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Nasal harmony in Paraguayan Guarani: Positional effects and the representation of nasality

Author
Cabrera, Marisabel

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Nasal harmony in Paraguayan Guarani:

Positional effects and the representation of nasality

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by

Marisabel Cabrera Sanchez

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ABSTRACT OF THE THESIS

Nasal harmony in Paraguayan Guarani:

Positional effects and the representation of nasality

by

Marisabel Cabrera Sanchez

Master of Arts in Linguistics

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Professor Benjamin J. Eischens, Co-Chair

Professor Claire Moore-Cantwell, Co-Chair

This thesis describes and analyzes the grammar of regressive nasal harmony in Paraguayan Guarani, a Tupi-Guarani language spoken by millions in Paraguay. Based on data from original fieldwork conducted in Coronel Oviedo, Paraguay, this thesis makes two empirical contributions and analytical claims in the study of Guarani nasal harmony. First, I show that Guarani suffixes display independence with regards to the distribution of the nasal-oral contrast, otherwise observed in roots and prefixes, due to the cyclic nature of suffixes combined with the limited domain of positional effects of nasality. I analyze this fact in a constraint-based framework by proposing output-to-output correspondence constraints as well as higher ranked requirements for faithfulness in nasality in the domain of suffixes. Finally, I argue that Guarani's nasal-oral stops are, contrary

to previous literature, phonologically full nasal segments that are postoralized in the presence of oral vowels. I present an analysis that unifies such claim with the general analysis of regressive nasalization, and briefly show that an analysis of progressive nasalization as phonologically conditioned allomorphy is compatible with both arguments proposed in this work.

The thesis of Marisabel Cabrera Sanchez is approved.

William Harold Torrence Jr.

Kie Zuraw

Claire Moore-Cantwell, Committee Co-Chair

Benjamin J. Eischens, Committee Co-Chair

University of California, Los Angeles

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I. Introduction

Nasal harmony refers to phonological processes in which the nasality of a segment spreads at a long distance onto other segments in adjacent syllables, morphemes, and even across word boundaries. Nasal spread usually occurs within words or within a smaller prosodic domain, and nasalization is usually transmitted locally to adjacent segments. Across the typology of languages, vowels and sonorant segments are frequent targets of nasal spread, while other segments either alternate under nasal spread, or fail to acquire nasalization altogether. For example, in Warao (isolate; Venezuela), the presence of a nasal consonant induces the nasalization of vowels, sonorants, and [h], that are to the right of the nasal consonant trigger. However, voiceless stops in Warao block nasality from spreading onwards.

(1)	[mõãũ]	'give it to him!'	[nãõte]	'he will come'
	[inãw̃ãh̃ã]	'summer'	[mẽh̃õkohi]	'mother'
	[mõj̃õ]	'cormorant'	[panãpanãh̃ãẽ]	'it is a porpoise'

data from Osborn (1966)

Paraguayan Guarani (Tupi Guarani, Paraguay; henceforth Guarani) has contributed significantly to the typology of nasal harmony and the formalization of long-distance harmony processes in phonological theory. Earliest works of the nasal harmony system of Paraguayan Guarani date back to the late 1960s (Gregores & Suárez, 1967), and its description and analysis continues throughout the decades leading up to this day (Lunt 1973; Rivas, 1975; Kaiser, 2008; Hamidzadeh & Russell, 2015; Estigarribia, 2020; 2021; Russell 2021; 2022). The language exhibits both regressive and progressive long distance nasal spread triggered by phonologically nasal segments. The data in (2) below shows examples of regressive nasalization in Guarani, compared to the lack of nasalization when such nasal segments are absent (2c).

(2)	a. *ai-pytyv**õ***	b. *a-kosin**a***	c. *a-karu*
	[ã$^{\tilde{\imath}}$.pɨ̃.tɨ̃.ˈʋ̃**õ**]	[ã.kõ.sĩ.ˈn**ã**]	[a.ka.ˈɾu]
	1SG-help	1SG-cook	1SG-eat
	'I help'	'I cook'	'I eat'

Guarani's nasal harmony system shows phonological and morphological properties that challenge our typological and theoretical understanding of this phenomenon. Specifically, in Guarani regressive (leftward) nasal spread, segments either nasalize or remain unaffected by nasal spread; the contrast in nasality is limited to certain positions within a form; and the language has complex segments consisting of a nasal contour followed by an oral contour (namely, nasal-oral stops) that play a unique role in nasal harmony. Furthermore, Guarani's nasal harmony pattern interacts with other suprasegmental processes such as stress, and with the general morphological and prosodic structure of the language. All these phonemic, phonological, and morphological properties of Guarani's nasal harmony system spur important debates regarding the representation of nasal segments both within the language and crosslinguistically, and the extent to which phonological processes such as nasal harmony interact with linguistic properties beyond the phonological grammar (Beckman, 1998; Piggott, 2003; Estigarribia, 2021; Russell, 2022).

Of particular interest in this work is the description and analysis of regressive nasalization in Guarani in the domain of suffixes, as well as the description and analysis of the language's nasal-oral contour stops and their role in regressive harmony.[1] Suffixes in Guarani exhibit an inability to affect, and be targeted by, the regular and productive phonology of roots and prefixes.

[1] For the description and analysis of progressive nasalization in Guarani, see Thomas (2014), Estigarribia (2020; 2021), and Russell (2021).

As shown (3) below, suffixes with nasal triggers (bolded) spread nasality onto preceding segments within the same suffix, but not onto syllables in preceding suffixes, roots, or prefixes.[2]

(3)	a.	*che-sy-pe-g̃uar**ã*** [ʃe.sɨ.pe.ɰ̃ʷã.ˈɾ̃**ã**] 1SG-mother-DOM-for ‘for my mother’	b.	*nd-a-ikatu-mo’**ã**-i* [nᵈai.ka.tu.mõ.ˈʔ**ã**ĩ] NEG-1SG-able-NEG.FUT-NEG ‘I won’t be able to’

I argue in this work that suffixes display different phonological properties than roots and prefixes due to the language’s cyclic morphological structure, as well as higher ranked faithfulness constraints for input nasality in the domain of suffixes. These two facts combined explain why regressive nasalization occurs within but not across suffixes, and why suffixes, regardless of stress, are still contrastively nasal or oral. Previous analyses of Guarani nasal harmony miss this important empirical fact, and therefore predict that nasal suffixes trigger regressive spread onto segments in preceding suffixes, roots, and prefixes, and additionally predict that unstressed suffixes neutralize the nasal-oral contrast. I analyze Guarani’s cyclic morphological structure in a parallel constraint-based framework via output-to-output correspondence (Benua, 1997), in which derived forms must remain fully faithful to their immediate morphological neighbor (McCarthy, 1998). These additional conditions on the domain of suffixes are well supported typologically: languages often exhibit phonological properties that are limited to certain morphological and prosodic domains. The description and analysis of Guarani’s suffix asymmetry presented in this work ultimately contributes to the typology of attested phonological asymmetries across affixal domains, specifically of “suffix independence”, which is found to be vastly less common than “prefix independence” (Elkins, 2020).

[2] In all Guarani language data in this work, the first line contains the orthographic transcription of the language, and the second line contains the broad phonetic transcription. Triggers of nasal spread are bolded.

The second crucial area of investigation and analysis in this work is in the phonological representation of the language's nasal-oral contour stops, frequently characterized as prenasalized stops in Guarani literature (Gregores & Suárez, 1967; Piggott, 2003; Kaiser, 2008; Thomas, 2014; Estigarribia, 2020). Nasal-oral contour stops are complex segments composed of a nasal consonant followed by its homorganic oral obstruent that behave as a single phonological unit (Stanton, 2017). The underlying representation of nasal-oral contour segments has brought about crucial debates in the phonetics-phonology interface and with regards to the status of nasal-oral stops of Paraguayan Guarani and those of unrelated languages (Iverson & Salmons, 1996; Riehl, 2008; Wetzels & Nevins, 2018; Krämer & Zec, 2020). Nasal-oral contour stops are argued to be either underlying oral stops or full nasal consonants that acquire prenasalization ([^{m}b]) or postoralization ([m^{b}]), respectively, to enhance other phonemic contrasts in the language. However, in Guarani, the phonological facts that are crucial for diagnosing the underlying representation of its nasal-oral stops are conflicting and ambiguous: nasal-oral stops trigger regressive nasalization, but they otherwise behave as phonologically oral segments.

In response, this work presents a comprehensive description of the distribution of Guarani's nasal-oral contour stops and argues that these must be underlying nasal consonants. Therefore, Guarani's nasal-oral contour stops are, instead, postoralized nasal consonants rather than prenasalized oral stops. Crucially, the analysis of Guarani's nasal-oral stops as prenasalized voiced stops is incompatible with the empirical facts since nasal-oral stops are triggers of regressive nasalization in any position, therefore these require a phonological specification for nasality. This work ultimately proposes a unified analysis of regressive nasalization, incorporating the analysis of nasal-oral contour stops as underlying nasal consonants following the theory of contrast enhancement (Flemming, 2004; Stanton, 2017).

This thesis is organized as follows. Section 2 of this work provides an overview of the language background and sociolinguistic status of Paraguayan Guarani and the fieldwork methodology used in data collection. Section 2 concludes with a brief description of the basic phonology of the language. Section 3 describes the regressive nasalization pattern of Guarani and introduces the two prominent theoretical analyses of the pattern, namely syllable-level nasality (Piggott, 2003) and positional faithfulness of the stressed syllable (Beckman, 1997; 1998).

Sections 4 and 5 hold the core contributions of this work. Section 4 introduces the pattern of regressive harmony in the domain of suffixes, noting that the phonology of nasality and nasal spread in this domain does not conform to the empirical generalizations and analysis for roots and prefixes presented in Section 3. I then highlight the main problems with the analysis of stressed syllable positional faithfulness in the domain of suffixes, and subsequently propose an analysis of Guarani regressive nasalization that formalizes their independence of suffixes from root-and-prefix phonology via the addition of two mechanisms: output-to-output correspondence across morphologically related forms, and higher ranked requirements for faithfulness in nasality in suffixes. Finally, in Section 5, I argue that the analysis of Guarani regressive nasalization requires nasal-oral stops to be phonologically represented as underlying nasal consonants. This simultaneously predicts the allophonic distribution of nasal-oral stops and nasal consonants, and the fact that both nasal-oral stops and nasal consonants trigger regressive spread. This section also discusses the incompatibilities of the analysis presented here with Piggott's (2003) analysis of syllable-level spread and nasal-oral stops. Section 6 concludes and briefly describes Guarani progressive nasalization, showing that the two arguments of this work are compatible an analysis of progressive harmony as phonologically conditioned allomorphy.

2. Background on Paraguayan Guarani

To motivate the empirical and theoretical claims argued for in this work, it is necessary to contextualize the data and arguments within the larger picture of Guarani's background, the methodology of data collection, and the language's basic phonological grammar. To this end, this section provides an overview of Guarani's language family and linguistic status in Paraguay, followed by a general description of the research methodologies of data collection and details on native speaker consultants. Finally, a basic description of the language's phoneme inventory and stress system is provided.

2.1 Overview of the language

Paraguayan Guarani (henceforth Guarani, endonym *avañe'ẽ* 'language of men', ISO: *gug*) is a member of the Tupian language family within the Tupi-Guarani subfamily. The Tupian family is comprised of 60 and 70 different languages spoken in Brazil, Argentina, Bolivia, French Guinea, Paraguay, and Peru.

Guarani is the Tupian language with the most speakers: it is among the three most widely spoken indigenous languages in the Americas, and the only spoken by a large majority that isn't exclusively indigenous in ethnicity. Both Paraguayan Guarani and Spanish are the official languages of Paraguay, with Guarani acquiring its status as an official language of the country in 1992. It is estimated that around 80% of Paraguay's population speaks Guarani at home, with an additional half a million to a million Guarani speakers residing in Argentina. Paraguay's population as of 2018 is estimated at 7 million people, leaving a total of 6 to 7 million speakers of the Paraguayan variety of Guarani, the most widely spoken variety of Guarani. The language is learned as a first language for many children. Although at a disadvantageous position relative to

Spanish, the language enjoys increasing support from the state, with the number of people learning the language at schools increasing at a steady rate.

Guarani possesses many grammatical traits that are characteristic of the Tupian family, including agglutinative morphology and exhibits remnants of polysynthesis, inclusive and exclusive first-person plurals, portmanteau person prefixes that simultaneously mark first and second person agents and patients, a distinction between active and stative verbs (split intransitivity), circumfixal negation, differential object marking, among other grammatical traits. Guarani has participated in important linguistic research beyond nasal harmony, ranging from the linguistic study of phonology, prosodic structure, and intonation, to morphosyntax, semantics, and language contact. Recent work argues that Guarani exhibits free affix order (Dąbkowski, 2022a; 2022b), where Guarani is found to have free affix order without affecting semantic scope or meaning. Guarani is also found to have typologically rare lexical tri-tonal pitch accent (Jun & Zubizarreta, 2022; Jun et al., 2023), with its intonational structure closely mirroring syntactic constituency (Zubizarreta, 2022). Comprehensive production experiments have studied Guarani's focus intonation (Clopper & Tonhauser, 2011; 2013; Turnbull et al., 2015). Guarani has also contributed to studies on language contact, wherein Guarani is found to have lexical strata given phonological variations among borrowed words (Pinta & Smith, 2017), including nasal harmony (Russell, 2022). Finally, the language's inverse-direct agreement morphology has participated in critical theoretical debates in morphosyntactic literature (Zubizarreta & Pancheva, 2017; Johnson, 2023). Morphosyntactic literature also argues that Guarani is a "tenseless" language (Tonhauser, 2011a; 2011b; Pancheva & Zubizarreta, 2020).

Of particular empirical, typological, and theoretical interest in this work is the distribution of the nasal-oral contrast, the presence of nasal-oral contour stops, and its suprasegmental phonological process of regressive nasal spread and its interactions with stress, phonemic inventory, and morphological structure. The language also shows progressive nasalization, but since it is independent from regressive nasalization, it is outside the scope of this work (see Section 6 of this paper, as well as Thomas, 2014; Estigarribia, 2020; 2021; and Russell, 2021).

2.2 Data collection

Unless otherwise specified, all Guarani language data present in this work were collected in consultation with eight native speakers of the language. The data from six of these speakers were collected in person in Coronel Oviedo, Paraguay, while the data for the remaining two speakers were collected remotely via *Zoom*. Coronel Oviedo is a mid-size town with a population of 50,000 people in east-central Paraguay.

The eight language consultants are composed of five females and three males between the ages of 24 and 70 years old. The six speakers whose data were collected in Coronel Oviedo are native speakers of Guarani and Spanish. The younger speakers in this group (1 female, 2 males) spoke Guarani at home and received formal education in Guarani Spanish in school. The older speakers in this group (2 females, 1 male) grew up with Guarani as their first language and did not receive a formal education in the language at school, and instead received formal education in Spanish. All six speakers currently live in Coronel Oviedo, Paraguay. The younger female and the older male consultants grew up in more rural communities around central-east Paraguay. All speakers in this group currently speak Guarani on a daily basis.

