications

1. Morphophonological status

Morphophonological status

- Two varieties of Amuzgo were looked at: **SPA** San Pedro Amuzgo and **XA** Xochistlahuaca Amuzgo
- NC sequences are common in both varieties
 - Occurs monomorphemically in roots (a)
 - And multimorphemically because segmentally homophonic {n} prefixes for both the nominal plural (b, c) and the future marker (d)

4)	<u>Word</u>	<u>Gloss</u>	<u>Phonological type</u>	<u>Variety</u>
a.	$\eta^{dj}o^H$	'mouth'	N^C Shielded nasal	XA
b.	n^{dio}^{MH}	'bottles', pl.'	N^C Shielded nasal	SPA
c.	$nd^{ju}\epsilon^L$	'hills', pl.	NC Nasal + obstruent cluster	SPA/XA
d.	$n-tje^{HL}$	'wash oneself', fut.	$\bar{N}.C$ Syllabic nasal + simple onset	SPA

Evidence for shielding /n/ → [n^d]

- Active morphophonological alternations between [n] and [n^d] based on nasality/orality of following vowel (Dobui 2021, Kim & Hernández 2021)
- In (a) the monomorphemic root's shielded nasal deoralizes when marked by a nasal 3sg possessive marker: **n^{dj}o^H 'mouth' → n^õ^H mouth.3sgposs**
- In (b) 'bottles' is multimorphemic: the plural nasal prefix triggers loss of the initial consonant of the singular stem : **tsio^{MH} → n^dio^{MH} 'bottles', PL.**

4)	<u>Word</u>	<u>Gloss</u>	<u>Phonological type</u>	<u>Variety</u>
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d.	n-t ^j e ^{HL}	'wash oneself', fut.	N ₁ .C Syllabic nasal + simple onset	SPA

Morphophonological status

- In (c) ‘hills’ is multimorphemic: the plural nasal prefix attaches to a stop-initial single stem without change to the base: $t^j u \epsilon \text{?}^B > n d^j u \epsilon \text{?}^B$ ‘hills’, PL.
- In (d) is a multimorphemic word where the stop-initial stem for ‘wash oneself’ is marked by the future prefix $\{n^H\}$, lexically high-tone

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Morphophonological status

NB: Stop voicing is non-contrastive
Before diphthongs, post-nasal stops
are automatically voiced

- In (c) 'hills' is multimorphemic. It consists of a stop-initial single stem without a plural marker and a plural marker. The word is $nd^j u \epsilon \text{?}^B$ 'hills', PL.
- In (d) is a multimorphemic word where the stop-initial stem for 'wash oneself' is marked by the future prefix $\{n^H\}$, lexically high-tone

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Morphophonological status

- The phonological constructions **N^C** and **NC** are both found in both mono and multimorphemic words

5)

	N^C	NC
Monomorphemic	hndɛ ^{MH} 'sell' (ma-hnɛ̃ ^{MH} 's/he is selling') [XA]	ntiʔ ^H 'excrement' ntõ ^M 'black'
Multimorphemic	n ^d -ɛ ^L 'arches, pl.'	n-tɛ ^L 'fruit, pl.' (tɛ ^L 'fruit, sg.)

Morphophonological status

- The phonological construction **N.C** corresponds to future marked verb stems where the future marker is a lexically high tone {n^H}

→ Before diphthongs, post-nasal stops are automatically voiced

6)

	N.C	gloss	Variety
Multimorphemic	n ^H -tj ^{HL} e ^{HL}	fut-wash.oneself	SPA
	ŋ ^H -dʒio ^M	fut-put	SPA

Morphophonological status

- NT sequences are more widely distributed in SPA than in XA given slightly different morphophonological strategies for nasal blocking
- SPA prefers [nd/t] shielding where XA has a diversity of surface forms: (7) an non-nasal allomorph [l] in plural marking and (8) and allomorphs [nl] in future marking

Compare:

<u>gloss</u>	<u>variety</u>	<u>form</u>	<u>phonological type</u>
7) 'bottles', pl.	in SPA:	n^dio^{MH}	N ^C Shielded nasal
	in XA :	lio^{HL}	
8) fut-eat	in SPA:	ṅ^H-tkwaʔ^M	N ₁ .C Syllabic nasal
	in XA:	ṅ^Hl-kwaʔ^M	

2. Phonetic nature of the contrast

Phonetic nature of the contrast

- Voicing alternations mean that the three-way contrast is potentially available with both voiced and voiceless plosive phases

	UR	Voiced context	Voiceless context
Shielded nasal	/n/	/nV/ → [n ^d V]	/nhV/ → [n ^t hV]
NC cluster	/nt/	Diphthong	Monophthong
Syllabic nasal + C	/nt/	Diphthong	Monophthong

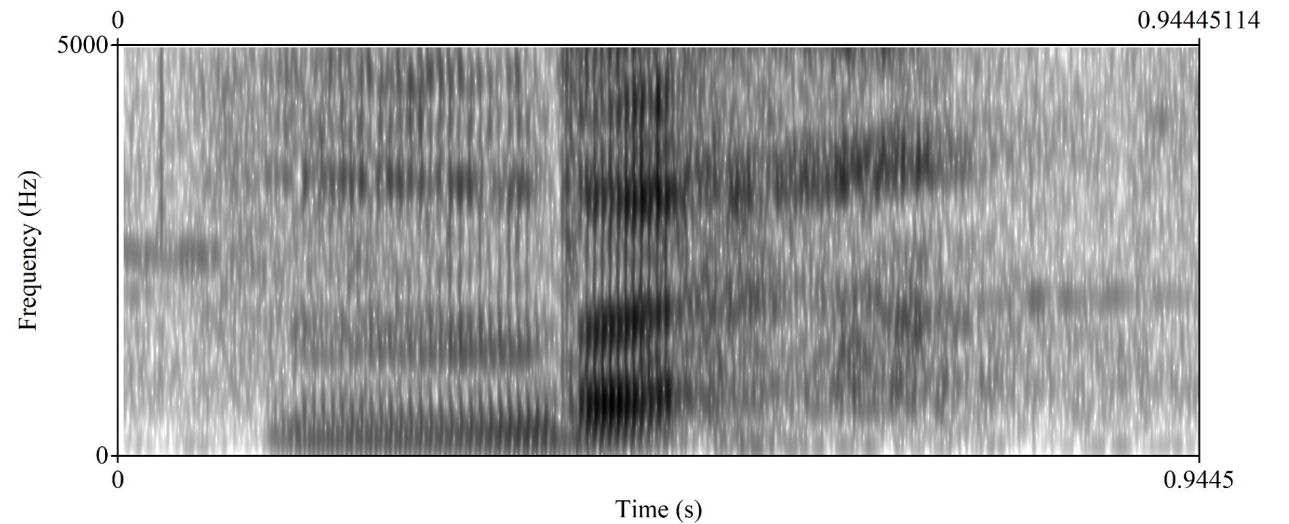
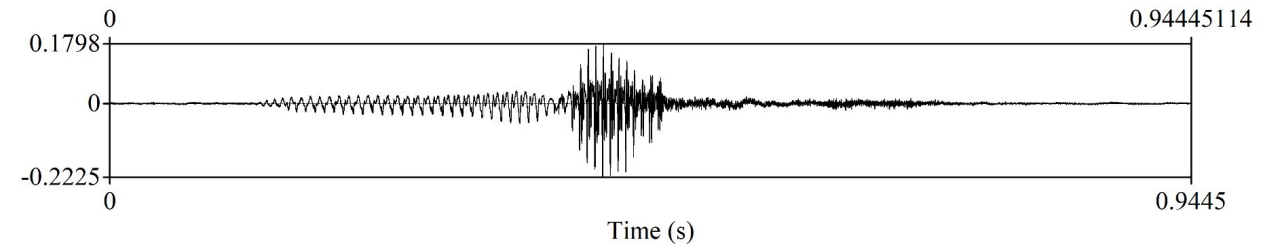
Phonetic nature of the contrast

- Initial analysis: a small amount of data from one male speaker (b. 1936) of SPA, native speaker linguist Fermín Tapia García
- Tapia García appears to distinguish robustly between the three types of NC sequences

Phonetics of [n^d] v. [nt]

Shielded [n^d]: very short
plosive duration

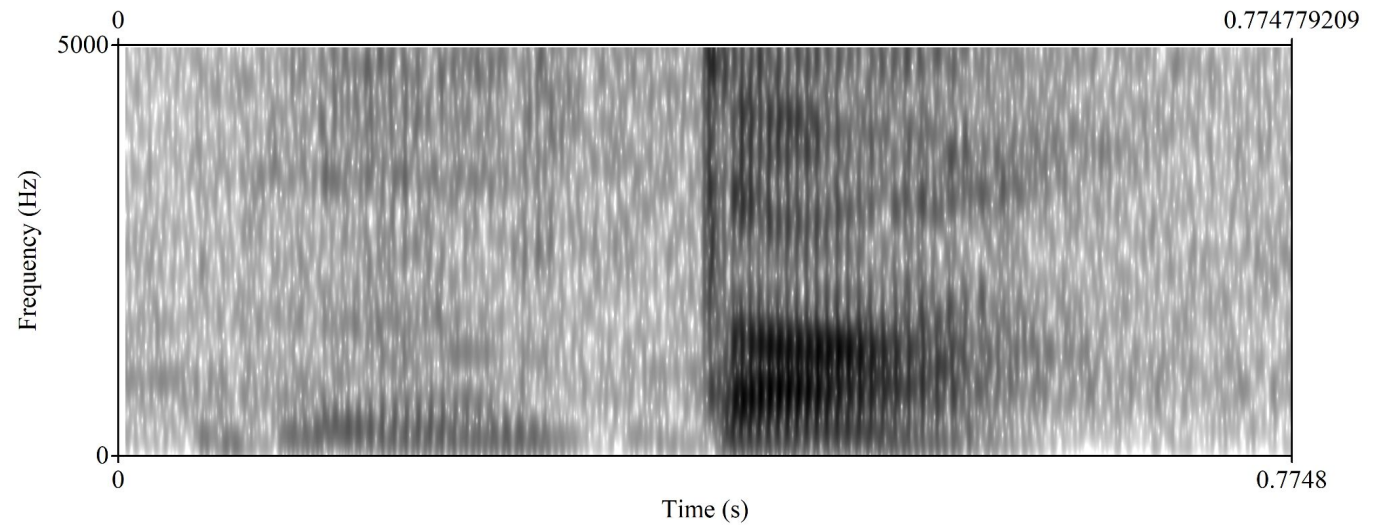
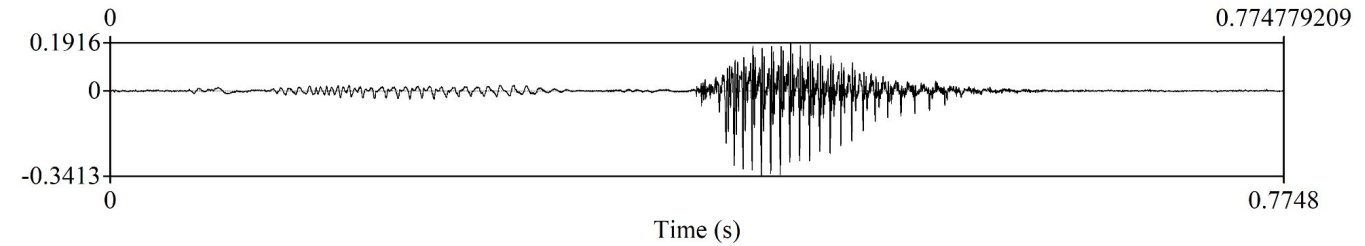
E.g. [n^dεʔ^{HL}] ‘graneros de maíz’



