Continuity lenition, auditory disruption, and the typology of positional neutralisation

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Abstract
This paper argues that processes traditionally classified as lenition fall into at least two subsets with distinct phonetic, formal, and positional properties. One type, referred to as loss lenition, weakens or reduces segments, frequently neutralising contrasts in positions where they are perceptually indistinct. The second type, referred to as continuity lenition, targets segments in perceptually robust positions, has the effect of increasing the intensity and/or decreasing the duration of those segments, and very rarely results in the positional neutralisation of contrasts. While loss lenition behaves much like other phonological processes, analysing continuity lenition is difficult or impossible in standard phonological approaches. We develop a phonetically based optimality-theoretic account that explains the typology of the two types of lenition. The crucial proposal is that loss lenition is driven by general segmental phonology, while continuity lenition is driven by constraints on the global phonetic properties of prosodic domains.

1 Introduction

This paper proposes a new analysis of certain lenition and fortition phenomena. The terms *lenition* and *fortition* have been used to describe an extremely broad class of phonological patterns; one claim of the current paper is that this class of patterns includes at least two sets that are phonetically and phonologically distinct and thus require different analyses. We call these two sets loss lenition and continuity lenition. 'Loss lenition' is meant to suggest the loss of length, features, or articulatory gestures; it also often entails the loss of one or more segmental contrasts. Loss lenition generally targets consonants or contrasts in perceptually weak positions, such as the ends of prosodic domains. Debuccalisation (e.g. /k'/ → [ʔ]) is a good example of loss lenition. 'Continuity lenition' is meant to suggest that consonants are realized so as to minimize the auditory disruption they create in the context of a stream of highly sonorous sounds. By hypothesis, these phenomena are driven by preferences for preserving auditory continuity inside prosodic constituents, and maximizing auditory disruption at the edges of constituents. Continuity lenition often targets consonants in perceptually strong positions, such as in between vowels, glides, and liquids. Unlike loss lenition, it rarely neutralises contrasts that are present elsewhere in a language; the exact conditions under which it may do so are discussed in detail in section 4. Spirantisation (e.g. /k/ → [x]) is an example of continuity lenition.

We propose here that the two types of lenition are driven by different sets of constraints. Loss lenition has no special status in phonology; it is a descriptive label for a set of phenomena that have been called 'lenition' by previous researchers but do not share the special formal and functional properties of continuity lenition. Loss lenition is driven by whatever constraints drive other kinds of positional neutralisation and/or allophony patterns. There is no shortage of proposals in the literature for what kinds of constraints these may be: positional markedness, positional faithfulness, licensing-by-cue, and perceptual distance constraints all serve this function. While we take no strong position here on what the right theory of positional neutralisation is, we outline an analysis in terms of perceptually-driven positional faithfulness.

The typology of continuity lenition, on the other hand, cannot be accurately described using any of the constraint families mentioned above. All of those constraint types predict that positional neutralisation should be a pervasive consequence of continuity lenition, but it is not. We introduce a new family of constraints, Boundary-Disruption, that call for points of auditory disruption to occur at *and only at* prosodic boundaries of a particular strength. In the current theory, the formal definition of continuity lenition is simply any pattern driven by Boundary-Disruption constraints. These constraints are unusual in marking one set of segments in one prosodic context, and the complement of those segments in complementary contexts. This property predicts that allophonic variation should be the norm in continuity lenition, with the possibility of positional neutralisation severely constrained. The precise typological claim advanced here, and explained in detail in sections 2 and 4, is that single-feature continuity lenition never neutralises contrasts in the absence of some confounding positional factor. We argue in section 4 that this typological prediction is correct.

Several of the generalizations mentioned above exist in one 'corner' of the phonetic or phonological literature on lenition without having much impact on other areas of the literature. One goal of the current paper is to provide a better theory of lenition by uniting these disparate threads of the lenition literature. Loss lenition and continuity lenition occur in different positions, affect different features, and behave differently with regard to segmental contrasts because they are the result of different types of constraints: markedness and positional faithfulness in the case of loss lenition; constraints on the perceptual properties of prosodic systems in the case of continuity lenition. The theory of lenition proposed here also avoids a kind of typological overgeneration that, we argue in section 2, is a problem for all extant theories of lenition.

The paper is structured as follows: in the remainder of this section, we introduce relevant background about contrast, lenition, and positional factors; section 2 presents a typological overview and analysis of continuity lenition; section 3 more briefly discusses loss lenition; section 4 discusses cases of apparent neutralising lenition; section 5 discusses the theoretical and empirical implications of the analysis.

1.1 Allophony and neutralisation

All theories of phonology of which we are aware share a fundamental prediction about features and contrast: if some process or constraint has the effect of changing a feature, and if that feature can be contrastive in some language, then the process or constraint can neutralise a contrast if it happens to be present in a language where the relevant feature is contrastive.[1] This is an eminently sensible claim, and is rarely even explicitly acknowledged, because it seems to self-evidently reflect a basic feature of phonology: allophonic processes have neutralising

[1] Articulatory Phonology (Browman & Goldstein 1986) is a partial exception: it does not allow gestures to be deleted, only reduced to activation and duration approaching zero. So there is a sense in which gestural/featural 'deletion' is never neutralising in this framework, because it isn't really deletion.

counterparts and *vice versa*. This is illustrated in (1) with pre-/i/ palatalisation, but many common phonological phenomena would suffice to make the point.

(1) Pre-/i/ palatalisation:
allophonic in Korean (Yoon 1999):
[sal] 'flesh' *[ɕal]
[ɕi] 'poem' *[si]
neutralising in Japanese (Li *et al*. 2009):
[saru] 'monkey' [ɕaɕiŋ] 'photo';
[ɕika] 'deer' *[sika]

The Korean alternation shows that there is some rule that changes /s/ to [ɕ] before /i/, or a markedness constraint against [si] sequences. Alveolar and alveopalatal fricatives happen not to contrast in Korean, so the pattern is allophonic. If instead alveolar and alveopalatal fricatives contrasted before other vowels, this rule or constraint would result in positional neutralisation before [i]; this is precisely what we see in Japanese. The rule or constraint responsible for this pattern contains a reference to the phonological feature that distinguishes /s/ and /ɕ/, which we might call [anterior], but it does not contain any reference to the contrastiveness or lack thereof of [anterior]. The process 'doesn't care' whether it results in the neutralisation of a contrast.

We claim in this paper that continuity lenition phenomena are *prima facie* counterexamples to this quite basic prediction of phonological theory. Intervocalic voicing of /p/ to /b/, for instance, is always allophonic and never neutralises a voicing contrast available in word-initial position. Other continuity lenition phenomena are similar (though there are a few exceptions to this generalization, discussed in section 4). A different way of putting this is that the processes that occur in a language are not independent of the system of contrasts in that language: some lenition processes (e.g. intervocalic voicing) systematically fail to occur in languages with certain systems of contrast (e.g. voicing contrasts). This is problematic for linguistic theory. Anticipating the analysis presented in section 2, we will attempt to resolve this problem by linking the realization of both initial and medial consonants to a single constraint family. This analysis essentially says that continuity lenition is 'special' because it pertains not solely to properties of individual segments, but to the global implementation of prosodic structure.

1.2 Lenition

The term *lenition* has been used to refer to a wide array of synchronic and diachronic phenomena, and is the subject of a large literature that goes back decades if not centuries. We do not attempt a comprehensive review here; for an extremely detailed history of the terminology and ideas surrounding lenition, we recommend Honeybone's (2008) review; Kirchner (1998) and Gurevich (2003) offer review chapters concerned with empirical and theoretical details of more recent literature. This section focuses on aspects of lenition that will be particularly relevant in the current context: the phonetic, phonological, and functional nature of lenition, and the implications of these domains for the question of whether lenition is a unified phenomenon.

To answer the question of whether lenition is a unified phenomenon, we must first agree on what *lenition* means. Although there is a fair bit of variation in how the term is used, almost every researcher who has written about the topic agrees on certain core phenomena that 'count' as lenition: we take these to include at least the processes listed in (2).

(2) Some examples of lenition processes:
degemination: a long consonant becomes short (tː → t)
debuccalisation: loss of supralaryngeal features (t' → ʔ)
voicing: voiceless obstruents become voiced (t → d)
spirantisation: stops become continuants (t → θ)
flapping: stops and/or trills become flaps (t → ɾ)

There are proposals, both phonological and phonetic, that treat this collection of phenomena as unified. Several phonological approaches characterise all lenition phenomena as reduction. One sense of 'reduction' would be coming closer to non-existence, and Hyman (1975) quotes Venneman to this effect: 'a segment X is said to be weaker than a segment Y if Y goes through an X stage on its way to zero'. This could be understood as referring to either diachronic or synchronic phenomena: all lenition processes have a unified characterisation as motion along a scale that ends in zero. This notion finds a parallel in both the feature-geometric notion of node delinking (McCarthy 1988) and the Government Phonology approach, which treats lenition as the loss of privative features (e.g. Harris 1990, Ségéral & Scheer 1999). Debuccalisation is the deletion of supralaryngeal place features or delinking of the place node, for instance; if we continue deleting features or delinking nodes, we will eventually be left with a null segment.

These are essentially abstract, phonological notions of lenition. The phonetic nature of the phonological predicates being lost is not really relevant to describing lenition: it is simply the loss of any kind of phonological material, which is more or less by definition a phonological step on the path to zero. Noting several weaknesses in this approach, other researchers have attempted to ground the notion of weakening or reduction in physical terms. Kirchner (1998) provides an influential analysis along these lines: he proposes that lenition is simply any phonological phenomenon that results from a reduction in articulatory effort. This is a unified theory of lenition in both phonetic and phonological terms: all lenition phenomena are driven by constraints in the grammar that refer to levels of physical effort; this constrains the set of possible languages because if any less effortful structure is subject to lenition then so are all more effortful structures. In this approach, spirantisation of a stop to a fricative between two vowels, for example, occurs because the constriction target of the fricative, being wider than that of the stop, is closer to the targets for the flanking vowels, and moving to and from that target is therefore less effortful. If a stop is lenited to a fricative adjacent to a word boundary or a consonant, where movement to a stop closure would be less effortful, then it must also be lenited between two vowels, where the movement would be more effortful.

Kingston (2008) provides strong arguments, both *a priori* and empirical, that this effort-based conception of lenition is wrong, at least for voicing and spirantisation. The *a priori* arguments concern the amount of effort involved: the difference between a stop and fricative articulation is one of millimeters and the difference in effort would be negligible; furthermore, the increased precision required for a fricative may well be *more* effortful than that required for a stop, which is free to overshoot its target. Kingston's empirical arguments concern distinctions in triggering environments for lenition: because the articulatory differences in stricture between various consonants are small compared to the differences in stricture between vowels, if lenition is sensitive to articulatory distance, then lenition processes should be sensitive to the height of surrounding vowels more often than they are sensitive to the stricture of surrounding consonants. Kingston shows that the opposite is true: lenition frequently applies adjacent to some consonants but not others, while Kirchner's few examples of sensitivity to the height of surrounding vowels are, Kingston argues, either illusory or subject to different analyses.

Kingston's proposal for what *is* relevant to lenition will figure prominently in this paper: he proposes that lenition and fortition are two sides of the same coin, decreasing intensity at the edges of prosodic constituents and increasing intensity internal to those constituents. For instance, voiced stops are more intense than voiceless stops, which contain periods of zero intensity; fricatives and approximants are more intense than stops; vowels are generally the most intense segments. Both intervocalic voicing and spirantisation can thus be characterized as rendering consonants more similar to surrounding vowels in terms of intensity, and therefore less disruptive in the context of those vowels. Fortifying or failing to lenite at the beginning or end of a constituent will render consonants in these positions less like vowels in terms of intensity than their lenited counterparts would be, and thus more disruptive. This is where the label *continuity* lenition (ours, not due to Kingston) comes from: the proposal is that these types of lenition are primarily motivated by the desire to preserve auditory continuity within prosodic constituents.

The motivation behind this pattern is that it aligns points of auditory disruption with constituent boundaries, and the lack of auditory disruption with the lack of boundaries, which plausibly helps a listener detect where the boundaries are. This general idea has precursors in the work of Keating (2006) and Harris (2003). Although there has been little experimental work on how these particular features contribute to listeners' perception of continuity and disruption, there is a large literature showing that allophonic variation in general can be helpful during word segmentation. Infants as young as 10.5 months can use allophonic patterns such as coarticulation (Johnson & Jusczyk 2001) and stop non-release (Jusczyk *et al*. 1999) to aid word segmentation. Adults also use such patterns to aid in word segmentation (e.g. Nakatani & Dukes 1977 for stop aspiration and light/dark liquid allphony). Prosodically conditioned duration variation such as final lengthening also aids in word segmentation (Saffran *et al*. 1996, Bagou *et al*. 2002); this is relevant to our suggestion in this paper that allophonic duration variation is a central component in some continuity lenition processes.

We take the position that some version of Kingston's disruption hypothesis is correct, but only for continuity lenition. We show that continuity lenition exists alongside phenomena that are sometimes referred to as lenition but have completely different phonetic and phonological properties; this residue is what we refer to as loss lenition. This claim is inspired by work from the last 20 years showing that the two kinds of lenition can be distinguished phonologically. We briefly review some of those studies.

