Word-initial NC sequences in two varieties of Amuzgo

Stephen Nichols

In collaboration with Yuni Kim, Bien Dobui, Natalia Hernández and Jair Apóstol Polanco

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1. Introduction

The phonological representation of NC sequences

Cross-linguistically, nasal–plosive (NC) sequences 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)

Monosegmental (unary)

- Prenasalised ^{n}d
- Postoralised n^{d}

Bisegmental (cluster)

- Tautosyllabic .nd-, -nd.
- Heterosyllabic n.d
- Syllabic nasal + onset n̩.d

No attested language-internal contrast between **/^{n}d/** and **/n^{d}/** (Cohn & Riehl 2012)

Riehl (2008) on monosegmental **/^{n}d/** vs bisegmental **/nd/** contrasts:

- **Nasal duration** is the main cue and so mono- and bisegmental NC can only contrast in languages with **phonemic length**, which facilitates speakers production and perception the nasal duration contrast

Amuzgo: An introduction

Branch of Oto-Manguean, probably most closely related to Mixtecan (Campbell 1997: 158, 346)

Up to ~60,000 speakers (INEGI 2020) in Guerrero and Oaxaca States in southern Mexico

4 distinct *variantes* recognised by INALI [1, 2]; 3 languages in Ethnologue and Glottolog

Our research compares 2 varieties:

- Xochistlahuaca [amu, guer1243]
    - Pop. ~30k; Guerrero
- San Pedro Amuzgos [azg, sanp1260]
    - Pop. ~5k; Oaxaca

~15mi apart as the crow flies (~50mi by road)

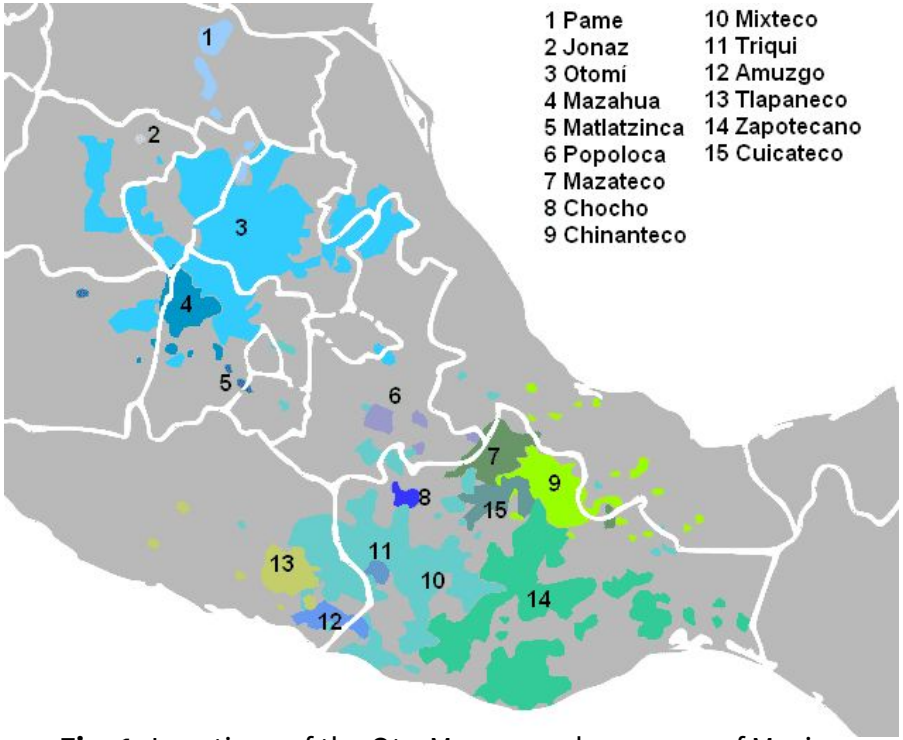

Fig. 1: Locations of the Oto-Manguean languages of Mexico [https://commons.wikimedia.org/wiki/File:Otomanguean_Languages.png]

Amuzgo: A phonological profile

Lexical roots historically *CVCV in Proto-Amuzgo–Mixtecan (Longacre & Millon 1961)

But a tendency towards monosyllabicity in modern Amuzgo

- $(C_1)(C_2)(C_3)V(n)(ʔ)$ with reduction of pretonic syllable (iambic root stress)
- Maximal complex onset is CCC where C_1 is a nasal and C_3 is usually a glide
  - XA: [**ɲtʃw**e^{M}] ‘tunics’
  - SPA: [**nkj**aʔ^{H}] ‘fearful’
- Obstruent–obstruent onset clusters also occur
  - XA: [**tsk**aʔ^{M}] ‘board’
  - SPA: [**tsk**e^{H}] ‘basket’

Amuzgo: A phonological profile

Nuclear contrasts:

- Tonally complex
  - XA: 3 level and 3 contour tones
  - SPA: 3–5 level and 3 contour tones
- Various diphthongs
- Contrastive oral–nasal vowel (for both mono- and diphthongs)
- Three-way phonation:
  - Modal
  - Laryngealised/Creaky
  - Aspirated/Breathy

Plus controlled vs ballistic syllables in XA

Amuzgo: Consonant inventory

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

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Rhotic		ɾ r			
Lateral		l			
Glide			j	w	

Though here, we only investigate the dentals to reduce dimensions – previous data suggest an effect of POA

Amuzgo: Vowel inventory

	Front	Back
High	i	u
Mid	e ẽ	o õ
	ɛ ɛ̃	ɔ ɔ̃
Low	a ã	

	Front _	Back _
_ High	iu	ui
_ Mid	io ĩõ	ue ũẽ
_ Low	ia ĩã	ua ũã

Amuzgo: A three-way NC contrast?

Previous sources vary widely in their characterisations of NC sequences (Bauernschmidt 1965: 476–80, Smith-Stark & Tapia García 1984: 208, Buck 2000, Herrera Zendejas 2009: 154, Buck 2018, Hernández 2019, Dobui 2021, Kim & Hernández 2021)

However, they imply a three-way phonological contrast, as in the data from SPA below:

N^C “Shielded” nasal, an allophone of /n, n^j/ before an oral vowel

(1) /**n**ia^H/ [**n^d**ia^H] ‘clothes’

NC Cluster of nasal + obstruent

(2) /**n-t**ĩõ^M/ [**nd**ĩõ^M] ‘corrals’ (cf. /tĩõ^M/ ‘corral’)

N̩.C Syllabic nasal + obstruent onset

(3) /**n̩^{H}-t**ũã^M/ [**n̩^{H}.d**ũã^M] ‘wash (3PL FUT)’

Outline and preview

Morphophonological definitions of the three categories of NC

Phonetic nature of the contrast, with single-speaker acoustic studies of SPA and XA:

- Is the three-way distinction just a **morphophonological** abstraction (cf. Ladefoged & Maddieson 1986) or is it also detectable on the **phonetic** level?

Preview: It's… messy

- In SPA, it's difficult to tell all NC categories apart based on duration
- In XA, things are perhaps more phonetically distinct, but not necessarily in expected ways

Consideration of implications for the phonological interpretation of NC

2. Morphological status

Morphological status

NC sequences are common in both Xochistlahuaca (XA) and San Pedro Amuzgos (SPA):

- They occur **monomorphemically** in roots

(4)

	Word	Gloss	Phonological type	Variety
a.	$n^{jd^j}o^H$	‘mouth’	N^C (shielded nasal)	XA
b.	n^da^H	‘water’	N^C (shielded nasal)	SPA
c.	$nt\tilde{o}^M$	‘black’	NC (nasal–plosive cluster)	SPA

- And **polymorphemically** because of segmentally homophonic prefixes for both the nominal plural (5a) and the future marker (5b–c)

(5)

	Word	Gloss	Phonological type	Variety
a.	$t^juɛʔ^L \rightarrow nd^juɛʔ^L$	‘hills’	NC (nasal–plosive cluster)	SPA/XA
b.	$n̥^H$-ta^M	‘sing (FUT)’	N̥.C (syllabic nasal)	XA
c.	$n̥^H$-t^je^{HL}	‘wash oneself (FUT)’	N̥.C (syllabic nasal)	SPA

Morphological status

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b.	n^da^H		d nasal)	SPA
c.	$nt\tilde{o}^M$		plosive cluster)	SPA

Plosive voicing is non-contrastive – before diphthongs, post-nasal plosives are automatically voiced

- And **polymorphemi** cause of segmentally homophonic prefixes for both the nominal plural (5a) and the f marker (5b–c)

(5)

	Word	Gloss	Phonological type	Variety
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c.	$n̥^H$-t^je^{HL}	‘wash oneself (FUT)’	N̥.C (syllabic nasal)	SPA

Evidence for shielding: /n, n^{j}/ → [n^{d}, n^{jd}]

We see active morphophonological alternations between [n, n^{j}] and [n^{d}, n$^{jd^{j}}$] based on the nasality/orality of the following vowel (Dobui 2021, Kim & Hernández 2021)

In XA, a shielded nasal **deoralises** when marked by a nasal 3sg possessive marker

(6)	n$^{jd^{j}}$o^{H}	‘mouth’	→	n^{j}õ^{H}	‘mouth (3SG.POSS)’

In SPA noun plurals, certain initial consonants (e.g. /ts/) are replaced by **[n]** before **nasal** vowels or **[n^{d}]** before **oral** vowels

(7)	a.	tsĩõ^{MH}	‘smoke (SG)’	→	nĩõ^{MH}	‘smoke (PL)’
	b.	tsio^{MH}	‘bottle’	→	n^{d}io^{MH}	‘bottles’

(See Dobui, Faust & Apóstol Polanco 2024 for more on plural marking in XA)

Variation between SPA and XA

NC sequences are more widely distributed in SPA than in XA given slightly different morphophonological strategies for nasal blocking

