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Spirantization in Spanish: The role of the underlying representation

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Abstract: Spirantization is one of the most frequently studied phonological phenomena of Spanish (Barlow, Jessica A. 2003. The stop-spirant alternation in Spanish: Converging evidence for a fortition account. *Southwest Journal of Linguistics* 22. 51–86; Zampini, Mary. 1994. The role of native language transfer and task formality in the acquisition of Spanish spirantization. *Hispania* 77. 470–481; among others). For a majority of dialects, Spanish voiced plosives have been traditionally described as having a continuant and a non-continuant realization in complementary distribution (Navarro Tomás, Tomás. 1977. *Manual de pronunciación española*. 19th edn. Madrid: Consejo Superior de Investigaciones Científicas; Hualde, José Ignacio. 2005. *The sounds of Spanish*. Cambridge and New York: Cambridge University Press; among others). Yet, phonetic studies reveal a more complex picture consisting of a great deal of phonetic variability and gradience among continuant realizations (Carrasco, Patricio, José Ignacio Hualde and Miquel Simonet. 2012. Dialectal differences in Spanish voiced obstruent allophony: Costa Rican versus Iberian Spanish. *Phonetica* 69. 149–179; among others; Simonet, Miquel, José Ignacio Hualde and Mariana Nadeu. 2012. Lenition of/d/in spontaneous Spanish and Catalan. Paper presented at INTERSPEECH) which is not captured by existing generative accounts (Bakovic, Eric. 1997. Strong onsets and Spanish fortition. *MIT Working Papers in Linguistics* 23. 21–39; Harris, James W. 1984. La espirantización en castellano y la representación fonológica autosegmental. *Estudis Gramaticals* 1.149–67; Hualde, José Ignacio. 1989. Procesos consonánticos y estructuras geométricas en español. *Lingüística* 1.7–44; Kirchner, Robert. 2001. Phonological contrast and articulatory effort. In Linda Lombardi (ed.), *Segmental phonology in Optimality Theory*, 79–117. Cambridge: Cambridge University Press; among others). Furthermore, most analyses focus almost exclusively on the general distribution of spirantization, excluding other dialectal patterns (Amastae, Jon. 1995. Variable spirantization: Constraint weighting in three dialects. *Hispanic Linguistics* 6(7). 265–285; among others). The current proposal accounts for the phonetic variability and gradience evinced by phonetic studies, as well as dialectal variation in one optimality theoretic-analysis. Spirantization is explained as the result of effort reduction, rather than the result of assimilation (contra

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Harris, James W. 1984. La espirantización en castellano y la representación fonológica autosegmental. *Estudis Gramaticals* 1.149–67; Hualde, José Ignacio. 1989. Procesos consonánticos y estructuras geométricas en español. *Lingüística* 1.7–44, among others). Phonetic variability in the general dialects is argued to be related to the underlying representation: voiced obstruents are underspecified for continuancy both in the input and the output of the phonology, which explains gradience in implementation and responds to the need to avoid the marked configuration represented by a combination of voicing and maximal stricture found in voiced stops (Colina, Sonia. 2016. On onset clusters in Spanish: Voiced obstruent underspecification and /f/. In Rafael A. Núñez Cedeño (ed.), *The syllable and stress: Studies in honor of James W. Harris*. Boston, MA: Mouton de Gruyter). Dialectal variation stems from differences in the underlying representation and in the ranking of the constraints. The proposal is also able to explain variations on the two major dialectal patterns.

Keywords: Spanish, spirantization, underspecification, voiced obstruents, dialectal variation

1 Introduction

Spirantization is perhaps one of the most frequently studied phonological phenomena of Spanish, having attracted the attention of not only phonologists and phoneticians, but also of researchers interested in first and second language acquisition (Barlow 2003; Zampini 1994; González Bueno 1995; Díaz-Campos 2004; Face and Menke 2009). For a majority of dialects, Spanish voiced plosives have been traditionally described as having a continuant and a non-continuant realization in complementary distribution, with the non-continuant surfacing after homorganic nasals and laterals and after a pause (Navarro Tomás 1977; Hualde 2005; Hammond 2001). Yet more recent phonetic studies reveal a more complex distribution, challenging our understanding of Spanish spirantization. For instance, continuant realizations, traditionally considered fricatives (Navarro Tomás 1977), have been shown to be closer in nature to approximants (Martínez Celdrán 1991; Romero 1995). Additionally, phonetic research reveals a great deal of phonetic variability and gradience among continuant realizations pointing at the existence of a continuum of constriction, often affected by the preceding segment and also by stress (Cole et al. 1999; Ortega-Llebaria 2004). The degree of constriction also shows an effect of point of articulation (Eddington 2011; Carrasco et al. 2012; Simonet et al. 2012); for instance, results for /g/ in Cole et al. (1999) and Ortega-Llebaria (2004) are contrary to the findings for /d/ in Simonet et al. (2012). In addition, deviations from the general pattern exist.

Current phonetic evidence calls for an analysis of the allophonic distribution of Spanish /b, d, g/ that incorporates these recent findings as well as dialectal variation. Furthermore, the reported phonetic variability in obstruent realizations is not captured by existing generative accounts (Bakovic 1997; Harris 1969, Harris 1984; Hualde 1989; Lozano 1979; Mascaró 1984) including more recent optimality-theoretic ones (Kirchner 1998, Kirchner 2001; some, however, address dialectal variation, cf. Piñeros 2002, Piñeros 2003). Additionally, most generative analyses focus almost exclusively in the general distribution of spirantization described above (i. e., spirants in all contexts except for after homorganic nasals and laterals and after a pause), despite the fact that other dialectal patterns exist (Amastae 1989, Amastae 1995). The current analysis offers a way to integrate recent phonetic evidence, explaining phonetic variability and gradience, as well as dialectal variation in one optimality theoretic-analysis. Moreover, the analysis accounts for spirantization across dialects, as the result of effort reduction and the avoidance of voiced stops in those contexts that make their production more effortful, rather than as the result of assimilation (contra Harris 1984; Mascaró 1984; Hualde 1989, among others). Phonetic variability in the general dialects is argued to be related to the underlying representation: voiced obstruents are underspecified for continuancy both in the input and the output of the phonology, which explains gradience in implementation and responds to the need to avoid the marked configuration represented by a combination of voicing and maximal stricture found in voiced stops (Colina 2013a, Colina 2016). Dialectal variation stems from differences in underlying representation and in the ranking of the constraints. This proposal is also able to explain variations on the two major dialectal patterns.

The paper is organized as follows: after this introduction and the presentation of the data in Section 2, Section 3 introduces the basic components of the account (underspecification and effort reduction) (3.1), the evidence for underspecification (3.2), as well as a discussion of underspecification under the framework of Optimality Theory (OT) (3.3). Section 4 presents the OT analysis of the general and stop-dominant dialects, including the intervocalic position (4.1), and the homorganic (and non-homorganic) contexts (4.2). Section 5 compares the proposed analysis with existing alternatives. Finally, some conclusions are offered in Section 6.

2 Data

As mentioned above, Spanish voiced plosives have a continuant and a non-continuant realization (Navarro Tomás 1977; Hualde 2005; Hammond 2001) in complementary distribution. While this allophonic pattern is subject to much dialectal variation, many dialects (comprising Peninsular as well as Latin American ones) exhibit a [+continuant] segment in all positions except for after homorganic nasals and laterals and in post-pausal position (1–2). I refer to this pattern of allophony as the ‘general’ pattern. It is also the pattern with the most spirants (i. e., continuant allophones) and the most widespread.

