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Exceptional prosodification effects revisited in Gradient Harmonic Grammar

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Abstract

In exceptional prosodification effects, individual lexical items pattern phonologically as if they occur in a prosodic structure that is inconsistent with the regular syntax-prosody mapping. These patterns have been analyzed as cases of prosodic prespecification (Inkelas 1989, Zec 2005), where morphemes subcategorize for a (non-default) prosodic representation. This paper argues that prespecification approaches should be reconsidered, and shows that such patterns are predicted to arise without morpheme-specific prosody in a weighted constraint system with gradiently active symbols, Gradient Harmonic Grammar (Smolensky et al. 2014; Smolensky and Goldrick 2016). Exceptional prosodification effects result from the interaction of two constraint penalty manipulations with independent support: [1] scaling of constraint violations according to prosodic context (Hsu & Jesney 2016) and [2] contrastive levels of activity in underlying forms (Smolensky & Goldrick 2016). The interaction is illustrated in an anlysis of the distribution of French nasal vowels and linking [n]. This approach reduces the amount of structure posited for URs, and provides new arguments for a more uniform syntax-prosody mapping.

1. Introduction

A large body of research in generative phonology aims to explain phonological generalizations that must be stated in terms of *domains* that refer to certain edges or junctures (Selkirk 1980; Nespor and Vogel 1986; Côté 2000; Flack 2009; Itô and Mester 2013). Although these domains often resemble the constituent structures produced by morphosyntax, the degree to which they correpond remains controversial. In direct reference theories, phonological processes have a syntactic constituent or phasal spell-out domain as their domain of application (Kaisse 1985; Odden 1987; Wagner 2005; Pak 2008; a.o.). In the most widely held indirect reference theory, Prosodic Phonology, the domains of phonological rules or constraints are stated in terms of a prosodic constituent structure that is potentially non-isomorphic with syntactic constituent structure (Selkirk 1981; 2001; Nespor and Vogel 1986; a.o.).

Key arguments advanced in favor of a prosodic structure arise from apparent mismatches between the domains of phonological rules and morpho-syntactic constituents. While some mismatches are systematic – affecting all lexical items in a certain configuration, others apply to a restricted set of lexical items. I will refer to the latter case as an *exceptional prosodification effect*. Exceptional prosodification effects have been generally been accounted for in terms of *prosodic prespecification*; some lexical items subcategorize for a non-default prosodic representation (Inkelas 1989; Poser 1990; Zec 2005; Paster 2006; Hsu 2015; Tyler 2017). The approach, however, requires an increase in the number of symbols posited in lexical entries, and in constraint-based grammars must be accompanied by constraints that enforce those prespecifications.

This paper proposes that prespecification approaches to exceptions to domain-based restrictions should be reevaluated in light of recent advances in phonological theory. Broadly, it builds on several arguments advanced in favor of an Optimality-Theoretic grammar (Prince and Smolensky 1993) in which constraints are numerically weighted rather than ranked, Harmonic Grammar (Legendre et al. 1990; Smolensky and Legendre 2006). In particular, weighted constraints can generate many phonological patterns using a smaller constraint set that better predicts attested typologies (Farris-Trimble 2008; Potts et al. 2010; Jesney 2011; Pater 2012, 2016), and correctly predict that phonological outputs can be determined by the interaction of constraints that refer to independent dimensions of structure (Zuraw and Hayes 2017). In addition, we consider recent claims that lexical variability and exceptionality receive a parsimonious analysis if the symbols of phonological representations can be gradiently active (Smolensky and Goldrick 2016; Zimmermann 2017; Rosen *to appear*).

We demonstrate that apparent exceptional prosodification effects are predicted to arise in such a framework, a Gradient Harmonic Grammar (Smolensky et al. 2014; Smolensky and Goldrick 2016), without lexically-specific variability in the mappings from syntactic to prosodic constituent structure. Specifically, we show that these patterns emerge from the interaction of two independently proposed constraint penalty adjustments: [1] scaling of constraint penalties according to the prosodic enironments in which they occur (Hsu and Jesney 2016; Inkelas and Wilbanks 2017) and [2] contrastive gradient activation of symbols in underlying forms (Smolensky and Goldrick 2016; Zimmermann 2017; Rosen *to appear*). The proposal is illustrated in an analysis of the distribution of nasal vowels in Standard French, which is sensitive to both general morpho-syntactic constituency and to several types of lexical exceptions. The approach is able to generate the patterns with a uniform set of underlying segments for lexical items with a nasal vowel allomorph, and without prosodic prespecification, two desiderata that have eluded previous analyses.

The proposal has several key implications. First, the source in underlying representations of exceptional prosodification effects is united with that of other exceptional patterns in terms of contrasts in gradient activity. As this reduces the number of structural prespecifications proposed for underlying forms, it results in a more parsimonious explanation for lexical exceptionality. In addition, this approach to exceptional prosodification effects allows morpheme-specific constraints on syntax-prosody alignment to be dispensed with, in line with recent research that proposes reduced variability in the possible mappings from syntactic to prosodic domains (Selkirk 2011; Tyler 2017).