Phonetics of [n^d] v. [nt]

Cluster: longer plosive phase;
voiceless

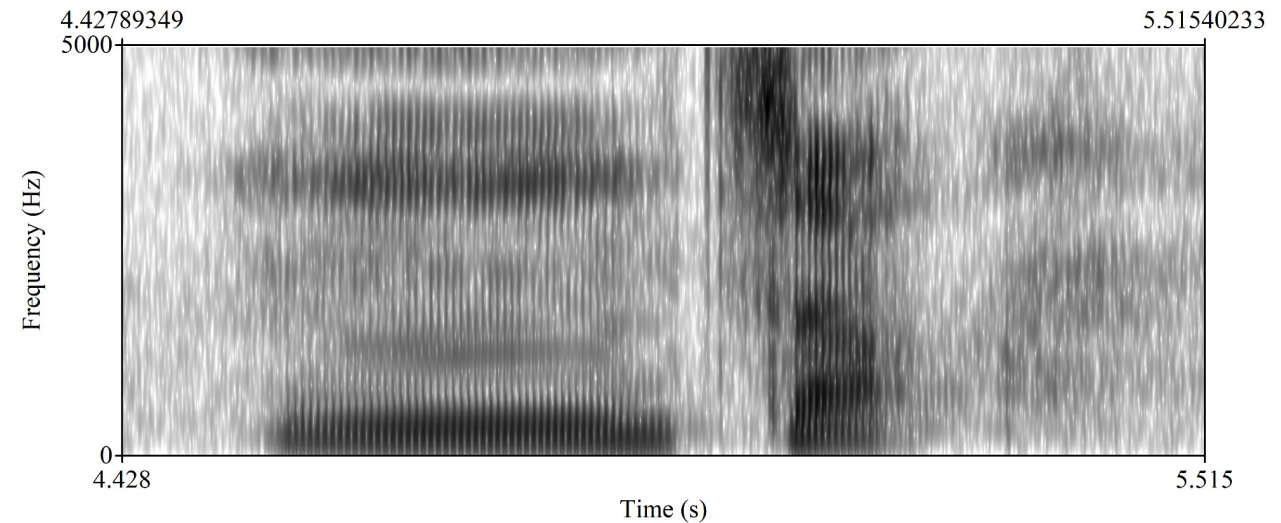
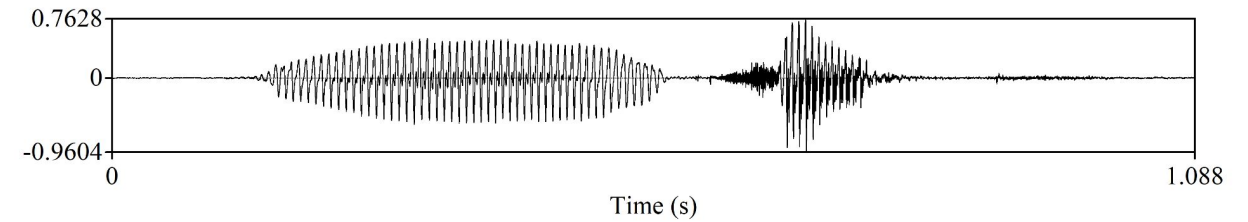
E.g. [nta^{HL}] ‘wedding’



Phonetics of syllabic nasals

Nasal duration of 300-400ms, as compared with ~200ms for non-syllabic NC clusters

E.g. [ŋ^H-tsaʔ^{HM}] 'do, 2sg. fut'



Phonetic nature of the contrast

Why was further study needed?

- The original wordlist was not designed for this purpose, so it does not contain tokens of every relevant type. It also consists of forms in isolation, rather than in a frame sentence.
- Notably, there is not enough data to keep voicing constant in comparisons of the three NC types. This is a confound because closure durations are expected to naturally be shorter for voiced plosive phase like in [n^d], than for voiceless ones like in [nt].
- Casual observation strongly suggests a high degree of phonetic variation in the younger generation's NC realizations.
- Phonetic information may inform orthographic choices about whether to write nd v. nt, nd v. nnd, etc.

Data collection

- 1 female SPA speaker (b. 1990s) (and 1 female XA speaker (b. 1954); only the SPA analysed as of yet)
 - Elicited targeted word list in carrier sentence *matsjö _ ra* 'well, I say _'
 - Total of 288 tokens collected (96 words, 3 repetitions each – with 6–24 tokens excluded)
 - Shure SM35 headset mic with Zoom H4n recorder

Partial overview of the data

	N	ND	D	T	Th
control	18	—	—	—	—
shielded	—	—	44	—	21
cluster	—	—	12	31	—
syllabic	24	44	51	15	3

Data processing

- Forced-aligned with SPPAS (customisations localised specifically and individually for SPA and XA)
- Manual correction for the segments of interest (i.e. word-initial /N(C)(h)/ sequences in target words) by one author and checked by another
- Extra tier added coding for (morpho)phonological metadata
- Metadata and durations extracted by Praat script for nasal portion, plosive closure, aspiration (though we won't see aspiration here)
- Both absolute and relative values calculated (only absolute values here)
- Extracted data were then processed and plotted using R

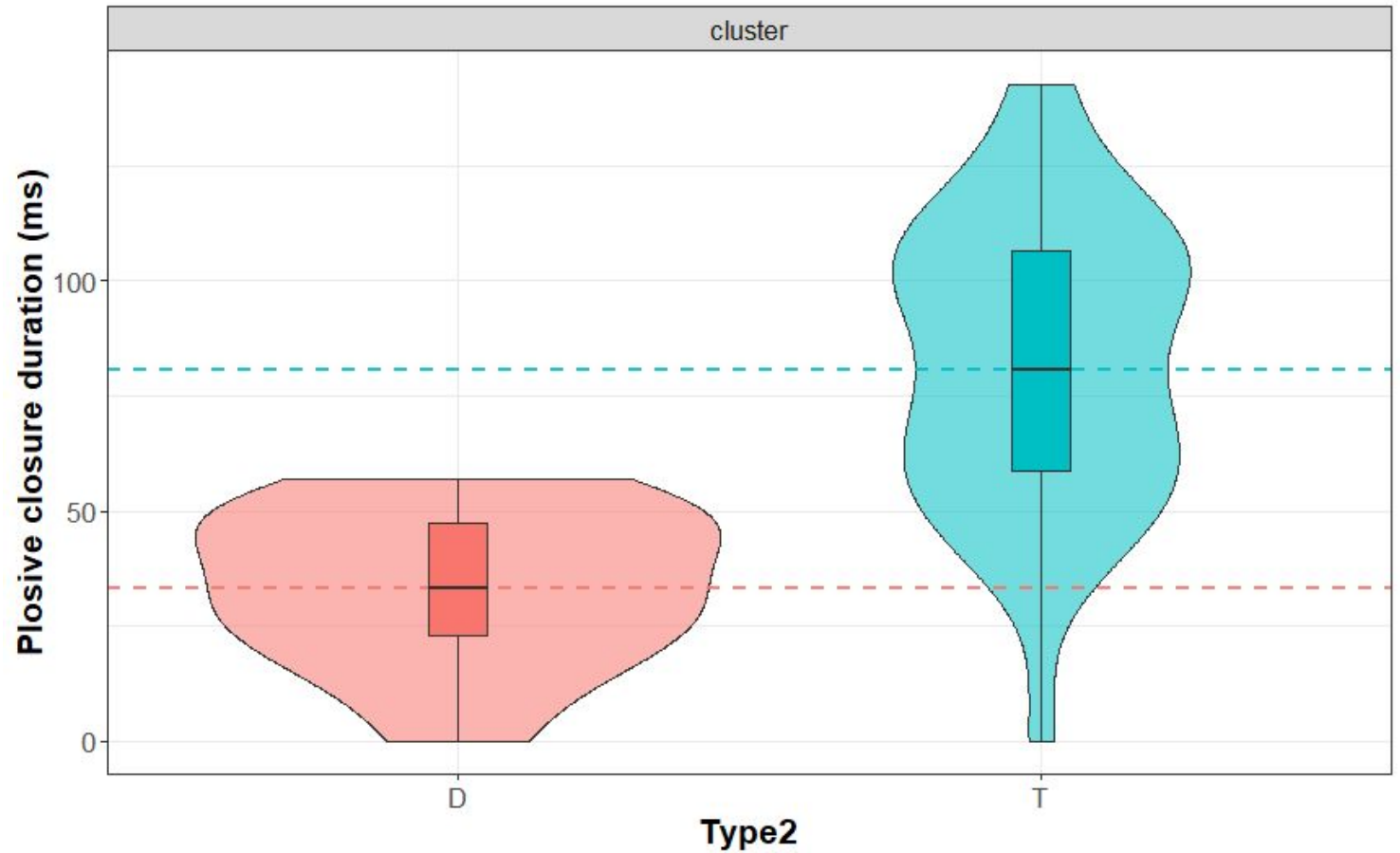
Headline results

- **Voicing matters.** Not only are **closure durations shorter for D** and longer for T, but there is also an **inverse effect on nasal durations: longer before D**, and shorter before T. This holds across all three NC categories.
- Unexpectedly, and also across all three NC categories, **plosive closure** durations are **longer for palatalized** than for non-palatalized consonants.
- When these factors are controlled for, there do not seem to be *consistent* durational differences between the three NC categories.
- However, similar medians sometimes disguise very different distributions, and this is something to follow up on. Shielded N^C shows very wide variation, such that extreme realizations - mainly, near-absence of the plosive closure - are limited to this category.