SPA prefers **[n^{d}/t]** shielding where XA has a diversity of surface forms, e.g. a non-nasal allomorph **[l]** in plural marking (7) and allomorphs **[n̥^{H}.l]** in future marking (8)

	Gloss	Variety	Form	Phonological type
(8)	‘bottles’	SPA	**n^{d}**io^{MH}	N^{C} (shielded nasal)
		XA	**l**io^{HL}	
(9)	‘eat (FUT)’	SPA	**n̥^{H}-t**kwaʔ^{M}	N̥.C (syllabic nasal)
		XA	**n̥^{H}l**-kwaʔ^{M}	

3. The phonetic nature of the contrast

3.1 Previous work

Phonetics of NC voicing contrasts cross-linguistically

Durational cues help preserve ND vs NT contrasts, given the pressures on voicing post-nasally (Cohn 1990; Solé 2012; Beddor 2007, 2009; Cohn & Riehl 2012)

- Both **absolute** and **relative** duration can matter
- Downing & Hamann (2021): Aspiration is a key cue to NT in Tumbuka

As previously mentioned, [d] is not phonemic in Amuzgo but arises, exclusively in post-nasal position

- Either through shielding
  - Shielding /**n**^{j}o^{H}/ ‘mouth’ → [**n**$^{jd^{j}}$o^{H}]
- Or through pre-diphthongal post-nasal voicing in clusters
  - Non-syllabic /**n**$_{plural}$ - **t**iõ^{M}/ ‘corrals’ → [**nd**iõ^{M}]
  - Syllabic /**n**$^{H}_{future}$ - **t**iu^{MH}/ ‘will break’ → [**n̥**^{H}**.d**iu^{MH}]

Phonetic nature of the contrast in Amuzgo

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

	UR	Voiced context	Voiceless context
N^C (shielded nasal)	/n/	/nV/ → [n^dV]	/nhV/ → [n^thV]
NC (cluster)	/nt/	diphthong	monophthong
N̩.C (syllabic nasal)	/n.t/	diphthong	monophthong

When controlling for voicing, what are the phonetic cues to the three-way prosodic contrast in NC?

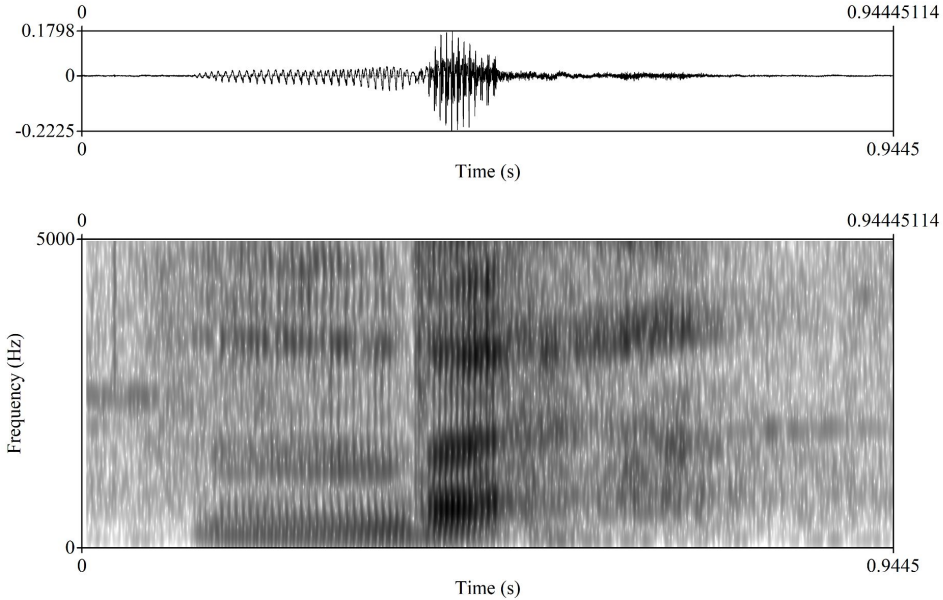
Phonetics of NC sequences in Amuzgo

Kim & Hernández (2021) claim that **plosive duration** distinguishes shielded N^C from cluster NC

Renowned native-speaker (SPA) linguist Fermín Tapia García (b. 1936)

Tapia García appears to show a robust phonetic distinctions between the three types of NC sequences

- Shielded: very short plosive duration
  - E.g. [$n^d\varepsilon ?^{HL}$] ‘corn cribs’

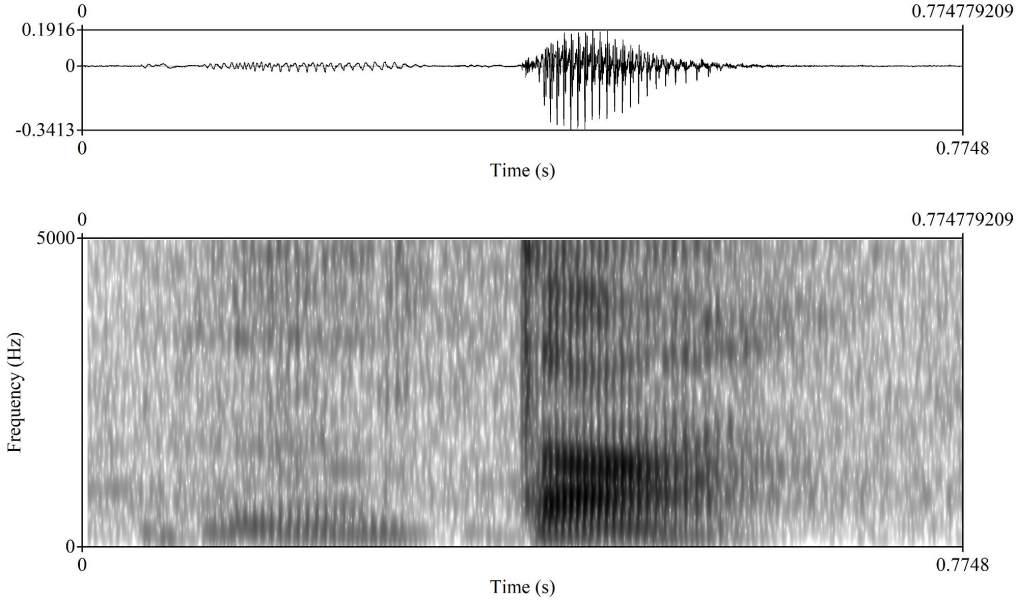


Phonetics of NC sequences in Amuzgo

- Cluster: longer plosive phase; voiceless
    - E.g. [**nt**a^{HL}] ‘wedding’

But…

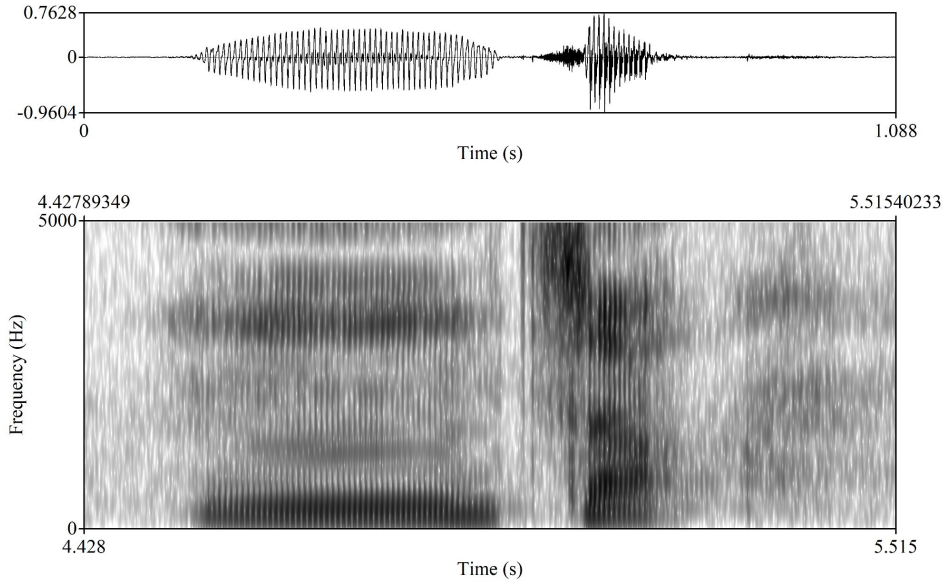
Is the durational difference just due to **voiceless [t]** vs **voiced [d]**, which we’d expect anyway? (Cohn & Riehl 2012)



Phonetics of NC sequences in Amuzgo

Syllabic nasals have a duration of about 300–400 ms compared to around 200 ms for non-syllabic NC clusters

- E.g. [n̥^{H}-tsaʔ^{HM}] ‘do (2SG FUT)’



Why is further study needed?