The remaining two speakers whose data were collected remotely are females of ages 45 and 60. They are native speakers of Guarani and Spanish, and they grew up speaking Guarani at home as their first language. They also speak English as their second language. The 45-year-old consultant is from Concepción, a small city in north-central Paraguay. The 60-year-old consultant is from Asunción, the capital and largest city of Paraguay. The two consultants have lived in the United States for more than a decade and use Guarani on a semi-regular basis.

Despite the speakers covering a range of areas of origin in Paraguay, all eight speakers of Guarani showed minimal inter-speaker variation with regards to the grammar of nasality and regressive nasalization. However, speakers showed significant variations regarding the language's progressive harmony system. Progressive harmony is briefly discussed in Section 6 of this paper.

The contact language for elicitation with all eight language consultants was Spanish. The general methods for data collection included eliciting translations of words, phrases, and sentences from Spanish to Guarani and from Guarani to Spanish, eliciting well-formedness judgments for target utterances in the proper discourse setting, asking for repetitions, and informal forced choice tasks where consultants were presented with two utterances (either well-formed or ill-formed) and were tasked to choose the more natural-sounding one. Lastly, large sets of 3-word sentences were elicited and recorded, with sentences randomized in order and repeated twice. The two language consultants whose data were collected remotely received financial compensation for their time. The six language consultants in Coronel Oviedo refused compensation.

2.3 Basic phonology

Paraguayan Guarani shows a six-vowel contrast where both oral and nasal versions of these vowel occur, rendering a total of 12 phonemic vowels. The oral and nasal high central vowels [ɨ] and [ɨ̃] are transcribed as *y* and *ỹ* in the orthography of Guarani.

(4)

Oral vowels			
	Front	Central	Back
High	i	ɨ	u
Mid	e		o
Low		a	

Nasal vowels			
	Front	Central	Back
High	ĩ	ɨ̃	ũ
Mid	ẽ		õ
Low		ã	

The minimal pairs below exemplify the nasal-oral contrast in stressed positions for each of the twelve phonemic vowels. In Guarani, vowels are contrastively oral or nasal only in stressed positions, given that the nasality of unstressed vowels is determined by the nasality of the stressed vowel via regressive nasal spread.

(5)

a.	*piri*	*pirĩ*	b.	*aky*	*akỹ*
	[piˈɾi]	[pĩˈɾ̃ĩ]		[aˈkɨ]	[ãˈkɨ̃]
	'fiber mat'	'chill; shiver'		'green; tender'	'wet'
	*[pĩˈɾi]			*[ãˈkɨ]	
c.	*hu'u*	*hu'ũ*	d.	*oke*	*okẽ*
	[huˈʔu]	[hũˈʔũ]		[oˈke]	[õˈkẽ]
	'to cough'	'soft; flexible'		'he sleeps'	'door'
e.	*tupa*	*tupã*	f.	*kói*	*kõi*
	[tuˈpa]	[tũˈpã]		[ko^{i}]	[kõ$^{\tilde{i}}$]
	'bed'	'god'		'farm'	'pair'

Vowels that are adjacent to each other are in hiatus, unless one of the vowels is a high vowel. In such cases, the high vowel is realized as a semivowel or glide. Speakers tend to pronounce central high vowel *y* [ɨ], both oral and nasal, as [i] or [j] in diphthongs. In the orthography, the nucleic vowel of a stressed syllable is specified with an acute accent unless the nucleic vowel is word final (*kói* [ko^{i}] 'farm' vs. *ambue* [ãˈm^{bw}e] 'other').

The consonant inventory of Guarani is given below. The orthographic transcription is given to the right of the phone in italics if it differs from its IPA symbol.

(6)

	bilabial	coronal	post-alv.	palatal	velar	glottal
plosives	p	t			k	ʔ *’*
nasal-oral stops	mᵇ *mb*	nᵈ *nd*			ŋᶢ *ng*	
nasals	m	n		ɲ *ñ*	ŋ *g̃*	
fricatives		s	ʃ *ch*	ʤ *j*		h
approximants	ʋ *v*	ɾ *r*			ɰ *g*	

The inventory above is of consonant *phones*, rather than of phonemes. The status of nasal-oral contour stops and nasal consonants as being fully contrastive, fully allophonic, or contrastive in certain environments has been a matter of debate for decades, both within the context of Guarani and other Tupian languages (Kaiser, 2008; Thomas, 2014; Lapierre & Michael, 2018; Wetzels & Nevins, 2018). This issue will be addressed in subsequent sections of this work. Crucially, nasal-oral stops in this work will be transcribed as postoralized nasal stops ([m^b]), as opposed to prenasalized oral stops ([^{m}b]), which goes against the transcription of nasal-oral stops in Guarani found in previous literature. I transcribe nasal-oral stops in this work as postoralized nasal stops since I later argue that these must be phonologically full nasal stops in the language.

The consonant inventory in (6) shows that the language displays a three-way contrast in place of articulation for plosives, nasal-oral contour stops, and approximants. The presence of nasal-oral stops in the inventory potentially explains why voiced stops /b/, /d/, and /g/ are missing from the inventory. Instead, the language shows a voicing contrast between voiceless stops and nasal-oral stops. The glottal stop [ʔ] is represented with the grapheme *’*, called a *puso*, in the orthographic system of the language. The glottal stop is often elided in rapid speech and in very frequent forms, where the now adjacent vowels, even if either are high vowels, are pronounced in hiatus. Similarly, the labiodental approximant *v* [ʋ] is also often elided in frequent words, such as in *máva* [ˈmã.a] ‘who’.

The velar consonants [ŋ^{g}] *ng*, [ɰ] *g*, and [ŋ] *g̃*, occur quite infrequently and have very limited distributions. The overwhelming majority of these are labialized (7), and they rarely occur without this labialization (8).

(7)	a.	*kangue*	b.	*-hag̃uã*	(8)	a.	*angiru*	b.	*óga*
		[ka.ˈŋ^{gw}e]		[hã.ˈɰ̃$^{w̃}$ã]			[ã.ŋ^{g}i.ˈɾu]		[ˈo.ɰa]
		‘hair’		‘in, from’			‘friend’		‘house’

The velar stop [k] is also labialized, although less frequently. The velar nasal-oral stop [^{ŋ}g] is found word-initially in only a few words, and the velar nasal [ŋ] *g̃* never occurs word- initially.

Guarani’s predominant syllable structure type is CV, where nasal-oral stops are possible complex onsets.[3] Stress is predominantly word final, although a limited number of forms show penultimate stress. Additionally, there is a limited number of stress-based minimal pairs, some shown in (9-12) below.[4]

(9)	*ava*	*áva*	(10)	*eira*	*eíra*
	[a.ˈʋa]	[ˈa.ʋa]		[ei.ˈɾa]	[e.ˈi.ɾa]
	‘person’	‘hair’		‘wild cat’	‘honey’
(11)	*ape*	*ápe*	(12)	*mbói*	*mboi*
	[a.ˈpe]	[ˈa.pe]		[m^{b}o^{i}]	[m^{b}o.ˈi]
	‘surface; skin	‘here’		‘snake’	‘to undress’

Another source of evidence that Guarani stress is lexical is the fact that suffixes are either stressed or unstressed in an unpredictable manner. In compounds, reduplication, and morphologically complex forms, the rightmost inherently stressed morpheme bears primary stress.

[3] Previous descriptive work argues that nasal consonants are the only acceptable codas in the language, which come as a product of the word-medial resyllabification of nasal-oral stops (Kaiser, 2008; Estigarribia, 2020). However, these are purely observational facts about the relative durational differences of the nasal contour between word-medial and word-initial nasal-oral stops, where the nasal contour of word-medial nasal-oral stops is longer than that of word-initial nasal-oral stops. Such observations have not been confirmed quantitatively, and there’s no phonological evidence for their resyllabification since codas are globally disallowed in the language.

[4] I’ve found only 5 of these stress-based minimal pairs in my fieldwork. It is likely there are more.

Example (13) below shows such distinction: stress shifts from the root onto the desiderative suffix *-se* in (13a) since it is lexically stressed, but stress remains at the root for (13b) and at *-se* for (13c) since the future suffix *-ta* is lexically unstressed.

(13)	a.	*a-japo-se*	b.	*a-japó-ta*	c.	*a-japo-sé-ta*
		[a.ʤa.po.ˈse]		[a.ʤa.ˈpo.ta]		[a.ʤa.po.ˈse.ta]
		1SG-work-DES		1SG-work-FUT		1SG-work-DES-FUT
		‘I want to work’		‘I will work’		‘I will want to work’

So, the stress system of Guarani has both lexical and predictable components: the syllables of morphemes are lexically specified as stressed or unstressed, but, when multiple morphemes are specified for stress in a morphologically complex form, the rightmost underlyingly stressed morpheme bears primary stress. Given these observations, this works assumes that stress is lexically specified.

3. Regressive nasalization in roots and prefixes

This section introduces the data and descriptive generalizations of the pattern of regressive nasal spread in Paraguayan Guarani, specifically within the domain of roots and prefixes. Regressive nasalization involving suffixes is described and analyzed in the next section since suffixes show asymmetries with regards to the general grammar of nasal harmony for roots and prefixes. I first introduce the general empirical facts about regressive nasalization in Guarani. I then highlight the phonotactics of nasality and how it has been formalized as a syllable-level contrast in nasality in previous literature (Piggott, 2003). I finally introduce the theory of positional faithfulness proposed by Beckman (1997; 1998) and the analysis therein for Guarani. The mechanisms of both analyses, syllable-level nasality and positional faithfulness, are important in understanding the status of suffixes in the grammar of nasal harmony and the phonological representation of nasal-oral stops in Guarani.

3.1 Data and descriptive generalizations

Regressive nasal spread in Guarani is triggered by nasal vowels in stressed syllables, given that nasality is only contrastive at this position. In (14b) and (14c) below, the nasal vowel in stressed syllable (bolded) triggers nasalization of all vowels to its left, as well as the sonorant consonant /ʋ/ in (14b). Voiceless stops and fricatives are transparent in Guarani: they don't nasalize or alternate under regressive nasal spread. In (14b) and (14c), the voiceless consonants *p*, *t*, *k*, and *s* do not nasalize or alternate in nasal spans. From here on, triggers of regressive spread are bolded.

(14)	a.	*a-karu*	b.	*ai-pytyv**õ***	c.	*a-kosin**a***
		[a.ka.ˈɾu]		[ãĩ.pɨ̃.tɨ̃.ˈʋ̃**õ**]		[ã.kõ.sĩ.ˈn**ã**]
		1SG-eat		1SG-help		1SG-cook
		'I eat'		'I help'		'I cook'

The nasal-oral stops of Guarani ([mᵇ], [nᵈ], and [ŋᵍ]) are in complementary distribution with nasal consonants: nasal consonants emerge when followed by a nasal vowel, and nasal-oral stops emerge when followed by an oral vowel. This is observed, for example, in person prefixes (15) and in the causative prefix (16), where nasal-oral stops surface in the absence of a nasal vowel trigger. Consonant alternations induced by regressive nasalization are boxed.

(15)	a.	*pe[nd]e-yvate*		b.	*pe[n]e-r-en**ó**i*	→ *2pl prefix*
		[pẽ.nᵈe.ɨ.ʋa.ˈte]			[pẽ.nẽ.ɾ̃ẽ.ˈn**õ**ĩ]	
		2PL-tall			2PL-INV-call	
		'y'all are tall'			'he/they call y'all'	
(16)	a.	*a-[mb]o-pupu*	*'y*	b.	*a-[m]o-kane'**õ***	→ *causative prefix*
		[ã-mᵇo.pu.ˈpu]			[ã.mõ.kã.nẽ.ˈʔ**õ**]	
		1SG-CAUS-hot	water		1SG-CAUS-tired	
		'I boil water'			'I made (someone) tired'	

Vowels that condition the allophonic distribution of nasal-oral stops and nasal consonants may be underlyingly nasal, as in stressed syllables (18), or may have become nasal due to regressive nasalization triggered by a following stressed nasal vowel (15, 16, 17). The overall distribution of Guarani's stops is summarized in (19) below.

(17) a. *mbo'a*
[mᵇo.ˈʔa]
'position'

b. *mo'**ã***
[mõ.ˈʔã]
'almost'; NEG.FUT

(18) a. *mimbi*
[mĩ.ˈmᵇi]
'radiant'

b. *mim**i***
[mĩ.ˈm**ĩ**]
'tiny'

(19) *Guarani distribution of stops*

Nasal consonant: Ṽ_Ṽ

Oral stop (voiceless): _V, and _Ṽ

Nasal-oral stop (voiced): Ṽ_V

Interestingly, the affricate *j* [ʤ] also surfaces as a nasal consonant, namely the palatal nasal *ñ* [ɲ], in nasal spans. Such alternation is observed for various prefixes, including the stative third person prefix (20) and the reciprocal prefix (21), among others.

(20) a. *ij-yvate*
[i.ʤɨ.ʋa.ˈte]
3-tall
'he is tall'

b. *iñ-akã-por**ã*** → *3 prefix*
[ĩ.ɲã.kã.põ.ˈɾ̃**ã**]
3-head-pretty
'he is smart'

(21) a. *o-jo-h-ayhu*
[o.ʤo.haⁱ.ˈhu]
3-REC-DIR-love
'they love each other'

b. *o-ño-h-en**ó**i* → *reciprocal*
[õ.ɲõ.hẽ.ˈn**õ**ĩ]
1SG-REC-DIR-call
'they call each other'

So, the affricate *j* patterns like nasal-oral stops in the sense that it surfaces as its homorganic nasal consonant in nasal spans. Additionally, the nasal counterpart of affricate *j* only emerges in nasal spans, therefore only as a product of regressive nasalization.

(22)	a.	*j**ara* [ʤa.ˈɾa] 'to remove'	b.	*ñan**a*** [ɲã.ˈn**ã**] 'herb'
(23)	a.	*aja* [a.ˈʤa] 'during'	b.	*añ**a*** [ã.ˈɲ**ã**] 'evil, bad'

So far, the nasal triggers observed in this data have been in nominal and verbal roots. However, phonemically nasal prefixes in Guarani also trigger regressive nasalization. Example (24) below shows that the phonemically nasal vowel of the causative prefix conditions the negation prefix to surface with a nasal consonant as opposed to with a nasal-oral stop.[5]

(24)	a.	*n-a-m**o**-ngaigue-i* [nã.m**õ**.ŋᵍaⁱ.ˈɰʷeⁱ] NEG-1SG-CAUS-bore-NEG 'I didn't bore him'	*ha'e* 3

Nasal spread and its segment alternations stack within a morphological word. Example (25b) below shows that nasal vowel in the nasal verb root *pytyvõ* [pɨ̃.tɨ̃.ˈʋ̃õ] 'help' induces three segment alternations in prefixes to its left, regardless of the distance between these prefixes and the nasal trigger of the verb root. However, the first inclusive person pronoun, *ñande*, surfaces as such for both oral and nasal verb roots.