Ségéral & Scheer (1999, published in French in 2001) are to our knowledge the first to point out that some types of lenition, such as spirantisation and voicing, frequently occur intervocalically to the exclusion of other contexts; while other types, such as debuccalisation and liquid gliding, do not occur specifically in intervocalic position, but frequently occur in coda position to the exclusion of other contexts. The discussion occurs in the context of an attempt by researchers in element theory and government phonology to characterize all types of lenition in a unified manner (e.g. Harris 1990, Ségéral & Scheer 1999). The idea is that all lenition types share a common representation as the deletion of privative phonological elements, and that the intervocalic and coda lenition contexts share properties with regard to complex hidden structure and abstract governing and licensing relations. Ségéral & Scheer's observation is problematic for this undertaking: if all lenition processes are 'the same' at some level of phonology, it will be harder to explain why they occur in different characteristic contexts. Note that earlier attempts to analyze intervocalic lenition as feature-spreading (e.g. Harris 1984, Jacob & Wetzels 1988) in some sense imply that it must be different from the domain-final processes that are labeled as lenition. There is no obvious way, for instance, in which debuccalisation could be analyzed as feature spreading. Nonetheless, we are not aware of any explicit mention in this earlier literature of the clear differences between intervocalic and domain-final lenition.

Subsequent research has proposed a substantive featural or phonetic view of this split (Ségéral & Scheer 2008, Szigetvári 2008). Smith (2008), for instance, proposes the following: processes that typically occur in syllable-, word-, or phrase-final position involve a reduction in phonological markedness, while processes that typically occur in medial position involve an increase in sonority. Although we generally agree with the divisions made in this work, we claim that the notion of intensity or energy that is relevant to lenition is not the same as the notion that is relevant to various sonority phenomena. The idea that lenition progresses along the same scale relevant to sonority phenomena is expressed by, among others, Smith (2008), Kingston (2008) and Bye & de Lacy (2008). We briefly digress to explain why we find this implausible.

Kirchner (1998) and Szigetvári (2008) provide compelling arguments that the scales involved in lenition and fortition are not the same as those involved in sonority phenomena. One problem is that nasals clearly participate in sonority phenomena, while we are not aware of any continuity lenition alternations involving nasal and oral consonants. A second problem with the idea of lenition as scalar sonority promotion pertains to obstruents. Szigetvári (2008) notes that lenition frequently makes distinctions between various obstruents while sonority sequencing rarely does. In our view, the problem is actually worse than this: at least one sonority relation must be reversed between the two domains. If we take typological asymmetries in complex onset 'reversability' (i.e., the sonority sequencing principle) to be a diagnostic of sonority, voiceless non-sibilant fricatives come out *lower* in sonority than voiceless stops. Many languages allow voiceless fricative-stop onsets while disallowing stop-fricative, e.g. Muniche (Michael *et al*. 2013), Takelma (Sapir 1912), Yatée Zapotec (Jaeger & van Valin 1982), and Camsa (Howard 1967), *inter alia*. The converse pattern is extremely rare: Nivkh (Shiraishi 2006) is the only possible example of which we are aware.[2] Yet voiceless fricatives are often the result of leniting voiceless stops, as in Tiberian Hebrew and Kupia (Gurevich 2003). This argues against conflation of the concept *sonorous* with the concept *lenis*.

[2] Morelli (1999) makes a similar claim, but this is based mainly on sibilant fricatives, which pattern differently with regard to cluster sequencing.

In what follows, we take the primary diagnostic criterion for continuity lenition to be the targeting of intervocalic consonants; a secondary criterion is the realization of these consonants as less disruptive, in a sense to be made more precise in section 2. It will not always be immediately apparent what 'counts' as continuity lenition and what does not. In particular, we note that the features involved in continuity lenition, such as voicing and continuancy, are sometimes targeted by other processes that are *not* continuity lenition. In addition, it is entirely possible that there exist continuity lenition processes targeting features other than the ones discussed here; theoretically, any feature that affects how disruptive a consonant is in a stream of vowels is a candidate for continuity lenition. Some ambiguous cases are discussed in section 4.

A final claim that serves as a starting point for this paper is that lenition rarely neutralises a contrast in some position in a language where that contrast is available elsewhere. Gurevich (2003) documents this tendency with an impressive cross-linguistic survey of lenition and contrast neutralisation. We will argue in this paper that, because Gurevich failed to distinguish between continuity and loss lenition, she partially missed the generalisation: loss lenition is as likely as any other phonological phenomenon to result in positional neutralisation; when we limit our attention to continuity lenition, the number of neutralising cases is vanishingly small and conforms to the typology predicted by BD constraints.

Using a fairly expansive definition of lenition and a fairly restrictive notion of neutralisation, Gurevich gathers 230 lenition processes from 153 languages, based on the surveys of Kirchner (1998) and Lavoie (1996), classifying only 8% of them as neutralising. She claims that the scarcity of neutralising lenition is due to functional pressure: languages avoid sound changes that would obliterate meaning contrasts. Smith (2008), citing an anonymous reviewer, suggests that the avoidance of neutralisation may be more pronounced for continuity lenition than for loss lenition. In this paper, we argue for a stronger version of this hypothesis: loss lenition behaves just like any other phonological phenomenon with regard to positional neutralisation, while neutralising continuity lenition is highly restricted cross-linguistically. Gurevich's survey is heavily skewed towards continuity lenition, but almost all of the neutralising cases she discusses are either loss lenition or processes like voicing assimilation that most researchers wouldn't consider lenition at all. She finds zero neutralising cases of voicing and tapping; the four continuancy alternations that she classifies as neutralising are different from spirantisation lenition, as discussed in section 4.

We claim here that a cluster of properties in three different domains distinguishes between loss lenition and continuity lenition: loss lenition involves the loss of phonetic or phonological material, is most likely in domain-final (or other perceptually weak) positions, and may neutralise contrasts that are licensed in other positions; continuity lenition involves increased intensity and/or decreased duration, is most likely in between vowels, and rarely neutralises contrasts that are licensed in other positions. This last fact is particularly troubling because phonological theory, as discussed in section 1.1, predicts that every allophonic process has a neutralising counterpart. We show that Kingston's hypothesis helps solve this problem: because continuity lenition is a way of indicating that a prosodic boundary is not present, it is most useful when coupled with a strategy for indicating when a boundary *is* present, i.e., fortition. If constraints refer directly to this motivation, the allophonic nature of continuity lenition is explained.

2 Continuity lenition and boundary marking

2.1 The typology of continuity lenition

The distinguishing characteristics of what we call continuity lenition are that it often targets consonants in intervocalic position to the exclusion of consonants in other positions and that it results in consonants that are shorter and/or more intense than their counterparts in other positions. The two most frequent types of continuity lenition are spirantisation (broadly construed) and voicing. We briefly illustrate both types in turn.

In spirantisation, stops in one context alternate with fricatives or approximants in another context. This is illustrated with data elicited from two Venezuelan Spanish speakers in (3); the pattern is similar across most varieties of Spanish (Harris 1969, Bakovic 1995).

(3) Spanish spirantisation

	#__	**[+approx]__V**	**V_[+approx]**	**[+nas]__V**
	[ɡoðo] ‘Goth’	[bisiɣoðo] ‘Visigoth’	[reɣla] ‘rule’	[uŋɡoðo] ‘a Goth’
	[beso] ‘kiss’	[elβeso] ‘the kiss’	[oβɾa] ‘work’	[umbeso] ‘a kiss’
	[dia] ‘day’	[ojðia] ‘nowadays	[siðɾa] ‘cider’	[undia] ‘a day’
Other:		[eldia] ‘the day’	[suβðito] ‘subject’	[maɣða] ‘Magda’
Phrase-final:		[sjuðad̚] ~ [sjuðadˀ] ‘city’	[baɣðad̚] ~ [baɣðadˀ] ‘Baghdad’	

Voiced stops are in complementary distribution with approximants or non-strident fricatives (notated as fricatives here and throughout the paper for typographical ease). Stops appear at the beginning of a phonological phrase, as in the left column. In between vowels, approximants, or glides, we instead find continuants, as in the middle two columns. Following a nasal, only stops appear, as in the right column. The coronal stop remains a stop following /l/. Finally, clusters of two voiced obstruents, which are fairly rare in Spanish, are generally described as continuants (Harris 1969, Bakovic 1995). Our elicitation suggests, based on the presence or absence of audible and/or visible stop bursts, that all combinations of stop and continuant in either position are possible, but stops in both positions do often spirantise. The coronal voiced stop is the only one that appears word-finally in Spanish. Phrase-medially it behaves as it does word-medially, i.e., the domain of spirantisation is some unit larger than a word. Phrase-finally, /d/ is somewhat difficult to characterise phonetically: it displays neither an audible release nor any period of frication; preceding a vowel in a following phrase it is often heavily glottalised (this dialect has glottal-stop insertion at the beginning of vowel-initial phrases). The non-glottalised realisations are consistent with an unreleased voiced stop or possibly an extremely short approximant.

Ondarroan Basque shows a nearly identical pattern to Spanish (Saadah 2011). Kinande also spirantises voiced stops in between vowels and glides but not after nasals; this is illustrated in (4) with data elicited from a native speaker. Note that consonant-glide sequences are the only clusters in this language besides homorganic nasal-stop.

(4) Kinande spirantisation

[boloβolo] 'bit by bit'	[oβoloβolo] 'bit by bit' (variant)
[gereɣere] 'perfect'	[omuɣereɣere] 'perfect person' (human/class 1)
[embwa] 'dog' (class 9)	[akaβwana] 'young dog' (diminutive/class 12)
[eŋgemu] 'tax' (class 9)	[eriɣemula] 'to pay a tax'

In phrase-initial and medial post-nasal positions (left column), voiced stops surface. But when a vowel occurs before the relevant consonant due to affixation or lexical variation (right column), continuants appear instead (probably best described as approximants). While the data in (4) are meant to show alternations, the most obvious evidence for spirantisation in Kinande, as in Spanish, is the complementary distribution of voiced stops and approximants. Similar patterns of spirantisation (sometimes limited to specific places of articulation) occur in Badimaya (Dunn 1988), Shina (Schmidt & Kohistani 2008), and Japanese (Kawahara 2006).

These data illustrate several widespread cross-linguistic characteristics of spirantisation. It is most frequently observed in between vowels or sonorant consonants, less frequently observed in medial clusters and final position, and is frequently blocked following nasals. It rarely results in positional neutralisation of contrasts that are present elsewhere in a language. Kirchner (1998), Lavoie (2001) and Gurevich (2003) provide brief descriptions of dozens more spirantisation phenomena, which overwhelmingly conform to this characterisation.

In voicing lenition, voiceless stops in initial position alternate with voiced stops elsewhere. This is illustrated in (5) with an optional alternation from Sanuma.

(5) Sanuma optional voicing (Borgman 1986)

#__	**V __V**
[telulu] 'dance'	[hude] 'heavy'
[paso] 'spider monkey'	[iba] 'my'
[kahi] 'mouth'	[ãga] 'tongue'
[t͡sinimo] 'corn'	[had͡za] 'deer'

Stops (and the alveolar affricate) do not contrast for voicing in any position in Sanuma; voiced and voiceless unaspirated series are in complementary distribution. Note that there is also an aspirated coronal stop, which contrasts with the plain one shown in (5), but this segment does not alternate for laryngeal features and the contrast between plain and aspirated is preserved in all contexts. Voiceless unaspirated stops appear word-initially, and voiced stops may appear elsewhere. Because Sanuma is largely a CV language, the 'elsewhere' condition is intervocalic. A similar optional intervocalic voicing phenomenon is described in Urubu-Kaapor (Kakumasu 1986). Voicing lenition in a language with more complex phonotactics is illustrated in (6) with data from the Chungli variety of Ao:

(6) Chungli Ao voicing (Gowda 1975)

(a)	$\underline{k}$a ~ $\underline{k}^{h}$a	‘one’		$\underline{k}$i ~ $\underline{k}^{h}$i	‘house’
(b)	a$\underline{g}$a	‘short’		te$\underline{g}$u	‘chest’
	aj$\underline{g}$a	‘many’		lɔŋ$\underline{g}$i	‘hole (made by insect)’
(c)	ja$\underline{k}$ta	‘soon’		aset$\underline{k}$ɔŋ	‘island’
(d)	sa$\underline{k}$˺	‘open’		jɔ$\underline{k}$˺	‘send’

The pattern is shown here for only the velar stop; it is identical for the labial and coronal stops and the palatal affricate (Gowda 1975). Word-initially, voiceless aspirated and unaspirated stops are in free variation (6a). In between vowels and sonorant consonants (6b), voiced stops appear instead. Clusters of obstruents are voiceless unaspirated (6c). Word-final stops are described as unreleased and voiceless, which we understand as indicating the absence of any clear voice bar following the vowel (6d). It is not entirely clear from the description whether obstruents following a vowel and preceding a sonorant consonant are voiced; this context would fall under the elsewhere condition he gives for unvoiced stops, but they are not specifically discussed and the only examples of words containing such clusters are given in a phonemic transcription that ignores allophonic voicing. Popjes & Popjes (1986) describe what appears to be a very similar pattern in Canela-Krahô, although there is some ambiguity in the description of the environment (it hinges on whether the authors intend for the term ‘voicing’ in the descriptions ‘preceding voicing’ and ‘following voicing’ to include vowels).

These examples illustrate several typological generalisations about voicing lenition. It most often targets intervocalic consonants, resulting in complementary distribution between voiced intervocalic obstruents and voiceless initial ones. Voicing also sometimes affects obstruents adjacent to liquids, glides, and nasals. Unlike spirantisation, we have no cases where voicing lenition extends to final obstruents or through clusters of obstruents. The theoretical proposal in section 2.5, however, will not attempt to ‘hard-wire’ this restriction into phonology, because we do not have a large enough sample to conclude with any certainty that this is a systematic typological fact. Kirchner (1998), Lavoie (2001) and Gurevich (2003) provide brief descriptions of many more voicing phenomena (although not as many as spirantisation, which seems to be more common), which almost always conform to the generalisations given here.