The original wordlist was not designed for this purpose and so does not contain tokens of every relevant type; it also consists of forms in isolation not in a frame sentence

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 a voiced plosive phase, as in [n^{d}], than for a voiceless one, like in [nt]

Casual observation strongly suggests a high degree of phonetic variation in the younger generation's realisations of NC sequences

Phonetic information may inform orthographic choices

- That is, when/whether to write e.g. <n>, <nd>, <nt>, <nnd>, <nnt>

3.2 Methods

Data collection and processing

Elicitation with target words embedded in a carrier sentence (more details in §§3.3 and 3.4)

- E.g. *matsjö* **X** *ra* ‘well, I say **X**’ for SPA

Shure SM35 headset mic with Zoom H4n recorder

Force-aligned with SPPAS using separate customised models for SPA and XA

Manual correction for the segments of interest 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 and plosive closure

Extracted data were then processed and plotted with R

Only descriptive stats thus far

3.3 San Pedro Amuzgos

Wordlist and recording

63 yo female recorded in San Pedro Amuzgos in August 2022

Controlled for phonation and place of articulation; tones varied

Total of 293 tokens

	[n^{C}]	[nC]	[n̩.C]
[nd]	82	20	37
[nt]	—	33	29

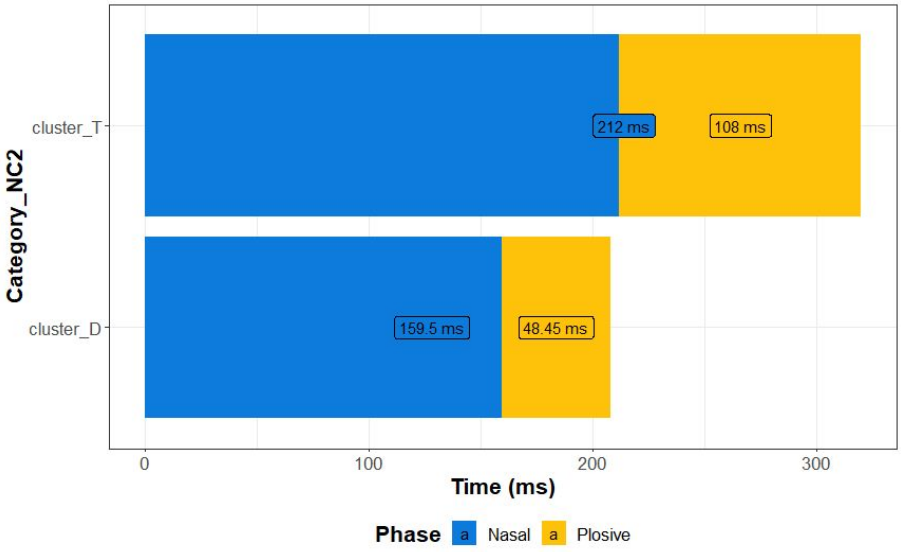
Plain nasals as controls:

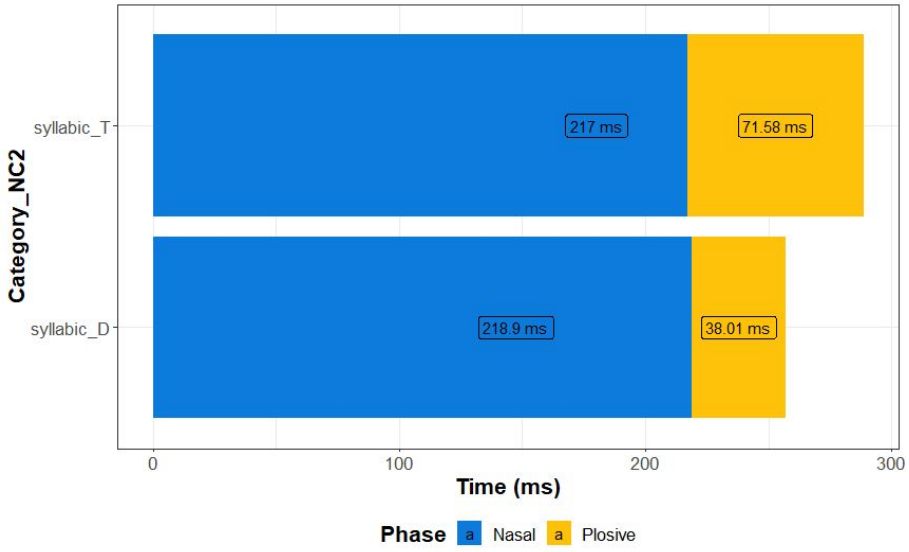
- 32 NV (non-syllabic); 35 syllabic N̩.NV

Bonus:

- 25 tokens of [n̩.n^{d}] (double nasal: syllabic + postoralised)

Absolute duration in bisegmental sequences

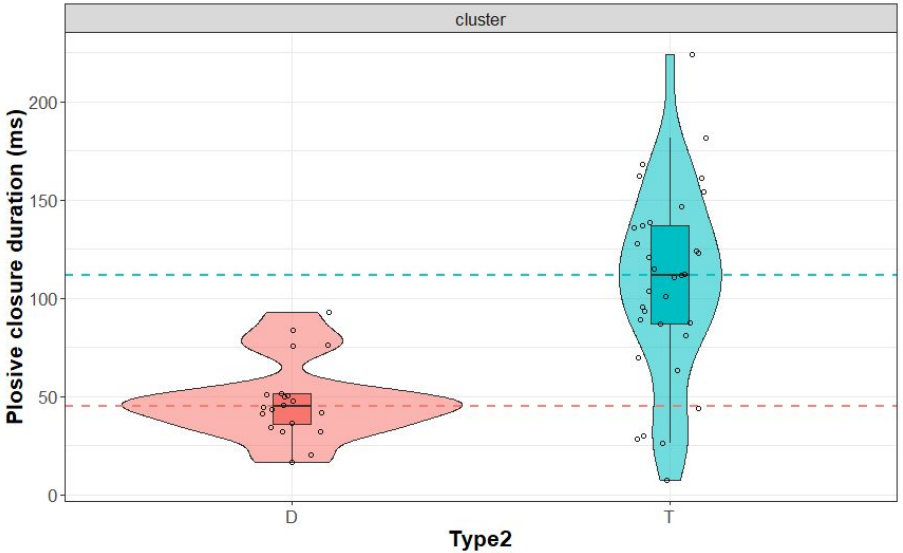


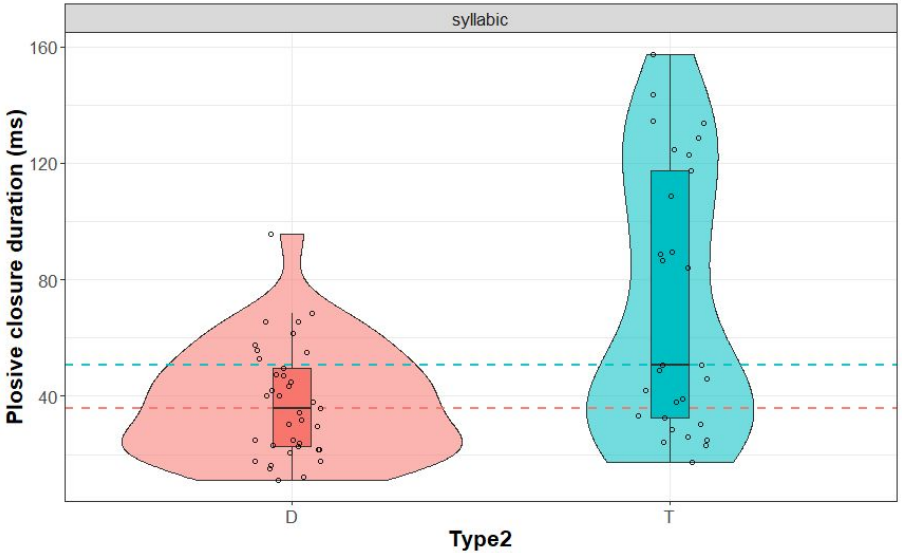


In absolute terms, voiced contexts show **shorter** aggregate durations

Nasal durations are not shorter in absolute terms in voiceless contexts

Absolute plosive duration in bisegmental sequences

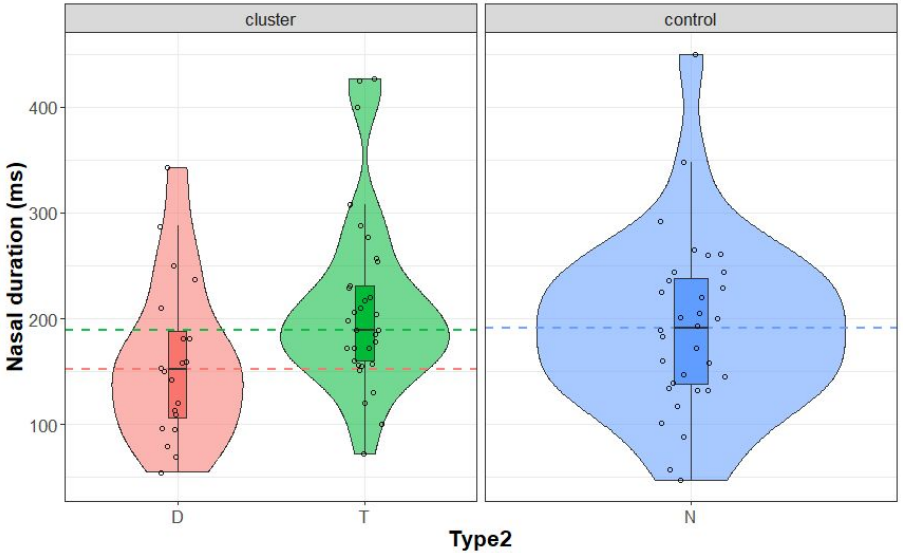




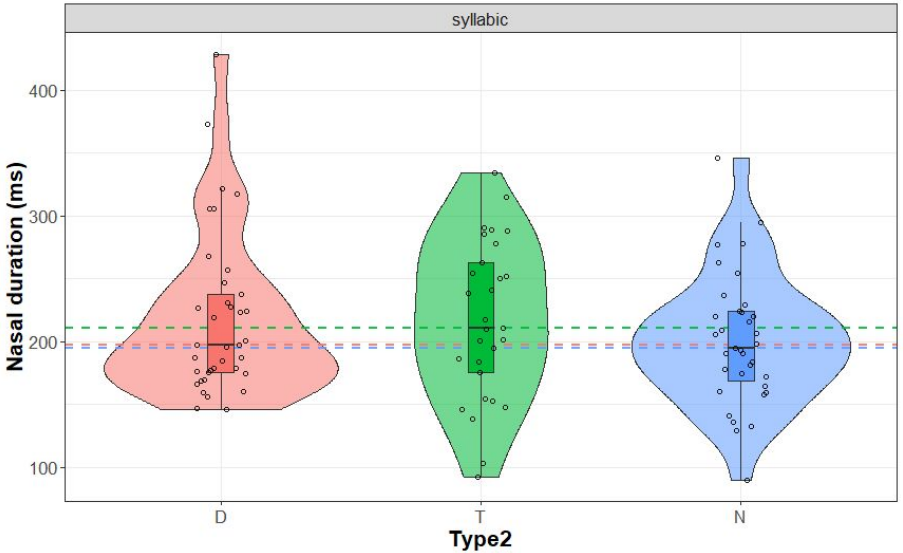
As expected, absolute plosive durations are **shorter** in the voiced contexts than in voiceless ones