[5] The causative prefix is the only prefix in Guarani that shows a phonemic oral-nasal contrast. This is observed in the distribution of exceptional and non-exceptional causative constructions, where the causative prefix is exceptionally phonemically nasal in the presence of certain roots (Estigarribia, 2021). Example (24) above is an exceptional causative construction. I assume that the nasality of the causative prefix in such examples is exceptionally phonemically nasal, rather than it being present because the prefix is an underlyingly stressed syllable.

(25) a. *ñande* *nda-ja-jo-h-ayhú-i*
[ɲã.ˈn^{d}e n^{d}a.ʤa.ʤo.ha^{i}.ˈhu^{i}]
1PL.INCL NEG-1PL.INCL-REC-DIR-love-NEG
'we don't love each other'

b. *ñande* *na-ña-ño-pytyv**õ**-i*
[ɲã.ˈn^{d}e nã.ɲã.ɲõ.pɨ̃.tɨ̃.ˈʋ̃**õ**^{ĩ}]
1PL.INCL NEG-1PL.INCL-REC-listen-NEG
'we don't help each other'

However, it can't be determined with certainty if the domain of regressive spread is the morphological word or larger. The fact that regressive spread doesn't affect person pronouns such as those in (25) could otherwise be due to stress and not due restrictions in the domain of spread. For example, the stressed oral syllable of the person prefix in (25), *nde* [n^{d}e], may be the blocking regressive nasal spread given its phonemic orality.

Finally, oral-nasal compounds and reduplicating forms show that nasal spread does not cross this morpheme boundary. In (26a) below, the stressed nasal vowel of the second root of the compound nasalizes the root-internal syllable to its left, but it doesn't nasalize the vowels and the sonorant consonant [ʋ] in the first root of the compound. In (26b), the nasal-oral stop to the left of the stressed nasal vowel, [õ], doesn't trigger regressive nasalization, as evidenced by the lack of nasality in the syllable of the first root *mbi* [m^{b}ɨ].

(26) a. *avati-mir**ĩ***
[a.ʋa.ti.mĩ.ˈɾ̃ĩ]
corn-small
'wheat'

avati [a.ʋa.ˈti]

b. *memby-k**õ**i*
[mẽ.m^{b}ɨ.ˈkõ^{ĩ}]
child-pair
'twins'

memby [mẽ.ˈm^{b}ɨ]

In summary, stressed nasal vowels are triggers of regressive nasalization. All vowels and sonorants to the left of the trigger become nasalized, even when these are at a long distance from the trigger. The spread of nasality also induces segment alternations of nasal-oral stops and the affricate *j* [ʤ], where these surface as nasal consonants in nasal spans. Finally, in oral-nasal compounds and in reduplication, nasal spread proceeds within the roots, if they contain nasal triggers, but nasality doesn't spread regressively from the second root onto the first root.

3.2 Analysis

3.2.1 Phonotactics and syllable-level nasality

Piggott (2003) argues that, crosslinguistically, languages may require that all segments within a syllable must be either oral or nasal. This is true of languages that don't have a nasal harmony system that would otherwise explain their syllable-internal agreement in nasality (such as in Yoruba, Kaingang, Gbe, among others). Piggott (2003) demonstrates this property for Kaingang (Jê, Brazil) with the data in (27) below. In Kaingang, segments in the same syllable agree in nasality, but Kaingang shows no nasal harmony, as evidenced by the lack of nasal spread to syllables either preceding or following nasal triggers.

(27)	nasal syllables			oral syllables		
	r̃ã	'sun'	**rã*	*ra*	'toward'	
	ỹãra	'spit'	*ỹãr̃a	*ᵑgoyo*	'water'	
	kur̃ã	'day'	*kurã	*kara*	'all'	*(select data from Piggott, 2003)*

Segments within a syllable also agree in nasality for Guarani. In (28) and (29) below, the approximants are nasalized along with their nucleic nasal vowel.

(28)	*ro*	***-rõ***	(29)	*-gua*	***-guã***
	[ɾo]	[ɾ̃õ]		[ɰɻʷa]	[ɰ̃ɻ̃ʷ̃ã]
	'bitter'	'if, when'		'for'	'of, from'

For Guarani, Kaingang, and languages alike, Piggott (2003) proposes the undominated markedness constraint SYLNAS, even for languages that show a nasal harmony system that would otherwise predict that target segments agree in nasality within a syllable. Under this analysis, the observed syllable-internal agreement is a result of the nasal feature being a property of syllables, rather than a property of individual segments. Then, target segments within the syllable license its nasal feature at the segment level. So, for Guarani, segments within a syllable agree in nasality because of this phonotactic property, rather than as a result of regressive harmony from the oral or nasal segment of the syllable. The relevant faithfulness constraint is defined in (31) below:

(30) SYLNAS

In an output nasal syllable, the feature must be associated with the nucleus and projected to all other sonorants. (Piggott, 2003)

Assign one violation for every output syllable containing segments that disagree in nasality.

(31) IDENT[NAS]

Assign a violation for each output syllable that doesn't have the same value for the feature [nasal] as its corresponding syllable in the input.

In the tableau in (32) below, input nasality is specified as a property of the syllable, rather than as a property of one or both of its segments. The constraint SYLNAS then requires the [+nasal] syllable feature to be associated with the nucleus and all other sonorants within the syllable. So, the winning candidate must nasalize both segments of the syllable as well as preserve the input nasality of the syllable (due to IDENT[NAS]).[6]

[6] For concreteness and brevity, I assume here that input nasality is already a property of the syllable. Under Richness of the Base, inputs may also have input nasality as a property of segments. Piggott (2003; p. 389) proposes the markedness constraint NASALLICENSING/σ, wherein [+/- nasal] features must be licensed as a property of the syllable. Both NASALLICENSING/σ and SYLNAS make surface-true predictions for Richness of the Base candidates that have input nasality specified at the segment level.

(32)

/(ɾo)[+nas]/ 'if, when'	SylNas	Ident[nas]
a. ɾo		*!
b. ɾõ	*!	
☞ c. ɾ̃õ		

Piggott (2003) further argues for syllable-level nasal spread, even in languages with nasal harmony, since it predicts the kind of neutrality that neutral segments exhibit. Recall that voiceless segments in Guarani are transparent to regressive nasal spread: voiceless segments fail to acquire the harmonizing feature or alternate due to its spread, but the spread of the harmonizing feature proceeds through them. Piggott (2003) argues that neutral segments are opaque for languages with segment-level spread, while neutral segments are transparent for languages with syllable-level spread. In both systems, neutral segments fail to acquire nasality through constraints ranked above the nasal harmony driving constraint that require them to remain oralized. In languages with segment-level spread, nasality cannot proceed through the neutral segment since nasal spread must be local. On the other hand, in languages with syllable-level spread, nasality spreads locally to adjacent syllables at the syllable level, and the neutral segment simply fails to acquire the nasal feature from the syllable level due to these higher-ranked constraints that ban its nasalization or alternation. Therefore, under Piggott's analysis, regressive nasal harmony in Guarani must be defined in a way that spreads nasality though the syllable level, as in (33) below.

(33) ALIGN-L[NAS]

The nasality of syllables must be aligned at the left edge of the morphological word.[7]

For a given output nasal syllable, assign a violation for each [-nasal] syllable in the output that intervenes between the nasal syllable and the left edge of the morphological word.

The higher ranked constraints that require neutral segments to remain neutral to the spread of the harmonizing feature have been formalized as markedness and faithfulness constraints in previous literature (Walker 1998; 1999; 2003). Piggott (2003) proposes the undominated faithfulness constraint MAXSTOPDIST, which, along with syllable-level spread, predicts that segments are transparent rather than opaque. Here, transparent segments fail to acquire the nasality from the syllable level, since these must remain fully faithful to their input specification. Piggott (2003) defines the faithfulness constraint that is relevant for a language with neutral obstruent stops as below:

(34) MAXSTOPDIST

An input obstruent stop has an output correspondent with identical feature specification. (Piggott, 2003)

The tableau in (35) below presents Piggott's (2003) analysis of transparent segments in Guarani, along with SYLNAS. A voiceless segment that acquires nasality violates the highly ranked faithfulness constraint MAXSTOPDIST, as is the case for Candidate a. And, a candidate that doesn't align the nasality of syllables to the left edge of the input incurs a violation of the nasal harmony constraint ALIGN-L[NAS] defined in (33) above. Transparent segments that fail to acquire the nasal

[7] As previously mentioned, the exact domain of leftward nasal spread cannot be determined with certainty. For simplicity, I assume here that the domain of regressive spread is the morphological word, though such assumption might be unnecessary. Beckman's (1998) analysis of positional faithfulness, presented in subsequent questions, would still make surface-true predictions even if the domain of regressive spread were to be larger than the morphological word.

feature don't incur violations of SYLNAS, since SYLNAS is defined over sonorant segments, and transparent segments in Guarani are voiceless stops.[8]

(35)

tu.ˈ(pa)[+nas] 'god'	MAXSTOPDIST	SYLNAS	ALIGN-L[NAS]	IDENT[NAS]
a. tupã	*!		*	*
☞ b. tũpã				*

SYLNAS also predicts the distribution of nasal-oral stops and nasal consonants in Guarani, but under a critical assumption: nasal-oral stops in Guarani are underlying voiced oral stops rather than underlying nasal consonants. Piggott (2003) argues that Guarani nasal-oral stops are underlying oral segments for two main reasons. First, voiced oral stops are entirely missing from the inventory, and, second, nasal-oral stops are in complementary distribution with their homorganic nasal consonant, so they are the oral counterpart of nasal consonants. He further argues that the prenasalization of these underlying voiced stops is a phonetic epiphenomenon rather than a true phenomenon present in the phonological representation of the segment. The status of nasal-oral stops and nasal consonants as being allophones or separate phonemes has been contested for decades (Kaiser, 2008; Thomas, 2014; Stanton, 2017; Wetzels & Nevins, 2018; Lapierre & Michael, 2018). This issue will be addressed in Section 5.

To avoid any premature claims about the phonological representation of nasal-oral stops, assume for now that these are underspecified for nasality. In the tableaus in (36) and (37) below,

[8] Piggott's (2003) MAXSTOPDIST encounters problems with Richness of the Base (Smolensky, 1998). An input nasal voiceless stop would be required to surface faithfully due to MaxStopDist, since its deletion of input nasality would incur a violation of such constraint. Alternative analyses that predict the neutrality of segments assume feature co-occurrence markedness constraints (Walker 1998; 1999; 2003). For Guarani, such constraint would be *[+NASAL -VOICE], since voiceless segments in Guarani are neutral to regressive spread. However, the distinction between opaque and transparent segments remains unclear in this account. I assume Piggott's analysis of transparency for uniformity and consistency, and the issue of transparency is later addressed in Section 5 of this work.

the underspecified input segment /Nb/ surfaces as either a nasal-oral stop or a nasal consonant given the phonotactic requirement for syllable-internal agreement in nasality (SYLNAS) and the input specification of nasality of the syllable (IDENT[NAS]).[9] Therefore, the underspecified input consonant surfaces as a nasal-oral stop in oral syllables and as a full nasal consonant in nasal syllables. Recall that, although Piggott (2003) argues that nasal-oral stops are phonologically oral segments with prenasalization, I still transcribe these as postoralized nasal stops given the main arguments of subsequent sections of this work.

Thus, Candidate a in (36) satisfies SYLNAS because both segments within the syllable are oral, and these incur no violations of faithfulness since the syllable associated with them is also oral. Candidate c. in (36) violates IDENT[NAS] since the nasality of the syllable is now nasal given the nasality of both of its segments. Similarly, Candidate b in (37) violates IDENT[NAS] since the syllable is now [-nasal] given that both of its segments are [-nasal].

(36)

$(mo)_{[-nas]}$	SYLNAS	ID[NAS]
☞ a. m^bo		
b. mo	*!	
c. mõ		*!

(37)

$(mo)_{[+nas]}$	SYLNAS	ID[NAS]
a. $m^bõ$	*!	*
b. m^bo		*!
☞ c. mõ		

Additionally, the SYLNAS constraint also predicts the complementary distribution between *j* [ʤ] and *ñ* [ɲ], where *j* surfaces in oral spans and *ñ* surfaces in nasal spans. Since *j* is a target of

[9] Piggott (2003) introduces the analysis of the distribution of nasal-oral stops and nasal consonants by assuming that these are neutralized given SYLNAS. For example, an input such as /$(m^bo)_{[+nas]}$/ would involve changing the initial nasal-oral stop to a full nasal consonant, since all sonorant segments within a syllable must license the nasal specification of their syllable at the segment level. However, it is unclear if Piggott (2003) argues that nasal-oral stops and nasal consonants are separate phonemes, or if these are allophones of the same phoneme and therefore have the same underlying representation. Subsequent sections of this work argue that the distribution of nasal-oral stops and nasal consonants is due to their allophony, rather than due to their neutralization given the requirements for syllable-internal agreement in nasality.

regressive spread, it must surface as its nasal consonant counterpart when followed by a nasal vowel, since it must realize the nasal specification of its syllable in accordance with SYLNAS.

In summary, the agreement in nasality of segments within a syllable is assumed to be a consequence of the prosodic level at which nasality is contrastive. Languages with syllable-internal agreement in nasality contrast such feature at the syllable level, while languages without such a property have nasality as a property of individual segments. Furthermore, languages with syllable-level nasal spread, such as Guarani, show transparent rather than opaque segments: nasality spreads locally at the syllable level, and neutral segments fail to acquire the nasal feature at the segment level due to higher-ranked feature co-occurrence constraints.[10] The next subsection details another analysis that is key in analyzing Guarani nasal harmony, namely positional faithfulness.

3.2.2 Positional faithfulness

Crosslinguistically, languages display asymmetries between prominent and non-prominent positions. Segmental contrasts are often maintained in prominent positions while they are neutralized in non-prominent environments. Additionally, segments in prominent positions often trigger phonological processes such as assimilation and harmony, and conversely, they often block such processes when these are triggered by other segments in the form. These strong positions are argued to be perceptually and psycholinguistically prominent, and they tend to be roots, root-initial syllables, stressed syllables, and syllable onsets.

The phonological grammars of languages systematize these perceptual and psycholinguistic prominence effects. Beckman (1997; 1998) observes three properties that are

[10] Piggott's (2003) analysis makes interesting and important typological predictions that require crosslinguistic investigations. First, the analysis predicts that language have *either* opaque or transparent segments, since languages parameterize the level at which the contrast in nasality is encoded. Second, the system also predicts that languages with nasal harmony systems with transparent segments must have syllable-internal agreement in nasality.

characteristic of positional prominence effects in phonological grammars: positional neutralization, positional triggering, and positional blocking. Beckman formalizes such patterns via higher-ranked faithfulness constraint that is relativized to the prominent position. This way, the phonological properties of inputs are preserved in the output in prominent positions, while features and segments in non-prominent positions are subject to the stronger requirements of markedness constraints.