2.2 The problem with continuity lenition

There has been an enormous amount of interesting work on the phonological analysis of lenition in the last 10 years or so, in many different frameworks: positional markedness (Smith 2008), positional faithfulness (Kingston 2008), articulatory constraints (Kirchner 1998), the dispersion theory of contrast (Kaplan 2010), and government phonology (Ségéral & Scheer 2008, Szigetvári 2008) are all represented in this literature. While each of these works offers interesting data, insights, and analysis, I argue that they all share a set of problematic features: lenition may be neutralising, fortition may be neutralising, and there is no implication between the presence of one phenomenon and that of its counterpart. If the claim made here about the near-absence of neutralising continuity lenition (and its inverse fortition) is correct, then none of these approaches can describe the facts correctly. We illustrate with a simplified version of Smith’s (2008) positional markedness theory, because her proposal is laid out in an admirably clear and precise manner. The same general logic applies to the other approaches mentioned above. The basic constraints driving lenition and fortition are shown in (7):

(7) Smith's (2008) positional markedness theory:
*VTV: assign a mark to every voiceless sound between vowels
*D/$_\sigma$[__: assign a mark to every voiced obstruent in onset
IDENT[voi]: assign one mark to every [voi] specification in the output that differs from its input correspondent

In this theory, positional markedness constraints drive voicing lenition in between vowels and devoicing fortition in syllable onsets, including word and phrase onsets. Voicing specifications are protected by a faithfulness constraint. It should be clear that if the lenition and fortition constraints dominate faithfulness, segments will always lenite and fortify in the relevant positions, and the result will be allophony. Equally clear is that if the faithfulness constraint dominates both lenition and fortition constraints, segments will never change their underlying voicing specifications, and the result will be voicing contrasts in all positions. What particularly interests us here is the two other possible configurations, where faithfulness is ranked in between lenition and fortition. These are illustrated schematically in (8) and (9):

(8) **Unattested language type I:**
intervocalic lenition (c, d); contrast elsewhere (a, b)

(a)

pa	*VTV	IDENT[voi]	*D/$_\sigma$[__
☞pa			
ba		*!	*

(c)

apa	*VTV	IDENT[voi]	*D/$_\sigma$[__
☞aba		*	*
apa	*!		

(b)

ba	*VTV	IDENT[voi]	*D/$_\sigma$[__
☞ba			*
pa		*!	

(d)

aba	*VTV	IDENT[voi]	*D/$_\sigma$[__
☞aba			*
apa	*!	*	

(9) **Unattested language type II**:
syllable-initial fortition (c, d); contrast elsewhere (a, b)

(a)

ap	*D/$_\sigma$[__	IDENT[voi]	*VTV
☞ap			
ab		*!	

(c)

ba	*D/$_\sigma$[__	IDENT[voi]	*VTV
☞pa		*	
ba	*!		

(b)

ab	*D/$_\sigma$[__	IDENT[voi]	*VTV
☞ab			
ap		*!	

(d)

pa	*D/$_\sigma$[__	IDENT[voi]	*VTV
☞pa			
ba	*!	*	

In (8), stops contrast for voicing initially but neutralise to voiced in between vowels. In (9), stops contrast for voicing in coda position but neutralise to voiceless in onset position. Despite the fact that hundreds of cases of continuity lenition have been described in the phonological literature, these language types are virtually unattested. A handful of cases that superficially resemble (8) are discussed in section 4 and given different analyses. We are not aware of any languages like (9) that preserve laryngeal contrasts in pre-consonantal and domain-final position while neutralising them elsewhere, and most theories predict this pattern should be impossible. As long as there are two positional constraints (markedness or faithfulness) with a general constraint of the other type (markedness vs. faithfulness) ranked between them, however, patterns like those in (8) and (9) are always possible outcomes.

Although the discussion here is couched in terms of OT, this is not an OT problem: the absence of positional neutralisation is equally problematic for all existing theories. In an approach where lenition is characterised as a default fill-in rule (Jacobs & Wetzels 1988), one must explain why these cross-linguistically common rules differs from others in precisely the matter of always appearing as a default fill-in rule. In government phonology (Ségéral & Scheer 1999 *et seq*.) or element theory (Harris & Urua 2001), one must explain why prime-deletion under government or lack of licensing only targets primes that are not contrastive in other positions. And in an approach that hinges on the idea that lenition is blocked from entering an existing language by considerations of contrast maintenance (Gurevich 2003), one must explain why lenition differs from other sound changes (e.g. final devoicing) in this respect.

Our claim is that the analysis of continuity lenition ought not to display the formal properties that allow positional neutralisation. How do we avoid such predictions? Note that the rankings for attested languages are those where lenition and fortition constraints are ranked the same with regard to faithfulness; in unattested languages, they are differently ranked with regard to faithfulness. This suggests a formal solution: there is only one constraint enforcing both lenition and fortition. If lenition and fortition constraints are not separate, then they obviously can't be ranked on either side of an intervening constraint. To illustrate this simple point, we use a temporary 'placeholder' constraint LEN-FORT. We remain vague about the content of this constraint until the next section; for now the only important property is that it militates against both lenited consonants in initial position and unlenited consonants in medial positions.

(10) Unified constraints eliminate positional neutralisation

(a) Allophonic lenition and fortition

pa	LEN-FORT	IDENT[VOI]
☞pa		
ba	*!	*

apa	LEN-FORT	IDENT[VOI]
apa	*!	
☞aba		*

ba	LEN-FORT	IDENT[VOI]
☞pa		*
ba	*!	

aba	LEN-FORT	IDENT[VOI]
apa	*!	*
☞aba		

(b) No lenition or fortition; contrast everywhere

pa	IDENT[VOI]	LEN-FORT
☞pa		
ba	*!	*

aba	IDENT[VOI]	LEN-FORT
apa	*!	*
☞aba		

ba	IDENT[VOI]	LEN-FORT
pa	*!	
☞ba		*

apa	IDENT[VOI]	LEN-FORT
☞apa		*
aba	*!	

With respect to any given continuity lenition process, these two constraints can only derive two language types. In (10a), lenition holds domain-medially and fortition holds initially; the result is complementary distribution. In (10b), neither lenition nor fortition obtains; the result is contrast in all positions. We claim that this is essentially the correct typology for single-feature lenitions of the type illustrated here.

Although the unified formalism in (10) seems to be a step in the right direction in terms of deriving the typology of continuity lenition, it relies some formally unusual constraints. LEN-FORT calls for two opposite properties (lenis, fortis) to hold in complementary sets of environments. This is quite unlike most markedness constraints, even positional ones, which tend to mark a single feature in a single environment. In the next section, we propose a family of constraints that may plausibly fulfill this function.

2.3 Boundary-disruption constraints

The question we address in this section is why a constraint would simultaneously target a feature value in one set of positions and the opposite feature value in the complement set of positions. The strategy of changing feature values from one set of positions to its complement set, we suggest, is useful for delimiting prosodic units. If a segment's phonetic realisation is predictable from its prosodic position, or *vice versa*, it is possible to identify prosodic units through phonetic properties.

Several researchers, in fact, have proposed that (continuity) lenition fulfills precisely such a demarcative function. Harris (2003, cf. Harris & Urua 2001) proposes that what makes lenition special is that it decreases the amount of information present internal to prosodic constituents, and increases the amount of information at their boundaries, thus rendering those boundaries more salient. In his view, this information loss is implemented by making consonants more similar to the 'carrier signal', which is essentially an unobstructed vocal tract; in other words, lenition makes consonants less distinct from the vowels around them. Harris' proposal also treats consonantal contrasts as a kind of information. Based on patterns of stem-initial contrast preservation in Ibibio, he claims that lenition tends to make fewer contrasts available internal to prosodic domains. Although the view advanced in the current paper has a lot in common with Harris', we disagree with this last point: typological surveys show that continuity lenition is extremely unlikely to neutralise consonantal contrasts. The stem-initiality patterns of Ibibio and other West African languages are discussed in section 4.

Kingston (2008) fleshes the demarcation idea out in terms of perception, in a way that has more in common with our formulation: lenition processes tend to preserve the auditory continuity of the speech stream domain-medially, by making consonants more like the vowels that surround them in terms of intensity. Conversely, fortition tends to disrupt continuity domain-initially, by making consonants less like surrounding sounds in terms of intensity. Note that the continuity idea bears some conceptual similarity to the proposal that intervocalic lenition is the spreading of features from vowels to adjacent consonants (e.g. Mascaró 1984, Lombardi 1991), but differs crucially in explaining which phonetic properties spread and why. The general idea of a demarcative function for 'strengthening' is also mentioned in work by Keating and various colleagues (see Keating 2006 for a review).

In this approach, continuity lenition is fundamentally about helping the listener distinguish between the presence and absence of a prosodic boundary. As such, it makes sense for the constraints that drive lenition to refer to both boundary-marking and non-boundary-marking positions. In general, we can think of these constraints as calling for the degree of auditory disruption at any point in the speech stream to match the degree of prosodic juncture at that point. A more specific way of implementing this general hypothesis is illustrated by the constraint schema in (11):

(11) BOUNDARY-DISRUPTION (I, D, P): Intensity drops to amount *I* or lower for at least duration *D at and only at* a prosodic boundary of level *P*.

The constraint has three free parameters. The *P* parameter is meant to deal with the scalar nature of prosodic boundaries in triggering lenition and fortition: if a boundary at some level triggers fortition, then all higher-level boundaries do as well; if lenition applies across a boundary at some level, then it applies across all lower levels. This is captured by the following entailments: (1) disruption reaches *D* at a *P*-level boundary, so it necessarily does so at higher level boundaries, which are also *P*-level boundaries; and (2) disruption reaches *D* only at *P*-level boundaries, failing to do so internal to *P*-level constituents, so it necessarily fails to do so in positions internal to lower-level constituents, which are also internal to *P*-level constituents.

The *I* and *D* parameters are meant to suggest the perceptual grounding of the constraints. We do not have a complete, experimentally-tested theory of what makes a consonant disruptive to a stream of vowels. But two phonetic properties that necessarily contribute to disruption, intensity and duration, will suffice to derive many of the lenition patterns discussed here. (12) shows our assumptions about the relative disruption associated with various consonant classes, based on gross characteristics of their intensity and duration. This is not meant to be a detailed quantitative model, and as such levels for each of the phonetic parameters are given in arbitrary small-integer units. The only crucial assumptions embedded in this toy model are the ones concerning relative properties. For instance, while it is important for the theory that voiced stops have shorter durations than voiceless ones, it is not important at all that the former are assigned duration 2 and the latter duration 3. In what follows: T = voiceless stop; D = voiced stop; S = voiceless continuant; Z = voiced continuant; R = tap; J = glide.

(12) Disruption indices for major consonant classes

Class	Intensity	Duration
T	1	3
S	2	3
D	3	2
Z	4	2
R	5	1
J	6	2

As an example, the constraint BD(1,3,Wd) assigns one mark for every decrease in intensity to level 1 or lower for at least duration 3 that fails to be adjacent to a word boundary; and one mark for every word boundary that fails to be adjacent to such a drop.

There are some complications with the notion 'intensity of a segment' that we will not settle here, but are worth calling attention to. Although the periodic component of voiced sounds adds intensity to them, the aperiodic components of these sounds are generally *less* intense than their voiceless counterparts. It may be that the relevant notion of intensity here is weighted towards the low end of the frequency spectrum. We leave this open as a possibility, but simply do not have the kind of phonetic data that would provide reliable evidence for such a hypothesis. Note that this hypothesis would help explain why sibilant fricatives are particularly rare as the output of spirantisation (Kirchner 1998): while they are generally more intense than other fricatives, that intensity pertains to very high frequency bands.

A further difficulty is that the intensity of a segment changes during the course of its articulation. This is most obvious for stops, but plausibly is true for other segments as well. We take the position here that something like the *average* intensity over the length of a segment is what is relevant to these constraints. A more principled way of dealing with stops would be to break them down into their component parts, so that a voiceless stop might be characterised as a period of 0 intensity for 2 units of time (closure) and then a period of intensity 2 for 1 unit of time (burst), for instance. This approach is more complex than necessary for the following analyses, so we do not pursue it here.

Different values of *I*, *D*, and *P* define a stringency hierarchy (DeLacy 2002): violation of some BD constraints by a given segment in a given position will entail violations of other BD constraints. The idea is that if a BD constraint marks some segment as too disruptive internal to a constituent, then it marks all more disruptive segments as well; the same is true, *mutatis mutandis*, for constituent edges. Examples are shown in (13). Here and in other cases where duration is not directly at issue, we set the *D* parameter to 0. This means that any drop to level *I* for any duration at a boundary will satisfy the constraint, and any such drop for any duration medially will violate the constraint. The *D* parameter will not figure prominently in the analysis of Spanish, but becomes crucial in the analysis of Chungli Ao.