Absolute plosive closure durations **longer** in NC clusters than N̥.C, especially in voiceless plosives

Absolute nasal duration in bisegmental sequences

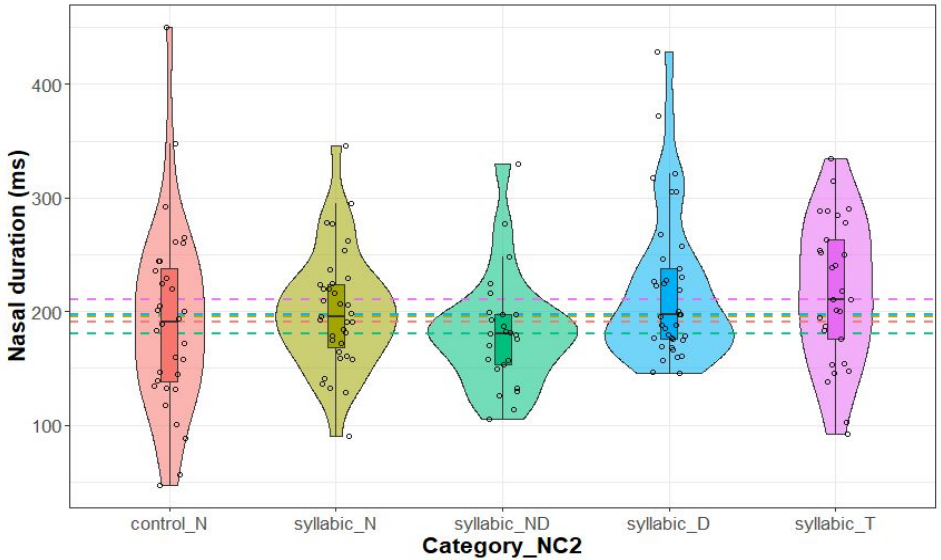


Non-syllabic nasals in NC clusters show similar durations to onset nasals in NV sequences



Even syllabic nasals are generally similar to singleton onset N (including pre-nasal syllabic nasals, i.e. N̩.NV)

Duration of onset and syllabic nasals



From left to right: [**n**Ṽ(Ṽ)(ʔ)], [**n̩.n**Ṽ(Ṽ)(ʔ)], [**n̩.n**^{d}V(V)(ʔ)], [**n̩**.dVV(ʔ)], [**n̩**.tV(ʔ)]

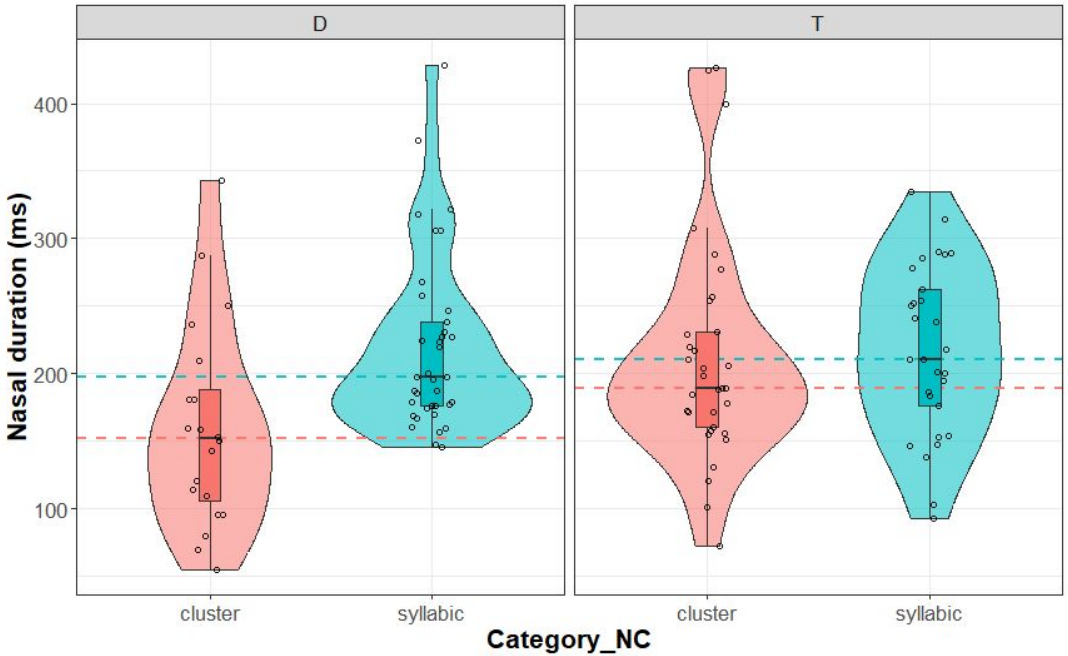
Despite the putative prosodic differences, all display very similar means and distributions

Duration of syllabic vs non-syllabic nasals

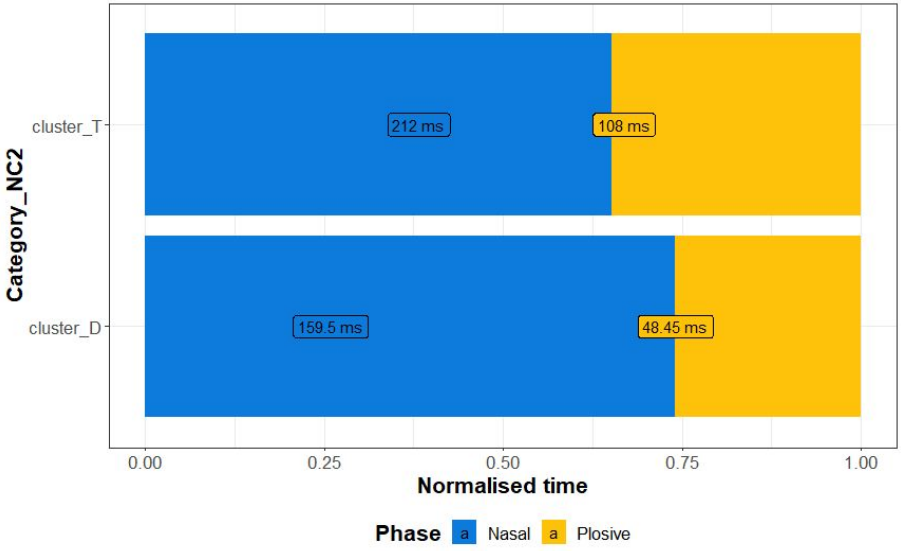
We might expect syllabic nasals to be **longer** in duration than non-syllabic nasals

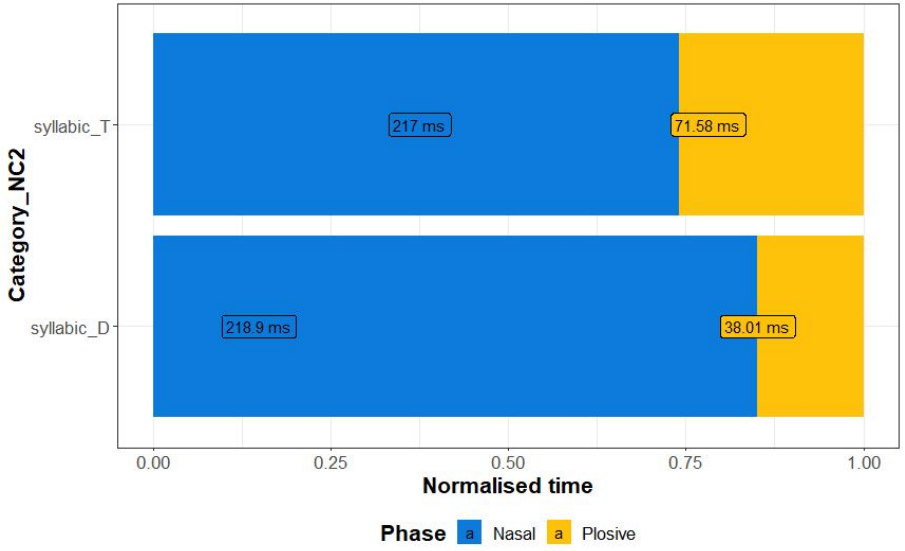
This appears to be the case in the **voiced** context (left)

However, this is not clear-cut in the **voiceless** context (right)