(1) [-continuant] after homorganic nasals and laterals, and after pause

bomba	[bómba]	‘bomb’
donde	[dón̪de]	‘where’
tango	[táŋgo]	‘tango’
toldo	[tól̪do]	‘awning’

(2) [+continuant] elsewhere

a. postvocalically

haba	[áβa]	‘bean’
nada	[náða]	‘nothing’
hago	[áɣo]	‘I do’

b. postconsonantally and after glides

árbol	[áɾβol]	‘tree’
sordo	[sóɾðo]	‘deaf’
largo	[láɾɣo]	‘long’
algo	[álɣo]	‘something’
calvo	[kálβo]	‘bald’
esbelto	[ezβélto]	‘slender’
desde	[dézðe]	‘since’
rasgo	[rázɣo]	‘feature’
vaivén	[bajβén]	‘back and forth’
deuda	[déwða]	‘debt’
caigo	[kájɣo]	‘I fall’

At the other end of the dialectal spectrum, some Central American varieties (e. g., Honduras, Cuba) have the fewest spirants, with stops in all contexts (after consonants and after glides), except for intervocalically (Hualde 2005; Amastae 1989, Amastae 1995; Hammond 1976). I refer to this allophonic distribution as the stop-dominant pattern.

(3) Stop-dominant dialects: continuants postvocalically

haba	[áβa]	‘bean’
nada	[náða]	‘nothing’
hago	[áɣo]	‘I do’

(4) Stop-dominant dialects: stops after homorganic nasals and laterals and after pause

bomba	[bómba]	'bomb'
donde	[dón̪de]	'where'
tango	[táŋgo]	'tango'
toldo	[tól̪do]	'awning'

(5) Stop-dominant dialects: stops postconsonantally and after glides

árbol	[áɾbol]	'tree'
sordo	[sóɾdo]	'deaf'
largo	[láɾgo]	'long'
algo	[álgo]	'something'
calvo	[kálbo]	'bald'
esbelto	[ezbélto]	'slender'
desde	[dézde]	'since'
rasgo	[rázgo]	'feature'
vaivén	[bajbén]	'back and forth'
deuda	[déwda]	'debt'
caigo	[kájgo]	'I fall'

These two patterns – general and stop-dominant – are well documented in the literature, including acoustic and empirical studies (Hammond 1976; Lipski 1994; Hualde 2005; Eddington 2011; Carrasco et al. 2012). As mentioned above, additional patterns exist, but they are less clearly described and exhibit higher degrees of variation, especially in postconsonantal and post-glide contexts (for Columbian, cf. Amastae 1995; for Panama Spanish, cf. Alvarado de Ricord 1971), often with insufficient acoustic evidence to support them. Further acoustic investigations are necessary to clearly establish dialectal patterns than can then be submitted to phonological analysis.

3 Spirantization in Spanish

3.1 Effort reduction and underspecification

A critical component of the account proposed lies in the motivation for spirantization in Spanish. As will be seen in Section 5, some accounts claim that

Spanish spirantization is an assimilatory process, whereas others attribute it to reduction of effort (cf. Kirchner 1998, Kirchner 2001, for the theory of effort reduction as a motivation for lenition). In this paper, I argue for a reduction-of-effort account for Spanish (in agreement with Piñeros 2002) according to which the elimination of phonemic contrast–whereby voiced obstruents do not contrast in stricture – results from the facilitation of the articulation of a marked sound, i. e., a voiced stop (cf. Piñeros 2002: 392–393 for additional arguments; Wheeler 2005 for an effort-reduction account of Catalan spirantization). Making a voiced stop less constricted (+continuant) facilitates voicing; in the words of Carrasco et al. (2012: 153) "spirantization may be a strategy to maintain voicing." As explained by Piñeros, spirantization is a drive to "reduce articulatory effort while maintaining the voicing of a segment that is originally intended to have full articulatory closure (2002: 393)."

Additionally, the present analysis contends that Spanish voiced obstruents are underspecified for continuancy (i. e., input underspecification in optimality theoretic terms) in the general dialects (Colina 2013a, Colina 2016). In other words, the input or underlying representation contains no specification for continuancy. In addition, it is argued that underspecification persists into the output of the phonological component (i. e., output underspecification). The value for [continuant] is later provided by the phonetics, on the basis of the surrounding context. Colina (2016) offers two major pieces of evidence to support the underspecification proposal, which I summarize in Section 3.2, followed by a brief discussion of the notion of underspecification in OT – input and output underspecification (Section 3.3). The analysis in Section 4 will provide further support for the need for underspecification, given that it is necessary to account for the differences in the two main dialectal patterns (i. e., general and stop-dominant).

3.2 Evidence for underspecification (Colina 2016)

As mentioned above, Colina (2016) offers two major pieces of evidence in support of an underspecified input: (i) unlike their voiced counterparts, voiceless fricatives retain their [+continuant] specification in postnasal position; this points to a 3-way contrast according to which continuancy is contextually determined for voiced obstruents; (ii) phonetic variability.

Regarding the first argument, voiceless fricatives show no alternation for the feature [continuant] when preceded by a homorganic nasal; in other words, they retain their underlying specification, i. e., [+continuant], rather than taking on the continuancy specification of the preceding nasal, i. e., [-continuant], as is the case for voiced obstruents.[1]

(6) a. un gitano [uŋ.xi.tá.no] ‘a gypsy-masc.’
b. una gitana [u.na.xi.tá.na] ‘a gypsy-fem.’
c. dos gitanos [dos.xi.tá.nos] ‘two gypsies-masc pl’
d. un bobo [um.bó.βo] ‘a silly person-masc.’
e. una boba [u.na.βó.βa] ‘a silly person-fem.’
f. dos bobos [doz.βó.βos] ‘two silly persons-masc.’

As seen in (6), a velar voiced fricative is realized as [x] post-nasally (6a), post-vocalically (6b) and after a consonant (6c); in contrast, voiced obstruents surface as stops [-continuant] only after a homorganic nasal (6d) or homorganic lateral. Colina (2016) argues that fricatives retain their [+continuant] specification in all contexts because they are underlyingly specified as [+continuant] (and this specification must be preserved), while voiced obstruents are underspecified for [continuant].

As a result, obstruents in Spanish show a three-way contrast in continuancy: [+continuant] (voiceless fricatives), [-continuant] (voiceless stops) and underspecified [continuant] (voiced obstruents). Voiceless obstruents can be [-continuant] (stops) or [+continuant] (fricatives). While the stops contrast in voice, fricatives exhibit no voice contrast; in other words, phonemically Spanish only has voiceless fricatives.[2]

(7) Underlying contrasting features in Spanish obstruents
[-sonorant, -voice, -continuant] /p t k/
[-sonorant, -voice, +continuant] /f θ s x/
[-sonorant, +voice, continuant] /B D G/

In an optimality theoretic account, this means that the constraint that requires faithfulness to the underlying (i. e., input) specification for continuancy–Id-[cont]–is ranked higher than the one requiring a stop after a homorganic nasal–NC[cont]. The absence of specification in [continuant] in voiced obstruents accounts for their alternation, as there is no violation of Id-[cont] (due to no

1 Note that the grapheme ‘g’ corresponds to a voiced obstruent /G/ when followed by ‘a, o, u’ and to /x/ when followed by ‘e, i’ in some Peninsular Spanish varieties (/h/ in others). ‘j’ is another possible spelling of /x/ when followed by ‘e, i’, e. g., *jinete* [xinete] ‘jockey.’
2 Voiced fricatives only surface allophonically, generally the result of voice assimilation /desde/ [dezðe] ‘since’.

specification for [continuant] in the input). I return to this constraint later. (8) and (9) show the relevant constraints and candidate evaluation.