(13) The stringency hierarchy for BD constraints

(a) domain-medial

Constraint violations	BD(1,0,Wd)	BD(2,0,Wd)	BD(3,0,Wd)	BD(4,0,Wd)
VTV	*	*	*	*
VSV	√	*	*	*
VDV	√	√	*	*
VZV	√	√	√	*

(b) domain-initial

Constraint violations	BD(1,0,Wd)	BD(2,0,Wd)	BD(3,0,Wd)	BD(4,0,Wd)
[TV	√	√	√	√
[SV	*	√	√	√
[DV	*	*	√	√
[ZV	*	*	*	√

In (13), strings of segments are shown on the left. Their violations of various BD constraints are shown in the following columns. The constraint BD(2,0,Wd), for instance, sets an intensity threshold of 2 or lower that should only appear at a word boundary. Consonants such as voiceless obstruents that are at that threshold or lower and do not appear at word boundaries, as in (13a), violate the constraint. The constraint also sets an intensity threshold of 2 or lower that *must* occur at word boundaries. Consonants such as voiced obstruents that exceed the threshold and appear at word boundaries, as in (13b), also violate the constraint.

A few further properties of the analyses that follow are worth outlining here. We take the general stance associated with OT that active alternations and 'static' distributional restrictions in the lexicon are driven by the same constraints. As such, we consider distributional restrictions to be as much an instance of lenition as alternations are. Our analyses here are subject to the general OT requirement known as Richness of the Base: phonological generalisations result from constraints, not from properties of the lexicon. This means that the proposed analyses should derive patterns of allophony in the output regardless of how the relevant features are configured in the input. In practical terms, this means that we present analyses of possible (though never realised) contrasting forms in every context in what follows. While this does entail an unfortunate abundance of tableaux in the text, it is an absolute necessity for an OT analysis to be explanatory in any way. Finally, we often include one or more inactive (low ranked) BD constraints in tableaux. These are not crucial for the analyses, and can be safely ignored if the reader wishes. We include them to illustrate how the stringency hierarchy works and to stand in for the full set of inactive BD constraints.

With the BD constraint family in place, we turn to some analyses of the continuity lenition patterns presented in section 2.1. These patterns are very much the norm in cross-linguistic surveys. In section 4, we consider exceptional patterns of neutralising lenition and fortition.

2.4 Continuity lenition in Spanish

Analysing Spanish will require one crucially active BD constraint, and we include several more inactive ones for illustrative purposes:

(14) BD(3,0,Phr): Intensity drops to 3 or lower for some duration *at and only at* a phonological phrase boundary.
BD(4,0,Phr): Intensity drops to 4 or lower for some duration *at and only at* a phonological phrase boundary.
BD(1,0,Phr), BD(2,0,Phr)…

One basic aspect of Spanish spirantisation is that singleton voiced stops in phrase-initial position are in complementary distribution with continuants in medial positions; voiceless obstruents, on the other hand, contrast for continuancy in all positions. These facts are analyzed as in (15), continuing to treat the lenis realisations as voiced fricatives. This analysis is a good illustration of some of the formal properties of this approach. Lenited voiced segments in initial position and unlenited voiced segments in medial position violate BD(3,0,Phr), which is high-ranked in Spanish. Candidates with initial voiced continuants violate the constraint because phrase-initial boundaries are not aligned with a drop in intensity to 3 or lower. Medial stops violate it because they entail a drop in intensity to 3 that is not aligned with a phrase boundary. These violations of a high-ranked markedness constraint compel violations of faithfulness to continuancy. The result is allophonic continuancy, as in (15a).

(15) Spanish spirantisation targeting voiced obstruents

(a) Voiced stops and continuants in complementary distribution

gol	BD(3,0,Phr)	ID[cont]	BD(4,0,Phr)
ɣol	*!	*	
☞gol			

lago	BD(3,0,Phr)	ID[cont]	BD(4,0,Phr)
lago	*!		*
☞laɣo		*	*

ɣol	BD(3,0,Phr)	ID[cont]	BD(4,0,Phr)
ɣol	*!		
☞gol		*	

laɣo	BD(3,0,Phr)	ID[cont]	BD(4,0,Phr)
lago	*!	*	*
☞laɣo			*

(b) Voiceless stops and fricatives in contrast

fila	IDENT[voi]	BD(3,0,Phr)	IDENT[cont]	BD(1,0,Phr)	BD(2,0,Phr)	BD(4,0,Phr)
pila			*!			
☞fila				*		
βila	*!	*		*	*	

pila	IDENT[voi]	BD(3,0,Phr)	IDENT[cont]	BD(1,0,Phr)	BD(2,0,Phr)	BD(4,0,Phr)
☞pila						
fila			*!	*		
βila	*!	*	*	*	*	

hefe	IDENT[voi]	BD(3,0,Phr)	IDENT[cont]	BD(1,0,Phr)	BD(2,0,Phr)	BD(4,0,Phr)
hepe		*	*!	*	*	*
☞hefe		*			*	*
heβe	*!					*

mapa	IDENT[voi]	BD(3,0,Phr)	IDENT[cont]	BD(1,0,Phr)	BD(2,0,Phr)	BD(4,0,Phr)
☞mapa		*		*	*	*
mafa		*	*!		*	*
maβa	*!		*			*

Leniting a voiceless stop, on the other hand, provides ‘diminishing returns’: it is not enough to satisfy the highest ranked BD constraint unless voicing is also altered, as in (15b). In Spanish, lenition constraints are not high-ranked enough to compel changes in voicing; in other languages this ranking differs. Another way of describing this pattern is that voiceless stops are subject to more pressure to lenite than voiced stops are because they violate more BD constraints, but they are also subject to more pressure from lenition blocking because more features would need to change in order to satisfy certain BD constraints. In the current theory, then, there is no implicational asymmetry between lenition of voiced stops and lenition of voiceless ones. Either class can lenite independently of the other, or they can both lenite.

High-ranked BD(3,0,Phr) also predicts lenition in medial clusters regardless of their underlying continuancy, as in (16). Here, the only way to avoid a drop in intensity to level 3 that isn't aligned with a phrase boundary is to lenite both stops. Given the ranking of BD(3,0,Phr) above faithfulness to continuancy, this is the optimal outcome.

(16) Cluster lenition

subdito	BD(3,0,Phr)	ID[cont]	BD(4,0,Phr)
subdito	*!		*
suβdito	*!	*	*
subðito	*!	*	*
☞suβðito		**	*

subðito	BD(3,0,Phr)	ID[cont]	BD(4,0,Phr)
subdito	*!	*	*
suβdito	*!	**	*
subðito	*!		*
☞suβðito		*	*

suβðito	BD(3,0,Phr)	ID[cont]	BD(4,0,Phr)
subdito	*!	**	*
suβdito	*!	*	*
subðito	*!	*	*
☞suβðito			*

Recall that Spanish spirantisation displays somewhat complex blocking effects. Voiced stops fail to spirantise following nasals and /d/ fails to spirantise following /l/. Following Bakovic (1995) and Kingston (2008), we propose that this pattern is not related to lenition *per se*, but is an instance of the typologically frequent post-nasal hardening phenomenon. One influential analysis is that this pattern optimises for articulatory efficiency: homorganic ND clusters are less marked than NZ because ND can share a single closure gesture (Steriade 1993, Padgett 1994). This analysis is independently motivated by the typology of contour segments and place assimilation. It is less standard to extend this analysis to /ld/ and /lð/ clusters, but we believe there are good reasons to do so. There is no reason why the complete tongue-tip closure in /l/ cannot be shared with a following stop.[3] Crucially, this is not the case in /ɾd/ clusters: /ɾ/ is a 'ballistic' gesture that lacks a sustained closure, unlike /l/, and correspondingly lenition is not blocked in /ɾd/ clusters. To prevent other post-/l/ consonants from assimilating to /l/ as /d/ does, we require a high-ranked constraint preserving major place features in prevocalic position.

A second principle necessary for analyzing these blocking phenomena is that nasalised continuants are marked. Again, there is independent evidence for this from phonetics and phonology. Nasalised continuants create aerodynamic (Cohn 1993) and perceptual (Shosted 2006) difficulties; and the typology of inventories reflects this markedness (Padgett 1994). Finally, we rule out the possibility of /l/ assimilating to a following continuant (and thus sharing a constriction gesture) by appealing to a constraint against geminates, which are absent in Spanish (although rhotics are sometimes analyzed as contrasting for geminacy). (17) shows the constraints we use to encode these principles and the analysis of constriction sharing.

[3] John Kingston notes that the /ld/ cluster involves only a change from open tongue sides to closed at some point during the cluster, while the /lð/ cluster involves a change from open tongue sides to closed *and* from tongue-tip closure to opening. On this proposal, the distinction is not between sharing a constriction and failing to do so, but between fewer articulatory adjustments and more. We leave this as an open question.

(17) Post-/n/ and -/l/ contexts create exceptions

AGREE(Constriction): Assign a mark to each pair of adjacent consonants that fails to share a single constriction gesture.
*s̃: assign a mark to each nasal continuant.
*GEM: Assign a mark to each geminate.
IDENT(Place)/__V: Assign a mark to each prevocalic output segment whose major place features differ from its input correspondent.

un + ðia	*s̃	AGR(Constr)	MAX	BD(3,0,Phr)	IDENT[cont]
unðia		*!			
☞undia				*	*
uððia	*!				*
uðia			*!		

un + dia	*s̃	AGR(Constr)	MAX	BD(3,0,Phr)	IDENT[cont]
unðia		*!			*
☞undia				*	
uððia	*!				*
uðia			*!		*

el + ðia	*GEM	AGR(Constr)	MAX	BD(3,0,Phr)	IDENT[cont]
elðia		*!			
☞eldia				*	*
eððia	*!				*
eðia			*!		

el + dia	*GEM	AGR(Constr)	MAX	BD(3,0,Phr)	IDENT[cont]
elðia		*!			*
☞eldia				*	
eððia	*!				*
eðia			*!		*

el + beso	*GEM	IDENT[place]/__V	AGR(Constr)	BD(3,0,Phr)	IDENT[cont]
☞elβeso			*		*
elbeso			*	*!	
eββeso	*!				*
eldeso		*!			

Outputs that fail to share a constriction gesture across the cluster are ruled out by the agreement constraint. Amongst the possible constriction-sharing candidates, nasal-stop clusters are preferred because geminates or nasal-contour fricatives are subject to high-ranked markedness constraints; these rankings are independently necessary to explain the absence of these segments elsewhere in the language. For non-coronal segments following /l/, progressive place assimilation is ruled out by a constraint preserving major place features in prevocalic position, where they are especially well-cued. Finally, alternative repair strategies such as deletion are ruled out by faithfulness constraints that outrank faithfulness to continuancy.

A final point of interest concerns domain-final voiced obstruents. The BD constraints call for them to be realised with maximum disruption, to better demarcate domains. This predicts that final consonants ought to be realised the same way as initial ones. This is not the case, however, in Spanish: these sounds are different from both initial and medial consonants. They are traditionally transcribed as continuants in phonological descriptions, but they differ from the continuants that occur medially in several phonetic characteristics. In our materials, final voiced obstruents are realised as unreleased stops or possibly very short continuants; note that it is rather difficult to make a principled distinction between a non-strident continuant that lasts 20-40 ms. and is followed by silence, on the one hand, and the gradual offset of voicing into a stop closure on the other. Their extremely short duration and consequent rapid fall in intensity (as well as, phrase-finally preceding a vowel, their glottalization) clearly set them apart from phrase-medial voiced obstruents, which tend to be 50-100 ms. in duration in these materials. So we believe that it is inaccurate to describe these segments as being like medial ones. They also, however, are different from initial stops, which are clearly released.

We propose here that *silence* is the crucial part of a final obstruent: the most disruptive event in a stream of sonorous sounds is the complete cessation of energy, and non-release with or without glottalisation will achieve this goal. We encode this in the grammar with a constraint, BD(0,0,Phr) that favors complete cessation of energy for some duration at a prosodic boundary. By hypothesis, faithfulness to stop release is not included in grammar (otherwise we would find languages with contrastive stop release, which do not appear to exist); as such, the release properties of these stops are entirely dictated by markedness constraints, here BD(0,0,Phr). This is illustrated in (18).

(18) Domain-final obstruents in Spanish

BD(0,0,Phr): Intensity drops to 0 for some duration *at and only at* a phrase boundary.

sjuðad	BD(3,0,Phr)	Ident[cont]	B-D(4,0,Phr)	B-D(0,0,Phr)
sjuðad				*!
☞ sjuðad˺				
sjuðað	*!	*		*

sjuðað	BD(3,0,Phr)	Ident[cont]	B-D(4,0,Phr)	B-D(0,0,Phr)
sjuðad		*		*!
☞ sjuðad˺		*		
sjuðað	*!			*

sjuðad˺	BD(3,0,Phr)	Ident[cont]	B-D(4,0,Phr)	B-D(0,0,Phr)
sjuðad				*!
☞ sjuðad˺				
sjuðað	*!	*		*

Note that we could equally well satisfy BD(0,0,Phr) by inserting a period of silence after a continuant. It is possible that this is what is happening in other dialects of Spanish that are transcribed with prepausal continuants. In those cases, prosodic demarcation may be served by a pause, with or without concomitant shortening of the continuant; if so, BD constraints will not favor any candidate over another, and the outcome will be dictated by low-ranked markedness constraints, perhaps those militating against voiced stops. In the absence of definitive phonetic evidence that such dialects exist, we simply leave it as a possibility.

The overall pattern that emerges here is that continuancy in voiced segments is allophonic and dictated by peripherality (initial or final) or non-peripherality within a phonological phrase. More complex patterns derive from blocking of the otherwise favored medial outputs by independently motivated factors such as post-nasal hardening and the avoidance of geminates. The most important aspect of the analysis from the perspective of this paper is that ranking the constraint BD(3,0,Phr) over faithfulness to continuancy predicts that continuancy for the affected segments can only be allophonic: if the preference for outputs that satisfy BD(3,0,Phr) prevails in one position, it will prevail in all positions.