Relative duration in bisegmental sequences

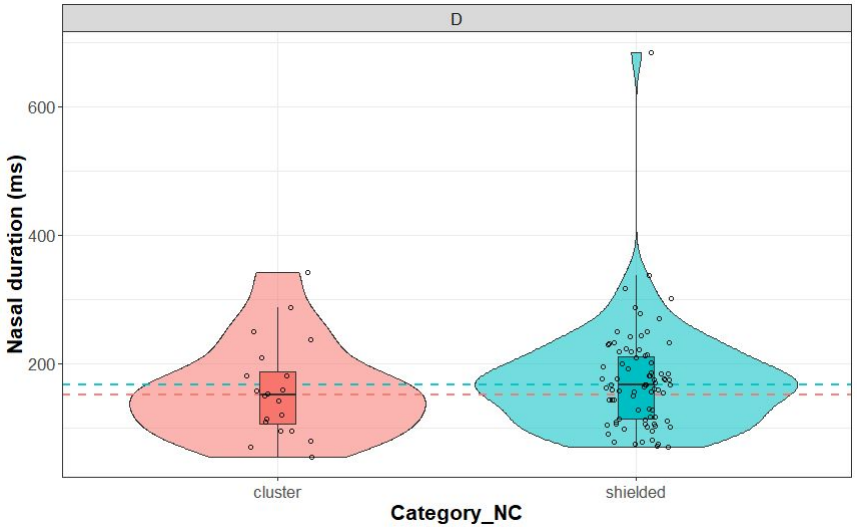


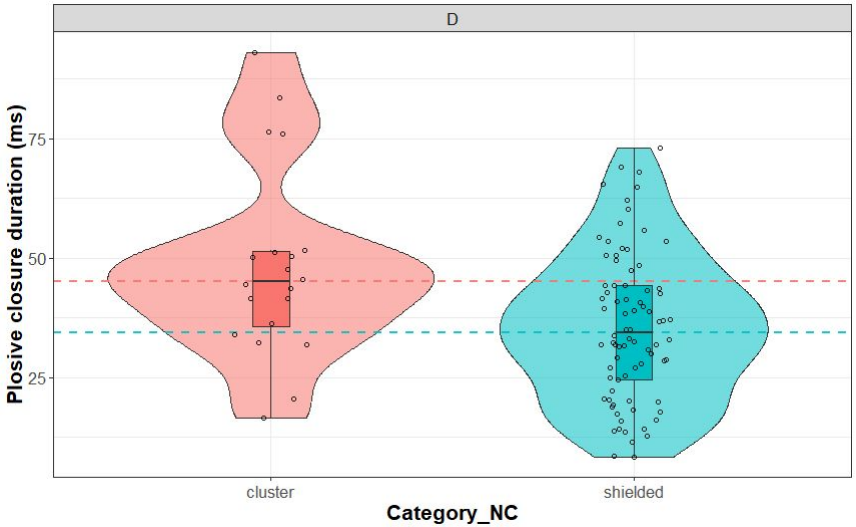


In relative terms, nasals are **slightly longer** and plosives are **slightly shorter** in voiced as compared to voiceless contexts

Nasals generally make up a **larger proportion** of N̥.C as opposed to cluster NC sequences

Absolute duration in cluster NC vs unary N[C]





Similar nasal durations for nasals in NC clusters and shielded N[C]

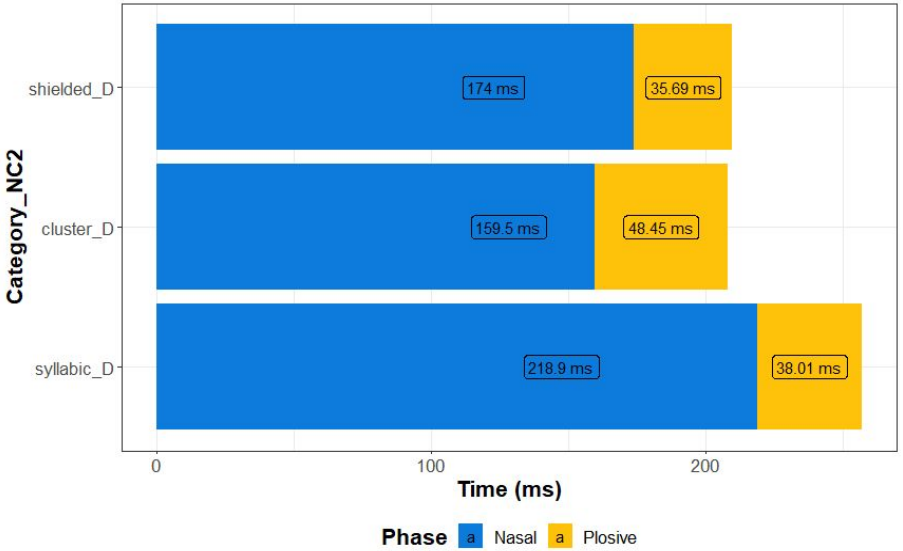
Maybe not entirely surprising given that both are underlying /n/ segments

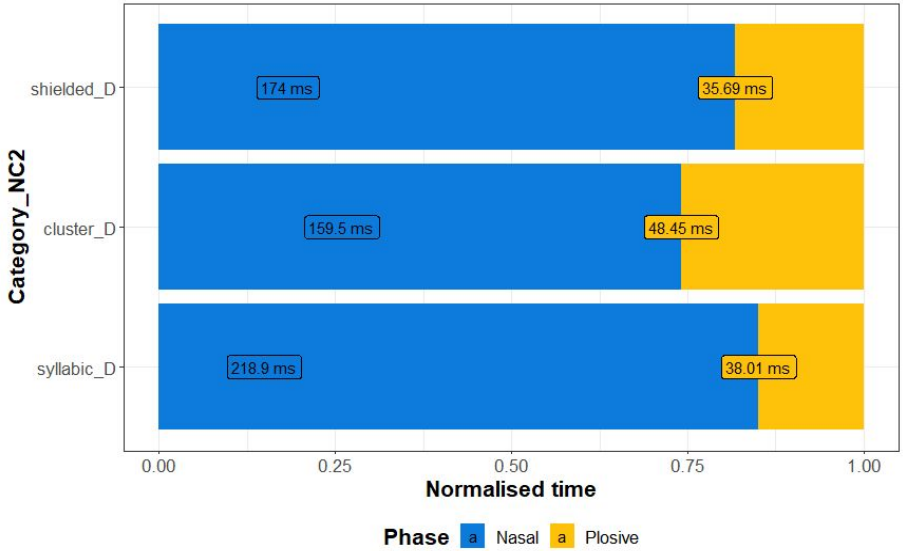
Plosive closure duration is slightly longer in the cluster context

But lots of overlap, fewer tokens of NC, bimodality in NC?

Is there really a three-way NC distinction?

In the voiced condition, we can make a direct three-way comparison





Absolute aggregate duration: n̥.d > nd ~ n^d

Absolute nasal duration: n̥.d >~ n^d > nd

Absolute plosive duration: nd > n̥.d ~ n^d

Relative nasal duration: n̥.d ~ n^d > nd

Relative plosive duration: nd ~ n^d > n̥.d

Interim summary: San Pedro Amuzgos

Cluster NC vs syllabic N̩.C:

- Voiced NC and N̩.C shorter than voiceless, including plosive closure
- NC has shorter plosive closure duration than N̩.C (both absolute and relative)
- Absolute nasal duration possibly longer for N̩.C than NC (more obvious for voiced)
- Nasal generally a larger relative proportion of N̩.C than NC

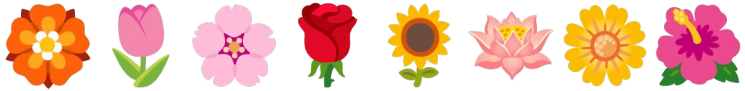
Cluster NC vs shielded N^C:

- Absolute plosive closure duration slightly longer in NC than N^C (highly caveated)
- Nasal is longer and plosive closure shorter in N^C than NC
- Nasal a larger relative proportion of N^C than NC

Three-way comparison:

- No clear-cut three-way distinction on any one measure of duration
- No phonetic three-way distinction or is it simply more complicated?

3.4 Xochistlahuaca



Wordlist and recording

58 yo female recorded in Xochistlahuaca in May 2022

Controlled for phonation and place of articulation; tones varied

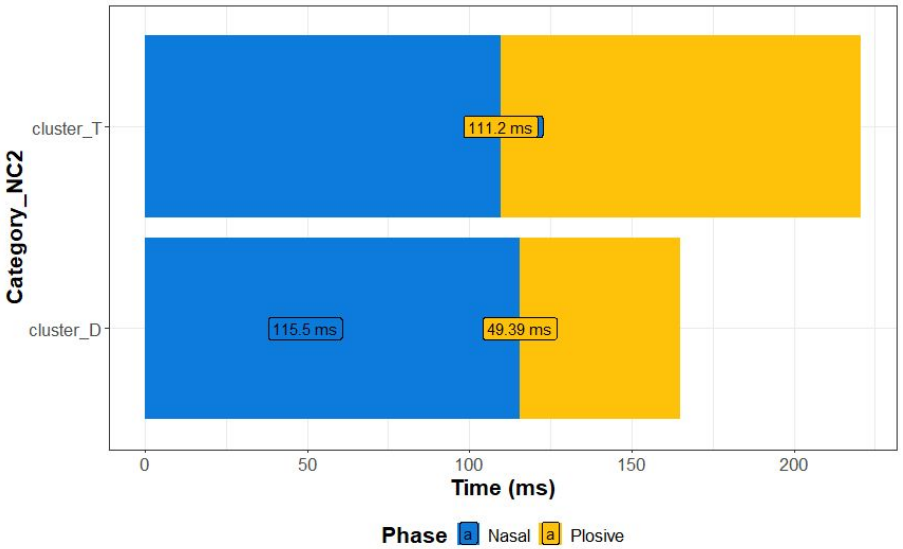
Total of 226 tokens

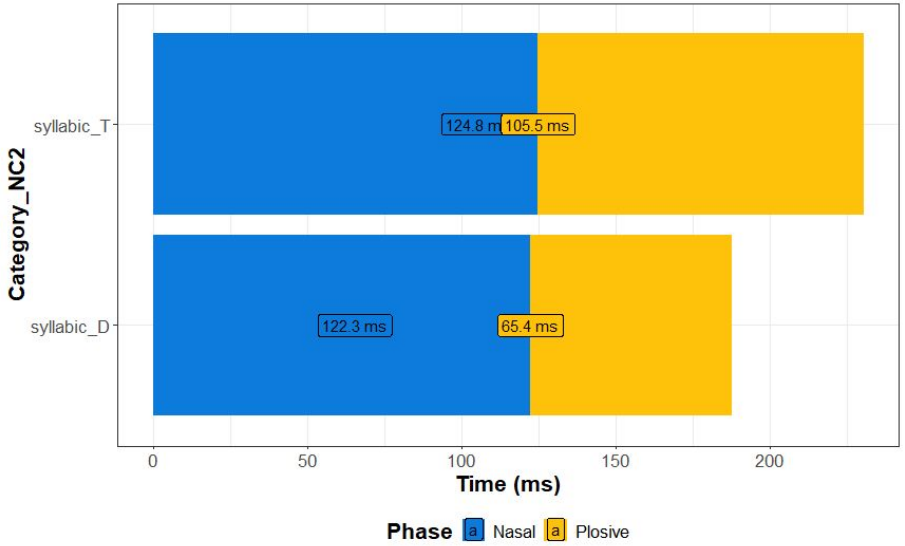
	[n^{C}]	[nC]	[n̩.C]
[nd]	16	39	12
[nt]	19	24	40