2. Effects of prosodic structure on French nasal vowels and nasal liaison

This section presents the distribution of nasal vowels ([ɛ̃], [ɔ̃], [ɑ̃]) in Standard French, focusing on its sensitivity to morpho-syntactic constituency, and lexical exceptions to the general pattern. It then presents an account of the regular pattern in terms of positional markedness constraints whose violations are scaled by the number of domains that fully contain a marked structure. I then present a possible prosodic prespecification analysis of the exceptional patterns, and discuss its theoretical shortcomings. This sets the stage for the Gradient Harmonic Grammar analysis in Section 3. Here, we focus on the segments that are permitted to immediately follow nasal vowels in various contexts, a restriction that is to some extent independent of the underlying representation(s) of the nasal vowels themselves, which will also be discussed in the proposal.

To preview the key pattern, Standard French shows evidence for increasing strength of restrictions against nasal vowels and following segments according to prosodic domain size. In general terms, the more prosodic constituents a ṼX sequence is contained in, the more restrictions are enforced on possible segments X (Hsu 2015), based on sonority. This is observed in both static phonotactic generalizations and in alternations at morpho-syntactic junctures. At any level of constituency, all exceptional lexical items pattern in a way that resembles the regular pattern that applies within a smaller prosodic constituent domain.

2.1 Stem-internal ṼX

With very few exceptions, nasal vowels precede obstruents only within stems. Nasal vowels followed by non-glide sonorants are highly underattested, restricted to a handful of forms like [ʒɑ̃ʁ] 'genre' and [ɑ̃nɥi] 'boredom.' Lastly, nasal vowels do not precede glides or vowels (Dell 1970). Note that the restriction against nasal vowels preceding other vowels is stronger than a general dispreference against vowel hiatus, as hiatus is attested for adjacent oral vowels VV (ex. [naif] 'naïve'), an oral vowel followed by a nasal vowel VṼ (ex. [leɔ̃] 'lion'), but not a nasal vowel followed by an oral vowel *ṼV or sequence of nasal vowels *ṼṼ.[1] The absence of nasal vowels before glides results to some extent from the restricted distribution of non-initial glides; neither /w/ nor /ɥ/ is permitted as a singleton onset in non stem-initial syllabes (Tranel 1987). Nonetheless, /j/ is permitted in these contexts, and is unattested following nasal vowels.

(1) a. Ṽ *before obstruents*

ɛ̃po	'tax'	kɛ̃z	'fifteen'
ɔ̃d	'wave'	dɑ̃s	'dance'
lɑ̃g	'language'	ɑ̃fɑ̃	'child'
tɑ̃t	'aunt'	lɛ̃ʒ	'laundry'

b. Ṽ *before non-glide sonorants* [m, n, l, ʁ] *(highly underattested)*

ʒɑ̃ʁ	'genre'	ɑ̃nɥi	'boredom'

c. Ṽ *before glides and vowels (unattested)*

*kɑ̃ju, *ɔ̃œʁ

The pattern here can be described in terms of the sonority of the segment following the nasal vowel, such that relatively sonorous segments are dispreferred as the second item of a ṼX sequence.

2.2 Word-internal ṼX across prefix boundaries

Restrictions on nasal vowels that precede morpheme boundaries can be observed for prefixes that have an allomorph that ends with a nasal vowel. The general pattern is illustrated in the alternations of *en-* [ɑ̃(n)], *non-* [nɔ̃(n)], *bien-* [bjɛ̃(n)] (Tranel 1981; Hannahs 1995). Before vowel-

[1] Tranel (1981) questions Dell's (1970 generalization about the absence of stem-internal ṼV sequences, noting that ṼV is found in proper names like *Panhard* [pɑ̃aʁ]. However, this can be understood as the result of a positional privilege afforded to proper nouns (Smith 2014; Moreton et al. 2017) that does not alter the basic generalization about stem-internal phonotactic restrictions.

initial stems, each prefix ends with a nasal vowel and coronal nasal (2). The prefixes end with a nasal vowel when affixed to a consonant-initial stem, regardless of the following consonant's sonority (3). In contrast to stem-internal nasal vowels, prefix nasal vowels are permitted before sonorant consonants.

(2)	ɑ̃n-ivʁe	'to intoxicate'	nɔ̃n-ɛ̃skʁi	'unregistered'
	ɑ̃n-ɔʁgœjiʁ	'to make proud'	nɔ̃n-inisje	'uninitiated'

(3)	ɑ̃-kɛse	'to cash'	nɔ̃-fɔ̃ksjɔnmɑ̃	'non-function'
	ɑ̃-nɔbliʁ	'to ennoble'	nɔ̃-ʁœspe	'non-respect'

As notably described by Tranel (1976), the negational prefix *in-* has a pattern of allomorphy distinct from other prefixes in that it is sensitive to the sonority of stem-initial consonants. *In-* surfaces as [in] before vowel-initial stems, [ɛ̃] before obstruent-initial stems, and [i] before sonorant-initial stems.[2]

(4)	a.	in-abil	'unskillful'	in-amikal	'friendly'
	b.	ɛ̃-fekɔ̃	'unfruitful'	ɛ̃-pɔsibl	'impossible'
	c.	i-mɔʁal	'immoral'	i-legal	'illegal'

A key observation to be made here is that this pattern of allomorph selection results in the distribution of ṼX sequences observed stem-internally, where nasal vowels can precede obstruents, but not sonorant consonants or vowels.

2.3 ṼX across word boundaries

The patterning of ṼX sequences separated by a morphological word boundary shows the greatest degree of variation across lexical items. The analysis of this variability, as well as identifying which pattern(s) should be treated as exceptional, has been the the subject of many analyses in generative phonology (Tranel 1981; 1995). Here, I focus specifically on pre-nominal adjectives that end in a nasal vowel when pronounced in isolation, and how they surface when they precede a vowel-initial word. Three patterns emerge in this context (Sampson 2001). First, certain pre-nominal adjectives end with a nasal vowel, with no change from their pronunciation in isolation. The second class of adjectives retain their nasal vowel, but surface with a linking (liaison) consonant [n]. The third class also surfaces with linking [n], but with an oral vowel in place of the nasal vowel that would appear in isolation.