(8) Voiceless fricatives remain fricatives after a nasal
a. Constraints
Id-[cont]: Assign one violation mark for every output that differs from its input correspondent in the feature [continuant] (Lombardi 2001).
Id-[voi]: Assign one violation mark for every output that differs from its input correspondent in the feature [voice] (Lombardi 2001).
NC[cont]: Assign one violation mark for every nasal/lateral that does not agree in [cont] with the following homorganic obstruent (cf. feature geometry in Padgett 1994; Pater 1999 for NC constraints).[3]
b. Relevant ranking
Id-[cont] ≫ NC[cont]

(9) Voiceless fricatives remain fricatives after a nasal[4]
[uŋ.xi.tá.no] 'a gypsy'

/uNxitano/	Id-[cont]	NC-[cont]	Id-[voi]
☞a.uŋ.xi.tá.no		*	
b.uŋ.ɣi.tá.no		*	*!
c.uŋ.ki.tá.no	*!		
d.uŋ.gi.tá.no	*!		*

As seen in (9), the candidates with stops are ruled out because they violate the highest ranked constraint by virtue of the mismatch in [continuant] between the input, [+continuant], and the output, [-continuant]. Both (a) and (b) incur violations of NC-[cont] because a nasal is followed by a [+continuant] fricative, but this constraint is ranked lower than Id-[cont]. (a) is the winner because (b) also violates Id-[voi], since a voiceless fricative in the input corresponds to a voiced one in the output.

3 While all coda nasals are homorganic with the following obstruent, this is not the case for laterals, which are not homorganic when followed by a labial or velar obstruent due to the articulatory difficulty involved in producing a labial or velar lateral (Hualde 1989, Hualde 2005). As a result, the lateral acts as [-continuant] before coronal stops and as [+continuant] elsewhere. In optimality-theoretic terms, the constraints against non-coronal laterals would be undominated, ruling out homorganic non-coronal laterals, and allowing for [+continuant] non-coronal consonants after laterals.

4 Shading in tableaux follows conventions in Kager (1999).

In contrast, voiced obstruents [b, d, g] are always [-continuant] in post-nasal position because, being underspecified in the input, ID-[cont] is vacuously satisfied. ID-[voi] requires preservation of their input voicing specification. The analysis of post-nasal voiced obstruents will be presented in further detail in Section 4.

The second piece of evidence for underspecification presented by Colina (2016) is phonetic variability. As mentioned above, recent phonetic studies reveal substantial phonetic variability among continuant realizations of voiced obstruents pointing at the existence of a continuum of constriction, often affected by the preceding segment and also by stress (Cole et al. 1999; Ortega Llebaria 2004). Such variability and gradience have been difficult to explain for formal accounts to date, mostly due to the heavy reliance on categorical analytical tools and to a lack of specificity regarding the interface between phonetics and phonology in spirantization. Colina (2016) argues that variability and gradience in spirantization can be explained in a formal optimality-theoretic account in which the input is underspecified and this underspecification persists into the output of the phonology. The underspecified output is selected by the constraints and the constraint ranking as the optimal output. In turn, the underspecified output is fed into the phonetics that assigns gradient values of aperture (corresponding to the feature [continuant]) on the basis of the surrounding context. Variability and gradience are thus understood as the result of the unintended effect of variable contextual factors (e. g., stress, segmental and prosodic context, speech rate) on the physical properties of the voiced obstruent. The view sponsored in this analysis disagrees with proposals like Piñeros (2002) who, following Keating (1985), proposes that all phonetic patterns are part of the grammar, but it is in agreement with Keating in that there are cases - such as Spanish spirantization – “in which a default pattern is not controlled by a phonologized rule and a value is filled in by a phonetic component after all rules have applied” (Keating 1985: 128). The underspecified output of the phonology is then interpreted/translated into physical and discrete extra-grammatical properties which are not part of the grammar (i. e., phonetic implementation). In Keating’s terminology, the segmental phonetic transcription (i. e., the output of the phonology) turns into continuous physical parameters (phonetic implementation).[5] Section 3.3 expands on the theoretical concepts of underspecification and output underspecification, given their crucial role in this proposal.

5 This touches upon a controversial issue in the phonetics/phonology interface: i. e., how gradual phonetic phenomena should be accounted for by formal phonology. Accounts range from those that incorporate formal mechanisms such as phonetically-grounded constraints, input-output relations (cf. van Oostendorp 2008) and/or underspecification (Colina 2016 and this paper), to those that argue against formalist views of phonology (Port and Leary 2005). While the specific mechanisms may be debatable, a majority of relevant phenomena, including

3.3 (Input) Underspecification and output underspecification in OT

The spirantization account proposed here relies on both input and output underspecification of the feature continuant. This section explains these notions within an OT framework. Both input and output underspecification (i. e., underspecified inputs and underspecified outputs) result from the constraints and constraint ranking, as is customary in OT.

Regarding the input, *Richness of the Base* (ROTB) proposes that no restrictions are possible on its form, which is entirely determined by the constraints and constraint ranking. Because underspecification refers to a specific form of the underlying representation, some authors contend that it contradicts ROTB and that inputs in OT need to be fully specified (e. g., for Galician, Martínez-Gil 2004). However, this is inaccurate as an underspecified form such as /B, D, G/ places no more restrictions on the input than a fully specified one, e. g., /b, d, g/, given that it is just one of many possible inputs. In fact, since ROTB requires that no restrictions be placed on the form of the input, an underspecified input cannot be excluded from consideration.[6] Also consistent with OT is the principle that the input – be it the underspecified one /B, D, G/, or another one – cannot be determined a priori. Underlying forms, including underspecified forms, are determined by the learner through the principle of *Lexicon Optimization* (LO) rather than by constraints holding directly on underlying forms (Inkelas 1995: 289). As Kager (1999: 33) puts it, "whenever the learner has no evidence (from surface forms) to postulate a specific diverging lexical form, (s)he will assume that the input is identical to the surface form." According to LO, of various possible inputs for which the constraints and constraint ranking select the same output, the learner will select the input that is most harmonious with the output (the one that incurs the fewest marks in the grammar for the highest ranked constraint). Consequently, the grammar (i. e., the constraints and the constraint ranking) sometimes will select an underspecified input, sometimes a fully specified one: the underspecified input is selected among various competing inputs when the mapping between that underspecified input

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spirantization, evince the presence of a phonological component, often through underlying distinctions (cf. voicing in Catalan and Dutch, van Oostendorp 2008: 1364). In this proposal, a three-way contrast in continuancy, [+] [-] and [ ], accounts for the alternations and phonological behavior observed in voiced obstruents (vs. voiceless stops and fricatives), thus demonstrating that, despite the important role played by the phonetics, the process is also phonological.