Voicing matters: Plosive closure duration

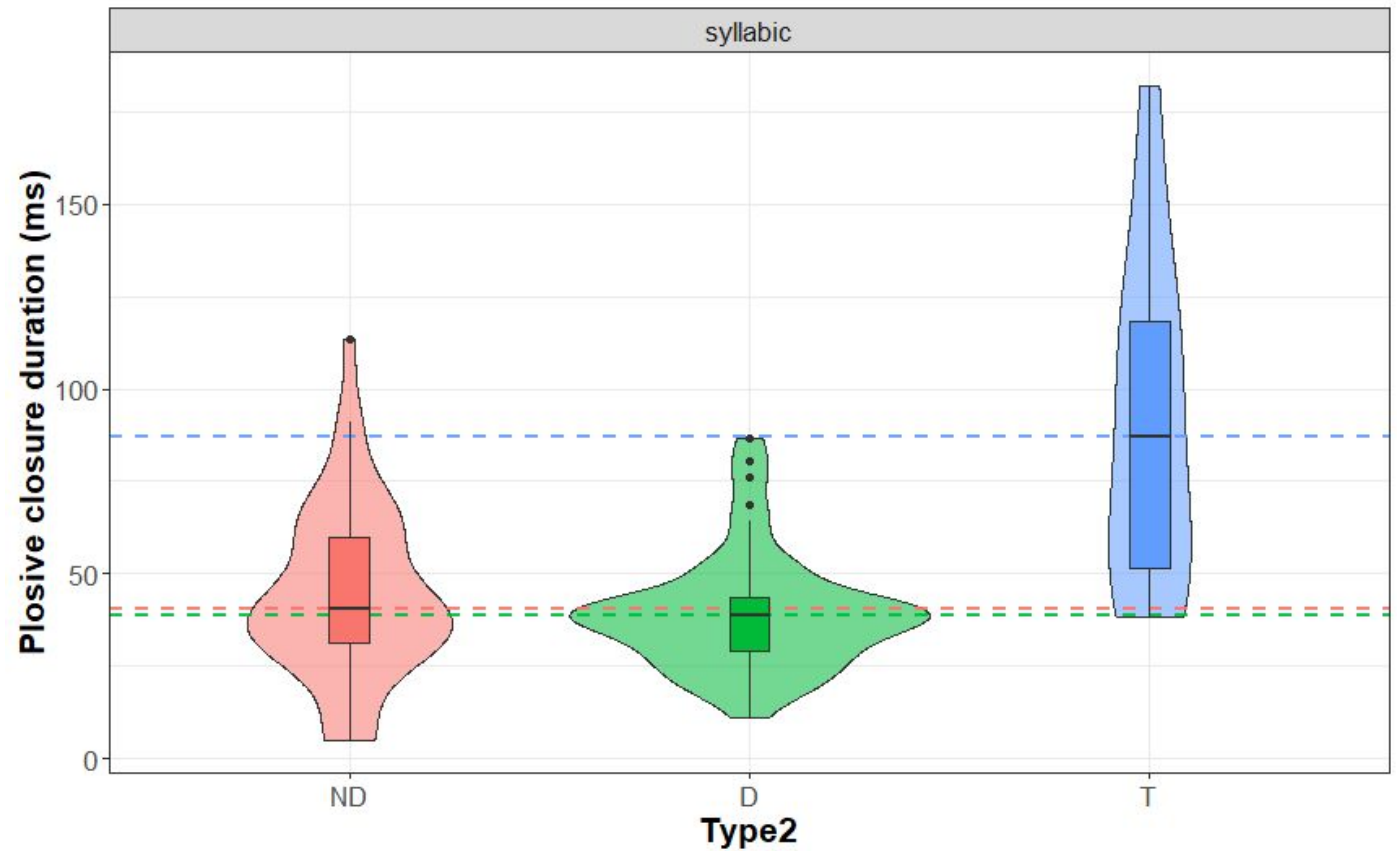
As expected, duration of the plosive closure is shorter for voiced **D** than for voiceless **T**

(Shown here for clusters)



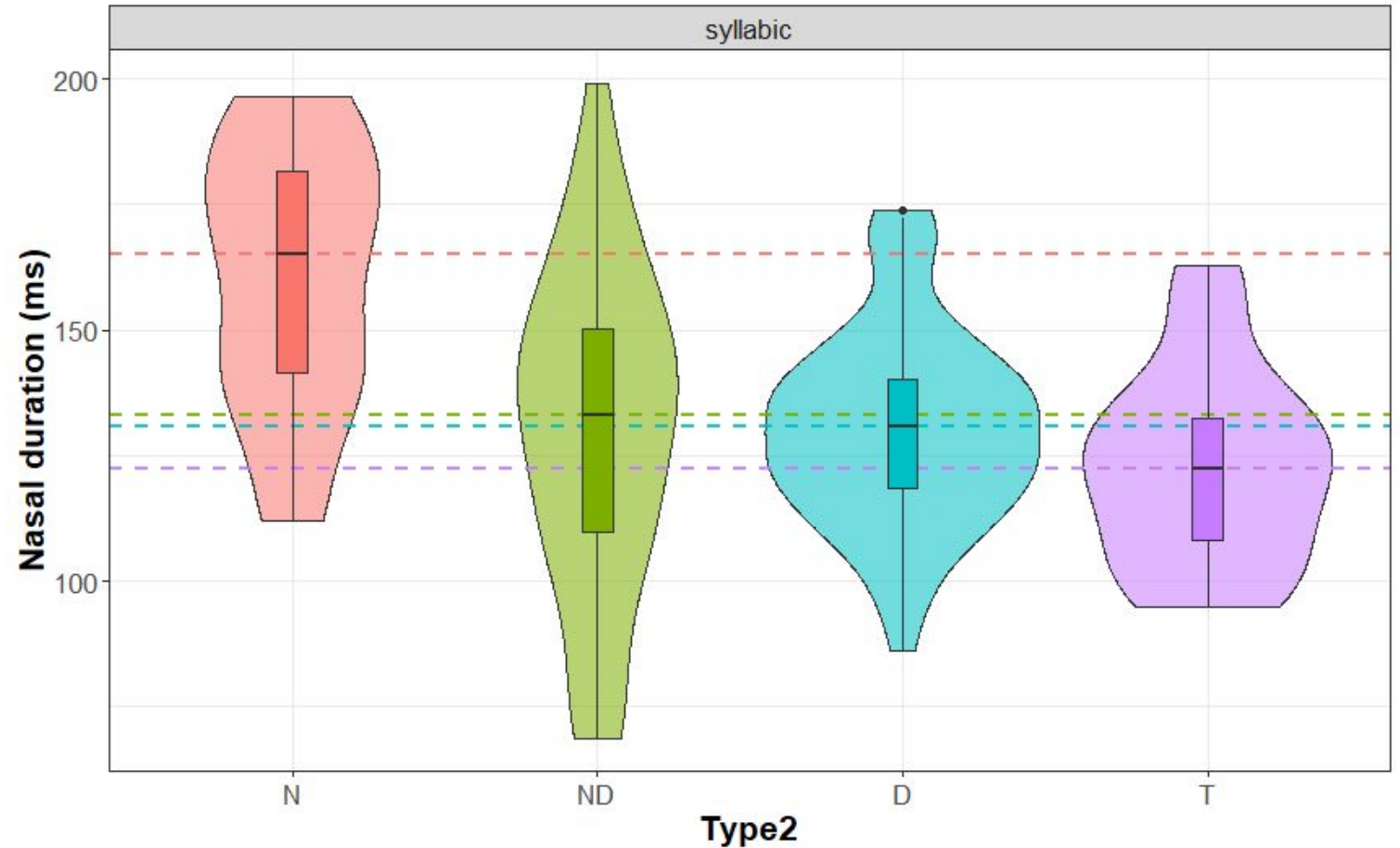
Voicing matters: Syllabic N.C (plosive closure duration)

- Same pattern: plosive closure duration shorter for voiced



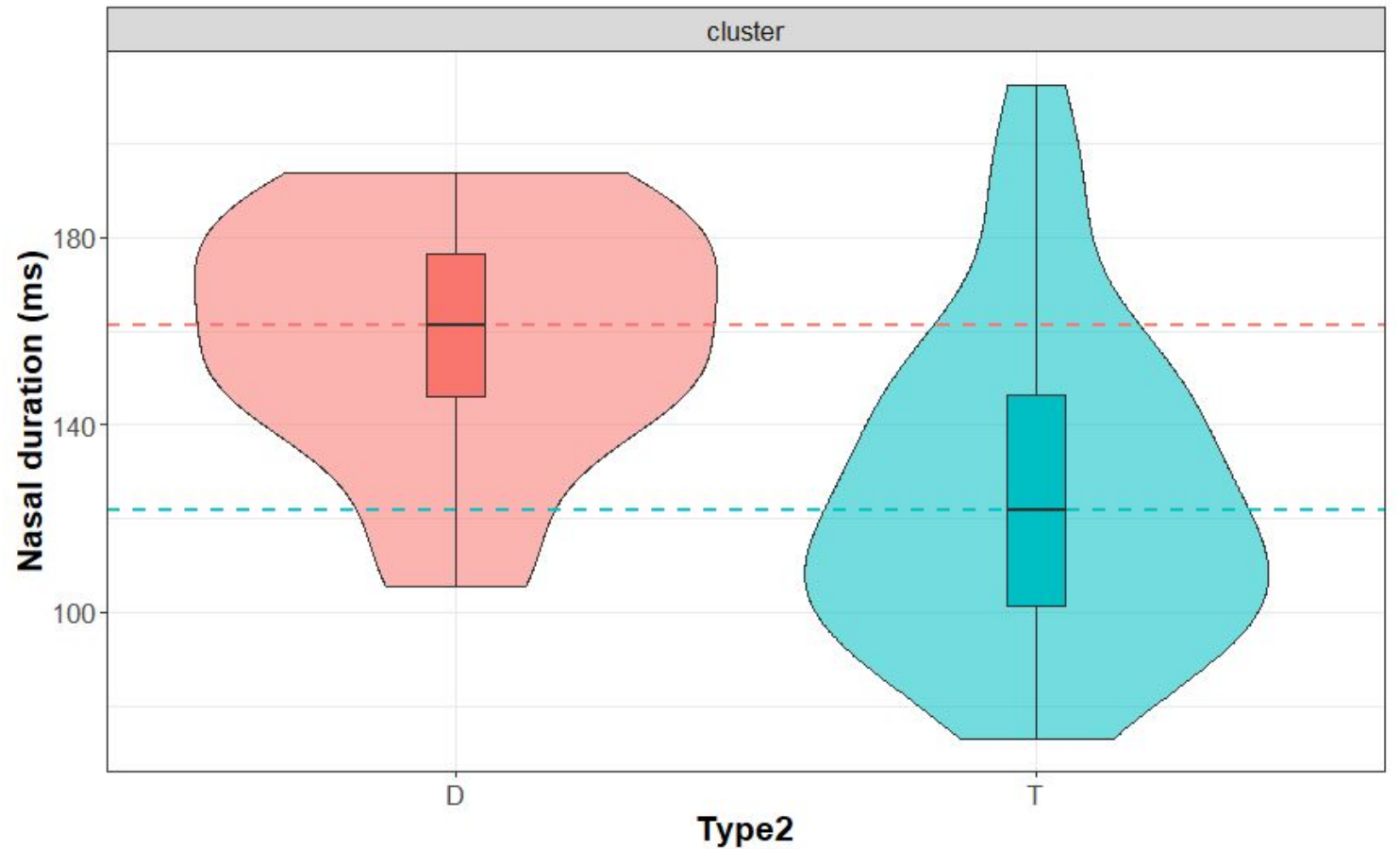
Voicing matters: Syllabic N.C (nasal duration)