(5) a. No liaison
[miɲɔ̃] 'cute' + [ɔbʒe] 'object' → [miɲ**ɔ̃** ɔbʒe]
[malɛ̃] 'clever' + [ɛspwaʁ] 'hope' → [mal**ɛ̃** ɛspwaʁ]
[lwɛ̃tɛ̃] 'distant' + [avniʁ] 'future' → [lwɛ̃t**ɛ̃** avniʁ]

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[2] An exception to this patterning of *in-* is observed when it attaches to adjectives formed by the suffix *–able* (Tranel 1976). Here, the prefix surfaces as [in] before vowel-initial stems and [ɛ̃] before consonant-initial stems, regardless of sonority (cf. ([**in**ɔfisjalizabl] 'that cannot be officialized'; [**ɛ̃**tʁɑ̃sfɔʁmabl] 'that cannot be transformed'; [**ɛ̃**memɔʁizabl] 'that cannot be memorized').

b. Nasal vowel with liaison [n]
[kɔmɛ̃] ‘common’ + [ɔbʒe] ‘object’ → [kɔm**ɛ̃** **n**ɔbʒe]

c. Oral vowel with liaison [n]
[bɔ̃] ‘good’ + [ɔbʒe] ‘object’ → [b**ɔ** **n**ɔbʒe]

Some key comments on this distribution are relevant. First, the observed pattern is conditioned by the identity of the pre-nominal adjective, rather than the following word (cf. Zymet 2018 for discussion of the effects of the first word in liaison with other consonants). There are some regularities in correspondence between properties of the adjectives and the resulting pattern. For instance, all words that trigger liaison with an oral vowel are adjectives that end in [ɛ̃] (orthographic *–ien, -ain*, *-ein*) and have a liaison form that resembles its feminine allomorph (*-enne*, *-aine*, *-eine* [ɛn]). In addition to characterizing some adjectives like *commun*, the liaison with nasal vowel pattern also applies to non-adjectival pre-nominal items like indefinite article *un*, and possessive pronouns *mon*, *ton*, *son*. However, these regularities are not without exceptions. Some pre-nominal adjectives that end in [ɛ̃] in isolation and have a feminine allomorph ending in [ɛn] do not trigger liaison with an oral vowel for most speakers, e.g. [lwɛ̃tɛ̃] ‘distant’, [malɛ̃] ‘clever’ (Encrevé 1986; Sampson 2001). Some speakers extend the liaison with oral vowel pattern to indefinite articles and possessive pronouns (Tranel 1981). More generally, there is inter-speaker and inter-dialectal variability in the patterning of certain adjectives; Some forms like [ɑ̃sjɛ̃] ‘old’ and [lwɛ̃tɛ̃] ‘distant’ have been described as following each of the three patterns for some set of speakers (Tranel 1981; Encrevé 1988; Sampson 2001).

While there are difficulties in eliciting production studies with novel adjective+noun sequences given the preference for most adjectives to appear post-nominally, Sampson (2001) shows that the no liaison pattern is to a large extent the productive one applied by speakers to novel sequences, and that it is possible to treat the two classes of liaison-triggering items as forming finite lists. From the criterion of productivity, no liaison is the regular pattern, and the two liaison with [n] patterns are exceptional. I will adopt this perspective in the remainder of this work.

It is noteworthy that the two liaison patterns replicate regular phonotactic generalizations that are attested at a word-internal level of constituency. *Commun*-class adjectives that trigger liaison with a preserved nasal vowel replicate the regular pattern found at prefix boundaries; nasal vowels surface before obstruents and sonorant [n], but not vowels. *Bon*-class adjectives that trigger liaison with an oral vowel replicate the stem-internal pattern; nasal vowels do not surface before either vowels or sonorant consonants. Aspects of this generalization have been made in previous works. Bybee (2001) observes that liaison (including with consonants other than [n]) is “very similar to morphologically and lexically conditioned alternations that occur word-internally.” Sampson (2001) characterizes the patterning of *bon* class adjectives as a type of partial lexicalization where they are “treated effectively as phonological words.” The similarity between the *commun objet* pattern of liaison with a nasal vowel and the allomorphic patterning of prefixes like *bien-* and *non-* is also noted by Tranel (1981) and Prunet (1986).

In summary, there are three basic patterns that characterize the distribution of permitted ṼX sequences in Standard French. Each pattern is one that applies regularly at some level of constituent structure. Furthermore, the behavior of all exceptional items resembles a pattern that regularly applies within a smaller domain. This distribution is summarized in Table 1 below.