Plain nasals as controls:

- 30 NV (non-syllabic onset)
- 46 N̩.NV (syllabic + onset N)

Absolute duration in bisegmental sequences

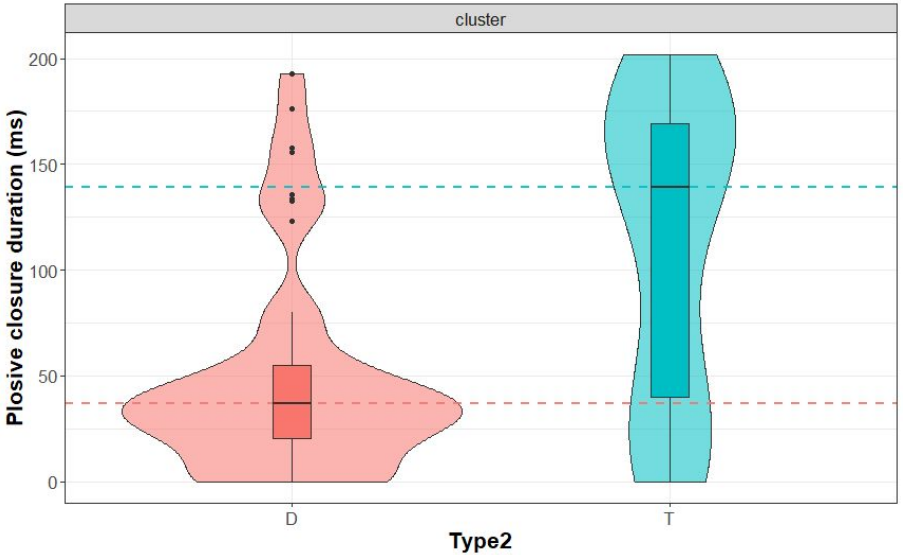


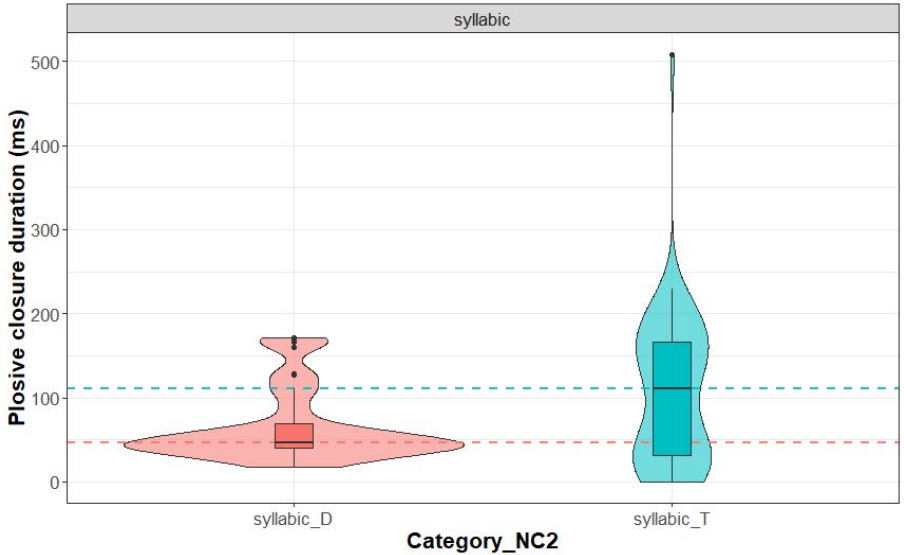


As in SPA, XA shows **shorter** absolute aggregate durations in the voiced contexts

Likewise, nasal durations are not generally shorter in voiceless contexts

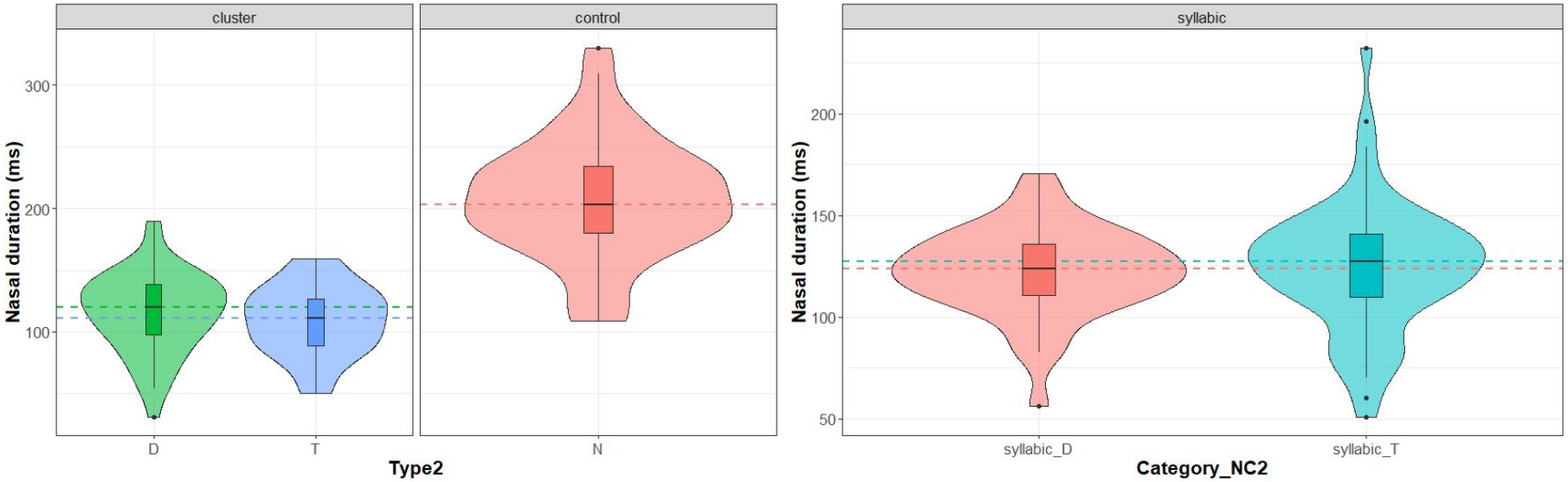
Absolute plosive duration in bisegmental sequences





Absolute plosive closure durations are generally **shorter** in voiced contexts than voiceless

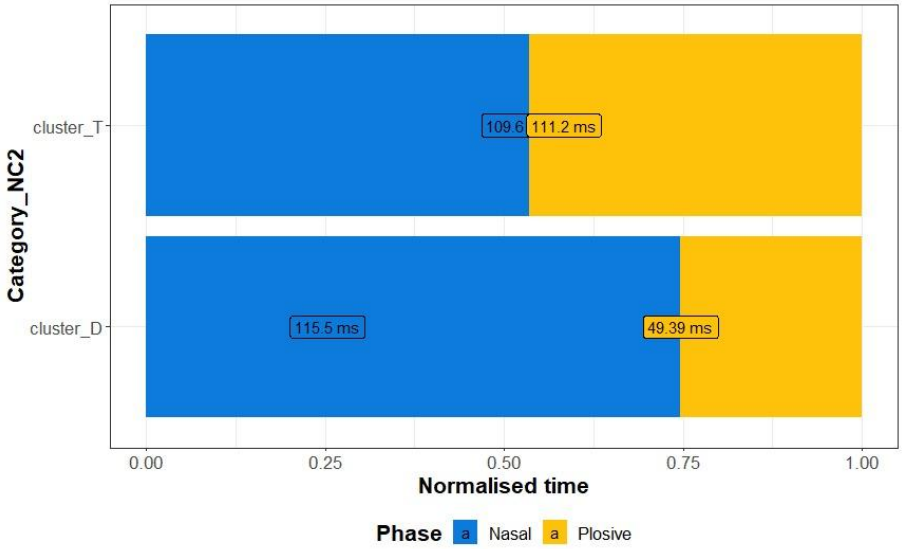
Absolute nasal duration in bisegmental sequences