- Inverse effect on nasal duration: slightly shorter before voiceless stem-initial T



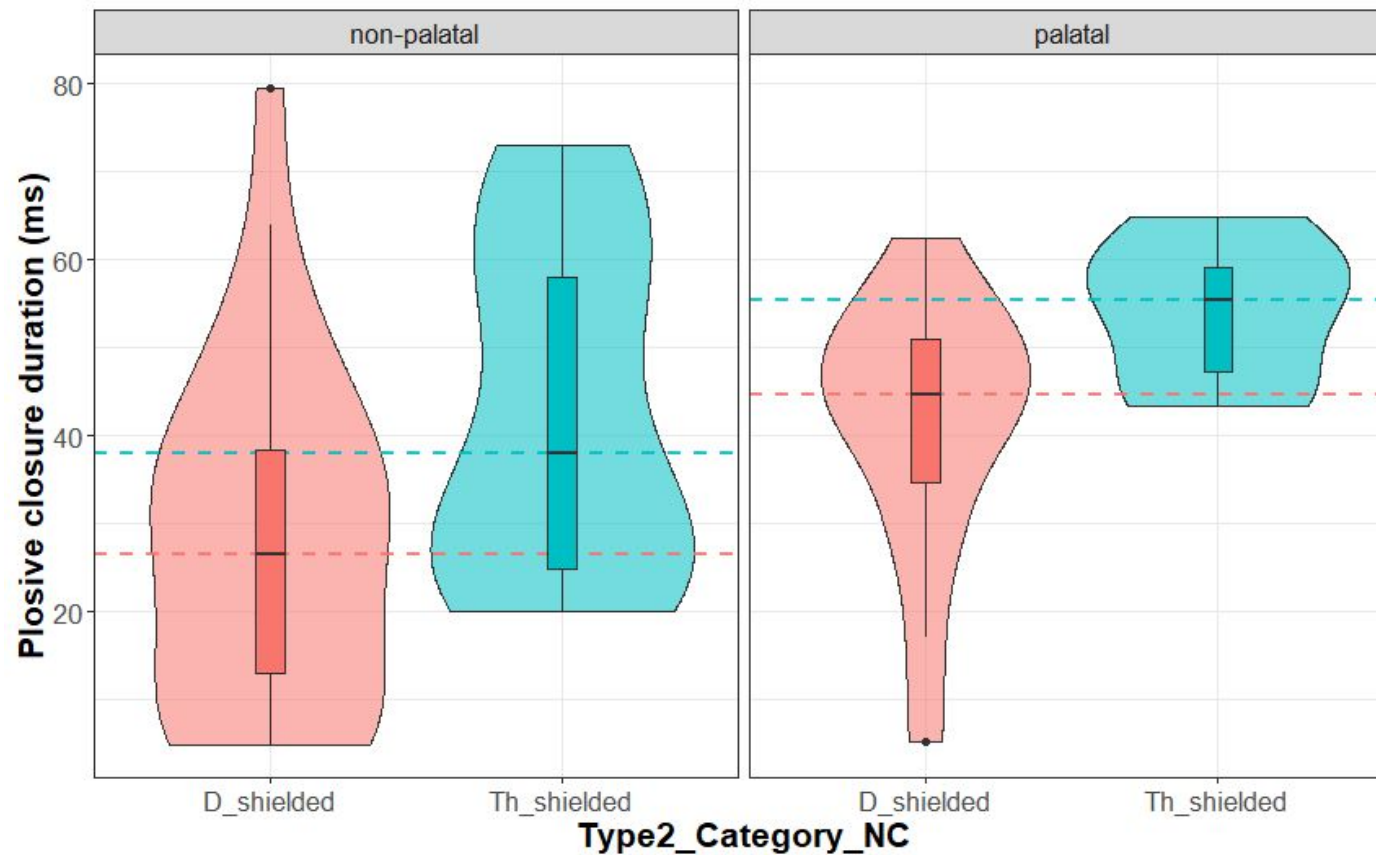
Voicing matters: Nasal duration

- Interestingly, the inverse is true for nasal duration: longer before **D** than before **T**
- (again, shown here for clusters)



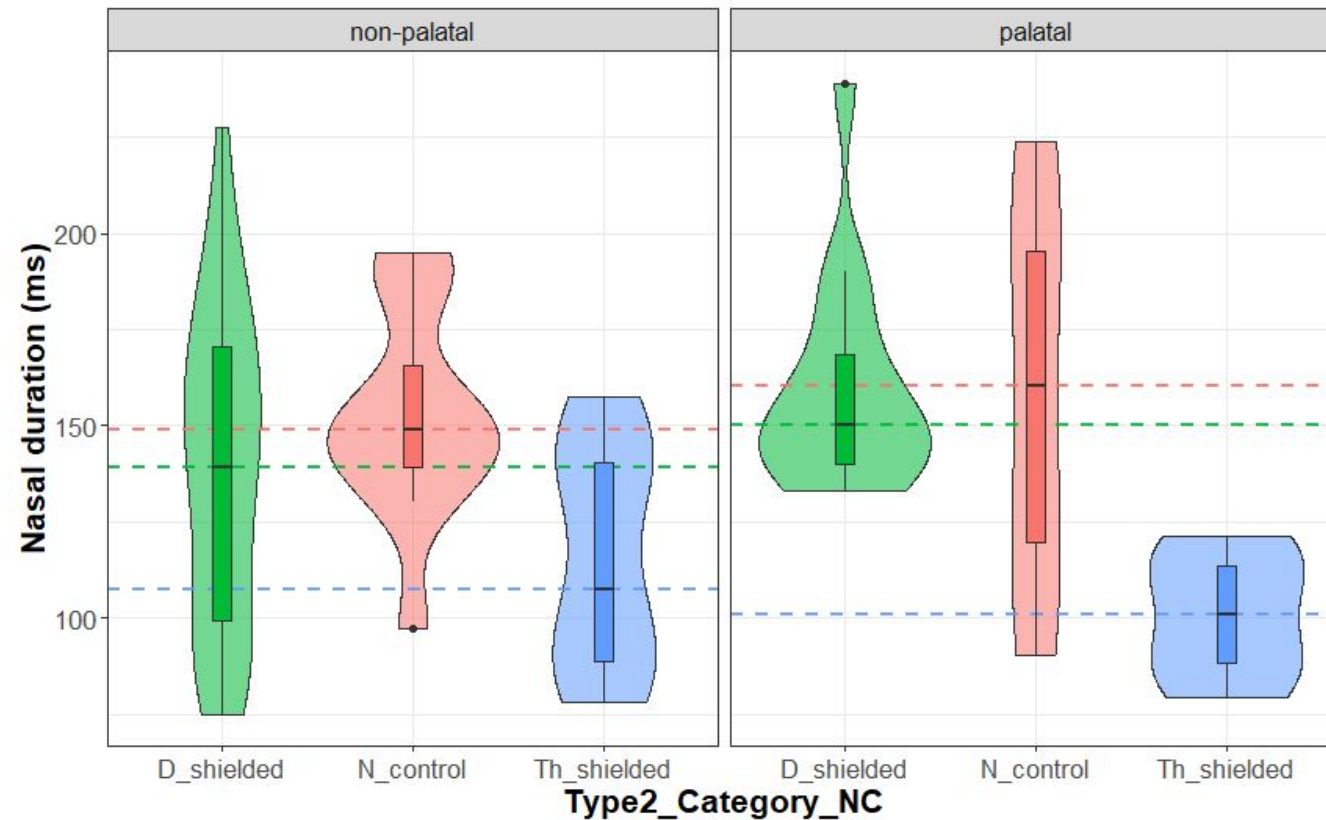
Voicing matters: Shielded nasals (plosive closure duration)