Beckman (1998) argues that Paraguayan Guarani exhibits all three key properties of positional faithfulness. First, nasal and oral vowels and consonants are contrastive only in stressed positions in the language. Second, since nasal and oral segments are only contrastive in stressed syllables, only nasal segments in stressed syllables can trigger regressive spread. Finally, stressed oral syllables block nasalization triggered by stressed nasal segments in other stressed syllables to their right, as observed in compounds and reduplication.

Example (38) below recapitulates the positional neutralization of nasality of Guarani: nasality cannot emerge as a property of unstressed positions unless the unstressed syllable acquired its nasality from a nasal syllable to its right.

(38)	a. *tupa* [tuˈpa] ‘bed’	b. *tupã* [tũˈpã] ‘god’	c. **tũpa* [tũˈpa]	d. **tupã* [tuˈpã]

To formalize this, Beckman proposes the higher-ranked positional faithfulness constraint IDENT-σ́[NAS], which serves to protect the stressed syllable from alternations motivated by lower-ranked markedness constraints. Its definition, following Beckman (1998), is given below.

(39) IDENT-σ́[NAS]

Output segments in a (underlyingly) stressed syllable and their input correspondents must have identical specifications for the feature [nasal].[11] (Beckman, 1998)

Assign one violation for every segment in a (underlyingly) stressed syllable that does not have identical feature specifications for the feature [nasal] as its input correspondent.

So, stressed syllables must retain their input specification of nasality to satisfy the positional faithfulness constraint IDENT-σ́[NAS]. This is not the case for unstressed syllables, since the nasal-oral contrast is neutralized in these positions. The neutralization of the nasal-oral contrast in unstressed syllables emerges from the ranking of IDENT-σ́[NAS] over *ṽ and IDENT[NAS], where *ṽ is a general context-free markedness constraint that rules out nasal vowels. The ranking of IDENT-σ́[NAS] over *ṽ preserves input nasality in stressed syllables and rules out input nasality in unstressed syllables. The ranking of *ṽ over IDENT[NAS] allows the nasality of input unstressed syllables to be removed. The tableau below analyzes the ungrammatical input *tũpa* from (38c) above.

(40)

/tũˈpa/	ID-σ́[NAS]	*ṽ	ID[NAS]
a. tũˈpa		*!	
b. tũˈpã	*!	**	*
☞ c. tuˈpa			*

Here, the higher-ranked positional faithfulness constraint rules out the nasalization of the stressed syllable since such syllable is oral in the input. This is not the case for the unstressed syllable of the input form, since the faithfulness constraint violated in its oralization, namely

[11] Beckman's (1998) definition of ID-σ́[NAS] didn't define such constraint according to underlying or surface stress. However, given their analysis of compounds, it is assumed that the constraint assigns violations for underlyingly stressed syllables.

IDENT[NAS], is ranked lower than the markedness constraint motivating its oralization, namely *ṽ. Therefore, input nasality is ruled out only in unstressed positions.

The analysis of positional triggering also involves the harmony-driving markedness constraint ranked between the positional faithfulness constraint IDENT-σ́[NAS] and the general faithfulness constraint IDENT[NAS]. Here, the ranking of IDENT-σ́[NAS] over the harmony-driving constraint ensures that the nasality of stressed syllables isn't removed to satisfy the demands of uniformity in nasality across a morphological word. And, the ranking of the harmony-driving constraint over IDENT[NAS] allows for the spread of nasality to non-nasal unstressed syllables. Crucially, the harmony-driving constraint must also rank above *ṽ, since surface forms that maximally abide to regressive spread have more nasal syllables than their inputs.

The tableau below demonstrates the ranking that generates positional neutralization and positional triggering. Here, the change in nasality of the stressed syllable to avoid violating the nasal harmony-driving constraint is ruled out by IDENT-σ́[NAS]. To meet the demands of nasal harmony, nasality spreads leftwards and optimally aligns to the left edge of the domain of spread (Candidate c).

(41)

/tuˈpã/ 'god'	ID-σ́[NAS]	ALIGN-L[NAS]	*ṽ	ID[NAS]
a. tupã		*!	*	
b. tupa	*!			*
☞ c. tũpã			**	*

The third and last property of positional effects observed in Guarani is positional blocking. Positional blocking is also predicted by the ranking presented above. Recall from Example (26) that, in oral-nasal compounds and in reduplication, nasal spread proceeds within the root but not across roots. The analysis under positional faithfulness assumes that, since the first root contains a syllable that is underlyingly specified for stress, then the stressed syllable of the first root is also protected by IDENT-σ́[NAS]. This predicts the simultaneous positional triggering and blocking patterns of nasal spread observed for compounds and reduplicating forms. The underlyingly stressed syllables in are underlined both in inputs and outputs. The tableau below analyzes Example (26a).

(42)

/aʋa<u>ti</u>-ɴʙi<u>ɾĩ</u>/ ‘wheat’	ID-σ́[NAS]	ALIGN-L[NAS]	*Ṽ	ID[NAS]
a. ãʋ̃ã<u>tĩ</u>mĩ<u>ɾ̃ĩ</u>	*!		*****	****
☞ b. aʋa<u>ti</u>mĩ<u>ɾ̃ĩ</u>		***	**	*

The higher ranked IDENT-σ́[NAS] constraint must protect syllables with underlying stress as opposed to only protecting those with surface stress. The tableau in (42) shows two underlyingly stressed syllables (underlined), but only the rightmost underlyingly stressed syllable has surface stress. If IDENT-σ́[NAS] were to only protect syllables with surface stress, then nasality is predicted to spread from the second nasal root and onto the first, as in Candidate a in (42).

In summary, Beckman’s (1998) theory of positional faithfulness predicts three important aspects of Guarani’s inventory markedness and nasal harmony system: the positional neutralization of the oral-nasal contrast, and the positional triggering and blocking of the spread of nasality. This analysis of such facts consists of a higher-ranked faithfulness constraint that preserves the input orality or nasality of stressed syllables over the demands of nasal spread and the general markedness of nasality. Notably, the analysis of the stress system of Guarani has important consequences for the predictive power of positional faithfulness. The assumption that stress is lexical in Guarani ensures that the observations for positional blocking are predicted by Beckman’s (1998) positional faithfulness framework. The next section describes the grammar of regressive nasalization in the domain of suffixes, where these show a different behavior with regards to the positional neutralization of the contrast in nasality as well as the domain of regressive nasalization.

4. Regressive nasalization in the domain of suffixes

The analyses of regressive harmony reviewed in the previous section fail to analyze the pattern in morphological domains beyond roots, prefixes, and compounds. Suffixes become important for the analysis of regressive spread because they show different phonological properties with regards to the contrast in nasality and nasal spread. More specifically, suffixes are contrastively oral and nasal even when these are lexically unstressed, and nasal suffixes fail to trigger regressive spread onto preceding suffixes, roots, and prefixes. Therefore, the data on suffixes is inconsistent with the predictions of positional faithfulness on all three properties: positional neutralization, triggering, and blocking.

This section holds the first main contribution of this work to the analysis of regressive harmony in the language. First, I briefly describe the new language data collected in my fieldwork in Paraguay that shows the regressive harmony pattern in morphologically complex forms that include suffixes. Second, I detail how the analysis of positional faithfulness fails to predict the attested nasal harmony pattern. Positional faithfulness wrongfully predicts that unstressed nasal suffixes should neutralize their contrast in nasality, and that nasal suffixes trigger regressive nasal spread onto preceding unstressed suffixes and beyond. To this end, this section argues that Guarani exhibits cyclicity in the domain of suffixes, wherein a derived form with suffixes must remain faithful to its immediate morphological neighbor (Benua, 1997; McCarthy, 1998). This analysis simultaneously predicts the fact that multisyllabic suffixes spread nasality onto preceding syllables suffix-internally, but that all suffixes fail to trigger nasal spread onto preceding elements across the morpheme boundary. Additionally, I argue that a higher ranked faithfulness constraint is required in the domain of suffixes, given that these are contrastively oral and nasal even when underlyingly unstressed and when not included in the base of correspondence.

4.1 Limits of positional faithfulness in suffixes

The previous section presented data and analyses in support of the fact that Guarani exhibits all three positional effects: positional neutralization, triggering, and blocking. The contrast in nasality is neutralized in unstressed syllables due to markedness in nasality (*Ṽ), but higher ranked faithfulness in nasality at stressed syllables (IDENT-σ́[NAS]) preserves the contrast in nasality in this position, it derives the fact that only stressed syllables trigger regressive spread, and it predicts that nasal spread proceeds within roots, but not onto other roots, in compounds and reduplication.

The new fieldwork data collected in Paraguay shows that regressive spread triggered by the stressed nasal syllable of a root still proceeds even if primary stress has shifted away from the trigger. For example, in (43b), the syllable with surface stress is the desiderative suffix *-se*, a lexically stressed oral suffix. Here, the underlyingly stressed nasal vowel of the root still triggers regressive nasalization, as evidenced by the nasalization of vowels and sonorants to its left as well as the alternation of the negation prefix to a full nasal consonant.

(43)	a.	*n-ai-pytyv**õ*** [nã$^{\tilde{\imath}}$.pɨ̃.tɨ̃.ˈʋ̃**õ**] NEG-1SG-help ‘I don’t help’
	b.	*n-ai-pytyv**õ**-sé-i* [nã$^{\tilde{\imath}}$.pɨ̃.tɨ̃.ʋ̃**õ**.ˈse^{i}] NEG-1SG-help-DES-NEG ‘I don’t want to help’

Although Beckman (1998) doesn't directly consider such data, their theory of positional faithfulness successfully predicts the fact that roots preserve their specification for nasality, even when these no longer host primary stress. Both the stressed syllable of the root and the stressed oral suffix are protected by the highly ranked IDENT-σ́[NAS], and nasality spreads leftwards from the root due the requirement for nasal harmony. The tableau in (44) below shows that a candidate with regressive nasalization and the oral suffix wins over a candidate that is fully nasal (Candidate b) or fully oral (Candidate c). Neither of the candidates in the analysis below incur violations of ALIGN-L[NAS]: nasality is aligned at the left edge for Candidates a and b, and Candidate c has no nasal segments to align to the left edge. Recall that underlined syllables mark the underlyingly stressed syllables in the input that are subject to IDENT-σ́[NAS].

(44)

/Nc-aⁱ-pɨtɨʋ̲õ̲-s̲e̲-i/ 'I don't want to help'	ID-σ́[NAS]	ALIGN-L[NAS]	*Ṽ	ID[NAS]
☞ a. nãĩpɨ̃tɨ̃ʋ̲̃õ̲s̲e̲ⁱ			****	***
b. nãĩpɨ̃tɨ̃ʋ̲̃õ̲s̲ẽ̲ĩ	*!		*****	****
c. nᵈaⁱpɨtɨʋ̲o̲s̲e̲ⁱ	*!			*

Positional faithfulness also predicts the fact that stressed nasal suffixes in Guarani never trigger regressive nasalization onto roots. In (45) below, the stressed nasal suffixes *-'ỹ* and *-rõ* don't trigger regressive spread: the vowels and sonorants to their left are oral, and the nasal-oral stop in (45a) and the affricate *j* in (45b) fail to surface as full nasal consonants.

(45) a. *h-e[nd]u-'**ỹ***
[hẽ.nᵈu.ˈʔ**ɨ̃**]
3POSS-listen-PRIV
'deafness'

b. *o-[j]ehu-r**õ***
[o.ʤe.hu.ˈɾ̃**õ**]
3-happen-if
'if it happens'

The tableau below shows that positional faithfulness successfully predicts the nasal harmony pattern attested in (45) above. Here, the higher-ranked IDENT-σ́[NAS] constraint protects the root from nasalizing given the stressed nasal suffix.

(46)

/o-je<u>hu</u>-<u>ɾõ</u>/ ‘if it happens’	ID-σ́[NAS]	ALIGN-L[NAS]	*Ṽ	ID[NAS]
☞ a. oje<u>huɾ̃õ</u>		***	*	
b. õɲẽ<u>hũɾ̃õ</u>	*!		****	**

Finally, positional faithfulness also successfully predicts the nasal harmony pattern for compounds and reduplication: the stressed oral syllable in the first root blocks the spread of nasality triggered by the second root due to highly ranked IDENT-σ́[NAS]. The analysis in (46) above applies in the same way to compounds and reduplication.

Crucially, the analysis of positional faithfulness fails to make surface-true predictions when unstressed nasal suffixes are involved. The novel fieldwork data collected in Paraguay shows that unstressed nasal suffixes preserve their input nasality, and, even when such nasality is preserved at the surface, they still fail to trigger regressive spread onto preceding elements. The examples below show that suffixes retain the oral-nasal contrast even in unstressed positions. The unstressed nasal suffixes in (47a) and (48a) also fail to trigger regressive nasalization, as evidenced by the presence of affricate *j* instead of its palatal nasal counterpart in both examples.[12]

[12] Recall that the distribution of stressed and unstressed suffixes is entirely unpredictable, which serves as evidence that stress must be lexically specified in the language. Suffixes are lexically stressed if they can host primary stress when they're the rightmost suffix in a form. In (47a) and (48a), the completive and requestative suffixes are lexically unstressed since primary stress remains at the root, while the privative and “if” suffixes in (45) are lexically stressed since stress shifts onto them from the root.

(47) a. *a-japo-m**a***
[a.ʤa.ˈpo.m**ã**]
1SG-work-CMPL
'I already work'

b. *o-ñe'**ẽ**-mba*
[õ.ɲẽ.ʔ**ẽ**.ˈmᵇa]
3-talk-TOT
'he finished talking'

(48) a. *e-ju-n**a***
[e.ˈʤu.n**ã**]
IMP-come-REQ
'please come!'

b. *ai-pytyv**õ**-ta*
[ãĩ.pɨ̃.tɨ̃.ˈʋ̃**õ**.ta]
1SG-help-FUT
'I will help'

For the data above, positional faithfulness instead predicts that unstressed nasal suffixes neutralize their contrast in nasality, since the constraint preserving input specifications of nasality in prominent positions does not protect changes in nasality in lexically unstressed syllables (Candidate b below). 💣 indicates a winning candidate that is not surface true, and ☹ indicates a candidate that is surface true but is not predicted under the current analysis.

(49)

/a-japo-NBã/ 'I already work'	ID-σ́[NAS]	ALIGN-L[NAS]	*Ṽ	ID[NAS]
☹ a. ajapomã		***	*!	
💣 b. ajapomᵇa		***		*
c. ãñãpõmã	*!		****	***

Additionally, positional faithfulness fails to make the surface-true prediction for forms with unstressed suffixes preceding a nasal suffix. Positional faithfulness predicts that stressed nasal suffixes spread their nasality onto unstressed suffixes to their left, as these previous suffixes aren't protected by IDENT-σ́[NAS]. Guarani unstressed suffixes instead preserve the oral-nasal contrast even in the presence of a stressed nasal suffix to their right. The example below shows that the future suffix *-ta* and the differential object marker *-pe*, both lexically unstressed suffixes, remain oral when followed by underlyingly stressed or unstressed nasal suffixes.