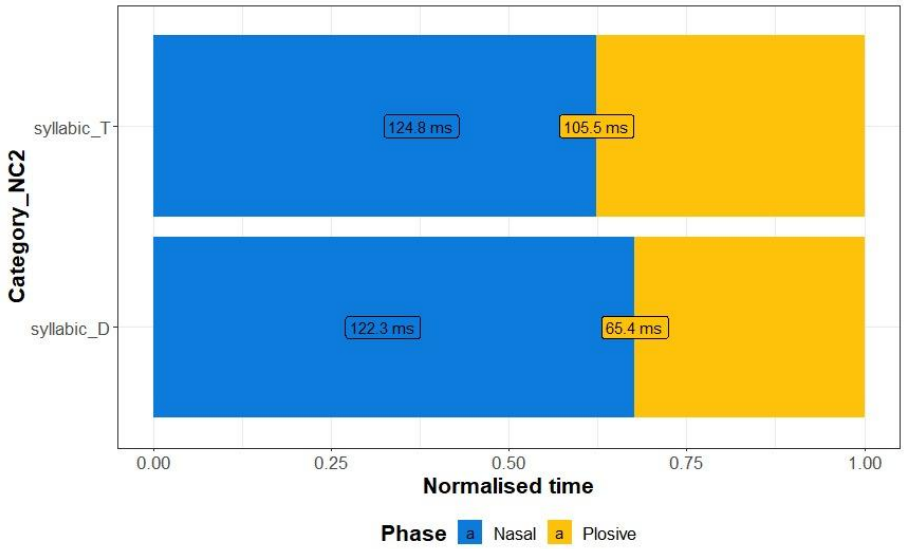


In contrast to SPA, in XA, both non-syllabic nasals in NC clusters and syllabic nasals are **shorter** in duration than onset nasals in NV sequences

Syllabic nasals are, on average, slightly **longer** than nasals in NC clusters

Relative duration in bisegmental sequences

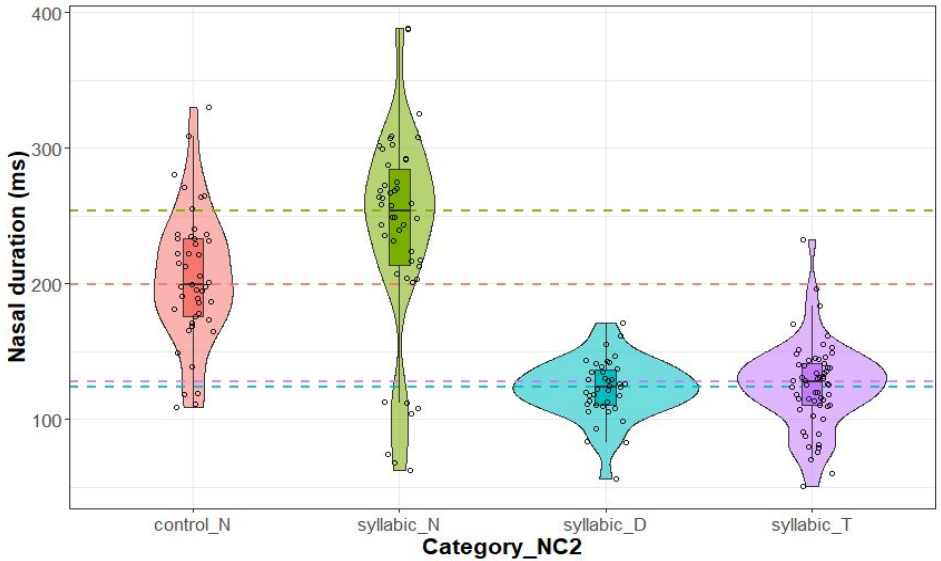




In relative terms, **plosives** are **shorter** and **nasals** are **longer** in voiced as compared to voiceless contexts, at least in clusters, again not dissimilar to SPA

Nasals are only a **larger proportion** of N̥.C compared to NC sequences in **voiceless** contexts

Duration of onset and syllabic nasals

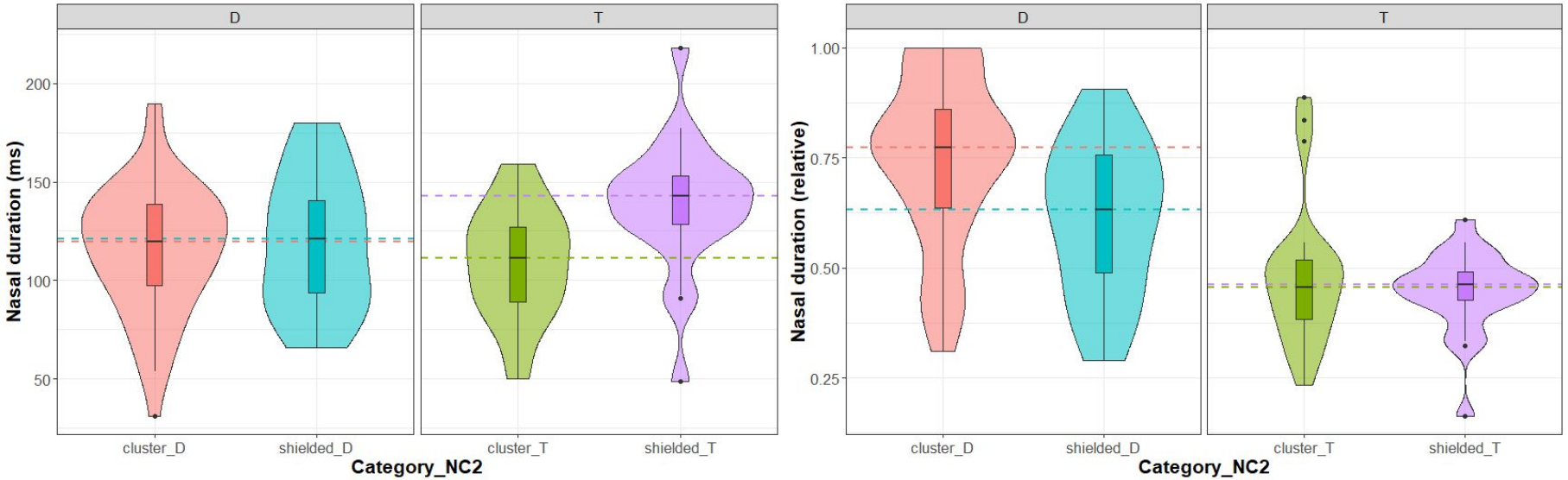


From left to right: [**n**Ṽ(Ṽ)(ʔ)], [**n̩.n**Ṽ(Ṽ)(ʔ)], [**n̩**.dVV(ʔ)], [**n̩**.tV(ʔ)]

“Double” nasals are generally longer than singleton onset nasals

As already seen, pre-plosive syllabic nasals are markedly shorter than onset nasals

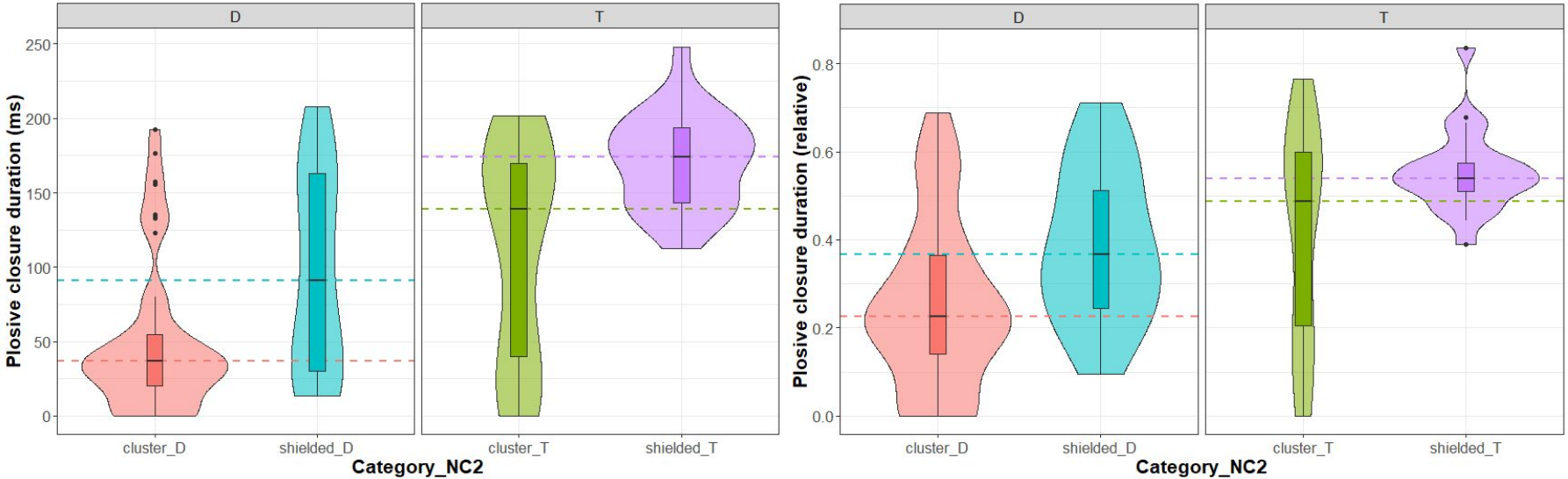
Nasal duration in cluster NC vs unary N [c]



No clear overall pattern in either absolute or relative nasal duration

[n^{t}] **longer** than [nt] in absolute terms but [n^{d}] **shorter** than [nd] in relative terms

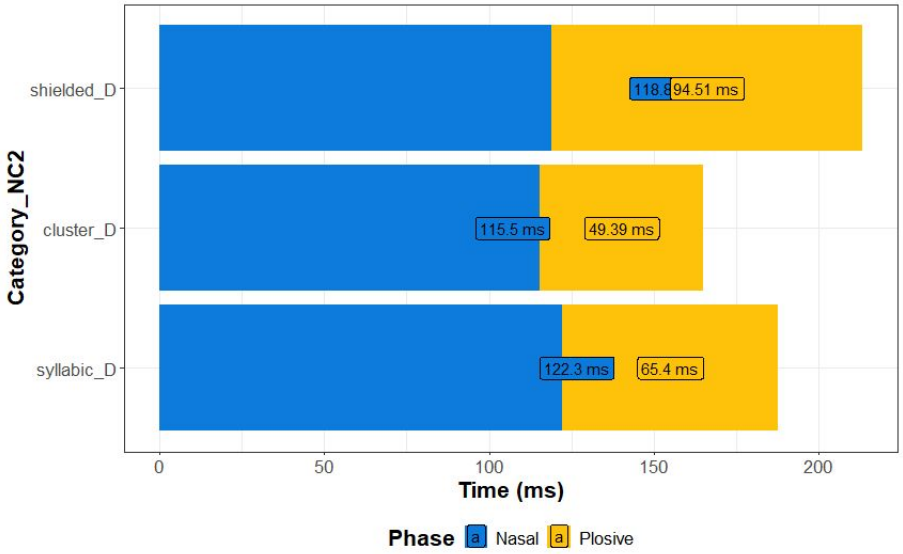
Plosive closure duration in cluster NC vs unary N C