6 Piñeros (2002), an optimality-theoretic analysis of Spanish spirantization, does not consider the underspecified input as a potential input, although he shows that in his analysis both a stop and an approximant input result in the selection of the optimal candidate.

and the output is the most harmonious in comparison with the mapping for other inputs.[7] In sum, underspecification does not go against ROTB, as long as underspecified forms are determined by the learner through LO (and the constraints and the constraint ranking) and not by any constraints holding directly on underlying forms (Inkelas 1995: 289). The underspecified input is preferred over fully specified ones because it is the one that incurs the least number of violations of ID-[cont] and therefore it is the most harmonious with respect to the output. Other languages and processes in which arguments have been made for underspecified inputs include Yoruba ATR harmony, Walpiri vowel harmony, Turkish vowel-glide alternations (Inkelas 1995) and Galician obstruent alternation (shown in the context of an analysis of *geada*, Colina 2013b).[8]

In addition to input underspecification (as argued for by Inkelas 1995 and others such as; Harrison and Kaun 2001; Inkelas 2006; Inkelas et al. 1997; Itô et al. 1995), the current proposal makes use of output underspecification. Hale and Kissock (2007) contend that output underspecification (*perseverant underspecification* in their terminology) is a form of underspecification that persists from underlying representation through the output of the phonology into the phonetics. It results in forms that are not fully specified featurally and that are implemented gradiently and variably in the phonetics according to the surrounding segments and other physical dimensions. Output underspecification was originally proposed by Keating (1985) (she showed that the velar fricative in Russian /ixa/ is underspecified for the feature [back]). Since output underspecification accounts for phenomena that are highly variable and gradient in nature, it can be claimed that the high degree of phonetic gradience in aperture in continuant allophones in Spanish spirantization, which is generally dependent on the adjacent sounds, is phonetic and the result of output underspecification (i. e., at the output of the phonology) (cf. Bradley and Delforge 2006a, Bradley and Delforge 2006b; Bradley 2007; Colina 2009 for output underspecification in Judeo-Spanish and in Ecuadoran Spanish; Colina 2016; cf., however, Colina 2013b, for geada, a phenomenon that requires input underspecification, but does not appear to involve output underspecification).

7 This is also known as *Grammar Optimization* (Kiparsky 1993; Inkelas 1995), especially in the context of language change.

8 *Geada* is a phenomenon in which some Galician dialects have a voiceless velar fricative [x] where other varieties have a voiced velar continuant [ɣ] (approximant or fricative), [péxa] [péɣa] ‘magpie’, except for in postnasal position where [g] surfaces, [loŋgo] ‘long’.

4 OT analysis

4.1 Postvocalic position

As seen in the preceding sections, underspecification is a critical component of the OT analysis proposed here, as it serves to account for the gradience and variability of continuant allophones. In turn, underspecification is a strategy to avoid the effortful configuration resulting from the combination of voicing and minimal aperture (i. e., a voiced stop). In other words, the current analysis relies on effort reduction as the motivation for spirantization. Reduction-of-effort constraints ban voiced stops (10).

(10) *VoiStop: Assign one violation mark for each voiced oral stop in the output (based on Kager 1999, Voice Obstruent Prohibition, VOP).

*VoiStop is a context-free, phonetically grounded constraint that when undominated implies reduction of effort, as it bans an effortful configuration–vocal cord vibration along with maximal stricture. Surrounding segments contribute to the effort required to produce voiced stops in isolation by facilitating it or impeding it (Piñeros 2002). Consequently, the context-free version of this constraint in (10) can be exploded into a context-specific family of constraints that reflect contextual effort combined with that required to pronounce the same segment in isolation (11). The more effortful configurations are captured by the more highly ranked constraints banning their presence, as in (12), which is similar in spirit to what Piñeros proposes for constraints like LAZY, minus the effort units.[9] The constraints proposed in (11)–(12) are also phonetically grounded, but in contrast with Piñeros' account, they are part of the phonology, and they refer to phonological units (features and natural classes) that are less gradient, and more categorical. The optimal candidate selected by constraint evaluation is an output

9 For Piñeros, if a stop in isolation requires full effort (say 100 points), the nasals are the segments that would contribute the most to effort reduction (35 points in his scale), followed by oral stops/pause (30 points), fricatives (25), approximants (20), laterals (15), rhotics (10), glides (05) and vowels (00). Vowels are the sounds that contribute the least, making the postvocalic context the least conducive to a voiced stop, as well as the most favorable to lenition/spirantization, in accordance with the empirical evidence. Subtracting these values from the total value of 100 effort units, Piñeros proposes the effort thresholds needed to produce voiced stops when preceded by other segments in connected speech, e. g., LAZY 100 (vowel) > LAZY 95 (glide) > LAZY 90 (rhotic) ≫ LAZY 85 (lateral) ≫ LAZY 80 (approximant) ≫ LAZY 75 (fricative) ≫ LAZY 70 (oral stop/pause) ≫ LAZY 65 (nasal stop).

phonological form that then enters the phonetics thereby acquiring its gradient nature. Furthermore, the constraints are formulated according to established constraint types, such as contextual markedness constraints that penalize a marked/effortful configuration in a particular context:

(11) *V-VoicedStop: Assign one violation mark for every voiced stop after a vowel.
*G-VoicedStop: Assign one violation mark for every voiced stop after a glide.
*C-VoicedStop: Assign one violation mark for every voiced stop after an oral consonant.

(12) *V-VoicedStop ≫ *G-VoicedStop ≫ *C-VoicedStop

As reflected in the hierarchy in (12), it is less effortful to produce a voiced stop after a consonant, than after a glide and after a vowel due to smoother stricture transitions (Uffman 2005; Pons-Moll et al. 2015; Jiménez et al. 2018). The constraints in (11)–(12) can be exploded into more specific ones if necessary, e. g., *C-VoicedStop: *Liquid-VoicedStop ≫ *Approximant-VoicedStop ≫ *Fricative-VoicedStop, etc. Additionally, the ranking of the relevant faithfulness constraints (e. g., Max-[cont], Dep-[cont],[10] Id-[cont]) with regard to the scale above determines in which contexts voiced stops are retained or modified in order to facilitate articulation.

(13) includes the ranking and the remainder of the constraints needed for the analysis (originally introduced in [8]), in addition to reduction-of-effort constraints, such as V-VoicedStop for the postvocalic context.

(13) Voiced obstruents: Constraints and constraint ranking
a.Constraints
Id-[cont]: Assign one violation mark for every output that differs from its input correspondent in the feature [continuant]. (McCarthy and Prince 1995; Lombardi 2001)
Dep-[cont]: Assign one violation mark for every output that contains the feature [continuant] with no correspondent in the input. (McCarthy and Prince 1995; Lombardi 2001)
Max-[cont]: Assign one violation mark for every input that contains the feature [continuant] with no correspondent in the output. (McCarthy and Prince 1995; Lombardi 2001)

10 (Lombardi 1998, Lombardi 2001; Piñeros 2006).

ID-[voi]: Assign one violation mark for every output that differs from its input correspondent in the feature [voice] (McCarthy and Prince 1995; Lombardi 2001).
NC[cont]: Assign one violation mark for every nasal/lateral that does not agree in [cont] with the following homorganic obstruent (cf. feature geometry in Padgett 1994).
*V-VoicedStop: Assign one violation mark for every voiced stop after a vowel.
b. Constraint ranking
*V-VoicedStop, ID-[cont], ID-[voi], DEP-[cont] ≫ MAX-[cont]

As established above, ID-[cont] is a highly ranked constraint that requires faithfulness to any continuant specification present in the input. Since the underspecified input is considered here, a faithfulness constraint that bans the insertion of a [± continuant] feature not present in the input – i. e., DEP-[cont] – becomes relevant. DEP-[cont] must be ranked high because the phonetic evidence supports the underspecification of continuancy in the output of the phonology (provided later in the phonetics on the basis of context) and thus bans insertion of [continuant]. Its counterpart MAX-[cont] is also listed in (13a). It is low-ranked constraint, as it will be violated by some underspecified inputs.