(50) a. *a-japo-ta-m**a***
[a.dʒa.ˈpo.ta.m**ã**]
1SG-work-FUT-CMPL
'I will already work'

b. *che-sy-pe-g̃uar**ã***
[ʃe.sɨ.pe.ɰ̃ʷã.ˈɾ̃**ã**]
1SG-mother-DOM-for
'for my mother'

The tableau below shows the predictions of positional faithfulness. Due to demands for leftward alignment in nasality (ALIGN-L[NAS]), positional faithfulness predicts the nasalization of unstressed suffixes that precede nasal suffixes (Candidate c).

(51)

/ʃe-sɨ-pe-ɰʷaɾ̲ã̲/ 'for my mother'	ID-σ́[NAS]	ALIGN-L[NAS]	*Ṽ	ID[NAS]
a. ʃes̲ɨ̲peɰʷaɾ̲a̲	*!			*
☹ b. ʃes̲ɨ̲peɰ̃ʷãɾ̲̃ã̲		***!	**	*
💣 c. ʃes̲ɨ̲pẽɰ̃ʷãɾ̲̃ã̲		**	***	**

In summary, the analysis of positional faithfulness fails when the new fieldwork data on suffixes is considered. This is understandable since the original formulation of the analysis did not take the domain of suffixes into account. Although positional faithfulness successfully predicts the preservation of nasality for lexically stressed suffixes, it fails to make the same prediction for unstressed suffixes, which still exhibit the oral-nasal contrast regardless of both underlying and surface stress. Further, positional faithfulness also predicts that stressed nasal suffixes trigger nasal spread onto preceding unstressed suffixes, when in fact preceding unstressed suffixes surface as contrastively nasal or oral. Therefore, the generalization is that suffixes exhibit no positional effects regarding stress: these fail to neutralize input nasality when unstressed and fail to trigger regressive spread when stressed. Next, I argue that the analysis of positional faithfulness must be restricted to the domain of roots and prefixes through output-to-output correspondence and suffix faithfulness.

4.2 Correspondence and suffix faithfulness

Given the shortcomings of positional faithfulness presented above, the analysis of Guarani regressive harmony then requires that (a) both stressed and unstressed suffixes retain their input specification of nasality, and (b) stressed nasal suffixes fail to trigger regressive spread onto preceding suffixes, roots, and prefixes. However, a third important empirical fact must be considered: nasality still spreads suffix-internally. Example (52a) below shows that the stressed nasal vowel of the suffix 'for' triggers regressive spread onto its preceding syllable, [ɰ̃ʷã], and not onto the preceding unstressed oral suffix *-pe*. Similarly, the stressed nasal vowel of the nasal suffix *mo'ã* NEG.FUT triggers the nasalization of its preceding vowel, [õ], which in turn conditions the emergence of the nasal consonant [m] as the first segment of the suffix rather than the nasal-oral stop [mᵇ].

(52)	a.	*che-sy-pe-g̃uar**ã*** [ʃe.sɨ.pe.ɰ̃ʷã.ˈɾ̃**ã**] 1SG-mother-DOM-for 'for my mother'	b.	*nᵈ-a-ikatu-[m]o'**ã**-i* [nᵈaⁱ.ka.tu.mõ.ˈʔ**ã**ĩ] NEG-1SG-able-NEG.FUT-NEG 'I won't be able to'

I argue that the observed differences in the domain of suffixes are due to the language's cyclic nature in derived forms with suffixes. Under this cyclic analysis, the addition of a nasal suffix into the derivation doesn't affect the phonological properties of preceding elements, since their phonology occurred at a previous cycle.[13]

In a parallel approach, this cyclic effect can be formalized as a higher-ranked requirement for output-to-output faithfulness to the immediate morphological neighbor, where the morphological base of correspondence is one that includes the entire form, including prefixes,

[13] Another piece of evidence, apart from regressive nasalization, that Guarani shows cyclicity in the domain of suffixes is in the language's stress pattern. Recall that stress shifts to the rightmost underlyingly stressed affix as more suffixes are added to a form.

except the last input suffix. Here, suffixes are unable to trigger regressive spread onto segments in preceding suffixes, roots, or prefixes, given that these are included in the morphological base and segments in output candidates must correspond to segments in the output morphological base. This output-to-output faithfulness constraint in nasality is defined below:

(53) OO-IDENT[NAS]
Assign a violation for each corresponding segment in output forms that don't have the same value for the feature [nasal].

The tableau below shows the analysis for Example (52a). Here, the winning candidate (Candidate a) is one in which nasality spread only within the stressed nasal suffix and not onto segments in preceding suffixes, roots, or prefixes. Candidate b is ruled out since the nasalization of the preceding suffix fails to correspond to the nasality of its correspondent in the base. Finally, Candidate c shows that underlyingly stressed suffixes are still subject to positional faithfulness, since their nasality is not neutralized given their lexical stress.

(54)

INPUT: /ʃe-s̲ɨ̲-pe-ɰ̟ʷaɾ̲ã̲/ BASE: [ʃesɨpe]	OO-ID[NAS]	ID-σ́[NAS]	ALIGN-L[NAS]	*Ṽ	ID[NAS]
☞ a. ʃes̲ɨ̲peɰ̟̃ʷãɾ̲̃ã̲			***	**	*
b. ʃes̲ɨ̲pẽɰ̟̃ʷãɾ̲̃ã̲	*!		**	***	**
c. ʃes̲ɨ̲peɰ̟ʷaɾ̲a̲		*!			*

So, the output-to-output correspondence analysis allows nasality to be blocked from spreading onto unstressed suffixes, given that preceding suffixes are included in the base of correspondence. On the other hand, this analysis makes surface-true predictions when prefixes are included or excluded from the base of correspondence: ALIGN-L[NAS] still predicts that prefixes are targets of regressive spread even when these aren't part of the base of correspondence. The tableau in (55) below shows the analysis for Example (48b) *ai-pytyvõ-ta* ‘I will help’. Candidate a shows that OO-IDENT[NAS] and IDENT-σ́[NAS] protect the root from oralizing given the oral future suffix -*ta*, and candidate b shows that ALIGN-L[NAS] predicts the nasalization of the first-person prefix -*ai*.

(55)

INPUT: /ai-pɨ̠tiɨ̠ʋ̃õ-ta/ BASE: [pɨ̃tɨ̃ʋ̃õ]	OO-ID[NAS]	ID-σ́[NAS]	ALIGN-L[NAS]	*Ṽ	ID[NAS]
a. aⁱpɨtɨʋota	*!	*			*
b. aⁱpɨ̃tɨ̃ʋ̃õta			*!	***	**
☞ c. ãĩpɨ̃tɨ̃ʋ̃õta				****	***

Regardless, I assume that prefixes are part of the base of correspondence to avoid the potential “missing base” problem previously identified for output-to-output correspondence frameworks (Bermúdez-Otero, 2011; Mascaró, 2016). It is typically assumed that the base of correspondence must be a true and attested surface form in the language. Since Guarani verbs are required to surface with, at the very least, a prefix, then forms without a prefix may never be the base of correspondence. Guarani verbs must always occur with either a person prefix or the agent demotion prefix -*je/-ñe*.

However, the analysis above would still predict the neutralization of unstressed nasal suffixes when such suffixes are final. Recall that, as previously seen in the tableau in (49), the nasality of unstressed nasal suffixes is neutralized given that *Ṽ rules out candidate forms with nasal vowels in unstressed syllables. So, an additional mechanism is required to preserve the nasality of suffixes regardless of their underlying specification for stress. To this end, I argue that a higher ranked faithfulness constraint in nasality is required in the domain of suffixes. The higher-ranked faithfulness constraint is defined as below:

(56) MAX[NAS]$_{\text{SUFFIX}}$

Assign a violation for each [nasal] feature present in a suffix in the input that is absent in the output.[14]

The tableau in (57) below shows an analysis in which the winning candidate (Candidate a) fails to neutralize the contrast in nasality for its unstressed suffix and additionally fails to spread its nasality onto the preceding unstressed suffix and beyond. Candidate b violates the OO-IDENT[NAS] constraint since it spreads nasality onto oral segments in the base of correspondence. Finally, Candidate c shows that input nasality in suffixes, regardless of their lexical specification for stress, must not be neutralized.

(57)

INPUT: /a-japo-ta-N_Bã/ BASE: [ajapota]	OO-ID[NAS]	MAX[NAS]$_{\text{SUFF}}$	ID-σ́[NAS]	ALIGN-L[N]	*Ṽ	ID[NAS]
☞ a. ajapotamã				****	*	
b. ajapotãmã	*!			***	**	*
c. ajapotam^{b}a		*!				*

Such phonological asymmetries across morphological domains have been documented for a variety of languages and for both strictly local phonological processes such as hiatus resolution, and long-distance processes such as stress assignment and vowel harmony (Elkins, 2020). Crosslinguistically, prefixes and suffixes may exhibit an inability to affect, and be affected by, the regular phonology of elements in different morphological domains, hence exhibiting "independence" from the phonology of roots or other morphological domains. Guarani shows

[14] The faithfulness constraints in nasality defined thus far have been symmetric: IDENT constraints are violated equally when the input is nasal and its output correspondent is oral, and vice versa. However, the faithfulness constraint protecting the nasality of suffixes proposed here must be asymmetric, given that nasal suffixes trigger regressive nasal spread onto its preceding suffix-internal syllables. Such nasal spread would incur violations of an otherwise symmetric IDENT[NAS]$_{\text{SUFFIX}}$ constraint.

suffix independence with regards to the distribution of nasality and regressive nasalization: unstressed suffixes retain the nasal-oral contrast that is otherwise neutralized in unstressed positions in roots and prefixes, and suffixes also fail to be targeted by nasal harmony in the presence of other contrastively nasal suffixes, even when these are underlyingly stressed. On the other hand, prefixes are integrated into the grammar of roots since these show the same phonological distributions and positional effects that roots display.

The mechanisms incorporated into the analysis presented here, namely output-to-output correspondence and domain-specific faithfulness, are frequently employed in the analysis of these observed asymmetries across morphological and prosodic domains. Output-to-output correspondence predicts the failure for certain elements to undergo a certain phonological process that is present otherwise in other domains. In the analysis presented here, OO-IDENT[NAS] rules out forms in which suffixes are targeted by regressive nasalization from other suffixes. Additionally, the analysis of suffixes failing to neutralize their input nasal-oral contrast involves a faithfulness constraint, MAX[NAS]$_{\text{SUFFIX}}$, that is evaluated only over a certain domain in the morphological word, namely the domain of suffixes. This is another instantiation of the "independence" of suffixes from the grammar of roots and prefixes. This has been characteristic of the analysis of reduplication, where "marked" structures only emerge in bases and not reduplicants since the markedness constraints only apply to the domain that contains the base of reduplication (The Emergence of the Unmarked (TETU); McCarthy & Prince, 1995).

It is important to note that the contrast in nasality and the lack of regressive spread suffixes seem to be only phonological properties that are restricted to suffixes. Stress assignment is also a suprasegmental process in Guarani, but it is not the case that suffixes display a different behavior regarding stress. Although prefixes are never stressed in Guarani, we observe the cyclic stress assignment in the domain of roots and prefixes when multiple roots are involves, as in compounds and reduplication. Here, primary stress still shifts to the rightmost lexically stressed syllable.[15] Additionally, in progressive nasalization, suffixes are affected by the nasality of the root, therefore these are not completely independent from the phonology of the root-and-prefix domain. The fact that Guarani exhibits suffix independence for some suprasegmental processes but not others brings about interesting questions regarding the morphological and prosodic structure of Guarani. Ordering theories of morphology predict that, since suffixes are independent with regards to regressive nasal spread, then these are structurally higher than prefixes in the prosodic and morphological structure (Lexical Morphology and Phonology; Kisparsky, 1982; Stratal OT: Kiparsky, 2000: Bermúdez-Otero, 2017). More recent work on Guarani stress and morphological structure argues that suffixes form their own prosodic words and roots and prefixes are in the same prosodic word (Dąbkowski, 2022a; 2022b). Under this analysis, the domain of regressive nasalization is the prosodic word, and the domain of stress assignment and progressive nasalization is at a higher level of prosodic structure, since suffixes are affected by stress assignment and the nasality of roots to their left. However, the status of unstressed nasal suffixes in such prosodic analysis remains unclear: unstressed suffixes cannot form their own prosodic words and would therefore be subject to positional faithfulness.

This section presented a description and constraint-based analysis of the distribution of the nasal-oral contrast and regressive harmony in the domain of suffixes. I argued that additional mechanisms beyond positional faithfulness are required, namely output-to-output correspondence and highly ranked faithfulness in nasality for suffixes. These two mechanisms combined establish the independence of suffixes from the nasalization pattern of roots and prefixes. However, a critical

[15] See (13) and (26) for reference.

question that remains to be addressed is that of the phonological representation of nasal-oral stops. Recall from the data and analysis so far that nasal-oral stops are in complementary distribution with full nasal consonants, but their underlying representation remains to be established. To this end, the next section describes the distribution of nasal-oral stops in more detail and outlines their role in Guarani regressive nasal harmony. I argue that nasal-oral stops are postoralized nasal consonants instead of prenasalized voiced stops, as frequently argued in previous descriptive and theoretical literature on Guarani (Piggott, 2003; Kaiser, 2008; Thomas, 2014; Wetzels & Nevins, 2018; Estigarribia, 2020).

5. The status of nasal-oral stops

The analysis of regressive harmony in Guarani so far predicts that nasal-oral stops are targets of regressive spread. Nasal-oral stops are in complementary distribution with nasal consonants in both stressed and unstressed syllables, where nasal consonants surface before nasal vowels and nasal-oral stops surface before oral vowels. So far, we've assumed an underspecified underlying representation for nasal-oral stops and nasal consonants, and the highly ranked SYLNAS constraint fully predicts their distribution due to demands for agreement in nasality within a syllable. Since syllables are contrastively nasal only when they're stressed, nasal consonants are found at these syllables, and elsewhere they're found only as a product of regressive spread.

However, an important fact about nasal-oral stops and nasal consonants that hasn't been introduced yet is that these trigger regressive nasal harmony. Additionally, nasal-oral stops trigger harmony in both stressed and unstressed positions, as opposed to nasal vowels which are only phonemic, and therefore only triggers, in stressed syllables. In (58) below, first person inclusive prefix is *ñande* [ɲã.n^{d}e] in oral spans (58a), but it surfaces as *ñane* [ɲã.nẽ] in nasal spans (58b and

58c): the target nasal-oral stop in the person prefix surfaces as a nasal consonant under nasal spread. As opposed to nasal consonants and vowels, nasal-oral stops trigger regressive spread in unstressed positions as well as in stressed positions. In (58c), the bilabial nasal-oral stop in an unstressed syllable triggers regressive spread, same as the stressed nasal-oral stop in (58b). Additionally, in (58a) the nasal-oral stop in the person prefix conditions the presence of the palatal nasal *ñ*, instead of its oral counterpart *j*, since the nasal-oral stop nasalizes its preceding vowel.