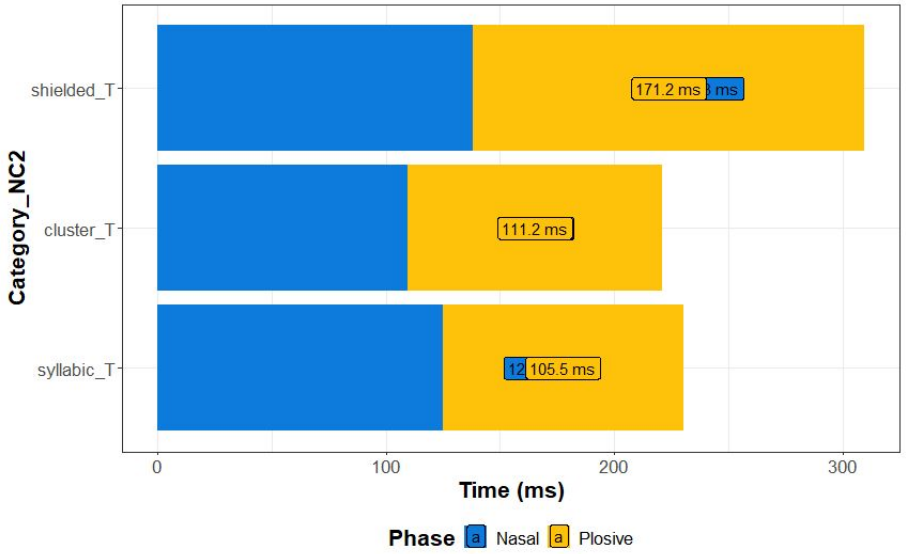


However, there seems to be a clear – if counterintuitive – pattern for plosive closure duration

N^C plosive closure **longer** than NC in both absolute and relative terms (but quite a bit of variance)

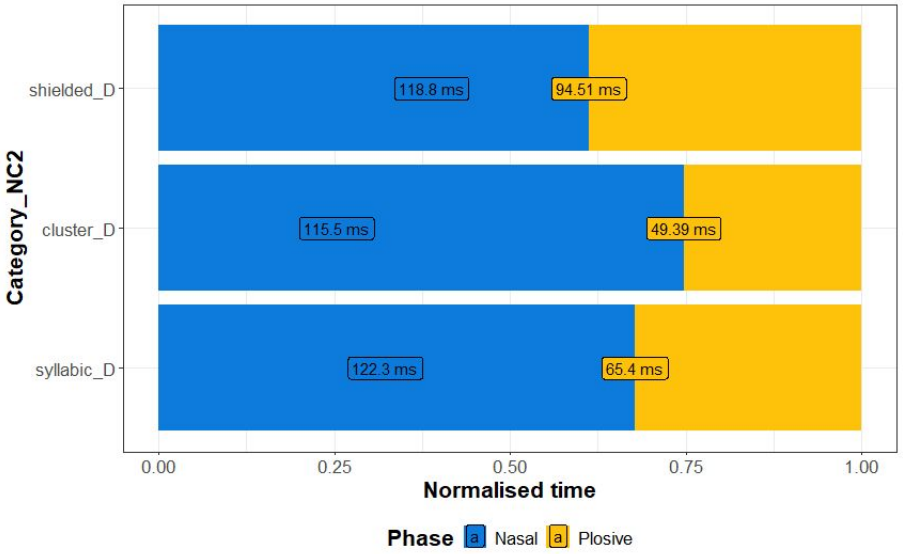
Is there a three-way NC distinction? (absolute)

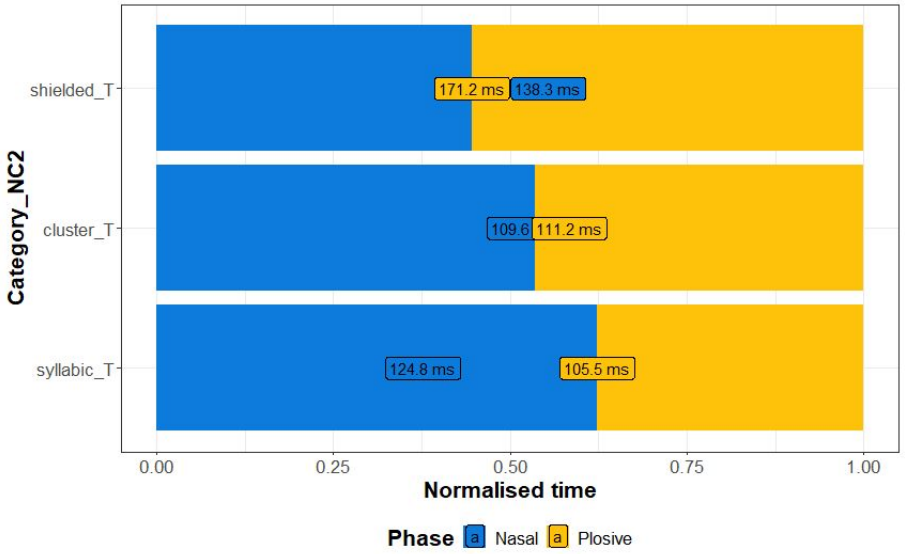




Absolute aggregate duration:	$n^d > n̩.d > nd$	$n^t > n̩.t >\sim nt$
Absolute plosive closure duration:	$n^d > n̩.d > nd$	$n^t > nt >\sim n̩.t$
Absolute nasal duration:	$n^d \sim n̩.d \sim nd$	$n^t > n̩.t >\sim nt$

Is there a three-way NC distinction? (relative)





Relative plosive closure duration:	$n^d > n̥.d > nd$	$n^t > nt > n̥.t$
Relative nasal duration:	$nd > n̥.d > n^d$	$n̥.t > nt > n^t$

Interim summary: Xochistlahuaca

Cluster NC vs syllabic N̩.C:

- Voiced NC and N̩.C are shorter than voiceless, including plosive closure
- Nasal in N̩.C generally slightly longer than in NC (but still shorter than NV)
- Nasal period only a larger relative proportion of N̩.C than NC in voiceless contexts

Cluster NC vs shielded N^C:

- Voiceless N^C longer than NC in absolute terms
- Voiced N^C shorter than NC in relative terms
- N^C plosive closure longer than NC in both absolute and relative terms (strangely)

Three-way comparison:

- Three-way distinction in absolute plosive closure duration (at least for voiced)
- Three-way distinction in relative plosive closure duration
- (But there is a mix of orders and not necessarily principled)

4. Discussion and conclusions

Phonological status

In phonological terms, all three NC sequences behave distinctly

- N^{C} regular pre-oral allophone of N, static patterns in roots and active alternations
- NC occurs both in roots and arises through prefixation
- N̩.C arises through prefixation of the future marker

In keeping with highly diversified tones, nasalisation, phonation, additional onset clusters

- Proliferation of syllable types is one strategy to mediated between the need for contrast and the structural constraints resulting from the tendency toward monosyllabification

Regardless of the phonetic implementation, typologically, Amuzgo is the only language we are aware of with a phonological three-way contrast in NC sequences

- Even two-way contrasts between mono- and bisegmental NC appear to be rare (Riehl 2008)

Phonetic implementation

It seems that, at least in part, Amuzgo joins at least some previous experimental work (Browman & Goldstein 1986, Maddieson & Ladefoged 1993) in not being conclusive on phonetic diagnostics of unary vs cluster status (Riehl & Cohn 2011)

Phonetics of NC vs N̩.C:

- SPA and XA: Perhaps longer nasal duration in N̩.C than NC (though not in all cases)

Phonetics of NC vs N^{C}:

- SPA: Plosive closure may be shorter in N^{C} than NC
- XA: Plosive closure longer in N^{C} than NC

Phonetics of N^{C} vs NC vs N̩.C:

- SPA: No neat three-way distinction on any one measure of duration
- XA: Three-way distinction in absolute plosive closure duration (at least for voiced), relative plosive closure duration (but very messily)

Challenges posed by a three-way contrast

Riehl (2008) and Riehl & Cohn (2011) on unary /ⁿd/ vs cluster /nd/ contrasts:

- Nasal duration is the main cue
- Unary and cluster NC can only contrast in languages with **phonemic length**

Amuzgo – or SPA – at least appears to be a counterexample to this

- Nasal duration may be cue in contrasting only NC and N̩.C (but not obvious)
- Plosive closure may in fact be a bigger cue, at least in XA
- Phonemic length is not contrastive in SPA
- Duration is a cue to controlled v. ballistic syllables in XA

Remaining questions

Are any of the potential effects discussed today actually real or simply spurious?

- In a study with more speakers do we find similar results?
- Are speakers actually able to perceive three phonetically different NC sequences?

If there is actually a phonetic three-way distinction…

- Could the cues involved in each pairwise comparison simply be different?
- Could it involve cues other than duration?
    - We already know this is at least partially the case because of the high tone in $\underset{\cdot}{N}^{H}.C$

Given Kim & Hernández's (2021) previous description, could this be a a diachronic change?

- Is the (phonetic) distinction collapsing? Apparent-time work needed…
- Possible implications for orthography: okay not to differentiate NC types?


Nkya yà ’u’
Thank you

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