- Plosive closure shorter for voiced D, both non-palatal and palatal



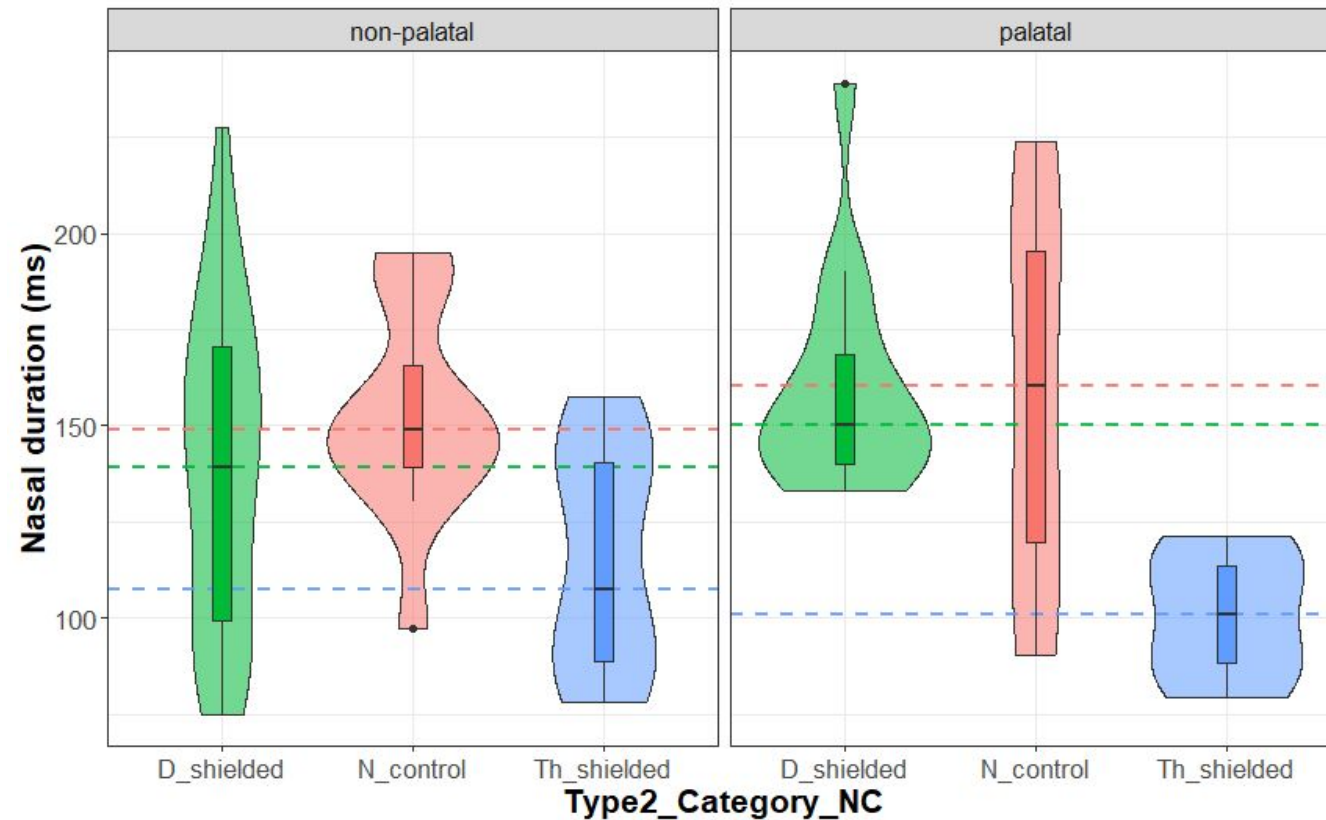
Voicing matters: Shielded nasals, nasal duration

- Inverse effect on nasal duration: before voiceless T is shortest

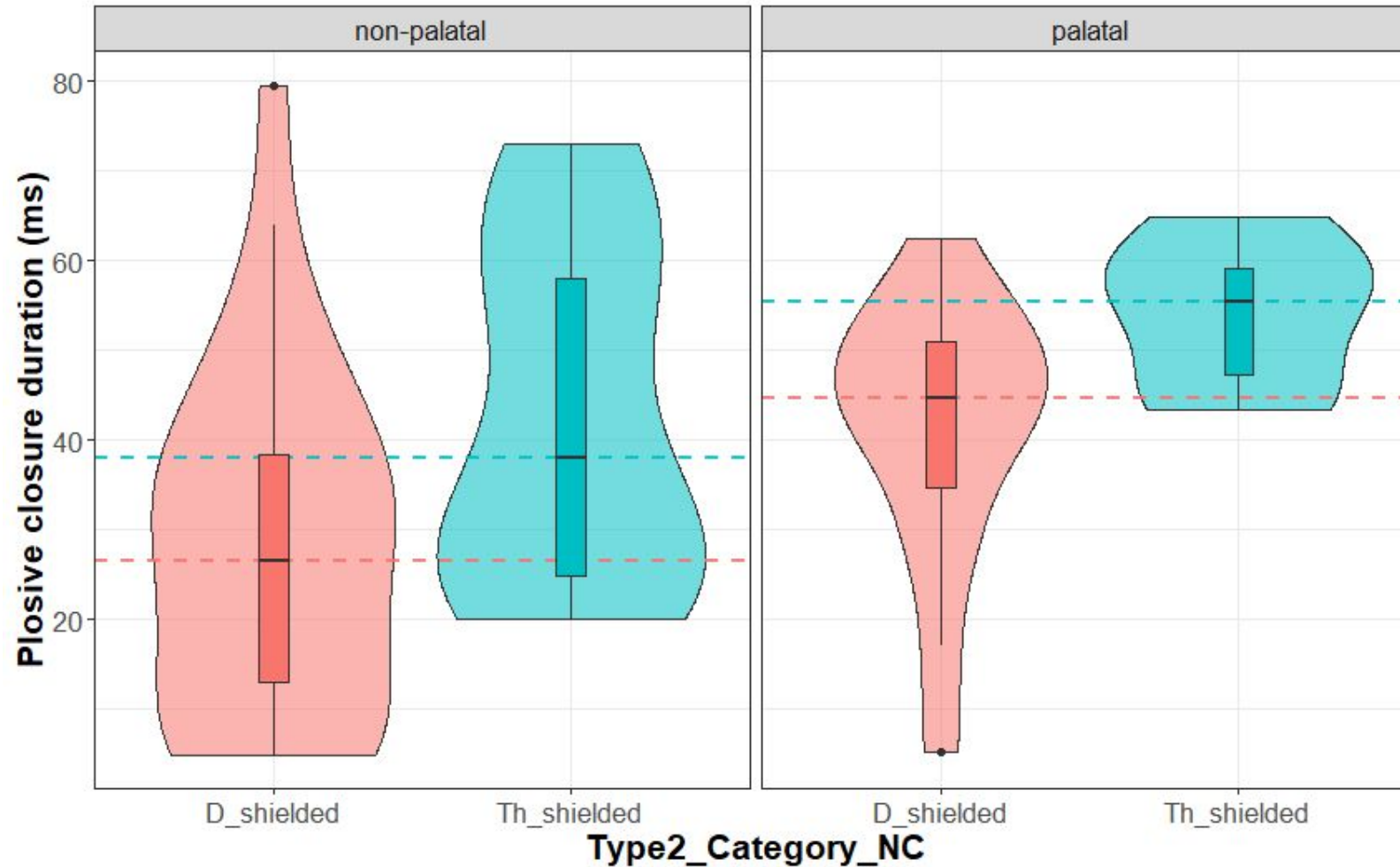


Does **palatality** matter? Shielded nasals, nasal duration

- No? Nasal duration is very similar before non-palatals and palatals

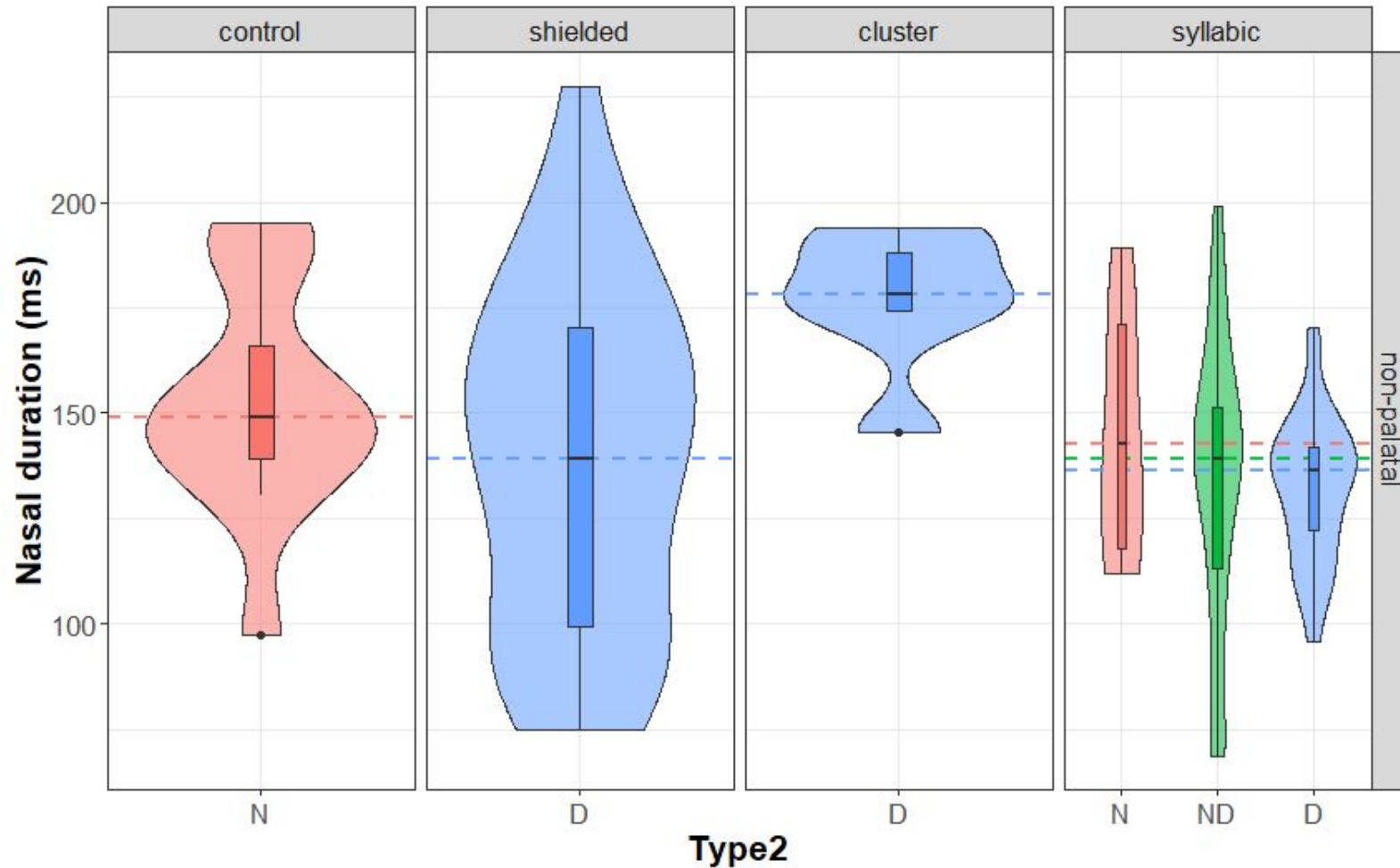


Palatality *does* matter: plosive closure duration (shielded nasals)