(58) a. *ña**nd**e-r-óga*
[ɲã.**n**^{d}e.ˈɾo.ɰa]
1PL.INCL-N3POSS-house
'our house'

b. *ñane-me**mb**y*
[ɲã.nẽ.mẽ.ˈ**m**^{b}ɨ]
1PL.INCL-daughter
'our daughter'

c. *ñane-**mb**okaja*
[ɲã.nẽ.**m**^{b}o.ka.ˈʤa]
1PL.INCL-coconut
'our coconut'

Examples (58b) and (58c) above also show the nasal harmony pattern when two nasal-oral stops are in the domain of spread. In forms with two or more nasal-oral stops, the rightmost nasal-oral stop triggers regressive spread and any nasal-oral stops to its left alternate to nasal consonants. Therefore, nasal-oral stops are both triggers and targets of regressive spread.

The fact that nasal-oral stops trigger regressive nasalization, and that they trigger such process in both stressed and unstressed positions, raises critical questions about their compatibility with the existing analyses of nasal harmony discussed in Section 3, and about the representation of nasality in general. Piggott's (2003) analysis predicts that, since Guarani's nasal-oral stops and nasal consonants are in complementary distribution, nasal-oral stops are phonologically oral segments that and nasal consonants are their nasal counterpart.[16] In fact, he argues that the nasal contour of nasal-oral stops is a phonetic epiphenomenon that plays no role in the phonology of languages. Crucially, the analysis of nasal-oral stops as underlying oral segments fails to predict

[16] Other work on Paraguayan Guarani and related languages argues that its nasal-oral stops are underlying voiced stops: Thomas (2014), Wetzels & Nevins (2018), Estigarribia (2020).

that these are triggers of nasal spread: these would still require some phonological specification for nasality for them to trigger regressive nasal spread. And, such nasality must be specified in a way that plays a large role in regressive harmony but does not play a role in syllable phonotactics, since Guarani nasal-oral stops trigger regressive spread but they only occur in phonologically oral syllables. Therefore, even if the nasal contour of nasal-oral stops were to be phonologically specified at the segment level, it remains unclear how it would trigger syllable-level regressive spread. Recall that, under Piggott's (2003) account, nasal spread must proceed at the syllable level to predict that neutral segments are transparent rather than opaque.

Notably, the representation of nasal-oral contour segments has been a matter of debate for decades both within and outside of Guarani and related languages. Crosslinguistically, nasal-oral contour stops are argued to be underlyingly either full nasal consonants or full voiced oral stops, where these become postoralized or prenasalized through predictable factors motivated by the perceptual enhancement of different phonemic contrasts in a language (Stanton, 2017; Wetzels & Nevins, 2018; Krämer & Zec, 2020). For example, the addition of the nasal contour to underlying voiced oral stops can serve to maximize the contrast between the voiced stop and its voiceless counterpart, as nasality maximizes the perceptibility of voicing of the prenasalized voiced stop.

Previous literature shows no consensus as to the underlying representation of nasal-oral stops in Guarani: previous work points to them as being either underlying voiced stops (Piggott, 2003; Thomas, 2014; Wetzels & Nevins, 2018), underlying nasal consonants (Lapierre & Michael, 2018), or as distinct phonemes to nasal consonants (Kaiser, 2008). Such lack of consensus stems from the fact that the phonological properties useful for the diagnosis of their underlying representation in Guarani point to either them being underlying nasal consonants or voiced oral stops: nasal-oral stops in Guarani are found in oral syllables but these still trigger regressive nasalization.

This section argues that the underlying representation of Guarani's nasal-oral contour stops, or prenasalized stops, must be the nasal consonant. The postoralization of the underlying nasal consonants maximizes the contrast between nasal and oral vowels in the environment of an underlying nasal consonant, since the oral contour between the nasal consonant and a following vowel blocks the natural phonetic perseveration of nasality onto the contrastively oral vowel. Crucially, the analysis presented here simultaneously derives the fact that Guarani's nasal-oral contour segments are triggers of regressive spread, as well as the fact that the complex segment is in complementary distribution with the plain nasal consonant counterpart. Ultimately, this account requires the abandonment of Piggott's (2003) analysis syllable-level nasality. Since both nasal-oral stops and nasal consonants are phonologically nasal segments, then a nasal-oral stop followed by an oral vowel would immediate violate SYLNAS.

In this section, I first provide a brief overview of the argued phonetic and phonological status of prenasalized and postoralized consonants, and detail the main arguments regarding their motivation to surface as complex segments in certain environments. I highlight the incompatibilities that the analysis of nasal-oral stops as underlying voiced stops presents for the empirical facts of regressive nasalization in the language and for its analysis presented previously. Then, I provide the first analysis of nasal-oral stops for Guarani, in which they are analyzed as underlying nasal consonants that surface with postoralization in the environment of an oral vowel. This analysis simultaneously predicts the allophonic relationship between nasal-oral stops and nasal consonants, and that these are triggers of regressive spread given their underlying specification for nasality. Finally, I discuss the implications for Piggott's (2003) syllable-level nasality and Beckman's (1998) analysis of positional faithfulness to accommodate the assumed phonological representation of nasal-oral stops proposed here.

5.1 Background: prenasalized vs. postoralized stops

"Prenasalized stops" has been used as a cover term for any complex segment that consists of a nasal span followed by an oral span. Previous literature observes measurable phonetic differences between prenasalized stops ([^{m}b]) and postoralized nasals ([m^{b}]) and highlights that it is unclear if their distinction should also be phonemic as well as phonetic (Maddieson & Ladefoged, 1993). However, more recent literature argues for a phonological distinction between these two kinds of nasal-oral contour segments: prenasalized stops are phonological voiced stops that acquire nasalization at the beginning of the segment, and postoralized stops are phonological nasal consonants that are oralized towards the end of the segment (Stanton, 2017; Wetzels & Nevins, 2018; Garvin et al., 2018). Such literature argues that prenasalization and postoralization emerge as a way of enhancing other phonemic contrasts in the language. So, nasal-oral stops are optimally licensed in contexts where the contrast between other phonemic features in the language requires enhancement and perceptual maximization.

There are two possible sources of the prenasalization for underlying voiced oral stop. The first involves *venting*, in which the addition of prenasalization to underlying voiced stops enhances their contrast in voicing against their voiceless counterpart. Iverson & Salmons (1996) point to prenasalization as "hypervoicing": a phonetic realization that helps maintain a contrast that is otherwise difficult to produce. Therefore, prenasalization is a secondary gesture that enhances the phonetic realization of the [+voice] feature, hence maximizing its contrast against the [-voice] feature. This account predicts that, for languages with a global contrast between voiced and voiceless stops, prenasalized stops may freely emerge word-initially, which is in fact observed in Guarani.

Alternatively, prenasalization is argued to arise due to the preservation of nasality from an immediately preceding nasal segment (Wetzels & Nevins, 2018; Garvin et al., 2018), where the underlying stop consists of a phase where the velum is open (gestural overlap, Articulatory Phonology; Browman & Goldstein, 1989). For example, Wetzels & Nevins (2018) argue that the nasal-oral stops of Kaiowá, a Tupi-Guarani language closely related to Guarani, are underlying voiced stops that acquire prenasalization due to "adjacent-triggered nasal harmony". Here, the nasal contour of nasal vowels preceding the underlying voiced stop persevered into the voiced stop. However, this consideration can be immediately abandoned for Guarani: since nasal-oral stops also occur in word-initial positions, their prenasalization may not always be derived via their preceding phonological environment.

The argument that Guarani's nasal-oral contour stops are underlying non-nasal voiced stops sees a few analytical and explanatory benefits. First, it explains the absence of plain voiced stops in the inventory, where instead the language has prenasalized stops.[17] So, the complete absence of voiced stops in the inventory is explained by their global contrast with their voiceless counterpart: all voiced stops must surface with prenasalization since their contrast to their voiceless counterpart must be maximized across all phonological environments. Second, this analysis is compatible with Piggott's (2003) analysis of syllable-level nasality. The SYLNAS constraint predicts the complementary distribution of underlying voiced stops and nasal consonants by enforcing syllable-internal agreement in nasality, leaving prenasalized stops as phonologically oral and their nasal consonant counterparts as phonologically nasal. The venting account is also

[17] Refer to the consonant inventory in (6).

consistent with Piggott's (2003) claim that prenasalization is a phonetic epiphenomenon that plays no role in the phonology of languages. However, as previously noted, prenasalization cannot be completely independent from the phonology of Guarani, since it consistently appears to be a trigger of regressive nasalization.

In fact, previous literature on this issue argues that Guarani and related languages display prenasalization via venting. Recall that a vowel preceding a nasal-oral stops in Guarani is always nasal, therefore venting predicts that the nasality of the preceding vowel perseveres onto the following voiced stop. In addition to the argument of Wetzels & Nevins (2018) for the nasal-oral stops of Kaiowá, Thomas (2014) also assumes that the nasal-oral stops of Mbya, a language also closely related to Guarani, are prenasalized stops. Thomas (2014) argues that prenasalized stops only occur between oral and nasal spans since this segment contains both oral and nasal edges that would satisfy a constraint against immediately adjacent nasal and oral spans.

However, the enhancement of the voicing contrast doesn't provide a unified explanation for both the prenasalization of voiced oral stops and their complementary distribution with nasal consonants: while venting predicts prenasalization for all voiced oral stops, an independent mechanism is required to derive their allophonic distribution with nasal consonants. In Piggott's (2003) analysis, this mechanism is the SYLNAS constraint, which predicts that prenasalized stops only occur before oral vowels and nasal consonants before nasal vowels. Regardless, the analysis of Guarani regressive harmony would still need an additional mechanism to derive the fact that prenasalization, a seemingly phonetic phenomenon, triggers a phonological process.

Alternatively, nasal-oral stops have also been analyzed as phonologically nasal consonants that are postoralized in some phonemic environments. The widely agreed upon source of postoralization of underlying nasal consonants is *shielding* (Herbert, 1986; Stanton, 2017; 2018;

Lapierre, 2023). Here, underlying nasal consonants are postoralized to protect the contrast in nasality of the following vowel. Due to coarticulation, the contrastively oral vowel following a nasal consonant carries a nasal contour, resulting in a less perceptible contrast between the coarticulated oral vowel against a contrastively nasal vowel in the same position. Postoralization, which involves raising the velum prior to the onset of the oral vowel, then blocks coarticulatory nasalization from occurring, therefore maximizing the perceptibility of the contrast between oral and nasal vowels. So, the phonetic realization of a nasal stop depends on its local vocalic context, where the nasal consonant would require a brief oral phase in any position adjacent to a contrastively oral vowel. For Guarani, the context that matters is to the right of the underlying nasal consonant, since both surface nasal-oral stops and nasal consonants trigger regressive spread and therefore any vowel to their left will be nasalized.[18]

Recall that the distribution of voiceless stops, nasal-oral stops, and nasal consonants follows exactly that which postoralization predicts: nasal-oral stops are found before oral vowels, and nasal consonants are found before nasal vowels (in (59) below). Unlike the venting account, shielding simultaneously predicts both the presence of nasal-oral stops and their allophonic relationship with nasal consonants: underlying nasal consonants must be postoralized given the demands of the language to maximize the contrast in nasality in vowels. The analysis of nasal-oral stops as underlying voiced stops via venting required the additional mechanism of SYLNAS to predict the allophonic distribution of nasal-oral stops and nasal consonants, and, perhaps, some

[18] Interestingly, some languages that display a vocalic contrast in nasality in any position can have "circum-oralized" stops, where postoralization appear both in the initial and final phases of the complex segment, which results in the enhancement of the contrast in nasality of both neighboring vowels. This is attested in Kaingang (Jê, Brazil) and Karitiâna (Tupian, Brazil) (Garvin et al., 2018). Such finding supports Q-Theory, a theory of phonology in which segments are argued to have a tri-partite representation (Shih & Inkelas, 2014; 2018).

mechanism that allows a phonetic phenomenon to trigger a phonological process such as regressive nasal harmony.

(59) *Guarani distribution of stops*

Nasal consonant: Ṽ_Ṽ
Oral stop (voiceless): _V, and _Ṽ
Nasal-oral stop: Ṽ_V

Under the shielding account, the analysis of syllable phonotactics and system of regressive nasal spread are neatly unified. Here, nasal-oral stops emerge before oral vowels due to requirements for contrast enhancement on the following vowel, and they still trigger regressive nasalization since these are phonologically nasal segments. Under venting account, the prenasalized contour of the underlying voiced stop played no role in the syllable-internal phonotactics of nasality, but it presumably had to trigger regressive nasalization since prenasalized stops are otherwise underlying oral stops.[19]

I argue in this work that the underlying representation of Guarani nasal-oral stops must be the underlying nasal consonant, as evidenced by their phonotactic distribution and the fact that these trigger regressive spread in any position. The next subsection integrates the argument that Guarani's nasal-oral stops are really postoralized nasal stops into the phonological analysis of regressive spread discussed so far. Such analysis simultaneously derives postoralization and their

[19] It might seem reasonable to assume that prenasalized stops show a shorter duration of the nasal contour when compared to that of postoralized stops, where the oral contour is expected to be longer. In fact, previous literature finds that languages utilize segment-internal durational differences to draw contrasts across complex segments (Garvin et al., 2018). These segment-internal distinctions in duration motivate Q-Theory ("quantized theory"; Shih & Inkelas, 2014; 2018), which argues for a tripartite phonological representation for segments. Under Q-Theory, pprenasalized stops have one nasal subsegment followed by two oral subsegments, while postoralized stops have two nasal subsegments followed by one oral subsegment. However, other literature argues that the difference between prenasalized and postoralized cannot be determined via relative timing of the nasal and oral contours (Riehl, 2008). This is especially true for languages where prenasalized and postoralized stops may not both be present in the language, as in Guarani, since the relative timing of their subsegments is uninformative and perhaps non-existent.

allophonic distribution with nasal consonants, and the fact that nasal-oral stops are still triggers of regressive nasalization regardless of postoralization and their position in a word. This consideration challenges Piggott's (2003) syllable-level spread account to explain phonotactics and transparency.

5.2 The analysis of postoralized stops in regressive harmony

I now integrate the fact that Guarani nasal-oral stops are postoralized nasal consonants, rather than prenasalized voiced oral stops, into the analysis of regressive nasalization previously outlined. The analysis of postoralization here closely follows that of Stanton (2017).

Recall that, under the shielding account, underlying nasal consonants are postoralized in the environment of oral vowels to maximize the contrast of this oral vowel against a nasal vowel. The nasality of the underlying nasal consonant leads to perseveration of nasality onto the following oral vowel, therefore minimizing its contrast with a nasal vowel in the same position. Stanton (2017) defines the markedness constraint motivating postoralization as in (60) below. Here, NASDUR rules out candidate forms that don't produce a salient enough contrast in nasality. Stanton's constraint-based analysis of shielding operates under Flemming's theory of contrast (Flemming 2004), wherein inputs are fully phonetically specified (Realized Input) and grammars can access and refer to predictable phonetic information such as the perseveration of nasality of the nasal consonant onto the following vowel.