2.5 Continuity lenition in Chungli Ao

Voicing lenition can in principle be analyzed in several different ways in the BD framework. Voicing adds some intensity to the signal, although the difference between voiced and voiceless stops or fricatives in this regard is probably not as large as that between, for instance, voiced stops and approximants (as in Spanish). The noise portion of voiceless obstruents is generally *more* intense than voiced ones. Voiced and voiceless medial stops, however, also generally display a large difference in duration: voiceless stops have much longer closures in intervocalic position (Lisker 1957). Because stops are inherently disruptive in the middle of a stream of vowels, it may be that minimising the duration of this disruption is a driving force behind 'voicing' lenition (cf. Lavoie 2001), with voicing itself being a secondary consequence of shortening: achieving voicelessness between two vowels requires a change in glottal state, which may be difficult to execute in a very short time. Extremely short stops may also be more likely to lack a full closure due to undershoot, which would render them even less disruptive.

Although either voicing or duration is a possible driver of lenition in the current approach, we will pursue the duration approach here, because we feel it nicely captures the relationship between voicing and duration and because we suspect that duration matters more than voicing for the relevant notion of 'disruption'. This means that we will need to use the *D* parameter of the BD constraints to analyse voicing lenition. The disruption indices for consonant classes and a stringency hierarchy involving the *D* parameter are shown in (19):

(19)

(a) Disruption indices for major consonant classes

Class	**Intensity**	**Duration**
T	1	3
S	2	3
D	3	2
Z	4	2
R	5	1
J	6	2

(b) Domain-medial stringency hierarchy for BD constraints, *D* parameter

Constraint violations	BD(6,1,Wd)	BD(6,2,Wd)	BD(6,3,Wd)	BD(6,4,Wd)
VTV	*	*	*	√
VSV	*	*	*	√
VDV	*	*	√	√
VZV	*	*	√	√
VRV	*	√	√	√

(c) Domain-initial

Constraint violations	BD(6,1,Wd)	BD(6,2,Wd)	BD(6,3,Wd)	BD(6,4,Wd)
[TV	√	√	√	*
[SV	√	√	√	*
[DV	√	√	*	*
[ZV	√	√	*	*
[RV	√	*	*	*

In this example, we set *I* to a fairly high level, 6 (associated with a glide). Segments of lesser intensity violate these constraints word-medially if they last as long as *D.* For instance, BD(6,3,Wd) is violated by voiceless obstruents (with duration 3) but not voiced obstruents (with duration 2) or taps (with duration 1). This is because voiceless obstruents entail a drop to intensity lower than 6 for a duration of at least 3 that is not aligned with a word boundary. Voiced obstruents entail a drop below 6 that is not aligned with a word boundary, but that drop does not last at least duration 3, so the constraint is not violated. Similarly, in word-initial position, voiceless obstruents satisfy BD(6,3,Wd) because they align the word boundary with a drop below intensity 6 for at least duration 3; voiced obstruents violate the constraint because the drop below intensity 6 that they align with the word boundary does not last for duration 3.

These constraints can drive the type of lenition seen in the Chungli Ao data in (10). In that data, voiceless stops in word-initial position and obstruent clusters are in complementary distribution with voiced stops medially. Analyzing that data also requires faithfulness constraints and a constraint penalising voiced obstruents, *D. The analysis is shown in (20):

(20) Voicing lenition in Chungli Ao

*D: Assign one mark to every voiced obstruent in the output.

(a) Voiceless stops initially

ka	BD(3,3,Wd)	*D	IDENT[voi]	BD(3,2,Wd)
☞ ka				
ga	*!	*	*	

ga	BD(3,3,Wd)	*D	IDENT[voi]	BD(3,2,Wd)
☞ ka			*	
ga	*!	*		

(b) Voiced intervocalically

aka	BD(3,3,Wd)	*D	IDENT[voi]	BD(3,2,Wd)
aka	*!			*
☞ aga		*	*	*

aga	BD(3,3,Wd)	*D	IDENT[voi]	BD(3,2,Wd)
aka	*!		*	*
☞ aga		*		*

(c) Voiced adjacent to [+son] consonants

lɔŋki	BD(3,3,Wd)	*D	IDENT[voi]	BD(3,2,Wd)
lɔŋki	*!			*
☞ lɔŋgi		*	*	*

lɔŋgi	BD(3,3,Wd)	*D	IDENT[voi]	BD(3,2,Wd)
lɔŋki	*!		*	*
☞ lɔŋgi		*		*

The constraint BD(3,3,Wd) penalises initial voiced stops for, in essence, not being long enough (less than duration 3) and punishes medial voiceless stops for being too long (duration 3), whether flanked by vowels (20b) or sonorants (20c). In the case of nasal-stop clusters, it may well be the case that the stop portion is substantially shorter than it would be in a singleton. This is not problematic for the analysis unless the voiceless stop shortens to a duration less than that of a voiced singleton (2, in this example). In that case, an independent constraint would be needed to enforce post-nasal voicing, perhaps along the lines of Pater's (1999) *NT.

Similar to Spanish, the occurence of final stops without audible release is due to BD(0,0,Wd), as seen in (21). Note that this analysis requires us to judge the duration of final unreleased stops. We assume that the listener, in the absence of any good way to judge the duration of such segments, attributes all the silence she hears at the end of a word or phrase to the stop closure. This would not apply to released stops, where the silence has a clear ending.

(21) Final non-release

sak	BD(3,3,Wd)	*D	IDENT[voi]	BD(3,2,Wd)	BD(0,0,Wd)
sak					*!
sag	*!	*	*		
☞ sak˺					

sag	BD(3,3,Wd)	*D	IDENT[voi]	BD(3,2,Wd)	BD(0,0,Wd)
sak			*		*!
sag	*!	*			
☞ sak˺			*		

The duration-based formulation of the high-ranked BD constraint also helps explain the behavior of medial clusters of obstruents, which surface as voiceless, as in (22). The basic insight here is that, as a sequence of consonants gets longer, sustaining voicing through that sequence will generate diminishing returns in terms of auditory continuity. Sequences of obstruents thus devoice because they are too long to really be 'helped' much by voicing. BD(3,3,Wd) penalises a sequence of two stops for being long, whether or not it is voiced, because any sequence of two stops will involve a decrease in intensity to level 3 or lower for at least the duration 3.

(22) Voicing blocked in clusters

jakta	BD(3,3,Wd)	*D	IDENT[voi]	BD(3,2,Wd)
☞ jakta	*			*
jagda	*	**!	**	*
jagta	*	*!	*	*
jakda	*	*!	*	*

jagda	BD(3,3,Wd)	*D	IDENT[voi]	BD(3,2,Wd)
☞ jakta	*		**	*
jagda	*	**!		*
jagta	*	*!	*	*
jakda	*	*!	*	*

jagta	BD(3,3,Wd)	*D	IDENT[voi]	BD(3,2,Wd)
☞ jakta	*		*	*
jagda	*	**!	*	*
jagta	*	*!		*
jakda	*	*!	**	*

2.6 A note on nasalisation lenition

As noted in section 1.2, we are not aware of any lenition processes that turn non-nasal consonants into nasals. This may seem surprising, as nasals are more intense than obstruents. They should thus better satisfy BD constraints medially, and be possible as lenition outputs. Note that this problem is similar to the 'too-many-repairs' one noted by Steriade (2009): final voiced obstruents are frequently avoided by devoicing but rarely or never by nasalisation, despite the fact that nasalisation would avoid the aerodynamic difficulty associated with voiced obstruents.

We propose here, also parallel to Steriade's (2009) suggestion, that nasalisation lenition doesn't occur because it involves perceptually larger feature changes than approximantisation while yielding less intense (more marked medially) outputs. For instance, lenition of /b/ to approximant /β/, as in Spanish and Kinande, will always be preferred to lenition of /b/ to /m/. This is because the approximant better satisfies BD constraints, and requires less of a perceptual change to the input /b/ segment. In terms of Steriade's P-map proposal, we would say that faithfulness to the feature separating /b/ and /β/, say [+approx], is always ranked lower than faithfulness to nasality, because changes in nasality are particularly perceptually salient. This predicts that, whenever a markedness constraint can be satisfied by either changing approximancy or changing nasality, approximancy will be preferred. The result, as shown in (23), is that spirantisation to an approximant is always preferred to nasalisation. For the purposes of this illustration, we assume that approximant β has intensity 5 and nasals have intensity 4.

(23) Blocking of nasalisation lenition

sab	BD(3,0,Wd)	IDENT[nas]	IDENT[approx]	BD(4,0,Wd)	BD(5,0,Wd)
sab	*!			*	*
saβ			*		*
☞ sam		*!		*	*

3 Loss lenition

Loss lenition is a descriptive label we use here to refer to processes that have been called lenitions in the literature, but are not 'special' in the ways that continuity lenition is. If we are correct, these phenomena are in a sense less interesting than continuity lenition, because they behave a lot like other phonological phenomena and they pose no particular challenge to existing phonological frameworks. We do, however, give an overview and a sketch of an analysis, in part to draw a contrast with continuity lenition.

The phenomenon of <u>debuccalisation</u>, where a consonant loses its supralaryngeal features, is illustrated by the data from Arbore in (24).

(24) Debuccalisation in Arbore (Harris 1990)

Unit reference	Multiple reference	Gloss
ɲaluɓ	ɲaluʔme	'afterbirth'
ɗossok'	ɗossoʔme	'blister'

Perfect affirmative

1sg	2sg	
ɲaaɓe	ɲaaʔte	'fight'
hiik'e	hiiʔte	'grind'

Ejectives and implosives neutralise to glottal stop before consonants, but not word-finally nor before vowels. In languages such as Slavey (Rice 1989), debuccalisation (and frication) of consonants extends to both pre-consonantal and word-final, but not pre-vocalic, positions. Kirchner (1998), Lavoie (2001), and Gurevich (2003) summarise several more cases of both types of debuccalisation.

A second type of loss lenition is <u>degemination</u>, when a long consonant becomes short. This is illustrated with the Polish data in (25). The forms in the first and last column of (25a) show that geminates contrast with singletons between vowels; the case alternations show that the contrast is neutralised to singleton domain-finally. The word-formation processes in (25b) show that the contrast also neutralises preceding or following a consonant. This prohibition results in both degemination (as in the last example) and blocking of junctural 'fake' geminates (as in the other examples), which are otherwise allowed in Polish (see the first form in (25b)).

(25) Polish geminates and degemination (Rubach & Booij 1990, Pajak to appear)

(a)	*Nominative*	*Genitive*	*Gloss*	*V_V singleton*
	fontan̠ːɨ	fontan̠	'fountains'	mekan̠ism 'mechanism'
	las̠ːa	las̠	'lassoes'	kos̠iç 'mow'
	flotɨl̠ːɛ	flotɨl̠	'fleets'	alkohol̠ovɨ 'alcoholic'

(b)		
	/sɛn-nɨ/ → [sɛn̠ːɨ]	'sleepy'
	/pʲɛ̃kn-nɨ/ → [pʲɛ̃kn̠ɨ]	'beautiful'
	prefix-/kupn-nɨ/ → [pʂ̥ɛkupn̠ɨ]	'corrupt (purchase-ful)'
	/frant͡sus-ski/ → [frant͡sus̠ki]	'French'
	/lozaɲː-ski/ → [lozaɲ̠ski]	'Lausanne-ian'

Note that geminates are marginally possible word-initially in Polish: there are four monomorphemic words that begin with geminate obstruents, and word-initial geminate fricatives can be formed from fricative prefixes (Pajak to appear). A more robust pattern of geminates licensed in intervocalic and word-initial positions occurs in Ganda (Clements 1986). Hungarian (Côté 2004, Pycha 2010) and Maltese (Hume *et al*. 2010) also allow geminacy contrasts between vowels while neutralising them adjacent to consonants, but these languages allow the contrast in word-final position while disallowing them in word-initial position. Dmitrieva (2012) and Pajak (to appear) offer more examples and details on the cross-linguistic distribution of geminates.

The examples above are meant to illustrate several cross-linguistic generalisations about debuccalisation and degemination. Both processes may result in the positional neutralisation of contrasts that appear in other positions in a language. When neutralisation does occur, it reflects a *positional scale*: neutralisation in some positions entails neutralisation in other positions. For debuccalisation, the scale can be stated, from least likely to neutralise to most likely, as: *pre-vocalic < word-final < pre-consonantal*. The scale for degemination is similar but not identical: *intervocalic < word-edge (vowel-adjacent) < consonant-adjacent*. Loss lenition processes thus involve positional constraints. Debuccalisation targets place features in classically 'weak' positions such as syllable codas; it is a case of non-assimilatory place and voice neutralisation. Degemination, while it targets different environments (non-intervocalic, in particular), can also be analysed as a case of positional neutralisation.

There are many ways of analysing positional neutralisation. Some theories posit neutralisation pressures that target segments in weak positions; this includes the Coda Condition (Ito 1986), which can also be construed as positional markedness constraints in OT (Lombardi 2001); deletion of phonological primes (privative features) in governed or unlicensed positions (Ségéral & Scheer 1999); and pressure to neutralise contrasts that are perceptually weak (Flemming

1995). Positional faithfulness (Beckman 1998) and its phonetically-driven cousin the P-map (Steriade 2001), on the other hand, posit pressure against neutralisation that singles out strong positions. Some theories disagree on how to characterise 'strong' and 'weak' positions: they may pertain to syllable structure, empty nuclei, or the availability of cues to phonological contrasts. In what follows, we adopt the P-map approach, but most of the theories mentioned above would make similar predictions about the loss lenition phenomena discussed here.