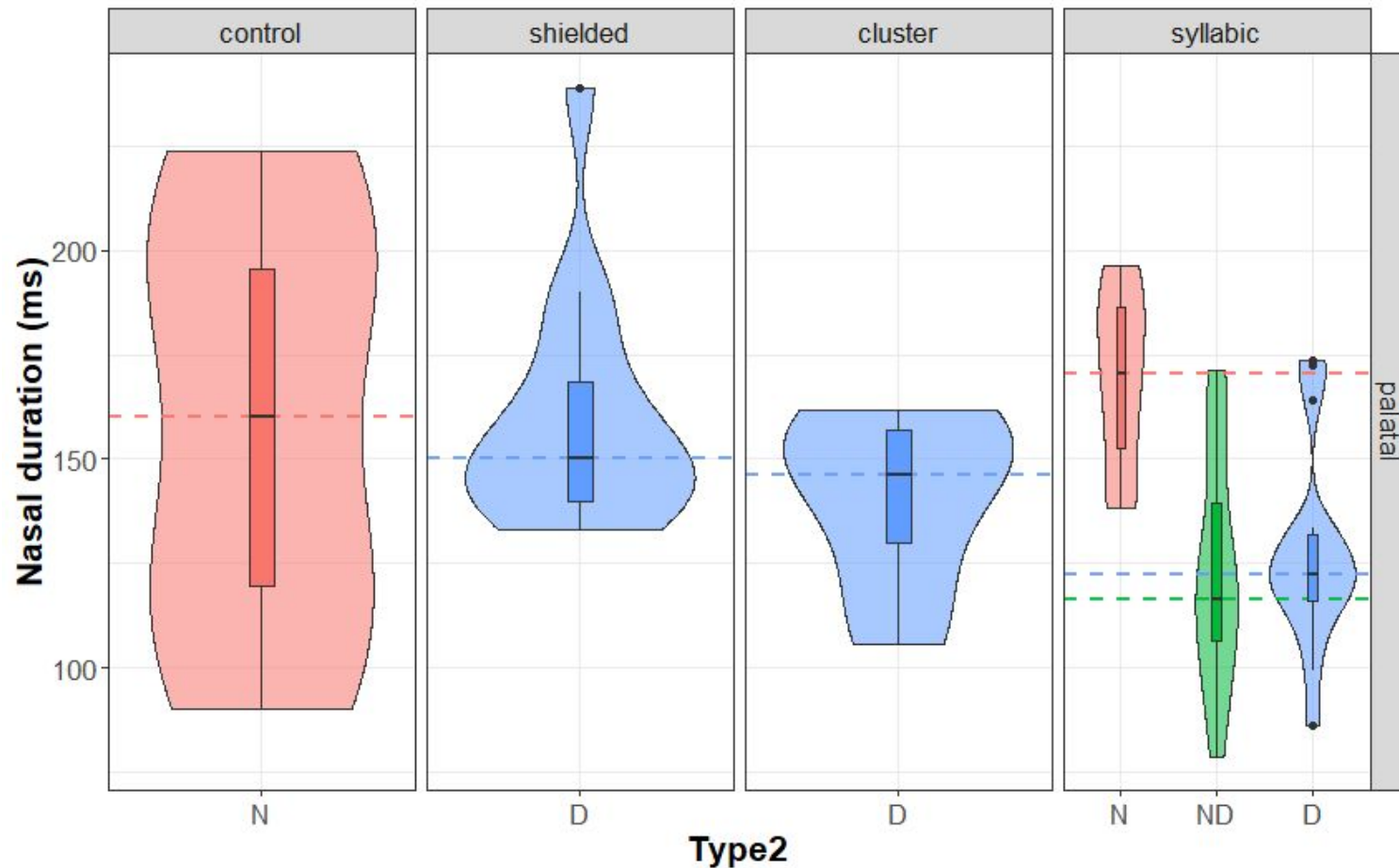
The search for cues: N^C - NC - $\underset{\cdot}{N}.C$

- Nasal duration with non-palatals (voiced condition only)



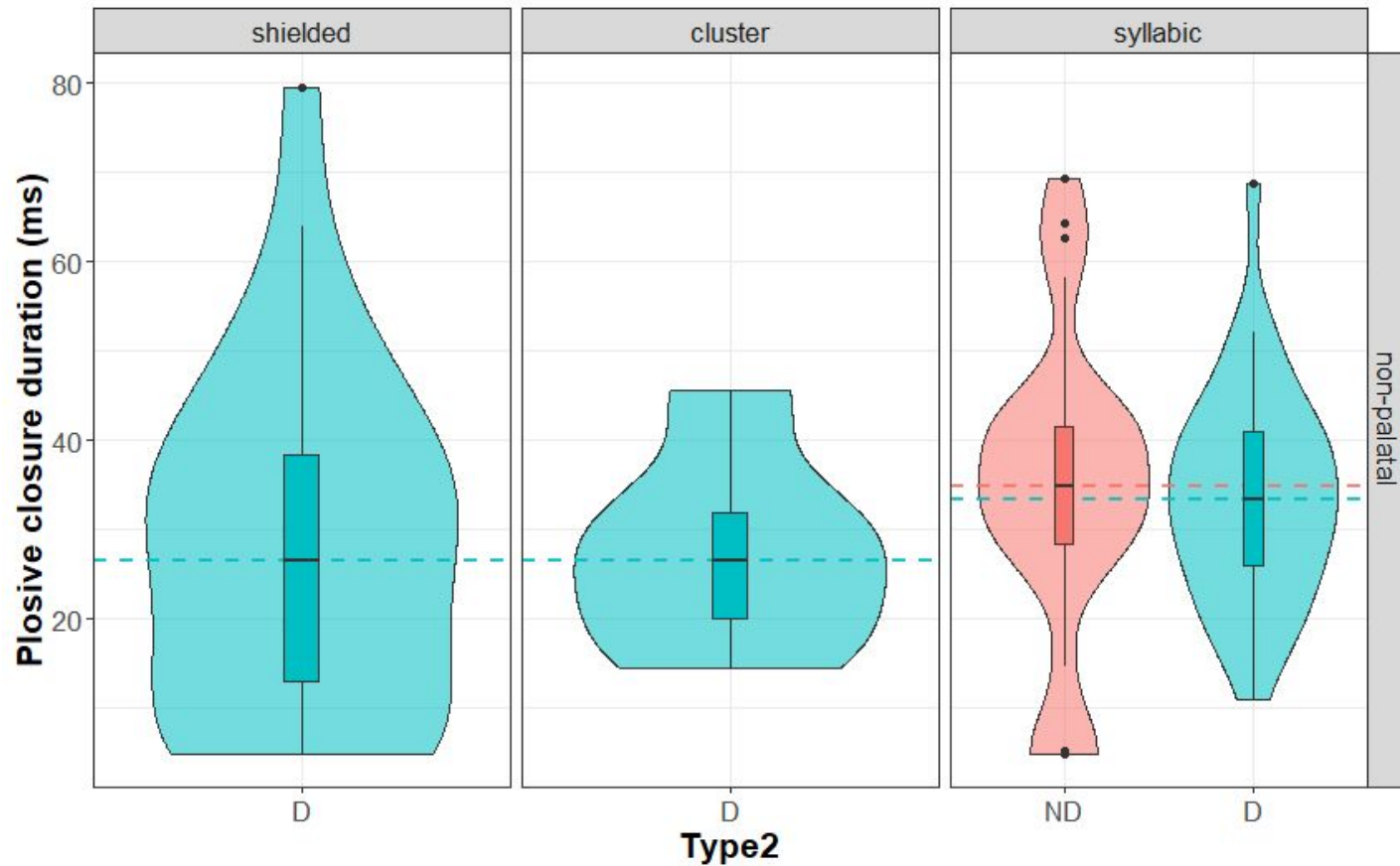
The search for cues: N^C - NC - $\underset{,}{N}.C$

- Nasal duration with palatals (voiced condition only)



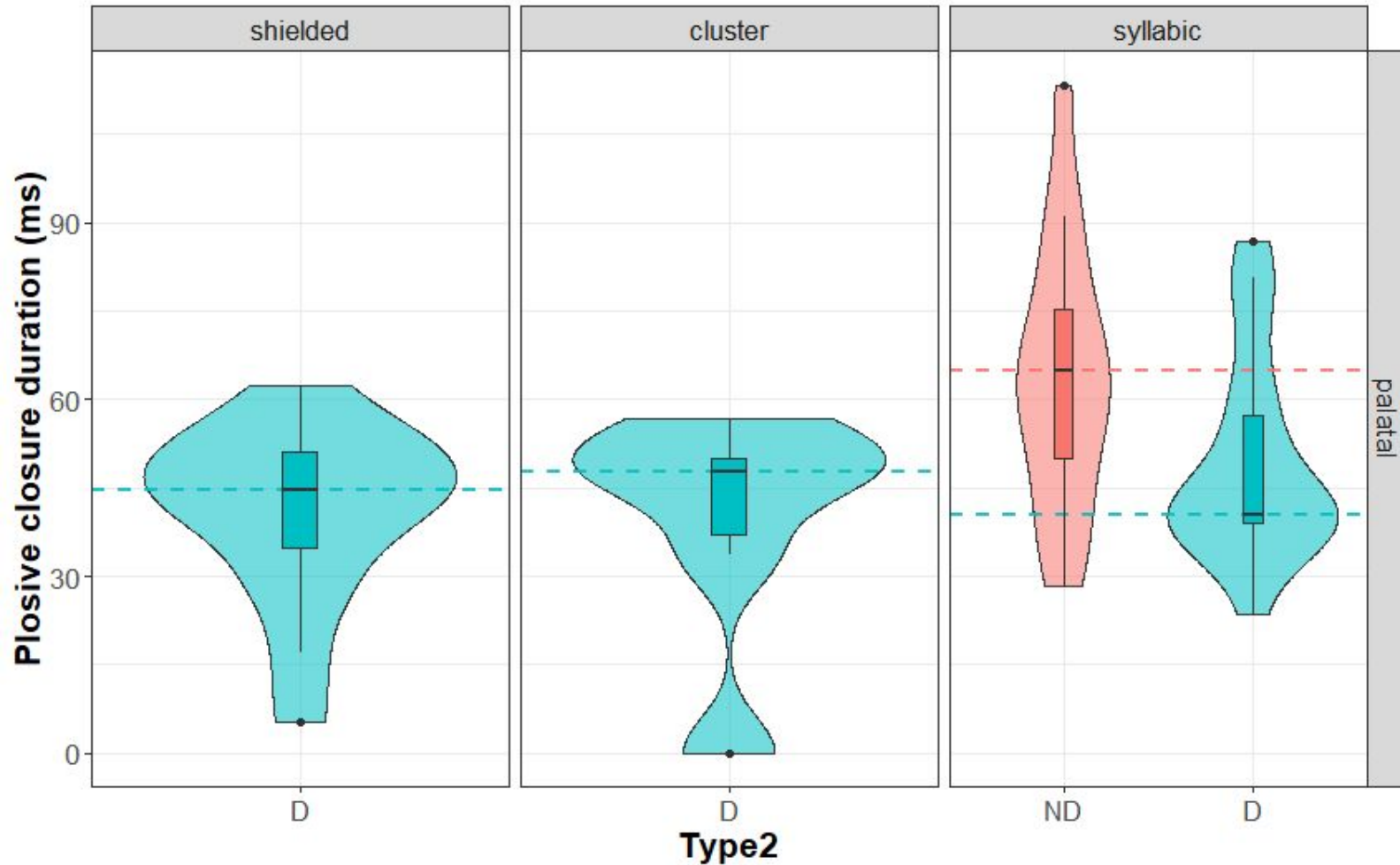
The search for cues: N^C - NC - $\underset{\cdot}{N}.C$