The tableaux in (14)–(16) show how the postvocalic output and input are selected on the basis of the constraints and constraint ranking. It must be noted that, although most of the examples in the tableaux in this paper contain the relevant segments within the word, evaluation will proceed the same way in an across-the-word context, e. g., [aBl] in *una blusa* ‘a shirt’. The output appears at the top of the tableaux. (14), (15) and (16) contain the details of the evaluation of each of the three different inputs: underspecified, [-continuant] and [+continuant], respectively. In (14) the optimal candidate and winner (a), underspecified [aBlo], does not incur any constraint violations.[11] Candidates specified for continuancy, (b)–(d), with default value insertion, violate the constraint against the insertion of this feature (be it + or -), DEP-[cont]; (d), [aplo], also incurs a violation of ID-[voi] since there is a change in the voicing specification and (c) violates *V-VoiStop because it has a voiced stop postvocalically.

11 It should be noted that, in addition to [continuant], the feature [sonorant] must also be underspecified. It is assigned in the phonetic component and it follows from the degree of constriction: the least constricted approximant realizations of the voiced obstruents are sonorants, while the more constricted fricative and stop realizations are obstruents.

(14)–(16) The underspecified input is the most harmonious input for the (underspecified) output
[aBlo] 'I speak'[12]

(14) /aBlo/	*V-VoiStop	ID-[voi]	ID-[cont]	DEP-[cont]	MAX-[cont]
a. ☞ aBlo					
b. aβlo				*!	
c. ablo	*!			*	
d. aplo		*!		*	
(15) /ablo/	***V-VoiStop**	**ID-[voi]**	**ID-[cont]**	**DEP-[cont]**	**MAX-[cont]**
a.☞ aBlo					*
b. aβlo			*!		
c. ablo	*!				
d. aplo		*!			
(16) /aβlo/	***V-VoiStop**	**ID-[voi]**	**ID-[cont]**	**DEP-[cont]**	**MAX-[cont]**
a. aBlo					*
b. ✗ aβlo					
c. ablo	*!		*		
d. aplo		*!	*		

(15) and (16) consider fully specified inputs. In (15), (a), the underspecified candidate, is again the winner and optimal candidate, as in (14), despite a different input, because it only incurs a violation of MAX-[cont], as a result of the deletion of [continuant]; its competitors have marks for higher constraints (i. e., *V-VoiStop, ID-[voi], ID-[cont]). (16) selects an incorrect output – (b), with a voiced approximant, identified with ✗ – as the winner because it does not incur any constraint violations. (b) is not the correct output because the actual output is [aBlo]. [aβlo] does not match the phonetic evidence, which indicates that the output has a variable degree of constriction and cannot be [aβlo]. It is crucial to clarify that under output underspecification – that argues that underspecification can persist into the

12 A potential constraint militating against lack of features (i. e., underspecification) in the phonology would be ranked lower than all other constraints presented here.

phonological output which is then fed into the phonetic component for phonetic implementation – the outputs [aBlo] [aβlo] are different phonologically. The difference between the underspecified and the [+continuant] output in the phonetic component can be difficult to grasp if mistakenly interpreted in phonological terms, given that both forms will be [+continuant] in the phonetic implementation. Yet, these two outputs do in fact differ phonetically in the degree of gradience reported by phoneticians in their implementation (vs. other specified fricatives) (cf. references in Section 1 in connection with the gradience argument).

In sum, the inputs in (14) and (15) result in the selection of the same correct outputs. (14a), however, incurs fewer marks than (15a) which means that the underspecified input in (14) is the most harmonious for the output and thus is selected as the optimal input for the output.

The stop-dominant dialects, with an underspecified output as the general dialects, are represented by tableau (15), with a voiced stop in the input/underlying representation. When comparing (14a) and (15a), one can argue that the input should be the underspecified /aBlo/ for the stop-dominant as well as the general dialects, because (14a) has no violation marks compared to (15a) that has one and is thus the most harmonious output. However, as the remainder of the analysis will show (Section 4.2), the stop-dominant dialects must have a voiced stop in the input in order to account for the data in post-consonantal positions. The analysis of the stop-dominant dialects, which differs from the general ones in the input and ranking of the constraints, will also present additional evidence in support of the underspecification proposal for the general dialects.[13]

4.2 The postconsonantal position and effort reduction

As mentioned above, some Central American dialects have stops in all positions, except postvocalically. I argue that the difference with respect to the general pattern is captured by the underlying representation, specified as

13 As mentioned in Footnote 2, some stop-dominant dialects appear to have voiced stops in postvocalic position, e. g., /desde/ [dede] ‘since’. These dialects also have /s/ aspiration and deletion. Thus, it can be argued that the voiced stop in these cases is actually not postvocalic because the deleted /s/ has left a time unit in the skeleton that is either empty or filled with the features of the stop consonant, resulting in a phonetic geminate (cf. Harris 1984; Amastae 1989).

[-continuant], and the ranking in (17) (that in (14)–(16) and (13b) with the inclusion now of *VoiStop, left out above for presentational reasons). In stop-dominant dialects, with continuants in postvocalic position only, the constraint against voiced stops in this context (the most effortful) dominates faithfulness to underlyingly specified stricture. In other words, if the voiced obstruent is a stop [-continuant] in the input, the degree of effort required to produce it in postvocalic position overrides the need to be faithful to the UR (markedness over contrast retention). Voicing specifications are not changed because the voiced stop does not become voiceless to get around the effort involved in combining [-continuant] [+voi]. Insertion of [±continuant] is not possible so DEP-[cont] is undominated. Finally, ID-[cont] outranks the general constraint against voiced stops *VoiStop, because it is only voiced stops in postvocalic position that alter their underlying specification for [continuant]; in other words, the input specification for [continuant] is retained in the output in all contexts other than the postvocalic one.

(17) Constraint ranking
*V-VoiStop, ID-[voi], ID-[cont], DEP-[cont] ≫ MAX-[cont], *VoiStop

The tableaux in (18)–(20) show how the postconsonantal output and input are selected on the basis of the constraints and constraint ranking in the stop-dominant dialects. Additional constraints in the VoiStop family (seen in 12) are included as they become relevant for the new contexts. The output appears at the top of the tableaux. (18), (19), and (20) contain the details of the evaluation for each of the three different inputs: underspecified, [-continuant] and [+continuant], respectively. (18)–(20) demonstrate that the input must be [-continuant] in order to obtain the correct output in a postconsonantal context. When the input is underspecified or [+continuant], the optimal candidate is incorrectly selected as in (19a) and (20b) (incorrect winners are identified with ✗, as before). In (18), with a stop in the input, (a) is ruled out because the feature specification for [continuant] is deleted (MAX-[cont] violation); (b) fails on account of the mismatch between input and output with regard to [continuant], since the input stop becomes an output fricative (i. e., ID-[cont] violation); (d) is eliminated because the voiceless stop changes the voicing specification of the input (i. e., ID-[voi] violation); finally, (c) is the winner because it only incurs marks for *C-VoiStop and *VoiStop, the lowest ranked constraints.