Pattern 1: Ṽ before obstruents only		Pattern 2: Ṽ before obstruents and sonorants		Pattern 3: Ṽ before all segments	
REGULAR	ṼX within stems	REGULAR	ṼX across prefix boundary	REGULAR	ṼX across word, phrase boundary
EXCEPTIONAL	*bon* class preverbal adjectives, *In-* prefix	EXCEPTIONAL	*commun* class preverbal adjectives		

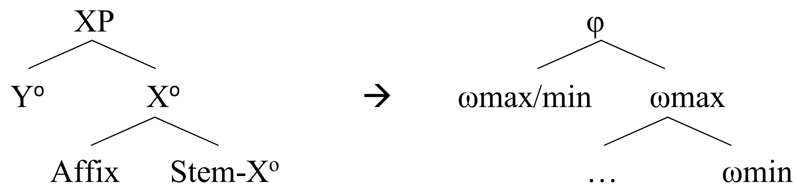
Table 1: Summary of regular and exceptional distributions of ṼX sequences

2.4 Scalar constraint analysis of regular sensitivity to prosodic context

We now turn to developing an analysis of the regular sensitivity of restrictions on ṼX sequences to morpho-syntactic context, using a standard set of representations within Prosodic Phonology. I will assume that prosodic constituency is defined in relation to syntactic structure, and that the primary constraints on this correspondence, MATCH constraints, call for an isomorphism between certain syntactic constituents and a corresponding prosodic constituent (Selkirk 2009; Selkirk 2011; Elfner 2012). Syntax-prosody mappings that satisfy these constraints are often recursive; any prosodic category can dominate an instance of the same category (Selkirk 2011; Elfner 2012; Itô and Mester 2013; Myrberg 2013). Furthermore, domain-sensitive phonological processes can target specific subcategories of a recursive structure (Elfner 2012; Itô and Mester 2013), such as maximal projections (a $PCat_i$ not dominated by another $PCat_i$) or minimal projections (a $PCat_i$ that does not dominate another $PCat_i$). While non-isomorphic mappings can be compelled by prosodic markedness constraints that outrank MATCH constraints, we will see that the regular French nasal vowel patterns are consistent with an isomorphic structure.

Given our focus on the patterning of nasal vowels within morphological words and nominal phrases, we will restrict our attention to the prosodic word (ω) and phonological phrase (φ) constituents. The key relevant syntax-prosody mappings are represented in the schematic example in (6). Syntactic phrases (XP) are mapped to φs (Selkirk 2009; 2011; Elfner 2012). Although the effect of word-internal morphological structure on MATCH constraints on ωs has received relatively little attention, a tentative approach is sketched here. There is an established cross-linguistic tendency for affixes or a subset of them to be exempt from phonological generalizations that apply to stems, suggesting that stems form a distinct prosodic domain from affixes (Booij and Rubach 1984; Nespor and Vogel 1986; Hannahs 1995). This can be captured by positing a recursive ω structure in which both the stem and the complete morphological word are mapped to ω nodes, one of which dominates the other (Guekguezian 2017 argues that such recursive representations ω follow from derivational cyclicity). Based on the relational definitions of Itô and Mester (2013), the stem corresponds to a minimal prosodic word (ωmin) because it does not itself dominate a ω. The full morphological word corresponds to a maximal prosodic word (ωmax) because it is not iself dominated by a ω.

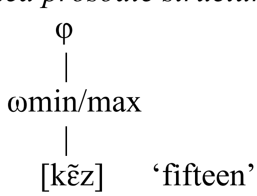
(6)



Note that given the above definitions, an unaffixed stem (here Yº) is mapped to a prosodic word that is both minimal and maximal, and thus subject to restrictions that apply to both constituent types. This structure predicts that all stems will be subject to restrictions that apply to ωmax and ωmin, while affixes are not subject to restrictions that apply to ωmin.

We now turn to the predicted prosodic representations that correspond to the morphosyntactic contexts discussed in the previous section. The key observation is that all restrictions on possible ṼX sequences can be stated in terms of the prosodic constituent domains that contain the relevant sequence. First, consider the status of ṼX sequences that are fully contained within stems. Regardless of whether other affixes are present, all stems are contained within a φ, ωmax, and ωmin. This is shown here for an unaffixed stem, which is dominated by a single ω node that is simultaneously maximal and minimal. In this context, nasal vowels precede obstruents only.

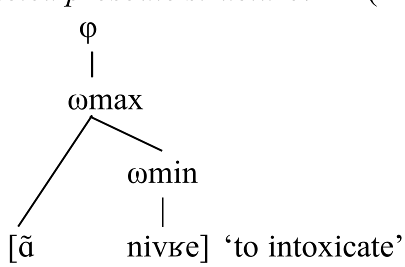
(7) *Predicted prosodic structure*: $(\quad (\ldots\tilde{V}X\ldots)_{\omega min/max} \quad)_{\varphi}$



ṼX fully contained in ωmin, ωmax, φ: Ṽ precedes obstruents only

Prefixes are syllables dominated directly by ωmax, and not contained within the ωmin that contains the stem. I'll assume that [n] associated with prefixes like *en-* and *bien-* before a vowel-initial root is dominated by ωmin, since it is syllabified as an onset with the stem-initial vowel. However, as long as the nasal vowel is associated with a prefix, the ṼX sequence is fully contained only within a φ and the ωmax that dominates the full morphological word, but not the ωmin that dominates the stem.

(8) *Predicted prosodic structure*: $(\quad (\ldots \tilde{V} \,(X \ldots)_{\omega min} \,)_{\omega max} \quad)_{\varphi}$



ṼX fully contained in: ωmax, φ: Ṽ precedes consonants only

Pre-nominal adjectives constitute morphological words that are independent from the nouns that they modify, but are contained within the same nominal phrase. In terms of their prosodic representation predicted by an isomorphic mapping, pre-nominal adjectives and their following nouns are dominated by distinct ωmax nodes. The ṼX sequence in a form like [miɲɔ̃ ɔbʒe] 'cute objet' is fully contained only within a φ.