- Plosive closure duration with non-palatals (voiced condition):



The search for cues: N^C - NC - $\underset{\cdot}{N}.C$

- Plosive closure duration with palatals (voiced condition)



Recap: Headline results

- **Voicing matters.** Not only are **closure durations shorter for D** and longer for T, but there is also an **inverse effect on nasal durations: longer before D**, and shorter before T. This holds across all three NC categories.
- Unexpectedly, and also across all three NC categories, **plosive closure** durations are **longer for palatalized** than for non-palatalized consonants.
- When these factors are controlled for, there do not seem to be *consistent* durational differences between the three NC categories.
- However, similar medians sometimes disguise very different distributions, and this is something to follow up on. Shielded N^C shows very wide variation, such that extreme realizations - mainly, near-absence of the plosive closure - are limited to this category.

3. Discussion

Discussion

- Typologically, Amuzgo is the only language we know of with a three-way contrast in NC sequences. Even two-way contrasts between monosegmental and bisegmental NC appear to be rare (Riehl 2008).
- It seems that Amuzgo joins at least some previous experimental work (Browman & Goldstein 1986, Maddieson & Ladefoged 1993) in not being conclusive on phonetic diagnostics of unary v. cluster status (Riehl & Cohn 2011).

Discussion

- Riehl (2008) and Riehl & Cohn (2011) hypothesize that monosegmental and bisegmental NC of identical voicing can only contrast within a language that also makes a phonemic length distinction, since speakers and listeners must already be sensitive to the subtle durational cues that would need to underlie the distinction
- Amuzgo appears to be a counterexample; there is no evidence for a length contrast in SPA, although XA does arguably have a vowel length distinction
- However, Amuzgo can still be understood in the spirit of their proposal, which is that such contrasts must be supported by the language's prosody; we see the development of the NC contrasts as fitting in with more general trends in the diachronic prosody of Amuzgo

Discussion

- More concretely, a variety of syllable types is potentially associated with this three-way contrast:
 - Monosyllables with unary post-stopped nasals N^C
 - Binary segment NC
 - Bisyllables of N.C where N is syllabic
- We propose that nasals participate in a broader syllabicity continuum that includes:
 - “minor” syllables (Matisoff 1973, Thomas 1992)
 - extrasyllabic consonants (Vaux & Wolfe 2009)

Discussion

- Along this continuum, type 2 NCV syllables constitute an in-between form made up of a minor and major syllable or one-and-a-half syllables: $[\sigma_w + \sigma_s]_\omega$
- Different terms have been used to describe these constructions: minor syllables (e.g. Shaw 1993) as part of sesquisyllables (e.g. Matisoff 1989) or bisyllables with common prosody (e.g. Butler Thompson 2010, 2014)
- Reduction of pretonic syllables on iambic feet has been commonly observed in e.g. South-East Asian languages
- In SPA and XA, non-shielded NC sequences likely arose through the diachronic compression of the Proto-Amuzgo-Mixtecan *CVCV couplet (Longacre & Millon 1961) into monosyllables:
 - Fixed stress is iambic > pretonic syllables reduce : CVCV > CvCV > (CəCV) > CCV

Discussion

- Nevertheless, in our SPA data, phonetic profiles fail to significantly differentiate between shielded N^C v. cluster NC sequences (types 1 and 2), despite distinct phonological statuses and at times morphological categories.
 - Given that the distinction seemed clearer in Fermín Tapia García's speech, there may be change in progress
- Work in XA remains ongoing and may show diverging phonetic correlates

Discussion

- Still NC sequences show diversified contrast
 - Fitting with highly diversified secondary articulation (tones, nasalization, non-modal phonation)
- The diversification of syllable types is one of several strategies that have mediated between the need for contrast and the structural constraints resulting from the tendency toward monosyllabification

Acknowledgments

- Fermín Tapia García, for recording and sharing the lexical and grammatical knowledge to which this study owes a great debt
- Community members in San Pedro Amuzgos and Xochistlahuaca who have been supportive of our research
- Audiences at the 3rd Workshop on Sound Systems of Latin America and 28th MFM
- Silke Hamann, for encouraging us to take a more critical approach to the voicing dimension in this project
- Bert Botma, Florian Breit, Faith Chiu, Nancy Kula & Kuniya Nasukawa for stimulating discussions about nasality in Amuzgo

Thank you

Merci

Obrigado

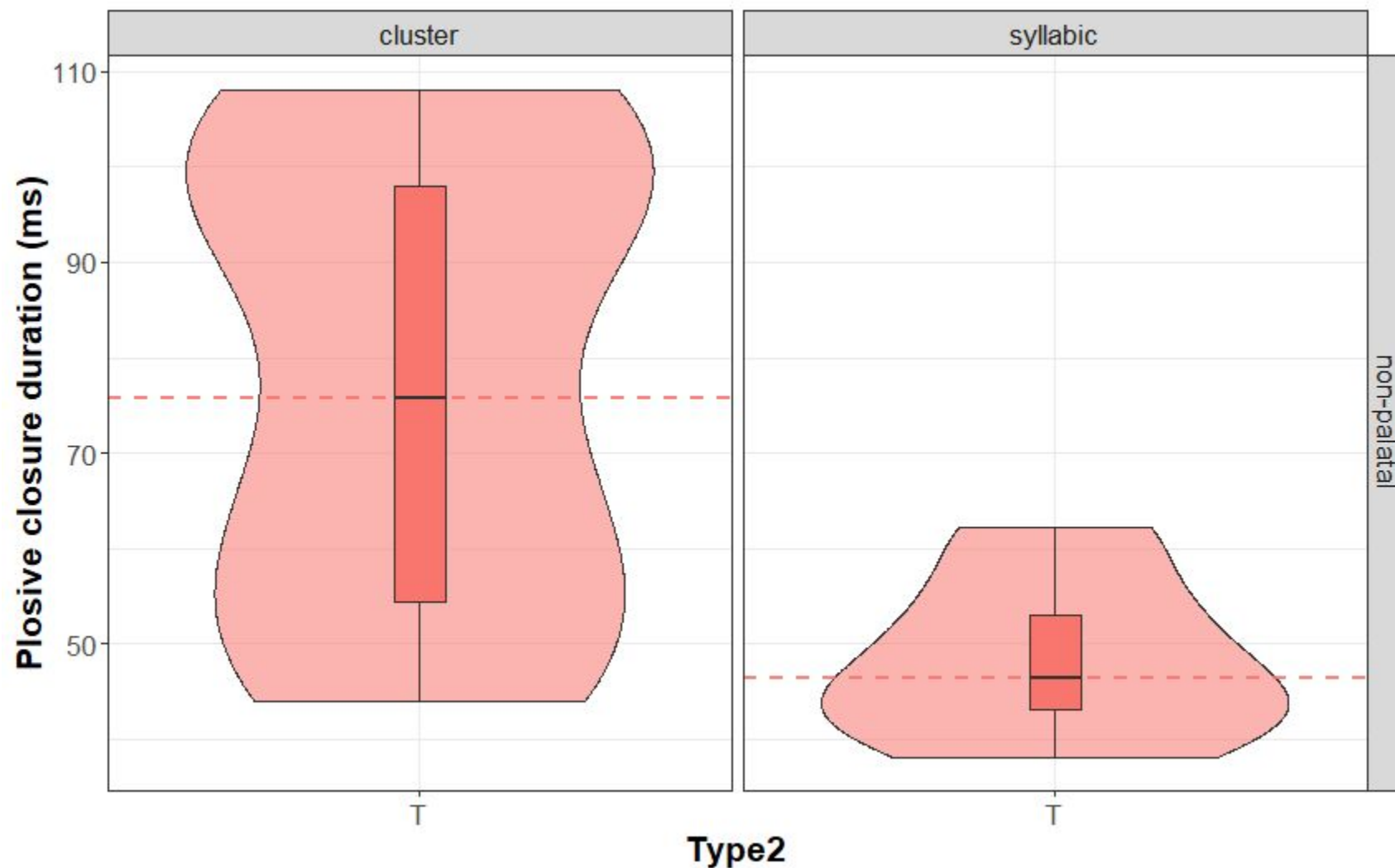
Nkya yà 'u'