(60) NASDUR (MINDISTV-Ṽ; Flemming)

For a contrast in nasality to be sufficiently distinct, the oral vowel must be fully oral and the nasal vowel must be fully nasal. Assign one violation for each violating pair. (Stanton, 2017)

So, an input pair such as /m$^{\tilde{a}}$a mã/ incurs a violation of NASDUR. The input includes two sequences of segments to suggest that the language contrasts oral and nasal vowels following an underlying nasal consonant. The contrast in nasality between the vowels of the input pair is not maximally distinctive, since the oral vowel of the first syllable of the pair acquired a nasal contour due to the phonetic perseveration of nasality from its preceding nasal consonant. An optimal candidate is one in which the nasal consonant postoralized, therefore blocking the perseveration of nasality. So, since the winning candidate under this involves a complex segment given that the underlying nasal consonant now has an oral subsegment to its right, Stanton (2017) defines the markedness constraint banning contour segments:

(61) *CONTOUR

Assign a violation for each input consonant linked to a [+nasal] and [-nasal].

The tableau in (62) below shows that, when encountered with an indistinct contrast in vocalic nasality as in the input /m$^{\tilde{a}}$a mã/, the winning candidate is one where the underlying nasal consonant postoralizes when followed by an oral vowel, since such candidate incurs no violations of NASDUR or higher ranked faithfulness constraints. The faithfulness constraints MAX[NAS] and DEP[NAS] rule out the alternation of the underlying nasal consonant to a full oral stop, and the alternation of the input oral vowel to a nasal vowel, respectively, to avoid violating NASDUR.[20] Stanton (2017) proposes that these four constraints derive the crosslinguistic typology of nasal-

[20] Stanton (2017) proposes the faithfulness constraints MAX[+NAS] and MAX[-NAS], rather than MAX[NAS] and DEP[NAS], respectively. I adopt the latter formalism for clarity.

vowel sequences.[21] From here on, the MAX[NAS]and DEP[NAS] faithfulness constraints will be collapsed into symmetric IDENT[NAS] for simplicity and uniformity.

(62)

/m^{ã}a mã/	NASDUR	MAX[NAS]	DEP[NAS]	*CONTOUR
a. m^{ã}a mã	*!			
☞ b. m^{b}a mã				*
c. ba mã		*!		
d. mã mã	*![22]		*	

Crucially, this analysis neatly predicts the complementary distribution between nasal consonant and nasal-oral stops: underlying nasal consonants surface with postoralization when followed by an oral vowel, and they surface as such when followed by a nasal vowel. And, nasal-oral stops are now underlying nasal consonants that trigger regressive spread.

However, incorporating this analysis of shielding into the analysis presented in previous sections requires some important modifications. Piggott's (2003) analysis of syllable-internal agreement in nasality via the SYLNAS phonotactic constraint is no longer compatible with the analysis of postoralized nasal consonants. The optimal candidate, [m^{b}a], would now incur violations of SYLNAS, given the presence of a nasal consonant and an oral vowel in the same syllable. Therefore, the argument that nasality is a property of the syllable is incompatible with the assumption that Guarani's nasal-oral stops are underlying nasal consonants. And, the SYLNAS constraint is no longer required to predict the complementary distribution of nasal-oral stops and

[21] For example, the ranking of * CONTOUR, NASDUR, and MAX[NAS] over DEP[NAS] predict a language in which nasal and oral vowels are not contrastive, and therefore there is no motivation to postoralize, or fully oralize, the underlying nasal consonant due to NASDUR.

[22] Stanton's (2017) analysis of this input pair doesn't include a violation of NASDUR for candidate d. I've added such violation since NasDur evaluates the contrast between the elements of the input pair, and such contrast has been neutralized in candidate d. through the introduction of nasality in the first pair. Regardless, candidate d. fails to win in given its violation of DEP[NAS].

nasal consonants: now, the mechanism that predicts their allophonic relationship and distribution is the maximization of the oral-nasal contrast of vowels (NASDUR), and the relevant faithfulness constraints.

Recall that Piggott (2003) proposes that nasality is licensed, and therefore spreads, at the syllable level to predict the transparency of neutral segments, while segment-level spread predicts their opacity. Now the transparency of neutral segments must be formalized via a different mechanism. As previously discussed, Walker (2003) alternatively argues that transparent segments indeed acquire the harmonizing feature in the phonology, but these fail to realize the harmonizing feature due to phonetic feature co-occurrence constraints. On the other hand, opaque segments have this feature co-occurrence constraint in the phonology, therefore they halt the segment-level spread of nasality. Under Walker's (2003) approach, segment-level spread may proceed without the need to posit non-local nasal spread, allowing both transparent and opaque segments to be predicted in segment-level spread without requiring syllable-level spread of nasality. For opaque segments, the feature co-occurrence constraints are present in the phonology, therefore opaque segments will block nasalization from spreading any further. The tableaus in (63) exemplify the difference between transparent and opaque segments, respectively, according to Walker's (2003) analysis. The relevant feature co-occurrence constraint is *[-VOICE +NASAL], since Guarani voiceless stops are neutral to regressive nasal spread.

(63)

phonology — *transparency*

/tupã/	ALIGN-L[NAS]
a. tũpã	*!*
☞ b. t̃ũp̃ã	

phonology — *opacity*

/tupã/	*[-VOI +NAS]	ALIGN-L[NAS]
☞ a. tũpã		**
b. t̃ũp̃ã	*!*	

phonetics

/t̃ũp̃ã/	*[-VOI +NAS]
a. t̃ũp̃ã	**
b. tupa	

Finally, positional faithfulness doesn't present problems for the analysis of nasal-oral stops as underlying nasal consonants. The constraint responsible for neutralizing nasality in unstressed positions, *Ṽ, applies specifically to vowels, therefore the nasality of underlying nasal consonants in stressed positions is not subject to such neutralization. Furthermore, the postoralization of underlying nasal consonants in stressed syllables doesn't violate the highly ranked IDENT-σ́[NAS] positional faithfulness constraint since the consonant is still phonologically nasal at the surface.

The tableau in (64) below analyzes the form *mimbi* [mĩm^{b}i] 'radiant', previously seen in Example (18a). Both the surface nasal consonant and nasal-oral stop are underlying nasal consonants, and the postoralized nasal triggers regressive spread onto the preceding syllable. Candidate a in the tableau below is ruled out by NASDUR since it has a sequence of a nasal consonant followed by a phonemic oral vowel with perseveration of nasality. Candidates a, b, and c incur violations of ALIGN-L[NAS], since nasality isn't spreading onto all preceding segments. Candidate e incurs violations of MAX[NAS] and IDENT-σ́[NAS], since the nasality of the input stressed vowel (underlined) has no correspondence in the output candidate.[23]

[23] Since syllable-level nasality has been abandoned, the violations of all constraints are now counted at the segment level.

(64) /m$^{\tilde{ɪ}}$imĩ/ /mi/ 'almost'	NASDUR	ID-σ́[NAS]	ALIGN-L[NAS]	*Ṽ	ID[NAS]	*CONTOUR
a. m$^{\tilde{ɪ}}$imĩ	*!		**	*		
b. bimĩ			*!*	*	*	
c. m^{b}imĩ			*!*	*		*
☞ d. mĩmĩ				**	*	
e. m^{b}im^{b}i		*!	**			**

Additionally, the analysis of postoralization is compatible with the distribution of nasality observed in the domain of suffixes. The tableau in (67) shows the analysis for the example below:

(65) *oi-pytyvõ-ta-mba*
[o^{i}.pɨ̃.tɨ̃.ʋ̃õ.ta.ˈmba]
3-help-FUT-TOT
'he will (completely) help'

This example shows that the underlying nasal consonant of the totalitative suffix still fails to trigger regressive spread onto preceding elements. Note that the totalitative suffix *-mba* is distinct form the completive suffix *-ma* seen in previous examples (47a vs. 47b, repeated in (66) below). The contrast between these distinct suffixes is specified at the vowel, where the totalitative suffix *-mba* has a phonemically oral vowel (/ma/), and therefore a nasal-oral stop, and the completive suffix *-ma* has a phonemically nasal vowel (/mã/).

(66) a. *a-japo-m**a***
[a.ʤa.ˈpo.m**ã**]
1SG-work-CMPL
'I already work'

b. *o-ñe'**ẽ**-mba*
[õ.ñẽ.**ʔẽ**.ˈm^{b}a]
3-talk-TOT
'he finished talking'

The tableau below shows that nasal suffixes fail to trigger regressive spread onto preceding morphemes given the high ranking of OO-IDENT[NAS]. Again, the postoralization of the nasal consonant in the stressed nasal suffix incurs no violations of IDENT-σ́[NAS] since output nasal-oral stops are still nasal segments.

(67)

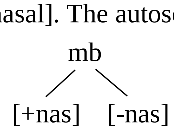
INPUT: /oi-pɨtɨʋõ-ta-ma/ BASE: [õĩpɨ̃tɨ̃ʋ̃õta]	NASDUR	OO-ID[N]	MAX[N]SUF	ID-σ́[N]	ALIGN-L	*Ṽ	ID[N]	*CNTR
a. õĩpɨ̃tɨ̃ʋ̃õtama	*!				*****	****	***	
☞ b. õĩpɨ̃tɨ̃ʋ̃õtamᵇa					*****	****	***	*
c. õĩpɨ̃tɨ̃ʋ̃õt̃ãmᵇa		*!				*****	****	*
d. õĩpɨ̃tɨ̃ʋ̃õtamã				*!	*****	*****	*****	

In summary, this section argues that the underlying representation of Guarani's nasal-oral stops must be a nasal consonant rather than a voiced oral stop. The primary piece of evidence stems from the fact that nasal-oral stops trigger regressive nasalization, therefore these must be phonologically specified as nasal in order to trigger the phonological process of regressive nasal spread. This section incorporates Stanton's (2017) analysis of postoralization, in which underlying nasal consonants must become postoralized when followed by an oral vowel so as to block the natural phonetic perseveration of nasality from the nasal consonant onto the vowel that would otherwise minimize the perceptual contrast of oral and nasal vowels in this position. When incorporating the shielding analysis into the analysis of regressive spread, crucial modifications must be made to the analysis of Piggott (2003): syllable-level nasality must be abandoned since now underlying nasal consonants can occur in the same syllable as an oral vowel.

It should be mentioned that an alternative analysis regarding the phonemic status of nasal-oral stops is to argue that these are contour segments *underlyingly*. The analysis discussed above only involves a nasal-oral contour representation *at the surface* and only when the underlying full nasal consonant precedes an oral vowel. An underlying autosegmental representation for nasal-oral stops sees a few advantages in the analysis of regressive harmony.[24] For example, the fact that these segments only trigger leftward spread, and not rightward spread, may be derived from the fact that the [-nasal] contour of the nasal-oral stop blocks such nasality from spreading rightwards. This approach potentially eliminates the need for harmony constraints that are parameterized for directionality of spread, which have been argued against for vowel harmony languages (Baković, 2000). The nasal harmony constraint can also be defined in a way such that any [+nasal] feature must be aligned to the edges of the domain, even if such [+nasal] feature is associated with a segment that is also associated with a [-nasal] feature. Then, to derive the alternation of nasal-oral stops to nasal consonants given the presence of triggers to their right, the [-nasal] contour becomes [+nasal], now rendering a full nasal consonant. Such autosegmental representation of nasal-oral stops is assumed in previous literature on the nasal harmony system of Guarani and related languages (Thomas, 2014).

However, the analysis of nasal-oral stops as underlying contour segments predicts that nasal-oral stops are *phonemically* distinct from nasal consonants, rather than these being only *derivationally* distinct. The analysis of postoralization argues that nasal-oral stops are a consequence of phonological processes as opposed to these being phonemically represented as such. However, the analysis argued here doesn't negate an autosegmental analysis of nasal-oral stops, therefore it doesn't fully negate the possibility that these might be phonemically distinct from full nasal consonants. All the distributional facts about nasal-oral stops and their role in regressive harmony still hold under the autosegmental approach: a nasal vowel spreads nasality

[24] The autosegmental representation for nasal-oral contour stops predicts that the segment is simultaneously [+nasal] and [-nasal], rather than having the phonological representation of the entire complex segment be either [+nasal] or [-nasal]. The autosegmental representation of nasal-oral contour stops is as follows:



onto the preceding nasal-oral contour stop given the demands of the harmony-driving constraint, and nasal-oral contour stops still trigger regressive spread given their [+nasal] contour in the autosegmental representation. Ultimately, I instead argue that, *if* we assume nasal-oral stops aren't underlying contour segments, then these must be phonologically [+nasal], which is in opposition to previous literature that claims these are phonologically [-nasal] stops that acquire nasalization at the surface.

6. Concluding remarks

Paraguayan Guarani's nasal harmony system has participated in major advancements in phonological theory and typology, specifically with regards to its representation of nasality and to the theory of long-distance processes in general (Beckman, 1998; Walker, 1998; Piggott, 2003; among others). This work presented new empirical data regarding regressive nasalization collected in original fieldwork conducted in Coronel Oviedo, Paraguay. The new empirical data on Guarani suffixes finds that these crucially show a different behavior regarding nasal harmony when compared to that of roots and prefixes: suffixes fail to neutralize the oral-nasal contrast in unstressed syllables, and they also fail to trigger regressive nasal spread onto preceding suffixes, roots, and prefixes. This work analyzes such facts via output-to-output correspondence in which derived forms must remain faithful to their morphological base, as well as higher-ranked faithfulness constraints in the domain of suffixes. The second contribution of this work is in the representation of nasality. This work argues that Guarani nasal-oral contour stops are underlying nasal consonants that become postoralized when preceding a contrastively oral vowel to maximize its contrast with a nasal vowel in the same environment. This is in opposition to the previously assumed phonological status of nasal-oral stops, where these are argued to be prenasalized oral stops rather than postoralized nasal consonants. I show that the analysis of Guarani nasal-oral contour stops as phonologically nasal segments predicts the distribution of Guarani nasal-oral stops and nasal consonants, as well as the fact that these trigger regressive spread in both stressed and unstressed syllables.

However, it remains to be shown how Guarani's progressive nasalization system fits into the two main arguments proposed here: that suffixes are independent from the nasality of roots and prefixes, and that Guarani nasal-oral stops are phonologically full nasal stops. Guarani progressive harmony is an independent system of nasalization, and, given its major differences to regressive nasalization and lexically specific alternations, it must involve a different phonological mechanism than regressive nasal harmony. This difference in mechanisms ensures that suffix independence is only predicted for regressive nasal spread, and therefore suffixes may freely surface with alternations conditioned by progressive harmony. I now briefly describe Guarani progressive harmony, quickly sketch an analysis of the process as phonologically conditioned allomorphy, and finally show that the two analyses proposed here based on the language's regressive harmony system are compatible with the given analysis of progressive harmony.