In any theory of positional faithfulness, faithfulness constraints militate against changing (including adding or deleting) phonological material; different constraints militate against changes in different positions. The example we analyse here involves IDENT(F) constraints, which penalise changes to the underlying value of some feature *F*.[4] Positional neutralisation occurs when a markedness constraint militating against the occurrence of *F* is ranked above faithfulness to *F* in one position but below faithfulness to *F* in another position. In the P-map theory, positional faithfulness to *F* is ranked higher for positions where the contrast between different values of *F* is more perceptually distinct. For major place features, this would entail the ranking IDENT(Place) / __ [+approx] » IDENT(Place) / __ # » IDENT(Place) / __ [-approx]. This is because perceptual cues to major place in stops and nasals are more robust before more sonorous sounds. Many important cues are contained in the burst (for oral stops, if present) and especially the formant transitions to the following segment (Stevens & Blumstein 1978, Kingston 1985, Hura *et al.* 1992, Jun 1995). These cues generally outweigh the cues contained in a preceding vowel for the perception of major place (Fujimura *et al.* 1978, Ohala 1990). Major place contrasts before vowels, glides, and liquids can exploit both release cues if present and following formant transitions; word-final ones can exploit consonantal release in languages where final stops are audibly released; and pre-obstruent/nasal contrasts are unable to exploit either set of cues in the common situation where the following segment partially or fully obscures the release cues of the preceding segment (Browman & Goldstein 1990, Jun 1995).

Given the faithfulness ranking above, deriving patterns of debuccalisation is fairly straightforward. We assume a constraint *SUPRA that militates against supralaryngeal place features. This constraint could be construed as pertaining to articulatory effort, under the hypothesis that the presence of a supralaryngeal constriction is more effortful than its absence, but this interpretation is not crucial. If *SUPRA is ranked between any two faithfulness constraints, it will result in debuccalisation only in the positions referred to by the faithfulness constraints ranked below it. The Arbore pattern illustrated in (24) is thus analyzed as in (26). In these tableaux, we only depict *relevant* violations of *SUPRA, glottalised oral stops in this case.

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[4] In fact, although we treat debuccalisation as a feature change here for expository ease, this is not a standard treatment in the literature. A more common characterization would be deletion of supralaryngeal features. Whatever the correct theory of the representation of debuccalised consonants turns out to be, the faithfulness constraints here should be interpreted as penalizing changes in just those properties that distinguish them from their non-debuccalised counterparts. Nothing crucial to our analysis hinges on the idea that the differences are feature changes.

(26) Arbore debuccalisation

(a) Place contrasts word-finally and before vowels

ɲaluɓ	ID[place] / __ [+approx]	ID[place] / __ #	*SUPRA	ID[place] / __ [-approx]
☞ ɲaluɓ			*	
ɲaluʔ		*!		

ɗossok̠ʼ	ID[place] / __ [+approx]	ID[place] / __ #	*SUPRA	ID[place] / __ [-approx]
☞ ɗossok̠ʼ			**	
ɗossoʔ		*!	*	
ʔossok̠ʼ	*!		*	

(b) Neutralising debuccalisation before consonants

ɲaluɓ + me	ID[place] / __ #	*SUPRA	ID[place] / __ [-approx]
ɲaluɓme		*!	
☞ɲaluʔme			*

ɗossok̠ʼ + me	ID[place] / __ #	*SUPRA	ID[place] / __ [-approx]
ɗossok̠ʼme		**!	
☞ɗossoʔme		*	*

The final (and prevocalic) glottalised consonants in (26a) are preserved because changing them violates a high-ranked faithfulness constraint. The preconsonantal glottalised consonants in (26b) change to glottal stop because changing their place specifications only violates the faithfulness constraint ranked below the prohibition on supralaryngeal place features. If the markedness constraint is instead ranked above the word-final faithfulness constraint, we derive a pattern like Slavey, where both final and preconsonantal consonants debuccalise.

Given the fixed ranking posited for the faithfulness constraints here, there are only two other possible patterns based on these constraints. When the markedness constraint is ranked below all of the faithfulness constraints, no debuccalisation takes place in any position. When the markedness constraint is ranked above all of the faithfulness constraints, the language will have only one (obstruent) consonant: a glottal. This type of language is unattested to the best of our knowledge, and seems extraordinarily unlikely to exist. The lack of languages with a single obstruent may be due to communicative, interactive, and diachronic factors outside the domain of the grammatical constraints examined here.

The analysis of degemination in the P-map framework is broadly similar to debuccalisation. The principal difference is in the positional hierarchy of perceptibility for consonantal length contrasts, and hence the ranking of positional faithfulness constraints preserving length. We refer the interested reader to Dmitrieva (2012) and Kawahara (2011, 2012) for details.

4 Neutralising low-boost lenition

Although the allophonic patterns of continuity lenition described in section 2 constitute the vast majority of attested cases, the phonological literature does include a few processes that appear to neutralise contrasts in one position or another. In this section, we describe all such phenomena that we are aware of. A few cases are either not neutralising or not lenition. In several other cases, we will see that the lenis-fortis distinction is confounded with some other difference that is independently known to affect patterns of phonological contrast; these include prosodic prominence, affixal status, and phonological length. In perhaps the best-known case of neutralising continuity lenition, American English flapping, what is occurring is two parallel lenitions to a third, less disruptive category, an exception that is predicted by the BD formalism.

4.1 Not neutralising

Kaplan (2010) notes Gurevich's (2003) claim that spirantisation is rarely neutralising. She singles out one language from that survey as displaying spirantisation at a place of articulation where a voiced fricative is also present underlyingly: Shina spirantises voiced velar stops despite the presence of an underlying voiced velar fricative in the language. Kaplan does not claim that this is a neutralisation; we wish to reiterate that it is in fact not one. Gurevich cites Rajapurohit (1983) as claiming that the 'slightly fricativized' realisation of /g/ does not neutralise with /ɣ/. Schmidt and Kohistani (2008) also scrupulously transcribe the lenited /g/ as distinct from /ɣ/.

4.2 Not lenition

Smith (2008) cites Burmese as a language with neutralising intervocalic voicing lenition. Burmese contrasts voiced, voiceless unaspirated, and aspirated stops (the aspirated series are not relevant and are omitted below). When the second element in certain compounds begins with a voiceless stop, however, it surfaces as voiced. This is shown for /p/ and /b/ in (27).

(27) Voicing in Burmese (Okell 1969, Green 2005)

# __ V	**V __ [+son]**	**Compounds: V [__ V**
[p̲oũ] 'can'	[təp̲əna] 'shrine'	--
[b̲oum^{h}u] 'Major'	[zəb̲wɛ] 'table'	[s^{h}i-b̲oũ] 'oil can'

In the context of compounding, then, the voicing contrast licensed elsewhere in the language is neutralised by intervocalic voicing. Note that this phenomenon is nearly identical to Japanese rendaku, which has been extensively studied in the phonological literature (McCawley 1968, Vance 1980, Ito & Mester 1986). One of the more influential analyses of rendaku is that it results from a compound-linking morpheme consisting solely of the feature [+voi] (Ito & Mester 1986 *et seq.*). The motivation behind this move is in part to keep the phenomenon in question *out* of the phonology, moving it to the lexicon instead. If the rendaku and Burmese facts were limited to those shown in (27), it might be plausible to analyze them as neutralising voicing lenition with blocking in non-derived environments. Both rendaku and its Burmese equivalent, however, apply only in certain cases of compounding. Neither of them is a general characteristic of affixation or phrasal phonology, for instance. As such, it is not possible to state the environment of the phenomenon in phonological terms: it only occurs in a particular construction. This type of idiosyncrasy is, in a sense, built into the concept of a lexicon, and this is why such phenomena are better analyzed in lexical rather than phonological terms.

The Dravidian language Kannada may include a similar compound voicing phenomenon. Gurevich (2003) describes it in terms nearly identical to the above, citing an out-of-print Russian monograph (Andronov 1969). Other grammars, however, differ in their descriptions. Upadhyaya (1976) fails to mention the process at all; his transcriptions of compounds in four dialects suggest that this linking occurs irregularly and is not limited to intervocalic context when it does occur. Nayak's (2001) more thorough illustration of compounding leads to a similar conclusion, but only /k/ appears to be affected.

4.3 Other continuancy alternations

There are several processes attested that turn stops into continuants and neutralise contrasts in doing so, but do not otherwise fit the profile of continuity lenition. The most common of these is *assibilation*: affrication or frication of (mainly coronal) stops before high vowels (see Hall & Hamann 2006 for a typological overview). Indeed, one of the handful of neutralising spirantisations noted by Gurevich (2003) is assibilation in Turkana. Whether or not one chooses to characterise such patterns as lenition is largely a matter of personal taste. What is important in the context of the current paper is that, above and beyond their potential to neutralise contrasts, they differ from continuity lenition in both their characteristic environment and their functional motivation. Such processes single out contexts with following high vocoids (and other segments with high tongue positions) in particular; they are not especially likely in intervocalic position before a non-high vowel. The most influential proposal for their functional motivation is due to Ohala (1983): the high pressure buildup of a preceding stop released directly into the relatively narrow channel associated with a high tongue position causes the beginning of a following sound to be fricated. Over time, this noise component is reanalysed as part of the preceding stop or, in some cases, may even replace that stop. So while assibilation does sometimes neutralise contrasts, as in Turkana, it is not driven by the BD constraints proposed here.

Other examples of neutralising spirantisation from Gurevich's (2003) survey are not as typologically widespread, nor as clear in their functional motivations, as assibilation. These processes, however, clearly do *not* affect stops in intervocalic position. Thus, in Nez Perce, some voiceless stops become fricatives before certain consonants or at the end of a phonological word. In Lama, the contrast between /p/ and /w/ neutralises to /w/ at the end of a word. The domain-final environment of these changes suggests that they cannot be analysed with BD constraints. As such, it is not surprising that they differ from BD-driven processes in their likelihood of neutralising contrasts. Frication of coronal stops in Liverpool English may be a similar coda spirantisation process, based on Honeybone's (2001) description, but other researchers describe the contextual facts differently (e.g. Sangster 2001).

4.4 Affixal neutralising lenition

A case of neutralising lenition is described in Djapu, a variety of Yolngu (Chong 2011). In this language, certain suffixes have initial consonants which are realised as stops following obstruents and nasals, but as glides between vowels or glides. The stop and glide realisations of these morphemes are segments that contrast elsewhere in the language, as shown in (28).

(28) Djapu spirantisation (Chong 2011)

{#, V} __ V	**Affix: [+cons] __ V**	**Affix: [-cons] __ V**
/p̱aːp̱a-/ ‘father’	[waːraŋ-p̱uj] ‘dingo-assoc.’	[wapit̪i-w̱uj] ‘stingray-assoc.’
/w̱aːj̱in-/ ‘animal’	[waːjin-ḵ(u)] ‘animal-dat.’	[pumparu-w̱(u)] ‘rock-dat.’
/ḵarap̱a-/ ‘spear’	[mijalk-t̪(u)] ‘female-erg.’	[juːlŋu-j̱(u)] ‘people-erg.’
/t̪uḵun-/ ‘trash’		

Parentheses indicate variable final-vowel deletion conditioned by the prosodic shape of the stem. The stems in the left column show that stops and glides contrast freely in both initial and medial positions. Suffix-initially, however, the alternations in the second and third columns show that the contrast is neutralised to glide in between vowels or glides, stop following a nasal or stop. This is thus a case of neutralising continuity lenition (and neutralising post-stop hardening).

An important point here is that lenition is neutralising a contrast in a particular context *given certain morphological conditions*. Those morphological conditions, namely being part of an affix as opposed to a root, display pervasive interactions with the licensing of phonological contrasts cross-linguistically. The most common analysis of these facts in OT is faithfulness to the root (Beckman 1998); this analysis, crucially, is motivated on the grounds of cross-linguistic evidence that has nothing to do with lenition. The root faithfulness account can be incorporated into the BD approach introduced here along the lines of (29). Note that in polymorphemic contexts, BD constraints are only assessed for the affix-initial consonant that is directly at issue here.

(29a) Allophonic lenition and blocking in the affix

mijalk + t̪u	Ident[son]$_{Root}$	BD(5,0,Wd)	Ident[son]	BD(6,0,Wd)
☞mijalkt̪u		*		*
mijalwju	*!		**	*
mijalkju		*!	*	*
mijalwt̪u	*!	*	*	*

mijalk + ju	Ident[son]$_{Root}$	BD(5,0,Wd)	Ident[son]	BD(6,0,Wd)
☞mijalkt̪u		*	*	*
mijalwju	*!		*	*
mijalkju		*!		*
mijalwt̪u	*!	*	**	*

juːlŋu + t̪u	Ident[son]$_{Root}$	BD(5,0,Wd)	Ident[son]	BD(6,0,Wd)
juːlŋut̪u		*!		*
☞juːlŋuju			*	*

juːlŋu + ju	Ident[son]$_{Root}$	BD(5,0,Wd)	Ident[son]	BD(6,0,Wd)
juːlŋut̪u		*!	*	*
☞juːlŋuju				*

(b) Contrast in the root

t̪ukun	Ident[son]$_{Root}$	BD(5,0,Wd)	Ident[son]	BD(6,0,Wd)
jukun	*!	*	*	
☞t̪ukun				

juːlŋu	Ident[son]$_{Root}$	BD(5,0,Wd)	Ident[son]	BD(6,0,Wd)
☞juːlŋu		*		
tuːlŋu	*!		*	

The basic analysis is that Djapu displays two different systems: in the root system, stops contrast with glides everywhere, while in the affix system, the contrast is allophonically neutralised. Both systems are perfectly well-behaved from the standpoint of the BD approach.