(18)–(20) Post-consonantal position in stop-dominant dialects
[aɾbol] 'tree'

(18) /aɾbol/	*V-VoiStop	ID-[voi]	ID-[cont]	DEP-[cont]	MAX-[cont]	*G-VoiStop	*C – VoiStop	*Voi Stop
a. aɾBol					*!			
b. aɾβol			*!					
c. ☞ aɾbol							*	*
d. aɾpol		*!						
(19) /aɾBol/	*V-VoiStop	ID-[voi]	ID-[cont]	DEP-[cont]	MAX-[cont]	*G-VoiStop	*C – VoiStop	*Voi Stop
a. ✗ aɾBol								
b. aɾβol				*!				
c. aɾbol				*!			*	*
d. aɾpol		*!		*				
(20) /aɾβol/	*V-VoiStop	ID-[voi]	ID-[cont]	DEP-[cont]	MAX-[cont]	*G-VoiStop	*C – VoiStop	*Voi Stop
a. aɾBol					*!			
b. ✗ aɾβol								
c. aɾbol			*!				*	*
d. aɾpol		*!	*					

As a result, the phonological inventory of the stop-dominant dialects must be slightly different from that of the general dialects (cf. 7), as in (21), with the stops exhibiting a contrast in voice.

(21) Underlying contrasting features in Spanish obstruents in stop-dominant varieties
-sonorant -voice -continuant /p t k/
-sonorant -voice +continuant /f θ s x/
-sonorant +voice -continuant /b d g/

The tableaux in (22)–(24) also show that for the general dialects to obtain the correct output, i. e., [aɾBol], the input must be underspecified /aɾBol/. (24), with a [+continuant] input, selects the wrong output (24b).[14] While (a) is the correct output in (22) and (23) – (a) is the winner both in (22) and (23) – the underspecified input /aɾBol/ in (23) is the most harmonious as (23a) incurs no violations, while (22a) has one. In addition, the general dialects are expected to have the constraints against stops after glides and consonants highly ranked (as opposed to stop-dominant dialects where they are low-ranked).

(22)–(24) Post-consonantal position in the general dialects
[aɾBol] 'tree'

(22)/aɾbol/	*V-VoiStop	*G-VoiStop	*C – VoiStop	Id-[voi]	Id-[cont]	Dep-[cont]	Max-[cont]	*Voi Stop
☞a. aɾBol							*	
b. aɾβol					*!			
c. aɾbol			*!					*
d. aɾpol				*!				
(23) /aɾBol/	*V-VoiStop	*G-VoiStop	*C – VoiStop	Id-[voi]	Id-[cont]	Dep-[cont]	Max-[cont]	*Voi Stop
☞a. aɾBol								
b. aɾβol						*!		
c. aɾbol			*!			*		*
d. aɾpol				*!		*		
(24) /aɾβol/	*V-VoiStop	*G-VoiStop	*C – VoiStop	Id-[voi]	Id-[cont]	Dep-[cont]	Max-[cont]	*Voi Stop
a. aɾBol							*!	
b. ✗ aɾβol								
c. aɾbol			*!		*			*
d. aɾpol				*!	*			

As mentioned above, the current analysis only focuses on two ends of the dialectal continuum (i. e., the general dialects, with approximants in all positions except for before a pause and post-nasally, and the stop-dominant varieties, with stops in all positions except for post-vocalically), because of

14 Recall that, as in (16b), (24b) is not the correct output because the actual output is [aɾBol]. [aɾβol] does not match the phonetic evidence, which indicates that the output has a variable degree of constriction and cannot be [aɾβol].

scarce acoustic evidence regarding the voiced obstruent alternation in dialects other than the general and the stop-dominant. However, the present account is also able to explain the extension of lenition to additional contexts. This can be accomplished through the re-ranking of markedness constraints in the *VoicedStop family (in the spirit of Piñeros' proposal) above faithfulness constraints (e. g., MAX-[cont], DEP-[cont], ID-[cont]). For instance, dialects with continuant allophones after glides (as well as after vowels) but stops in postconsonantal position would have the ranking in (25a) (compare to (25b) for the general dialects and to (25c) for stop-dominant dialects with a stop after a glide).

(25) Dialectal variation: Constrating reranking
  a. *V-VoicedStop ≫ *G-VoicedStop ≫ FAITH≫ *C-VoicedStop
  b. *V-VoicedStop ≫ *G-VoicedStop ≫ *C-VoicedStop ≫ FAITH (General dialects)
  c. *V-VoicedStop ≫ FAITH ≫ *G-VoicedStop ≫ *C-VoicedStop (Stop-dominant dialects)

(26)–(28) show how evaluation would proceed after a glide with all three possible inputs, demonstrating that for dialects with stops only postconsonantally the input would also have an underspecified input (26). Candidate evaluation with a [+continuant] input results in the selection of incorrect output, (27a). In (26) and (28) the correct output is selected, (26b) and (28b); however, the input must be the underspecified one in (26), as (26b) incurs no violations, whereas (28b) incurs one.

(26)–(28) Stops postconsonantally only (i. e., output underspecified after a vowel and a glide)
[deu̯Da] 'debt'

(26)/deuDa/	*V-VoiStop	*G-VoiStop	Id-[voi]	Id-[cont]	Dep-[cont]	Max-[cont]	*C-VoiStop	*VoiStop
a. deu̯ða					*!			
b. ☞deu̯Da								
c. deu̯da		*!			*			*
d. deu̯ta			*!		*			
(27)/deuða/	*V-VoiStop	*G-VoiStop	Id-[voi]	Id-[cont]	Dep-[cont]	Max-[cont]	*C-VoiStop	*VoiStop
a. ✗ deu̯ða								
b. deu̯Da						*!		
c. deu̯da		*!		*				*
d. deu̯ta			*	*!				
(28) /deuda/	*V-VoiStop	*G-VoiStop	Id-[voi]	Id-[cont]	Dep-[cont]	Max-[cont]	*C-VoiStop	*VoiStop
a. deu̯ða				*!				
b. ☞deu̯Da						*		
c. deu̯da		*!						*
d. deu̯ta			*!					

(29)–(31) and (32)–(34) show how evaluation would proceed after glides for the dialect groups at the end of the continuum dialects, i. e., the stop-dominant and the general dialects.

(29)–(31) Stop dominant dialects: after glides
[deu̯da] ‘debt’

(29) /deuDa/	*V-VoiStop	ID-[voi]	ID-[cont]	DEP-[cont]	MAX-[cont]	*G-VoiStop	*C -VoiStop	*Voi Stop
a. deu̯ða				*!				
b. ✗deu̯Da								
c. deu̯da				*!		*		*
d. deu̯ta		*!		*				

(30)/deuða/	*V-VoiStop	ID-[voi]	ID-[cont]	DEP-[cont]	MAX-[cont]	*G-VoiStop	*C -VoiStop	*Voi Stop
a. ✗deu̯ða								
b. deu̯Da					*!			
c. deu̯da			*!			*		*
d. deu̯ta		*!	*					

(31)/deuda/	*V-VoiStop	ID-[voi]	ID-[cont]	DEP-[cont]	MAX-[cont]	*G-VoiStop	*C -VoiStop	*Voi Stop
a. deu̯ða			*!					
b. deu̯Da					*!			
c. ☞deu̯da						*		*
d. deu̯ta		*!						

(29) and (30), with underspecified and [+continuant] inputs respectively, select the wrong candidates (29b) and (30a). (31) with a stop in the input selects the correct [-continuant] output, (31c).

(32)–(34) General dialects: after glides
[deu̯Da] ‘debt’

(32)/deuDa/	*V-VoiStop	*G-VoiStop	*C-VoiStop	Id-[voi]	Id-[cont]	Dep-[cont]	Max-[cont]	*VoiStop
a. deu̯ða						*!		
b. ☞deu̯Da								
c. deu̯da		*!				*		*
d. deu̯ta				*!		*		

(33)/deuða/	*V-VoiStop	*G-VoiStop	*C-VoiStop	Id-[voi]	Id-[cont]	Dep-[cont]	Max-[cont]	*VoiStop
a. ✗deu̯ða								
b. deu̯Da							*!	
c. deu̯da		*!			*			*
d. deu̯ta				*!	*			

(34) /deuda/	*V-VoiStop	*G-VoiStop	*C-VoiStop	Id-[voi]	Id-[cont]	Dep-[cont]	Max-[cont]	*VoiStop
a. deu̯ða					*!			
b. ☞deu̯Da							*	
c. deu̯da		*!						*
d. deu̯ta				*!				