(9) *Predicted prosodic structure*: (((… Ṽ $_{\omega\text{min}}$)$_{\omega\text{max}}$) ((X…) $_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$

φ

ωmax/min ωmax/min

[miɲɔ̃ ɔbʒe]

ṼX fully contained in φ only: Ṽ precedes all segments

In summary, restrictions on possible ṼX sequences depend on the number of prosodic constituent types that contain them. The more prosodic category types fully contain a ṼX sequence, the more restrictions hold on possible segments X.

We now turn to the formalization of these restrictions in a weighted constraint grammar. A number of works have shown that many influences on phonological patterns can be successfully modeled by scalar constraints, whose penalties are adjusted based on some contextual property. Scaling provides a parsimonious account for phonological patterns that depend on a prominence scale of some kind, including continuous phonetic values (Flemming 2001; Cho 2011; McAllister Byun 2011; Ryan 2011), the sonority scale (Pater 2012, 2016; Jesney 2015), trigger and target strength in vowel harmony (Kimper 2011), morphological locality in vowel harmony (McPherson and Hayes 2016), prosodic boundary strength (Hsu and Jesney 2016), distance from prosodic boundaries (Inkelas and Wilbanks 2017), lexical category and frequency (Coetzee and Kawahara 2013; Linzen et al. 2013), and degree of nativization (Hsu and Jesney 2017).

Here, we propose that markedness constraint violations are scaled according to the number of prosodic category types that fully contain the marked structure. Schematically, a constraint against a marked sequence *M* is defined such that its total penalty is adjusted based on the number of prosodic category types *P* that contain all segments of *M*. The restriction to full containment within a prosodic constituent resembles that of Selkirk's (1980) domain span rules, which apply only to segments that are dominated by a specified prosodic category. For each scalar constraint, we define a prominence scale that corresponds to a set of numerical values {0, 1, … n} and a constraint-specific scaling factor *s*.

Consider the definition of a scalar positional constraint that penalizes sequences of nasal vowels followed by sonorant consonants, *Ṽ[SON,CONS].

(10) $_{\text{P}}$(*Ṽ[SON,CONS])
Given a basic constraint weight *w*,
a scale {0, 1, … n} corresponding to some set of domains,
and a scaling factor *s*,
For any nasal vowel + sonorant sequence fully contained within a domain $d \in$ D,
Assign a weighted violation score of $w + s(d)$

The base violation w is incurred by any nasal vowel followed by a sonorant, regardless of where it occurs in the prosodic structure. Turning to the definition of the prominence scale, we'll rely on the observation that the number of prosodic constituent types that contain a Ṽ[SON,CONS] sequence can be restated in terms of the size of the smallest prosodic category that contains Ṽ[SON,CONS], assuming the principle of Layeredness on prosodic representations (Selkirk 1996). We will use this notation for the prominence scale {φ, ωmax, ωmin}, which corresponds to numerical values {0, 1, 2}. The total penalty calculations associated with P(*Ṽ[SON,CONS]) violations in the three relevant prosodic contexts are given below.

(11) *Sample calculations of penalties of* P(*Ṽ[SON,CONS])
Weight $w = 1$
Prominence scale = {φ, ωmax, ωmin}
Scaling factor $s = 2$

Ṽ[SON,CONS] across word boundary:	violation of 1 + s(φ) = 1 + 2(0) = 1
Ṽ[SON,CONS] across prefix boundary:	violation of 1 + s(ωmax) = 1 + 2(1) = 3
Ṽ[SON,CONS] within stem:	violation of 1 + s(ωmin) = 1 + 2(2) = 5

We can now address the basic weighting and scaling conditions that generate the French nasal vowel distribution, using the scalar markedness constraints P(*Ṽ[SON,CONS]) and P(*ṼV), which penalizes sequences of nasal vowels followed by another vowel, oral or nasal. For sake of illustration, assume that non-faithful candidates violate a single FAITH constraint. For now, we will also make the representational assumption that vowels are nasalized underlyingly, and that linking [n] in an output is epenthesized. A different representation will be proposed for the final analysis, as the adoption of gradient representations allows different input structures to be considered.

Recall the patterns that we wish to generate: For ṼX sequences that span a word boundary (fully contained only in φ), Ṽ is permitted before all segments. For ṼX sequences that span a prefix boundary (fully contained in φ, ωmax), Ṽ is not permitted before vowels. For stem-internal ṼX sequences (fully contained in φ, ωmax, ωmin), Ṽ is not permitted before sonorants or vowels. This is accomplished by the weights and scaling factors shown in Figure 1. The basic weight of FAITH, w=4, exceeds that of P(*Ṽ[SON,CONS]), w=1, and P(*ṼV), w=3. When the only prosodic constituent that fully contains the ṼX sequence is a φ, these weights are unaffected by the scaling factor, as φ has the value 0 on the prominence scale. Nasal vowel+oral vowel seqeuences and nasal vowel+sonorant consonant sequences surface faithfully. If the ṼX sequence is contained within both a φ and ωmax, the scaled penalty of P(*ṼV), 3+2(1) = 5, now exceeds the penalty of FAITH, predicting that nasal vowel+oral vowel sequences will be repaired. Because the penalty of FAITH still exceeds the scaled penalty of P(*Ṽ[SON,CONS]), 1+2(1) = 3, nasal vowels remain permitted before sonorant consonants. Finally, for ṼX sequences conained in a φ, ωmax, and ωmin, the scaled penalties of P(*ṼV), 3+2(2) = 7, and P(*Ṽ[SON]), 1+2(2) = 5 both exceed the penalty of FAITH, predicting that both marked sequences will be repaired.