4.4 Prominence-sensitive neutralising lenition

A number of languages display contrasts for laryngeal features or continuancy in stem-initial position that are neutralised medially. These include the paleo-Siberian isolate Nivkh (also called Gilyak, Shiraishi 2006); a number of Benue-Congo languages including Fe'fe', Koyo, Tiene (Hyman 1972, 2008, 2010, respectively), and Ibibio (Harris & Urua 2001); and some Khoisan languages (Downing 2004). The general pattern is illustrated with Fe'fe' verbal stems in (30):

(30) Fe'fe' lenition in the stem (Hyman 1972)

[ɣɑʔ] 'refuse'	[kɑʔ] 'fry'
[cɑk] 'seek'	* [cɑɣ]
[cɑɣi] 'seek him'	[cɑɣmu] 'seek the child'

The forms in the first row show that /k/ and /ɣ/ contrast in stem-initial position. The contrast for voicing and continuancy is neutralised elsewhere, described as voiceless word-finally (second row, although Hyman indicates (p.c.) that the phonetic voicing here is somewhat in question) and as voiced non-finally (third row). This pattern, then, appears to be one of neutralising medial lenition (and final devoicing). Nivkh shows a somewhat similar pattern: obstruents contrast for laryngeal specifications word-initially, but those contrasts are neutralised in other positions (31):

(31) Nivkh lenition (Shiraishi 2006)

#__	**[+son]__V**	**V_[+son]**	**V__#**
[t^{h}u] 'sledge'	[nɨjda] placename	[t^{h}ɨtŋɨs] 'roof'	[tot] 'arm'
[tu] 'lake'	[atak] 'grandfather'	[kutlix] 'from outside'	[t^{h}ɨt] 'morning'
[k^{h}eŋ] 'sun'	[p^{h}ɨŋgaj] 'cook'	[ŋɨki] 'tail'	[ɨtɨk] 'father'
[keŋ] 'whale'	[tɨlgu] 'tell a story'	[kikun] 'eagle-owl'	[hisk] 'nettle'
[fi] 'dwell'	[fulvul] 'creep'	[ɨɣrɨki] 'once'	[c^{h}xɨf] 'bear'
[vi] 'go'	[eŋvak] 'flower'	[hava] 'open (mouth)'	[tolf] 'summer'

Both stops and fricatives contrast for laryngeal features (left column), but these contrasts are neutralised in other contexts: for fricatives, voiced in between two sonorants and voiceless elsewhere; for stops, voiced following a sonorant consonant and voiceless unaspirated elsewhere. This is a case of neutralising continuity lenition: aspiration/voicing contrasts in word-initial position are neutralised by voicing or de-aspiration in all other positions.

All the languages mentioned above display a pattern with more segments licensed in stem- or word-initial position than are licensed in non-initial position. But the positional distinction is actually confounded with another factor here: phonological prominence. Nivkh is described as having fixed initial stress (Shiraishi 2006). And the Fe'fe' fortis/lenis alternations in (30) are part of a much broader pattern observed in West African languages: expanded consonantal, vocalic, and tonal contrasts in stem-initial position (see Downing 2004 for a review). This pattern is sometimes referred to as ‘accentual prominence’ and is analyzed, as the name suggests, as a type of prosodic prominence (Downing 2004, Hyman 2008).

This means that all of the examples mentioned above can be analyzed as stress- or prominence-sensitive neutralisation. Much like root vs. affix asymmetries, this pattern can be captured with independently attested positional faithfulness constraints (Beckman 1998); here, segments in prominent syllables would be protected by specific faithfulness in the domain of the prosodic head of a phonological word (or possibly some other prosodic unit). This is illustrated in (32) for Nivkh. We do not deal with the issue of stress placement here, assuming that Nivkh features an undominated constraint calling for stress at the left word edge.

(32) Prominence-sensitive contrast

fi	IDENT[voi]$_{\text{HD-PWD}}$	BD(2,0,Wd)	IDENT[voi]	BD(4,0, Wd)
☞ fi				
vî	*!	*	*	

vî	IDENT[voi]$_{\text{HD-PWD}}$	BD(2,0,Wd)	IDENT[voi]	BD(4,0, Wd)
fi	*!		*	
☞ vî		*		

fúlful	IDENT[voi]$_{\text{HD-PWD}}$	BD(2,0,Wd)	IDENT[voi]	BD(4,0, Wd)
fúlful		*!		*
☞ fúlvul			*	*

fúlvul	IDENT[voi]$_{\text{HD-PWD}}$	BD(2,0,Wd)	IDENT[voi]	BD(4,0, Wd)
fúlful		*!	*	*
☞ fúlvul				*

It is thus possible to give an account of Nivkh lenition in terms of stress, which is all that is required in order for the language to be analysable in the BD framework. A stronger argument would be that the prominence-based account is *better* than its initiality-based counterpart. We know of no arguments either way for Nivkh. For the African languages mentioned above, however, there is such an argument. Voicing and continuancy neutralisations are one small part of a pervasive pattern of non-stem-initial neutralisation in these languages (Downing 2004, Hyman 2008). Even in languages such as Basaa (Hyman 2008), where the voicing and continuancy alternations are allophonic rather than neutralising,[5] other contrasts such as tone,

[5] Hyman (p.c.) objects to the use of ‘allophonic’ to describe these alternations, preferring ‘demarcative’, because they have no obvious phonetic conditioning. I keep my terminology, but wish to accurately represent his views.

vowel quality, and place of assimilation are still neutralised in non-stem-initial position. If the voicing and continuancy alternations in such languages are driven by neutralising lenition constraints, they must be analyzed as entirely independent from the other effects of stem-initiality. Because features like vowel quality, tone, and place of articulation are not targeted in continuity lenition, they would have to be neutralising under the influence of entirely different constraints than voicing and continuancy. The fact that these other features cluster with neutralising lenition across several languages can thus only be seen as a coincidence. Under the prominence analysis, these facts are given a unified explanation: contrasts surface at the beginning of the stem because its prosodic prominence drives special faithfulness. This is in fact a version of the argument advanced by Downing (2004) in her review of the phenomenon.

4.5 Length-as-voicing lenition

Butcher (2004) describes a group of non-Pama-Nyungan languages that display what is often called a *fortis-lenis* contrast for medial stops; he notes that it is sometimes also described as *voiced-voiceless*, *short-long*, or *singleton-geminate*. The language he investigates is Burarra, whose stop distinction is described by Glasgow (1981) as in (33); we ignore allophonic variation in the realisation of schwa here, which is irrelevant to the phenomena under consideration.

(33) Burarra stop contrasts (Glasgow 1981)

V __ V	**[+son] __ V**	**# __ V**
[kɔ**p**ə] ‘keep for self’	[wuɽ**p**ə] ‘sum total’	[**p**alə] ‘house’
[kɔ**b**ə] ‘magpie goose’	[wɔɽ**b**ə] ‘work sorcery on’	--
[pu**k**ulə] ‘forehead’	[mɪŋ**k**ə] ‘sandfly’	[**k**algʊ] ‘flying fox’
[pu**g**ulə] ‘water’	[ɖɪŋ**g**ə] ‘pandanus nut’	--

Two series of stops contrast between vowels (left column) and sonorants (middle column); the contrast is neutralised to the voiceless series word initially (right column). As transcribed here, this is a perfect example of neutralising fortition. This would be an unusual pattern for voicing neutralisation, which tends to target consonants in non-prevocalic position; as a pattern of length neutralisation, however, it would be completely typical. And in fact there is evidence that the relevant phonetic distinction here is duration rather than voicing. Butcher (2004) describes VOT in Burarra and related languages as ‘short-lag and variable (in both series), and not a reliable cue to the stop contrast’. He claims furthermore that ‘[t]he most consistent cue to the contrast appears to be the duration of the articulatory stricture’, and presents data from a Burarra speaker showing that the acoustic correlate of closure in /p/ is 70% longer than that in /b/.

Why, then, was this opposition ever described as voiced vs. voiceless? Glasgow (1981) explains in a footnote that she began by using the singleton/geminate notation, but that a Burarra teaching assistant she was working with preferred the voiced/voiceless notation. This (completely justified) decision, then, had nothing to do with the phonetics of the language in question.

Butcher (2004) notes that the group of languages with this length distinction neutralises the opposition everywhere but medially. He argues that a different group of non-Pama-Nyungan languages, including Murrinh-Patha, have a true phonetic voicing distinction. This distinction, however, only neutralises in final position, exactly in line with laryngeal neutralisation in other languages. Correspondingly, Butcher shows that one Murrinh-Patha speaker produces medial /p/ and /b/ with a far smaller duration distinction than the Burarra speaker.

4.6 Parallel lenitions

The most extensively studied case of neutralising lenition is probably American English flapping (Kahn 1980, see de Jong 2011 for an extensive history and review). In the most basic form of the phenomenon, non-foot-initial inter-sonorant alveolar stops are realised as some form of extremely short occlusion (tap or flap). The formulation ‘non-foot-initial’ expresses the fact that in word-medial position the phenomenon generally only holds before unstressed vowels; we take stress to be a diagnostic of foot-initiality in English and assume that every left word edge is also a foot edge. The pattern is illustrated in (34) with data from the author’s dialect; note that we ignore blocking contexts (and many irrelevant phonetic details of English) here.

(34) American English flapping

[tʰɪn] ‘tin’	[bæt˺] ‘bat’	[ətʰen] ‘attain’
[dɪn] ‘din’	[bæd˺] ‘bad’	[ɔɹden] ‘ordain’
[bærəɹ] ‘batter’	[rɪvərəɹ] ‘riveter’	
[bærəɹ] ‘badder’	[kɑməri] ‘comedy’	

The laryngeal contrast that is attested word-initially and before stressed syllables is neutralised medially to tap. This is thus a case of neutralising continuity lenition. This particular pattern, however, is one of the few ways in which the BD theory *does* predict the existence of neutralisation: two sounds leniting to a third. This is illustrated in (35):

(35) Parallel lenitions in American English

(a) Contrast foot-initially

tʰɪn	BD(3,0,Ft)	Id[Voi]	BD(1,0,Ft)
☞ tʰɪn			
dɪn		*!	*
rɪn	*!	*	*

rɪn	BD(3,0,Ft)	Id[Voi]	BD(1,0,Ft)
tʰɪn		*!	
☞ dɪn			*
rɪn	*!		*

dɪn	BD(3,0,Ft)	Id[Voi]	BD(1,0,Ft)
tʰɪn		*!	
☞ dɪn			*
rɪn	*!		*

(b) Neutralising flapping foot-medially

bæt + əɹ	BD(3,0,Ft)	ID[Voi]	BD(1,0,Ft)
bætəɹ	*!		*
bædəɹ	*!	*	
☞ bærəɹ		*	

bæd + əɹ	BD(3,0,Ft)	ID[Voi]	BD(1,0,Ft)
bætəɹ	*!	*	*
bædəɹ	*!		
☞ bærəɹ			

The basic logic is that flapping is driven by a BD constraint militating against drops in intensity to the level of a voiced stop or lower domain-internally; this constraint incidentally compels changes to laryngeal features in the case of /t/, as in (35b). At domain boundaries, the same constraint will penalise any drop in intensity that is not at least as low as that of a voiced stop. But changing the laryngeal specifications of /t/ or /d/ won't make any difference in this environment, because they both already satisfy the constraint; it is only tap that must be altered domain-initially, as in (35a). Another way of describing the pattern is that both /t/ and /d/ are in allophonic alternation with tap; the fact that /t/ and /d/ happen to also neutralise with each other is a secondary effect.

This is one of the few configurations in which the BD approach predicts neutralising lenition. Several of the African languages mentioned in section 4.4, including Ibibio and possibly Fe'fe', display this type of parallel lenition. Note that this configuration is only predicted to be possible when at least three segments distinguished by two features are involved. A more abstract and general way of describing the situation (using intensity-based lenition and ignoring duration) is that there are three segments: segment *A* of intensity *n*, the most fortis; segment *B* of intensity *n+1*, intermediate; and segment *C* of intensity *n+2*, the most lenis. Segments *A* and *B* are distinguished only by feature *F*; segment *C* is distinguished from *B* only by feature *G* (and therefore distinguished from *A* by both *F* and *G*). The BD constraint calling for events of intensity *n+1* or lower to be aligned with boundaries is ranked above faithfulness to both *F* and *G*. In initial position, *C* is the only segment of the three that violates this BD constraint; it will be minimally modified to satisfy it (by changing feature *G*). In medial position, both *A* and *B* violate the BD constraint, so features *F* and *G* both change as needed to satisfy the constraint. The result is that *F* is contrastive in initial position but not medial (while *G* is contrastive in neither position). Note that this crucially relies on there being a segment *A* that needs to change 2 features in medial position, which is why the theory predicts neutralization only with more than two categories involved; single-feature lenitions never result in positional neutralisation.

4.7 Word-initial exceptionality and its limits

This section deals not with any putative cases of neutralising continuity lenition, but with theories that predict such cases should be pervasive. The most influential theory of this type is Beckman's (1998) positional faithfulness theory, which singles out root-initial consonants as being protected by special positional faithfulness constraints due to their psycholinguistic prominence. If such constraints exist, they should sometimes block fortition in root-initial position without affecting lenition elsewhere, resulting in neutralising lenition. We have claimed here that such patterns are exceedingly rare. What data, then, is the Beckman theory based on?