The evaluation in (33) selects the wrong candidate, (33a). While (32) and (34) select the correct one, the underspecified input in (32) is more harmonious, as (32b) does not incur any violations and (34b) incurs one.

4.3 Homorganic clusters

As to the post-nasal context, the reader will recall that the stop is the most common allophone, and variation is minimal. The account proposed so far predicts that stop-dominant dialects will have a voiced stop after a nasal. A more detailed explanation is needed for the general dialects. Recent phonetic studies suggest that in some dialects the aperture continuum may also affect the postnasal position, e. g., Carrasco et al. (2012). This seems to indicate that [-continuant] may be acquired in the phonology, from the adjacent consonant.[15]

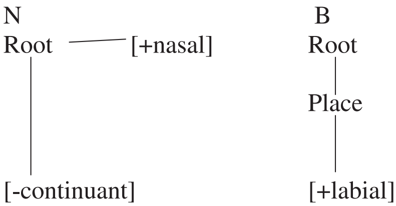
That obstruents agree in continuancy with a preceding, homorganic nasal (captured by the constraint NC[cont], in [8] and [13]) can be motivated in a model of feature geometry like the one proposed by Padgett (1994) in which sharing place features means sharing the aperture nodes dominated by them (cf. also Holt who argues that "place of articulation and stricture of a segment are intimately related and are executed as a single gesture, with stricture structurally dependent on place [2002: 87]").

The connection noted by many researchers between nasal homorganic clusters and voiced stops is a consequence of the domination of aperture nodes by place features in feature geometry models. In (35a) a sequence of a nasal (or lateral), underspecified for point of articulation, and a voiced bilabial obstruent, without a continuancy specification, becomes a bilabial nasal + bilabial stop through the sharing of the place and aperture nodes (35b), a violation of LINK, a constraint that bans the double association of features (cf. [37]). Voiced obstruents, being underspecified for continuancy, share the [-continuant] specification of the nasal (35b).

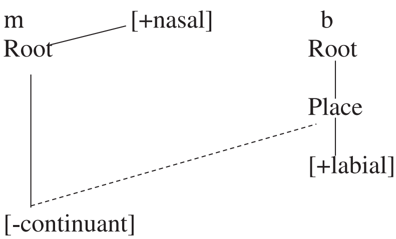
15 Another context exhibiting minimal (if any) variability is absolute word-initial position (postpausal). The pause favors a stop in the phonetic implementation of the underspecified output.

(35) Feature-geometric representation for nasal + voiced obstruent clusters

a.



b.



Agreement in continuancy with a preceding nasal only affects voiced obstruents: voiceless fricatives are not affected (36). This is because the sharing of aperture nodes only takes place when it does not require altering the aperture node of the post-nasal segment. Recall that it was argued (Section 3.2) that voiced obstruents are underspecified for continuancy, but voiceless stops and fricatives are specified as [-continuant] and [+continuant], respectively. In Optimality-Theoretic terms, as seen in (8) and (37), this means that ID-[cont] dominates NC[cont]. Segments underlyingly specified as [+continuant], such as voiceless fricatives, retain their [+continuant] specification due to the domination of ID-[cont] over NC[cont].[16]

16 Colina (2016) argues, in agreement with Martínez-Gil (2001), that among fricatives, /f/ is the only one underspecified for [continuant] because labiodental stops are highly marked and Spanish – like many other languages – does not contrast [+] and [-] continuant for labiodentals. In an /Nf/ cluster /f/ does not become a stop, despite its underspecification for [continuant], because the resulting labiodental stop would be a marked segment and a constraint against it would be very highly ranked.

(36) Feature-geometric representation for nasal + voiceless fricative clusters

a. Input

```
N       [+nasal]          s
       /
Root                     Root
|                        |
|                        Place
|                        |
                         [coronal]
[-continuant]            [+continuant]
```

b. Output

```
n             [+nasal]    s
Root_________/           Root
|                        |
|                        Place
|                . . . ' |
|        . . . '         [coronal]
| . . . '                [+continuant]
[-continuant]
```

(37) Constraints and constraint ranking for NC clusters

NC[cont]: Assign one violation mark for every nasal/lateral that does not agree in [cont] with the following homorganic obstruent (cf. feature geometry in Padgett 1994).

Link: Assign one violation mark for every feature associated to two root nodes (Itô et al. 1995; Colina 2009).

Id-[cont], Id-[voi] ≫ NC[cont] ≫ Link

As explained above, Link must be dominated by NC-[cont], which is in turn dominated by Id-[cont]. The ranking between Link and Id-[voi] is undetermined (not captured by the tableaux).

(38)–(39) Voiced obstruents in homorganic NC clusters
[tjemblo] 'I tremble'

(38) /tieNBlo/	ID-[voi]	ID-[cont]	NC-[cont]	LINK
a. tjemBlo			*!	
b. tjemβlo			*!	
☞c. tjemblo				*
d. tjemplo	*!			*
(39) /tieNblo/	ID-[voi]	ID-[cont]	NC-[cont]	LINK
a. tjemBlo			*!	
b. tjemβlo		*!	*	
☞ c. tjemblo				*
d. tjemplo	*!			*

I argue that LINK is the responsible constraint in (38) (rather than DEP-[cont]) because insertion (a DEP-[cont] violation) would incur an additional OCP violation by having two contiguous identical association lines. In (38) candidates (a) and (b) are ruled out because they do not agree in continuancy with the nasal, violating NC-[cont]. (38b) also violates DEP-[cont] (not shown). (38c) is better than (d) because it only contains a violation of LINK, whereas (d) incurs an additional mark for ID-[voi], since a voiced input now corresponds to a voiceless output.

When the input is identical to the output (i. e., a stop), as in (39), the correct output is also selected. This in turn requires a stop in non-nasal contexts, which is precisely what we find in stop dominant dialects. Evaluation in (39) is as in (38), except for an additional violation of ID-[cont] incurred by (39b).

The representation in (36b) may suggest that the sibilant is realized as an affricate, given that it is associated to [+continuant] and [-continuant]. (Recall that [+continuant] must be preserved due to the high ranking of ID-[cont]). An affricate output is ruled out by an undominated constraint against alveolar affricates in Spanish, *t͡s, as seen in (40a). (40b) incurs an ID-[cont] violation because it changes the input specification of the fricative, while (40e) is ruled out on account of ID-[voi]. (40c), with a sibilant underspecified for continuancy, loses out to the winner (40d) because it incurs an additional mark for MAX-[cont], due to the deletion of the underlying [+continuant] specification.

(40) Nasal + fricative voiceless fricative cluster (no affricate)
[pjenso] ‘I think’

/pieNso/	*t͡s	Id-[voi]	Id-[cont]	NC-[cont]	Max-[cont]	Link
a. pjentso	*!					*
b. pjento			*!			*
c. pjenSo				*	*!	
☞ d. pjenso				*		*
e. pjenzo		*!		*		*

NC-[cont] is also relevant in the case of laterals that are homorganic with the following voiced obstruent, i. e., /lD/ (41)–(42).