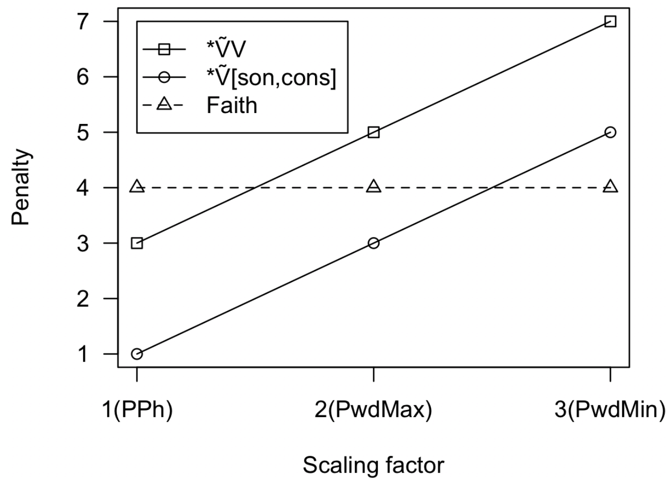


Figure 1: Prosodic context sensitivity generated by scalar markedness constraints.

The necessary weighting conditions are summarized below. In this notation, the name of each constraint stands for its basic weight, and the degree of scaling is indicated in parentheses. For instance, *Ṽ[son,cons](φ) should be read as 'the penalty incurred by a *Ṽ[son,cons] violation scaled to the prosodic phrase level of prominence.'

(12) Faith > *Ṽ[son,cons](φ), *ṼV(φ)
*ṼV(ωmax) > Faith > *Ṽ[son](ωmax)
*ṼV(ωmin), *Ṽ[son,cons](ωmax) > Faith

Breaking up Faith into the two constraints IdentNas, violated by output segments that differ from their input correspondent in having a [nasal] feature and Dep, violated by output segments with no input correspondent (McCarthy and Prince 1995), the pattern can be generated by the weights and scaling factors in the tableaux below. The input for each tableau contains a ṼV sequence, and each tableau compares three output candidates: (a) faithful surfacing of ṼV, (b) insertion of [n] following Ṽ, and (c) insertion of [n] and change from a nasal to oral vowel. Each tableau reflects one of the three prosodic structures discussed, and thus differs in the scaling applied to the positional markedness constraints. At each level of prosodic organization, constraint scaling alters the relative harmony of the three candidate types.

(13) ṼX fully contained in φ only: *mignon objet* 'cute object'

/miɲɔ̃ ɔbʒe/	IdentNas w=6	Dep w=4	*Ṽ[son,cons] w=1, s=3	*ṼV w=3, s=6	*H*
☞ $(((\text{miɲɔ̃})_{\omega min})_{\omega max}((\text{ɔbʒe})_{\omega min})_{\omega max})_{\varphi}$				-1_{φ}	-3
$(((\text{miɲɔ̃})_{\omega min})_{\omega max}((\text{n ɔbʒe})_{\omega min})_{\omega max})_{\varphi}$		-1	-1_{φ}		-5
$(((\text{miɲɔ})_{\omega min})_{\omega max}((\text{n ɔbʒe})_{\omega min})_{\omega max})_{\varphi}$	-1	-1			-10

(14) Ṽ X fully contained in φ, ωmax: *bien aimé* ‘well-liked’

/bjɛ̃ ɛme/	IDENTNAS w=6	DEP w=4	*Ṽ[SON,CONS] w=1, s=3	*ṼV w=3, s=6	*H*
((bjɛ̃ (ɛme)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$				-1$_{\omega max}$	-9
☞ ((bjɛ̃ (n ɛme)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$		-1	-1$_{\omega max}$		-8
((bjɛ (n ɛme)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$	-1	-1			-10

(15) Ṽ X fully contained in φ, ωmax, ωmin: Hypothetical input stem /ɔ̃œʁ/

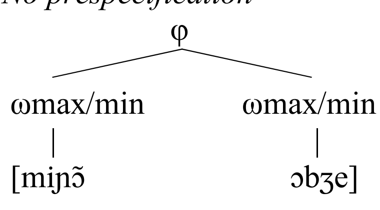
/ɔ̃œʁ/	IDENTNAS w=6	DEP w=4	*Ṽ[SON,CONS] w=1, s=3	*ṼV w=3, s=6	*H*
(((ɔ̃œʁ)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$				-1$_{\omega min}$	-15
(((ɔ̃nœʁ)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$		-1	-1$_{\omega min}$		-11
☞ (((ɔnœʁ)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$	-1	-1			-10

2.5 *Prosodic prespecification analysis of exceptional patterns*

Although the no liaison pattern has received little discussion aside from Sampson (2001), the contrast between the *commun objet* and *bon objet* patterns has received many analyses in rule-based generative phonology (more detailed overviews are given by Tranel 1981; 1992; Prunet 1986). While there is substantial variation in these accounts, all of them posit either [1] a difference in the rules or ordering of rules that applies to each class or [2] a constrast in underlying segments. For instance, Schane (1968; 1973) proposes an underlying /Vn/ form for both classes, but marks forms like *commun* as exceptions to a requirement that vowels are not nasalized before C$_{[\text{NASAL}]}$V sequences. Dell (1970; 1973) similarly maintains underlying /Vn/ for both classes, but proposes that they are subject to different orderings of vowel nasalization and resyllabification rules. Tranel (1981) posits a /Ṽ/ underlying form for both classes, and that only the *bon* class undergoes a minor rule of vowel denasalization in the context __nV. Selkirk (1972) maintains a single set of rules, but posits that *commun*-type items with non-alternating vowel quality have /Ṽn/ underlying forms, in contrast to /Vn/ for the *bon* class.