First off, it is based on an impressive and rather convincing catalogue of cases where a greater variety of vowel qualities, quantities, and/or syllable structures are licensed in the initial syllable of a root than elsewhere. The idea that initial onset consonants should also be protected by special constraints fits in quite nicely with this view, but Beckman actually presents very little evidence that word-initial consonants in particular are 'protected' in this way. Two of the three cases she presents involve click licensing in !Xóõ and licensing of secondary articulations in Doyayo; these languages both fall in the class of initial-accent languages discussed in section 4.4. The last example involves licensing of secondary articulations in Shilluk, a Nilotic language whose close relative Dholuo is described as having fixed stem-initial stress (Downing 2004).

None of these inventory asymmetries, which involve airstream mechanisms and secondary articulations, need to be analysed as continuity lenition. So one possibility is that word-initial consonant faithfulness exists and protects certain features, but not the ones involved in lenition. However, given the small number of cases identified by Beckman and the plausible hypothesis that these languages all have initial stress or accent, we favor the hypothesis that these are all cases of prominence-sensitive faithfulness 'masquerading' as word-initial faithfulness. Under this hypothesis, Beckman's positional faithfulness constraints may refer to the structure or nucleus of a root-initial syllable, but not to the segmental characteristics of a root-initial consonant. This would help explain the relative paucity of initial consonant contrast preservation.

Smith (2002) makes a nearly identical proposal involving *markedness* constraints for word-initial consonants. The idea here is that psycholinguistic prominence favors less sonorous consonants in absolute word-initial position, because they are 'stronger'. This is thus a proposal that word-initial consonants are subject to a hierarchy of sonority-based fortition constraints, precisely the view that we've argued against in this paper. Although the proposal is conceptually similar to Beckman's, the empirical predictions are the opposite: some medial contrasts should be neutralised to fortis in initial position, where lenis consonants are specifically marked. Like Beckman's proposal, Smith's arguments for word-initial exceptional markedness are strongest for vowel quality and syllable structure; the examples she gives of initial neutralising fortition are extremely limited and questionable as to being scalar or sonority-based.

Although her hierarchy predicts that any sonority distinction could be the basis for an initial merger, the only attested ones seem to be languages that ban rhotics and sometimes laterals in word-initial position. What's more, these languages all allow glides in initial position, with the exception of Campidanian Sardinian. So while Smith posits a hierarchy of scalar neutralising constraints in initial position, only one such constraint (against liquids) is attested and most of those cases are not straightforwardly scalar.[6] We propose instead that scalar word-initial fortition constraints should be abandoned and replaced with a single constraint banning liquids word-initially. Of course, one may refer to such patterns as fortition if one wishes, but we contend that they are not driven by BD constraints and are not the same as the continuity patterns discussed in this paper.

[6] Smith proposes that initial glides are licensed in these languages because they are part of the nucleus rather than the onset. In the absence of any converging evidence for this hypothesis, we do not find it convincing.

5 Conclusion

We have argued that the term 'lenition' as used in the phonological literature includes at least two distinct types of phenomena, which differ in their functional, substantive, and positional properties. One type of lenition, referred to here as *continuity*, is particularly problematic for phonological theory as it seems to exist primarily in allophonic form. We proposed a phonetically driven theory that correctly captures the differences between different types of lenition. Putative cases of neutralising continuity lenition were discussed and it was demonstrated that the current proposal can adequately describe such cases. In concluding the paper, we discuss some theoretical and empirical implications of the approach taken here.

5.1 Partitioning lenition processes

We have proposed a cluster of typological properties that distinguish between continuity and loss lenition. The claim is that particular featural changes tend to occur in particular positions and have particular consequences for contrast. One question that arises is how to analyse phenomena that don't seem to fit neatly in either category. For instance, one might read the typology presented here as saying that voicing alternations always affect intervocalic position if they affect any position and that they never neutralise contrasts. This is obviously wrong.

In general, picking out particular lenition phenomena for analysis is not meant to suggest that the same features or contexts cannot be involved in other phenomena. In the case of voicing, it is fairly easy to tell the difference between lenition and non-lenition phenomena. This is because non-lenition voicing alternations such as assimilation and final devoicing never target intervocalic consonants and they result in positional neutralisation of contrasts almost by definition. This suggests that the intervocalic target of continuity lenition processes is the crucial property that distinguishes it from other processes involving the same feature, and indeed this is the hypothesis that we are currently working with.

Continuancy is somewhat less clear in this regard, because neutralising continuancy (and/or approximancy) alternations appear to be far less common than laryngeal ones. The few instances of which we are aware, however, such as Lama /p/-/w/ neutralisation and Nez Perce neutralising spirantisation (Gurevich 2003), target consonants in pre-consonantal and/or domain final positions, but not intervocalic ones. As such, these particular cases should not be analysed as continuity lenition; rather than targeting auditory continuity, these processes may be neutralising consonantal manner contrasts in contexts where they are less distinct. The fact that continuancy and approximancy contrasts have fairly robust perceptual cues internal to consonants themselves may help explain why this type of positional neutralisation is less common than, for instance, neutralisation of stop voicing; laryngeal contrasts for stops depend far more on cues in adjacent segments. The logic here is that a continuancy alternation is an instance of continuity lenition if and only if it targets intervocalic stops, and that if it meets this criterion it will not neutralise contrasts present elsewhere in the language.

Duration is in some sense the clearest phonetic property in terms of identifying continuity processes. As shown in section 3, consonantal length contrasts tend to neutralise in non-intervocalic position, resulting in degemination or shortening. The BD constraints proposed here suggest that continuity lenition involving duration should have the opposite effect: shortening in intervocalic position (and other medial positions). We believe this prediction is correct, but easy to miss. This is because BD constraints predict allophonic shortening of medial consonants in languages where, by definition, the length of those consonants is not contrastive. But in such a language, phonologists and phoneticians are exceedingly unlikely to refer to such alternations as 'degemination', a term that is mostly reserved for languages with a geminacy contrast.

Instead, these patterns tend to be discussed in the phonetic literature under the rubric of 'initial strengthening' (see Keating 2006 for a review). This general phenomenon involves several articulatory parameters: consonant gestures display greater magnitude and stiffness at the beginnings of larger constituents, which plausibly could correspond in many cases to larger and more abrupt drops in intensity relative to medial consonants; Kingston (2008) shows this is true even for Spanish consonants that are not involved in spirantisation. More directly relevant, the articulatory and acoustic duration of consonants is longer at the beginning of larger constituents. This effect has been found for one or more consonants at one or more prosodic levels in at least Korean (Jun 1993), English (Fougeron & Keating 1997), French (Keating *et al.* 2003), Taiwanese (Keating *et al.* 2003), and Japanese (Onaka *et al*. 2003). Presumably, the effect extends to other languages; these examples are just the ones that happen to have been tested in the relatively new initial lengthening literature. The size of the effects ranges from extremely large for some speakers in some languages (at least as large as a typical geminacy contrast) to extremely small (up to and including small trends that don't reach statistical significance). This range of initial lengthening (or medial shortening) effects, including some of very small magnitude, fits well with the formulation of BD constraints as referencing small, non-contrastive differences in duration.

5.2 Positional asymmetries in clusters?

This paper has made several references to Ségéral & Scheer's (1999 *et seq*.) important work on lenition. These authors provide arguments for a positional asymmetry in lenition and fortition that they call the *coda mirror effect*: pre-consonantal and word-final segments tend to pattern with intervocalic ones in undergoing lenition, while post-consonantal segments tend to pattern with initial ones in resisting lenition (the two latter positions are referred to as the 'coda mirror'). We have not incorporated the coda mirror effect into the current theory, and it seems worth explaining why not.

First, many instances the authors cite of positional asymmetries in clusters concern properties other than those implicated in intervocalic lenition in the same languages, such as consonant deletion in the history of French, sonorant gliding in the history of Portuguese and Gallego. and stop non-release in Somali. As these cases do not involve intervocalic consonants, they are best analyzed as holding in non-pre-vocalic (or coda) position rather than some general lenition context; our approach would not characterise them as continuity lenition in the first place.

Second, it is not clear to us that for actual continuity lenition processes the coda mirror effect is more common than any other pattern. The few cases of lenition in languages with medial clusters discussed here, such as Spanish, Chungli Ao, and Nivkh, all show patterns where lenition either holds throughout or fails to hold throughout such clusters. This would be difficult to analyze in a framework where post-consonantal position is strong with regard to lenition and pre-consonantal position is weak. On a related point, voicing, which is one of the more common forms of continuity lenition, apparently never displays a coda mirror effect. Ségéral & Scheer (1998, 2008) do not discuss any such cases and none of the cases in the surveys consulted here show such effects. Taken as a whole, then, we do not believe that there is sufficient evidence for the coda mirror effect to incorporate it into our analysis.

In general, we find the phonetic implementation of lenition in clusters to be understudied in the literature. This is regrettable, because the details of how segments behave in various non-intervocalic positions is potentially crucial in determining the correct form of lenition constraints or rules. There are a number of open questions concerning the typology of lenition in clusters that can only be answered by phonological and phonetic investigation of more languages. For instance, we have not seen a single instance of voicing lenition applying through a medial cluster of obstruents, but we do not have detailed descriptions from enough languages to know if this tendency is accidental, probabilistic, or even universal. Such investigation would surely also shed light on the question of to what extent and for which features the coda mirror effect exists.

5.3 Broader theoretical implications

Finally, we consider some of the broader consequences of our analysis for phonological theory. The account given here assumes that phonological representations contain a great deal of fine phonetic detail. The BD constraints make reference to small differences in intensity and duration that are not in and of themselves contrastive. To the extent that the analysis succeeds in places where more abstract accounts fail, it can be seen as evidence that such detail is relevant to phonology. We thus join a long list of researchers who have argued for similar conclusions about the level of phonetic detail in phonological representations (e.g. McCawley 1967, Selkirk 1982, Kingston 1985, Browman & Goldstein 1986, Flemming 1995, Boersma 1998, Steriade 1999, Pierrehumbert 2000).

The analysis also predicts that allophonic lenition patterns may include small changes in duration, aperture, timing, or release that may never be minimally contrastive in any language, in addition to the ‘larger’ lenitions that tend to be noted in phonological grammars. The initial strengthening literature described above suggests to us that this prediction is on the right track. The typological breadth of this literature is still somewhat limited relative to the phonological lenition literature, however, and only time will tell how typologically widespread such contextual variation is. In general, the current proposal makes no distinction between allophony and any other kind of contextual phonetic variation. On this view, spirantisation of Spanish voiced stops and small reductions in English /n/ duration medially are both equally ‘phonetic’ or ‘phonological’. Because neither change is contrastive, if grammar regulates one, there is no principled reason to say it doesn’t regulate the other. Conversely, if small contextual differences in duration are outside the scope of the phonological grammar, there is no principled reason why spirantisation should be inside the scope of that grammar.

Another ‘big-picture’ question concerns the role of contrast in grammar. Continuity lenition, as presented here, is fundamentally about the contrast between the presence and absence of a prosodic boundary: at any given point in the speech stream, it helps a listener decide whether a prosodic domain is ending or failing to end. Yet while BD constraints make reference to the presence and absence of boundaries, they do not make any statement about this contrast *per se*. It is possible that a more directly explanatory account would result from an approach where contrast is directly assessed in the grammar, such as the Dispersion Theory of Contrast (Flemming 1995). We have not taken this step here. Such an analysis would necessitate the introduction of a new class of constraints into the theory, which assess the perceptual distinctiveness of contrasts between, e.g., the sequence /apa/ internal to a word and the sequence /a[pa/ with a word boundary intervening. The number of forms to be compared in such a system, as well as the number of possible repair strategies, would quickly explode, without even considering more complex contexts such as consonant clusters. Given the formal difficulties posed by such an undertaking, we think it makes more sense to approach this problem in a separate paper, perhaps starting from simpler phenomena than those discussed here.[7]

The BD constraints are presented here as categorical. Note, however, that the scalar representations of intensity, duration, and prosodic strength that these constraints reference are equally (or perhaps more) compatible with a weighted, gradient constraint model (Flemming 2001, Pater 2009, Katz 2010, Ryan 2011). We use the categorical constraint model here because it seems easier to work with typologically and more familiar to phonologists, and it makes very similar predictions to the gradient model. The one major advantage that we can see for a gradient model is that the cost assessed to each candidate in such a model could serve as a useful starting point from which variability and gradience in phonetic realisation might be described. Lenition phenomena are often marked by substantial variation in both the likelihood of some outcome applying and the phonetic nature of that outcome.

Large parts of the lenition literature are taken up with discussion of what lenition is. We close by giving our take on the question. If continuity lenition has special formal and functional characteristics, but loss lenition does not, one reaction would be to say that only continuity lenition is real lenition. While this move has some logical appeal, attempting to change the way an entire field uses a label that has been around for so many years seems to us to be a somewhat quixotic undertaking. Instead, we take the following view: ‘lenition’ is a useful descriptive label given by many researchers to overlapping but non-identical sets of phonological and phonetic phenomena involving some sense of reduction. These sets tend not to correspond to coherent entities with respect to formal, functional, or contextual properties. Within the class of generally recognised lenition phenomena, however, at least one functionally and phonologically cohesive subset exists and it has a lot to teach us about the nature of phonology.

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[7] See Padgett 2009 for an interesting but, in our opinion, deeply flawed attempt at such an account of Catalan rhotic distributions.

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