(41)–(42) Voiced obstruents in homorganic LC clusters
[kaldo] ‘soup’

(41) /kalDo/	Id-[voi]	Id-[cont]	NC-[cont]	Link
a. kalDo			*!	
b. kalðo			*!	
c. ☞ kaldo				*
d. kalto	*!			*
(42) /kaldo/	Id-[voi]	Id-[cont]	NC-[cont]	Link
a. kalDo			*!	
b. kalðo		*!	*	
c. ☞ kaldo				*
d. kalto	*!			*

As seen in (41), in a similar way to the evaluation of nasal + voiced obstruent clusters, the underspecified voiced obstruent and the [+continuant] allophone are ruled out in (41a) and (41b) due to NC-[cont] violations; (41c) is better than (41d) because it only incurs a mark for Link, whereas (40d) also violates Id-[voi]. Evaluation in (42) is as in (41), except for an additional violation of Id-[cont] incurred by (42b).[17]

17 Please note that for reasons of space and presentation the [+continuant] input is not included in (38)–(39) and (41)–(42). As the reader can check for himself/herself, this input, in conjunction with the constraints and constraint ranking, results in the selection of the wrong output, [+continuant], rather than the correct [-continuant].

(43) shows how evaluation proceeds when the voiced obstruent is not homorganic with the preceding lateral. All candidates vacuously satisfy NC-[cont] because they are not homorganic; (b), (c) and (d) incur violations for DEP-[cont], assuming that they obtain [+continuant] and [-continuant] specifications through insertion (rather than LINK, since they do not share their point of articulation with the preceding nasal); as in (41)–(42), (d) obtains an extra mark for being voiceless and therefore also unfaithful to the voice specification of the input (i. e., ID-[voi] violation). A homorganic candidate (43e), which would satisfy NC-[cont], is ruled out on the basis of a highly ranked markedness constraint that bans labial laterals on articulatory grounds *l [lab]. A hypothetical labial lateral is represented as [l͜w], given the lack of an IPA symbol. When the input is a stop (44), the output selected by the constraints and the constraint ranking has a stop, as predicted for the stop-dominant dialects.

(43) Voiced obstruents in non-homorganic LC clusters (general dialects) [kalBo] 'bald'

/kalBo/	*l [lab]	ID-[cont]	NC-[cont]	ID-[voi]	DEP-[cont]	MAX-[cont]	LINK
a. ☞ kalBo							
b. kalβo					*!		
c. kalbo					*!		
d. kalpo				*!	*		
e. kal͜wbo	*!						*

(44) Voiced obstruents in non-homorganic LC clusters (stop-dominant dialects) [kalbo] 'bald'

/kalbo/	*l [lab]	ID-[voi]	ID-[cont]	NC-[cont]	DEP-[cont]	MAX-[cont]	LINK
a. kalBo						*!	
b. kalβo			*!				
c. ☞ kalbo							
d. kalpo		*!					
e. kal͜wbo	*!						*

Finally, in absolute word-initial position, the phonetic output contains a stop (still underspecified at the output of the phonology in the general dialects) because the post-pausal position is a strong position in which phonetic implementation favors a stop (as a continuation of the occlusion present in silence). Stop dominant dialects have a stop in the output of the phonology, which is of course also a stop in the phonetics.

5 Previous accounts and literature review

Before concluding, we summarize existing analysis of spirantization to contextualize the current proposal. Among generative analyses, extant proposals differ with regard to the directionality of the process, the form of the underlying representation, and the feature that spreads:

(i) Directionality of the process. Some analyses see the process as one of fortition of underlying continuant segments (Hammond 1976; Bakovic 1997; Barlow 2003), while others claim that the [+continuant] allophones are the result of lenition (Harris 1969), in agreement with the diachronic development from Latin voiced stops. More specifically, fortition accounts see the stop as the appropriate less sonorous realization for a post-nasal obstruent in the onset position. Determining the directionality of the process (fortition or lenition) is a frame-specific issue that becomes irrelevant in a non-serial model like OT and in the proposal presented here.

(ii) The nature of the underlying representation. Some studies take the underlying representation to be a stop which becomes [+continuant] in the relevant contexts (Harris 1969); others start from a continuant input (Hammond 1976; Bakovic 1997; Barlow 2003), realized as a stop in post-nasal and post-pausal position (and after a lateral for the voiced coronal); finally, some phonologists propose an underlying representation underspecified for continuancy (Lozano 1979; Harris 1984; Mascaró 1984; Hualde 1989). One argument for an underspecified input is the lack of evidence for any of the specified forms. The current proposal concurs with those who argue for an underspecified input, but it also explains phonetic gradience through output underspecification (i. e., the output of the phonology is also underspecified).

(iii) Accounts that argue that the alternation is driven by assimilation differ with regard to the feature that spreads. For some it can be either [+] or [–] depending on the specification of the preceding segment ([αcontinuant], Mascaró 1984); for others it is [-continuant] in homorganic clusters (Hualde 1989).

Existing analyses argue for two types of motivation for the allophonic variation in Spanish voiced obstruents, namely, assimilatory, in which the surface allophone (+ or – continuant) is the result of becoming more like the preceding segment (Bakovic 1997; Harris 1969, Harris 1984; Hualde 1989; Lozano 1979; Mascaró 1984), and effort-reduction, which views the more open stricture of approximants (+continuant) as a contributor to articulatory ease (Branstine 1991; Kirchner 1998, Kirchner 2001; Piñeros 2002). Some non-derivational, optimality theoretic analyses propose effort-reduction accounts in which the articulatory difficulty (markedness) of a voiced stop is avoided by relaxing the degree of stricture of a full occlusion in favor of less occluded allophones (e. g., Kirchner 1998, Kirchner 2001; Piñeros 2002). As seen above (cf. Section 4.1), this is achieved through the domination of an effort-reduction family of constraints (LAZY) over faithfulness constraints that restrict the range of input alterations. Optimality-theoretic effort-reduction accounts like the one proposed here argue that the form of the underlying representation is a result of the constraints and constraint ranking in conjunction with the postulate of Lexicon Optimization. As was mentioned earlier, there is no clear agreement in previous analyses as to the form of the underlying representation and the motivation for the process (as well as its directionality). The analysis presented in this study shows that the form of the underlying representation is underspecified for the general dialects and a stop for the stop-dominant ones; the motivation for the process is effort-reduction. Finally, existing proposals do not provide a unified account of dialectal variation, as it is done here.

6 Conclusions

This paper argued for an optimality theoretic account of voiced obstruents in Spanish in the general dialects in which the input and output of the phonology are underspecified. Spirantization is the result of avoiding a phonetically marked voiced stop, by changing its articulation from maximal constriction (occlusion) to a continuant, more open articulation. Input underspecification results from the constraints and constraint rankings. The underspecified input is the most harmonious input for the output. Output underspecification explains the variability and gradience in the degree of aperture revealed by the acoustic evidence, so far unaccounted for in the generative literature.

In addition to the variability and gradience of the continuant allophones, spirantization is known to exhibit significant dialectal variation. The analysis explains the most widespread pattern of variation – comprising the dialects with the most continuant allophones – as well as the pattern with the most stops (spirants only in postvocalic position), at the other end of the dialectal continuum, accounting thus for dialectal variation – something rarely done in existing analyses. It is argued that this variation responds to differences in constraint ranking and in the form of the underlying representation (e. g., a stop for the stop-dominant varieties). Further acoustic research is necessary to clearly describe additional varieties; however, some suggestions are made on how additional patterns of variation can be accounted for.

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