Alternatively, Hsu (2015) presents a prosodic prespecification analysis for each of the patterns treated as exceptional here. In this approach, pre-nominal adjectives have three possible prosodic representations. Regular pre-nominal adjectives that bear no prespecification are dominated by their own maximal prosodic word nodes. In accordance with the syntax-prosody correspondence that satisfies MATCH constraints, this ωmax node is a sister of the ωmax node corresponding to the following noun, and both ωmax nodes are contained within a single φ that corresponds to the full nominal phrase.

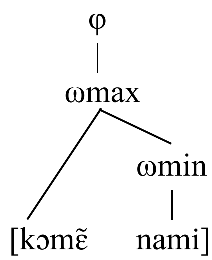
(16) *No prespecification*



mignon objet ‘cute object’

The first class of exceptions, words that trigger the *commun ami* pattern of liaison with a retained nasal vowel, have a prespecification to be dominated by the ωmax node of the following word. Note that this is the default prosodic organization of prefixes.

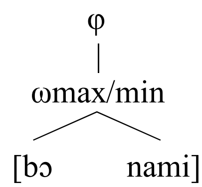
(17)



commun ami ‘common friend’

The second class of exceptions, those that trigger the *bon ami* pattern of liaison with an oral vowel, are prespecified to be contained within the ωmin node that dominates the following word. These items are in essence phrased as if they are part of the same stem as the following word.

(18)



bon ami ‘good friend’

An advantage of this approach is that all three classes of pre-nominal adjectives can receive a uniform segmental underlying form in final position. For instance, the same representation proposed for the final segment of *mignon*, /Ṽ/ can also be used for the *commun*- and *bon*- class exceptions. The difference in their optimal output forms is generated by the regular pattern of constraint interaction that applies at the prespecified level of prosodic constituency.

(19) Exceptional prespecification 1: *commun objet* ‘common object’

/kɔmɛ̃ ɔbʒe/	IDENTNAS w=6	DEP w=4	*Ṽ[SON,CONS] w=1, s=3	*ṼV w=3, s=6	*H*
((kɔmɛ̃ (ɔbʒe)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$				-1$_{\omega max}$	-9
☞ ((kɔmɛ̃ (nɔbʒe)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$		-1	-1$_{\omega max}$		-8
((kɔmɛ (nɔbʒe)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$	-1	-1			-10

(20) Exceptional prespecification 2: *bon objet* ‘good object’

/bɔ̃ ɔbʒe/	IDENTNAS w=6	DEP w=4	*Ṽ[SON,CONS] w=1, s=3	*ṼV w=3, s=6	*H*
(((bɔ̃ɔbʒe)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$				-1$_{\omega min}$	-15
(((bɔ̃nɔbʒe)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$		-1	-1$_{\omega min}$		-11
☞ (((bɔnɔbʒe)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$	-1	-1			-10

The exceptional allomorphy of the prefix *in-* can be accounted for with the same prosodic prespecification of *bon*-class adjectives: *in-* is prespecified to be contained in the ωmin node of the root that it attaches to. The allomorphic pattern of *in-* is sensitive to the sonority of the following consonant simply because the constraint against nasal vowels followed by sonorants is enforced within ωmin.

(21)

φ
|
ωmax/min
[in abil] *inhabile* 'unskillful'

(22) Exceptional prespecification of *in-* : *inhabile* 'unskillful'

/ɛ̃ abil/	IDENTNAS w=6	DEP w=4	*Ṽ[SON,CONS] w=1, s=3	*ṼV w=3, s=6	*H*
(((ɛ̃abil)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$				-1$_{\omega min}$	-15
(((ɛ̃nabil)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$		-1	-1$_{\omega min}$		-11
☞ (((inabil)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$	-1	-1			-10

Although the prosodic prespecification approach successfully captures the generalization that each exceptional pattern resembles the regular pattern at a different level of prosodic constituency, it introduces additional complexity to the phonological grammar. First, it requires the theory of syntax-prosody correspondence to allow for morpheme-specific idiosyncracy. In addition, in order to enforce morpheme-specific syntax-prosody mismatches in a constraint-based theory, the grammar must include contain constraints that enforce morpheme-specific prespecifications like SUBCAT (Tyler 2017, Bennett et al. *to appear*), which can compel violations of MATCH constraints. While these claims may ultimately receive sufficient independent justification from other phonological patterns, we will seek an alternative approach that obviates these additions to the theory.

The prosodic prespecification analysis also faces an empirical difficulty in that *in-* displays a mix of prefix-like and stem-like phonological properties. Tranel (1976) notes that for some speakers, *in-* preceding a sonorant-initial stem can optionally be realized with a geminate version of the stem-initial segment (ex. [il(l)egal] 'illegal', [im(m)ɔʁal] 'immoral'). Tranel shows that the optional degemination pattern is a general characteristic of Standard French prefixes, as seen in the examples in (23). Although some speakers permit stem-internal geminates in forms like [gʁammɛʁ] 'grammar,' optional degemination seems to be a property specific to prefixes.