In Guarani progressive harmony, the initial voiceless stop of some roots and suffixes alternates to either a nasal-oral stop or a full nasal consonant in the presence of a nasal root. Examples (68-71) below show that the nasality or orality of the rightmost (and stressed) vowel in the root conditions the emergence of either an underlying nasal consonant or a voiceless stop suffix-initially.

(68) a. *jagua-[p]e*
[ʤa.ˈɰ̞ʷa.pe]
dog-DOM
'dog'

b. *mitã-[me]*
[mĩ.ˈtã.mẽ]
child-DOM
'child'

(69) a. *jagua-[k]uéra*
[ʤa.ɰ̞ʷa.ˈkʷe.ɾa]
oral-PL
'dogs'

b. ***tãi**-[ng]uéra*
[tãĩ.ˈᵑgue.ɾa]
tooth-PL
'teeth'

(70) a. *a-karu-*[*t*]*a*
[a.ka.ˈɾu.ta]
1SG-eat-FUT
'I will eat'

b. *ai-pytyv**õ**-*[*t*]*a*
[ã$^{\tilde{\imath}}$.pɨ̃.tɨ̃.ˈʊ̃õ.ta]
1SG-help-FUT
'I will help'

(71) a. *o-pupu-*[*m*]*a*
[o.pu.ˈpu.mã]
3-hot-CMPL
'it is already hot'

b. *o-ñe'**ẽ**-*[*m*]*a*
[o.ɲẽ.ˈʔẽ.mã]
3-talk-CMPL
'he already talked'

The above examples also show that progressive harmony is a lexically specific process. First, the differential object marker *-pe/-me* (68) and the plural suffix *-kuéra/-nguéra* (69) alternate given the nasality or orality of the root, but future *-ta* (71) and completive *-ma* (71) fail to alternate across oral and nasal roots. And, of the suffixes that alternate, some are affected by nasal spread up to only the first segment (69), and others are affected up to the following vowel (68). The distribution of alternating vs. non-alternating suffixes cannot otherwise be predicted by the phonological properties of the triggers and targets such as segmental features, or by number of syllables, stress, domains of harmony, etc. [25]

Notice that progressive nasalization differs from regressive nasalization in various ways. First, voiceless stops are targets of progressive nasal spread, wherein underlying nasal consonants surface in the presence of a preceding root or prefix and the voiceless stop surfaces in the presence of oral roots or prefixes. On the other hand, in regressive nasalization, voiceless stops are completely transparent: they remain unaffected by leftward nasal spread. Second, phonemic nasal vowels are the only triggers of progressive harmony: as seen in (72) and (73) below, nasal-oral stops fail to trigger the alternation of initial stops of roots and suffixes, but they still trigger

[25] The alternations observed in suffixes are also observed in roots, wherein the nasality of preceding roots or prefixes induces the alternation of root-initial voiceless stops to a nasal segment. This is observed in nasal-oral compounds (A) and in exceptional causative constructions as in (B). Such causative constructions are exceptional since oral roots in causative construction typically show the causative prefix *mbo-* [m^{b}o], rather than *mo-* [mõ], without any alternations observed for the root-initial voiceless stop (see Estigarribia (2021) for more on exceptional causatives. I subsequently focus on discussion of alternations in suffixes rather than in roots.

(A) i. *o-*[*k*]*y*
[o.ˈkɨ]
3-rain
'it rains'

ii. *h-asẽ-*[*ng*]*y*
[hã.sẽ.ˈ^{ŋ}gɨ]
3POSS-cry-rain
'weep'

(B) i. *o-*[*p*]*áy*
[o.ˈpa^{ɨ}]
3-wake.up
'they woke up'

ii. *o-mo-*[*mb*]*áy* *diégo-pe*
[õ-mõ-ˈm^{b}a^{ɨ}]
3-CAUS-wake.up Diego-DOM
'they woke up Diego'

regressive nasalization onto preceding segments. Third, the domains of nasal spread are different: regressive nasalization requires nasality to spread up to the left edge of the morphological word, while progressive nasalization spreads nasality either to the initial stop or up to the vowel of the first syllable of suffixes, therefore predicting the variable emergence of nasal-oral stops and nasal consonants due to progressive harmony, as in (68) and (69) above.

(72) a. *panambi-kuéra*
[pã.nã.mᵇi.ˈkʷe.ɾa]
butterfly-PL
'butterflies'

b. ***tãi***-*nguéra*
[tãĩ.ˈᵑgue.ɾa]
tooth-PL
'teeth'

(73) a. *mbokaja-ty*
[mbo.ka.ʤa.ˈtɨ]
coconut-COLL
'coconut plantation'

b. *ñan**a**-ndy*
[ɲã.n**ã**.ˈnᵈɨ]
herb-COLL
'herb plantation'

Lastly, and perhaps most importantly, suffixes aren't completely neutral or independent to the phonological features of their roots: the presence of suffix-initial nasal segments, as opposed to initial voiceless oral stops, is conditioned by the nasality of the stressed vowel of the root. However, as already discussed in Section 4, suffixes are quite independent from the phonology of roots and prefixes regarding regressive spread: lexically unstressed suffixes fail to neutralize the contrast in nasality, and suffixes fail to trigger regressive nasal spread onto preceding elements.[26]

[26] Yet another difference between progressive and regressive nasalization in Guarani is that regressive spread occurs locally and iteratively onto adjacent segments, while progressive harmony may occur discontinuously and across non-alternating suffixes. As in (C) below, multiple suffixes may be affected by the nasality of the root in a discontinuous manner, regardless if the preceding suffix is phonemically oral. In (D.ii), the phonemically oral and stressed suffix -*se* appears between the nasal root and the alternating suffixes without blocking progressive harmony alternations. Note that the nasal-initial suffixes in (C.ii) and (D.ii) fail to trigger regressive nasal spread onto preceding suffixes, which is predicted by the higher ranked faithfulness constraints OO-IDENT[NAS] and MAX[NAS]$_{\text{SUFFIX}}$ introduced in Section 4.

(C) i. *jagua-kuéra-pe*
[ʤa.ɰʷa.ˈkʷe.ɾa.pe]
dog-PL-DOM
'dogs'

ii. *mitã-nguéra-me*
[mĩtã.ˈᵑgʷe.ɾa.mẽ]
child-PL-DOM
'children'

(D) i. *o-karu-se-pa-pota-péve*
[o.ka.ɾu.se.pa.po.ta.ˈpe.ʋe]
3-talk-DES-TOT-INCIP-until
'until he is about to finish wanting to eat'

ii. *o-ñe'ẽ-se-mba-mbota-méve*
[õ. ɲẽ.ˈʔẽ.se.mᵇa.mᵇo.ta.ˈmẽ.ʋe]
3-talk-DES-TOT-INCIP-until
'until he is about to finish wanting to talk'

However, the fact that suffixes are "sensitive" to the nasality of roots in progressive harmony doesn't pose problems for the analysis of suffix independence presented here. This is because progressive nasalization, I argue, involves phonologically conditioned allomorphy. Under analysis of progressive harmony, the alternations of the initial stops of roots and suffixes are already be present in the input to the regular phonological grammar, therefore progressive harmony alternations won't violate the higher ranked OO-IDENT[NAS] and MAX[NAS]$_{\text{SUFFIX}}$ faithfulness constraints that protect suffixes. Although no analyses of progressive harmony as phonologically conditioned allomorphy have been proposed and formalized in previous literature, I briefly sketch such analysis going forward and show that the non-independence of suffixes in progressive harmony poses no problems for the analysis of the independence of suffixes in regressive harmony.

In progressive harmony, roots with phonemic nasal vowels (stressed syllables) select for suffix allomorphs with initial underlying nasal segments. Suffixes therefore have two allomorphs: one with an initial voiceless stop and the other with an initial underlying nasal consonant. This allomorphy analysis is necessary since, as previously discussed, the distributions of suffixes that do or don't undergo progressive harmony, and those that alternate to a nasal consonant or to a nasal-oral stop, aren't predictable. So, suffixes that never alternate due to progressive harmony have one listed allomorph, which can be either oral-initial or nasal-initial. And, the listed allomorphs across suffixes differ, therefore predicting that some suffixes nasalize only the suffix-initial stop while others also nasalize the following vowel. The table in (74) below shows the lexical listings for various suffixes observed so far. Recall that nasal-oral stops are underlying nasal consonants.

(74)	*listed allomorphs*	*example number*
	{/pe/, /mẽ/} DOM	(68)
	{/ˈkʷe.ɾa/, /ˈŋʷe.ɾa/} PL	(69); (72)
	{/ta/} FUT	(70)
	{/mã/} CMPL	(71)
	{/tɨ/, /nɨ/} COLL	(73)
	{/ˈpe.ʋe/, /ˈmẽ.ʋe/} 'until'	(D) in footnote 26

The mechanism that selects such allomorphs must be phonological, since it is the phonemic nasality of roots and prefixes that selects allomorphs with initial nasal segments. I propose the following markedness constraint that is essentially the mechanism of progressive nasalization:

(75) *[αNAS] … [-αNAS -CONT] (PROGHARM)[27]

Assign a violation for each pair of segments at an arbitrary distance that disagree in nasality.

The selection of allomorphs with initial nasal segments when roots are phonemically nasal is phonologically optimizing since it incurs no violations of PROGHARM. On the other hand, selecting an allomorph with an initial oral stop when the root is nasal incurs a violation of PROGHARM. Tableaus (76) and (77) below shows the analysis for the suffix *-pe/-me* LOC; DOM (example (68)). As shown in (76), a candidate that selects the nasal suffix allomorph *-me* for the input oral root *jagua* 'dog' violates PROGHARM (Candidate b). And, the nasality of the stressed syllable must not be changed to avoid violating PROGHARM for candidates that instead select the nasal suffix allomorph (Candidate c): the familiar IDENT-σ́[NAS] constraint enforces faithfulness in

[27] This constraint definition omits some important details for the sake of brevity. For example, the nasality of the leftmost segment in this constraint must be phonemic, such that only the causative prefix and the stressed syllable of roots select for root and suffix allomorphs. And, the selection must occur only across prefixes and roots (see footnote 25) or across roots and suffixes, since the phonemic vowels of suffixes never select for following suffix allomorphs.

nasality in stressed syllables and is ranked above PROGHARM.[28] Only the relevant constraints are included in the tableaus below for concreteness.

(76)

/ʤaɰ̠ʷa̠-{pe, mẽ}/ dog-DOM	ID-σ́[NAS]	PROGHARM	ALIGN-L[NAS]	*Ṽ	ID[NAS]
☞ a. ʤaɰ̠ʷa̠pe					
b. ʤaɰ̠ʷa̠mẽ		*!	****	*	
c. ɲãɰ̠̃ʷã̠mẽ	*!			***	**

The tableau in (77) below analyzes the suffix *-pe/-me* in the environment of nasal root, namely *mitã* 'child'. A candidate that selects the oral allomorph *-pe* is ruled out by PROGHARM, therefore the nasal allomorph must be selected. As expected, regressive nasal spread proceeds onto the leftmost syllable of the root given the demands of ALIGN-L[NAS]. Finally, since *-pe/-me* is an unstressed suffix, candidates that neutralize the nasality of the suffix vowel are ruled out by MAX[NAS]$_{SUFFIX}$, as in Candidate d.

(77)

/mitã̠-{pe, mẽ}/ child-DOM	ID-σ́[N]	PROGHARM	MAX[N]$_{SUFF}$	ALIGN-L[N]	*Ṽ	ID[N]	*CNTR
a. mĩtã̠pe		*!				*	
b. m^b^ita̠pe	*!					*	*
☞ c. mĩtã̠mẽ					***	*	
d. mĩtã̠m^b^e			*!			**	*

Crucially, the analysis of nasal-oral stops as underlying nasal consonants is also consistent with the analysis of progressive harmony as phonologically conditioned allomorphy. As observed elsewhere in the grammar of Guarani, nasal-oral stops surface when they're followed by an oral

[28] Such candidate also violates OO-IDENT[NAS], which is not shown in (76) to avoid redundancies in violations: any violation of IDENT-σ́[NAS] that occurs in the base of correspondence also violates OO-IDENT[NAS].

vowel and nasal consonants surface when followed by a nasal vowel. Recall that this is due to NASDUR, defined in Example (60) in Section 5. Therefore, roots and suffixes that surface with an initial nasal-oral stop have allomorphs in which the vowel in the initial syllable is oral, as opposed to the -pe/-me suffix analyzed in (76) and (77) in which its vowel of the nasal allomorph is phonemically nasal. The tableau below analyzes the plural suffix *-kuéra/-nguéra* in the environment of a nasal root. Here, NASDUR predicts an initial nasal-oral stop for the nasal-initial allomorph of the suffix, since the initial nasal consonant is followed by an oral vowel and must postoralize in this environment.

(78)

/mitã-{kʷeɾa, ŋʷeɾa}/ child-PL	NASDUR	ID-σ́[NAS]	PROGHARM	ALIGN-L[N]	*CNTR
a. mĩtãkʷeɾa			*!		
b. mᵇitakʷeɾa		*!			
c. mĩtãŋʷe.ɾa	*!				
☞ d. mĩtãŋᵍʷe.ɾa					*

Finally, surface forms with suffixes that have a single listed allomorph may constitute a violation of PROGHARM if such suffix allomorph has an initial oral stop. However, a fully faithful candidate with the violation of PROGHARM still wins, since avoiding this violation of PROGHARM would otherwise violate higher-ranked faithfulness constraints in nasality. The tableau in (79) sketches the analysis for suffixes with a single oral-initial allomorph, such as the future suffix *-ta* previously introduced in (70). Here, avoiding a violation of ProgHarm induces violations of higher-ranked faithfulness constraints in nasality.

(79)

/ai-pɨtiɨ<u>ʋõ</u>-{ta}/ 1SG-help-FUT	ID-σ́[NAS]	PROGHARM	ALIGN-L[NAS]	*Ṽ	ID[NAS]
☞ a. ãĩpɨ̃tɨ̃<u>ʋõ</u>ta		*!		****	***
b. aipɨtiɨ<u>ʋo</u>ta	*!				*

In conclusion, the fact that suffixes are targets of progressive harmony, and therefore not completely independent from the phonology of roots and prefixes, doesn't pose problems for the analysis of suffix independence presented here. In essence, this is because the alternations induced by progressive harmony must be lexically listed, so these are already present in the input to the regular grammar of positional faithfulness, regressive nasal spread, and suffix faithfulness. Progressive harmony necessarily involves phonologically conditioned allomorphy since only a handful of suffixes alternate given the nasality of roots, and, among the suffixes that alternate, some surface with initial nasal-oral stops and other with initial nasal consonants. Since the segmental alternations observed in suffixes are in the input, these don't constitute violations of the highly ranked faithfulness constraints that otherwise protect suffixes from positional neutralization and regressive nasal spread.

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