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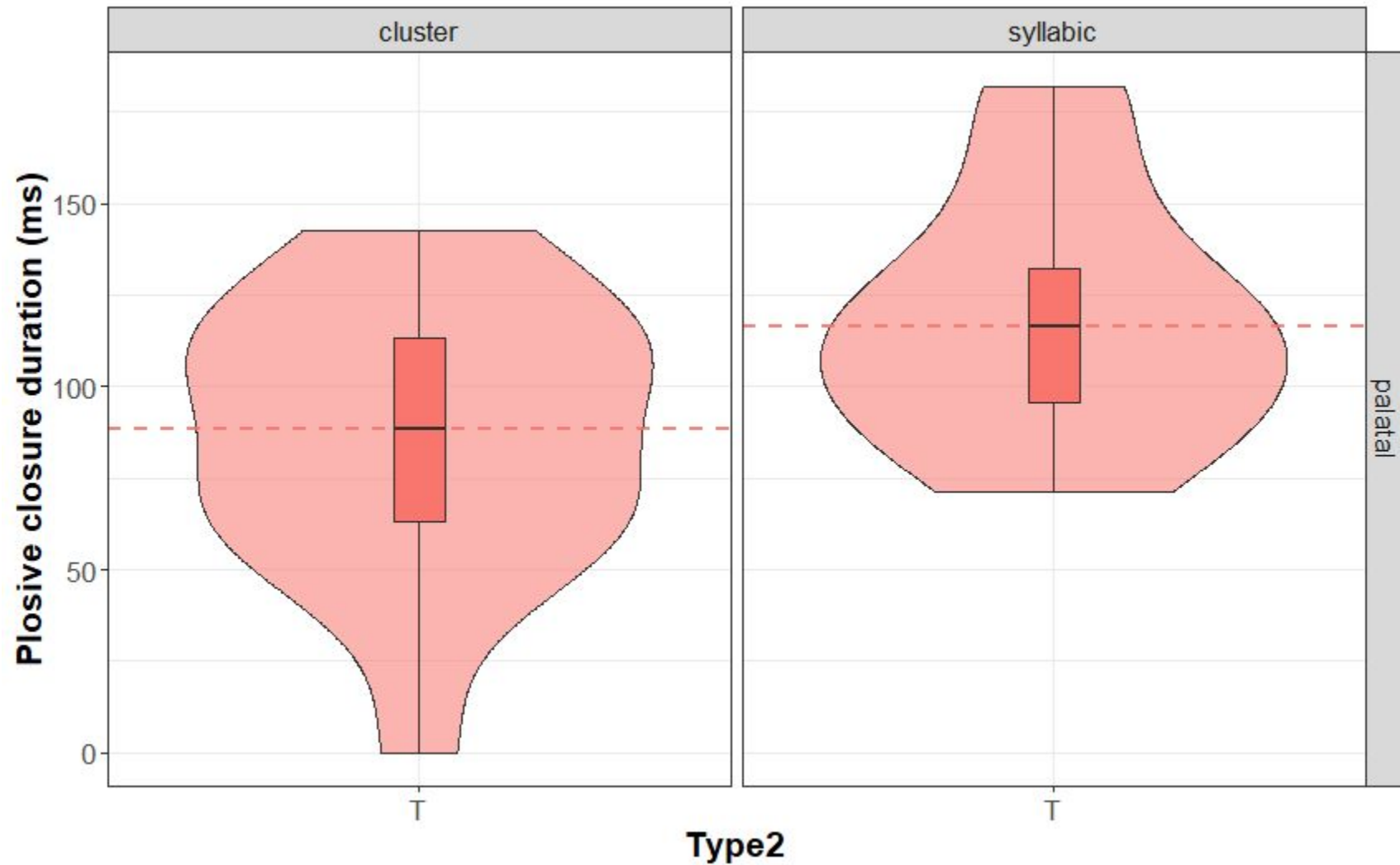
Appendix

> Closure duration in clusters are longer

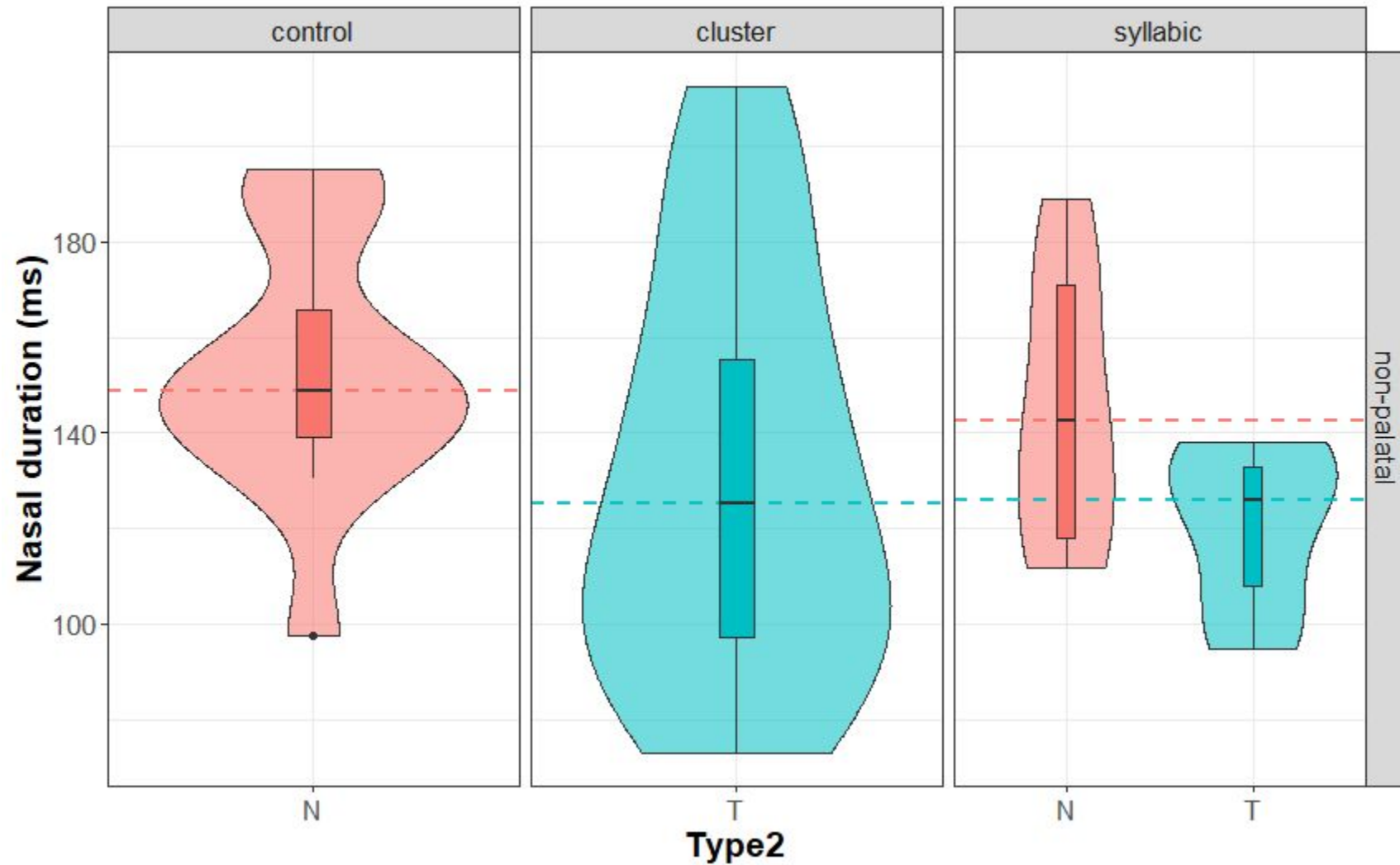


- Non-palatal across categories – plosive closure duration:
 $T_{\text{syllabic}} < T_{\text{cluster}}$

> closure duration in syllabic NC are slightly longer
> while in clusters, T has a larger variation



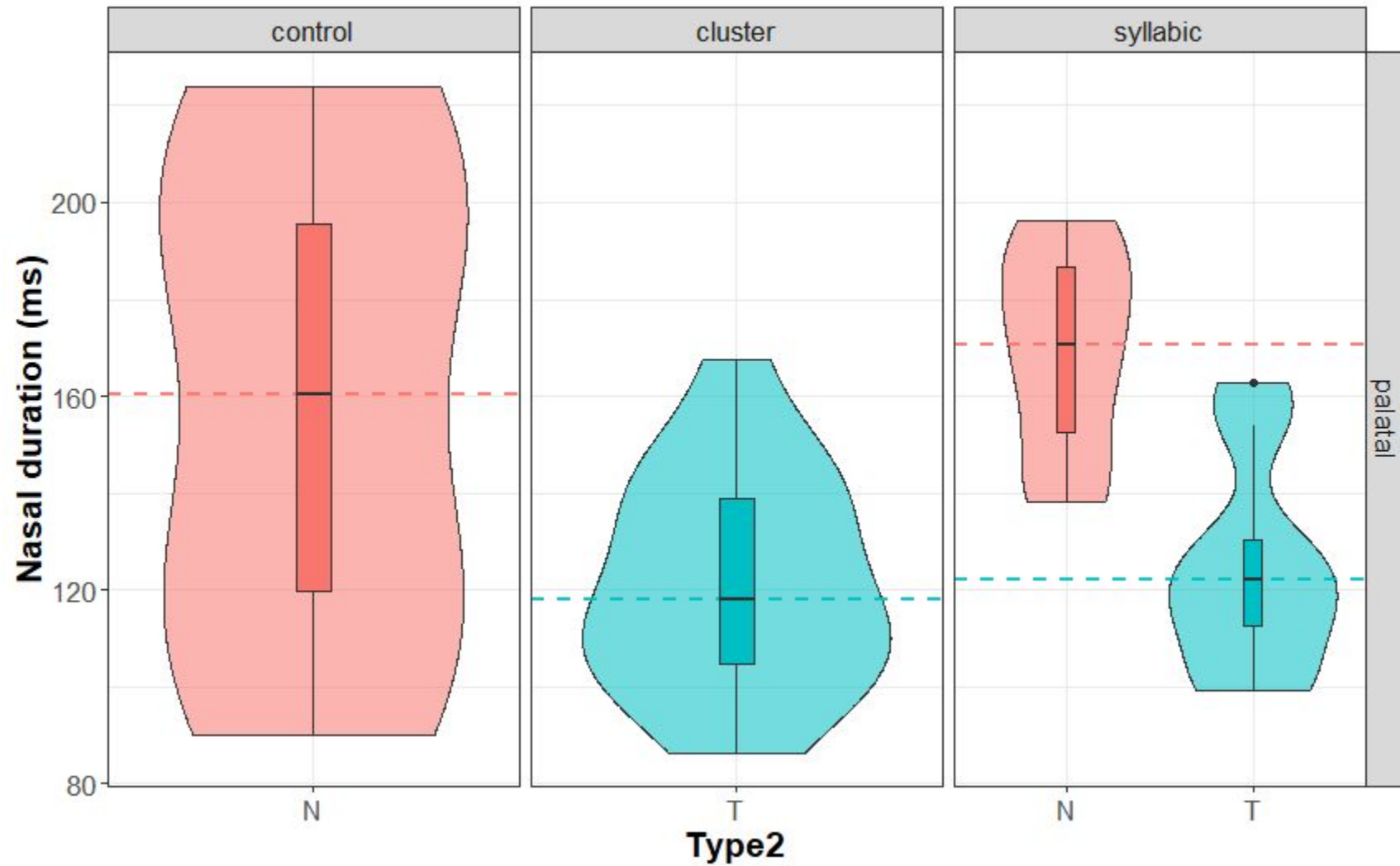
- Palatal across categories – plosive closure duration:
T_{syllabic} > T_{cluster}



- Non-palatal across categories – nasal duration:

$$T_{\{\text{cluster, syllabic}\}} < N_{\{\text{control, syllabic}\}}$$

>



- Palatal across categories – nasal duration:
 $T_{\{cluster, syllabic\}} < N_{\{control, syllabic\}}$