(23) [tʁɑ̃(s)saaʁjɛ̃] 'trans-Saharian'
[di(s)sɑ̃blabl] 'dissimilar'
[sy(ʁ)ʁealism] 'Surrealism' (Tranel 1976)

If the optional degemination process reflects the basic prosodic organization of prefixes, the pre-specification analysis leads to a bracketing paradox, as *in-* is predicted to obey all prosody-sensitive generalizations that apply to stems, but not to regular prefixes.

2.6 *A cyclic approach and its challenges*

We can also consider whether the nasal vowel pattern can be accounted for in terms of a cyclic derivational model of phonology, such as Stratal Optimality Theory (Bermúdez-Otero 1999; Kiparsky 2000). In this approach, constraint evaluation takes place in cycles, at the stem level, word level, and phrase levels. The output structures created on one cycle form the inputs for later cycles of constraint evaluation. In this approach, the weakening of restrictions against ṼX sequences across larger morpho-syntactic boundaries is predicted if faithfulness constraints become higher-ranked in later cycles. The rankings on each cycle that generate this pattern are shown below. At the stem level, both markedness constraints *ṼV and *Ṽ[SON,CONS] outrank FAITH; Outputs of the stem-level cycle thus only contain nasal vowels preceding obstruents. On the word cycle, FAITH outranks *Ṽ[SON,CONS]. Sequences of of nasal vowels followed by sonorants thus surface faithfully if they are created by morpheme concatenation within the word. Lastly, the ranking of FAITH above both markedness constraints at the phrase level predicts that nasal vowels can precede any segment across a word boundary.

(24) Stem-level ranking: *ṼV, *Ṽ[SON,CONS] >> FAITH
Word-level ranking: *ṼV >> FAITH >> *Ṽ[SON,CONS]
Phrase-level ranking: FAITH >> *ṼV, *Ṽ[SON]

However, it becomes difficult to generate the patterning of exceptional items in this approach. One could entertain a type of prespecification in which certain morpheme combinations undergo cyclic constraint evaluation at an earlier stage than expected. For instance, it could be specified that *commun* + noun sequences are exceptionally evaluated by the word-level grammar, while *bon* + noun sequences are exceptionally evaluated at the stem-level grammar. However, this leads to an unorthodox complication of cyclic spell-out rules, which are not expected to be sensitive to lexical idiosyncracy. One is thus forced to propose either distinct underlying segments for each exceptional class, morpheme-specific constraints, or introduce prosodic prespecification independently, all of which make the analysis substantially less parsimonious.

3 Exceptional prosodification effects and gradient symbolic representations

3.1 A Gradient Harmonic Grammar alternative

Smolensky et al. (2014) and Smolensky and Goldrick (2016) propose that individual discrete symbols manipulated by grammars have a degree of presence in their input representation, and that the degree of presence of a symbol, its *activity*, can take continuously gradient values. These gradient activity values are directly relevant to grammatical computation in a weighted constraint system like Harmonic Grammar. The penalty of a constraint violation is proportional to the activity of the structure that incurs the violation.

Given that grammatical outputs are determined by comparing the harmony scores of competing output candidates, a key consequence of this proposal is that changes to the underlying activity of otherwise identical symbols can lead to different optimal outputs, while assuming a uniform set of constraints and constraint weights. This is illustrated in the simplified example below. Both tableaux contain the same input segments /pak/, but differ only in the activity of /k/. Under the assumption that all symbols in output candidates have integer activity values (but cf. Zimmermann

2017 for arguments for gradient activation in outputs), this predicts the following effects on the evaluation of faithfulness constraints. The violation of DEP is proportional to the amount of activity that needs to be added to bring a segment's activation to 1. Thus, DEP's contribution to the total harmony of the first candidate in (25), which realizes [k] in the output, is the weight of the constraint (*w*=2) multiplied by 1 minus its underlying activity, 2(1-0.75) = 0.5. Likewise, the violation of MAX is proportional to the underlying activity of a segment that is deleted in the output. MAX's contribution to the total harmony of the second candidate in (25), in which /k/ is deleted, is the weight of the constraint (*w*=4) multiplied by its underlying activity, 4(0.75) = 3. Compare this interaction with the one in tableau (26), in which /k/ has an activity of 0.25. This alters the harmony scores of both candidates, such that the coda deletion candidate now has the highest total harmony.

(25)

/$p_1a_1k_{0.75}$/	DEP w=2	MAX w=4	NOCODA w=1	*H*
☞ pak	-0.25(k)		-1(k)	-1.5
pa		-0.75(k)		-3

(26)

/$p_1a_1k_{0.25}$/	DEP w=2	MAX w=4	NOCODA w=1	*H*
pak	-0.75(k)		-1(k)	-2.5
☞ pa		-0.25(k)		-1

This paper focuses on a key prediction made in Gradient Harmonic Grammar: Changes to levels of gradient activity of otherwise identical inputs can replicate the effects of scaling based on prosodic context. This can be illustrated by revisiting the schematic example discussed in Section 2.4, a grammar that contains scalar markedness constraints P(*Ṽ[SON,CONS]) and P(*ṼV), and where non-faithful candidates incur a single violation of FAITH. Now let's suppose that input structures can vary in their degree of gradient activation, and that the penalty incurred by a violation of FAITH is proportional to the underlying level of activity. As shown below in Figure 2, when the input structure has an activity level 1.0, the constraint interaction is identical to the pattern in Figure 1. This is compared to the predicted patterning of inputs with activity levels of 0.5 and 0.1, which proportionally reduce the FAITH penalty.

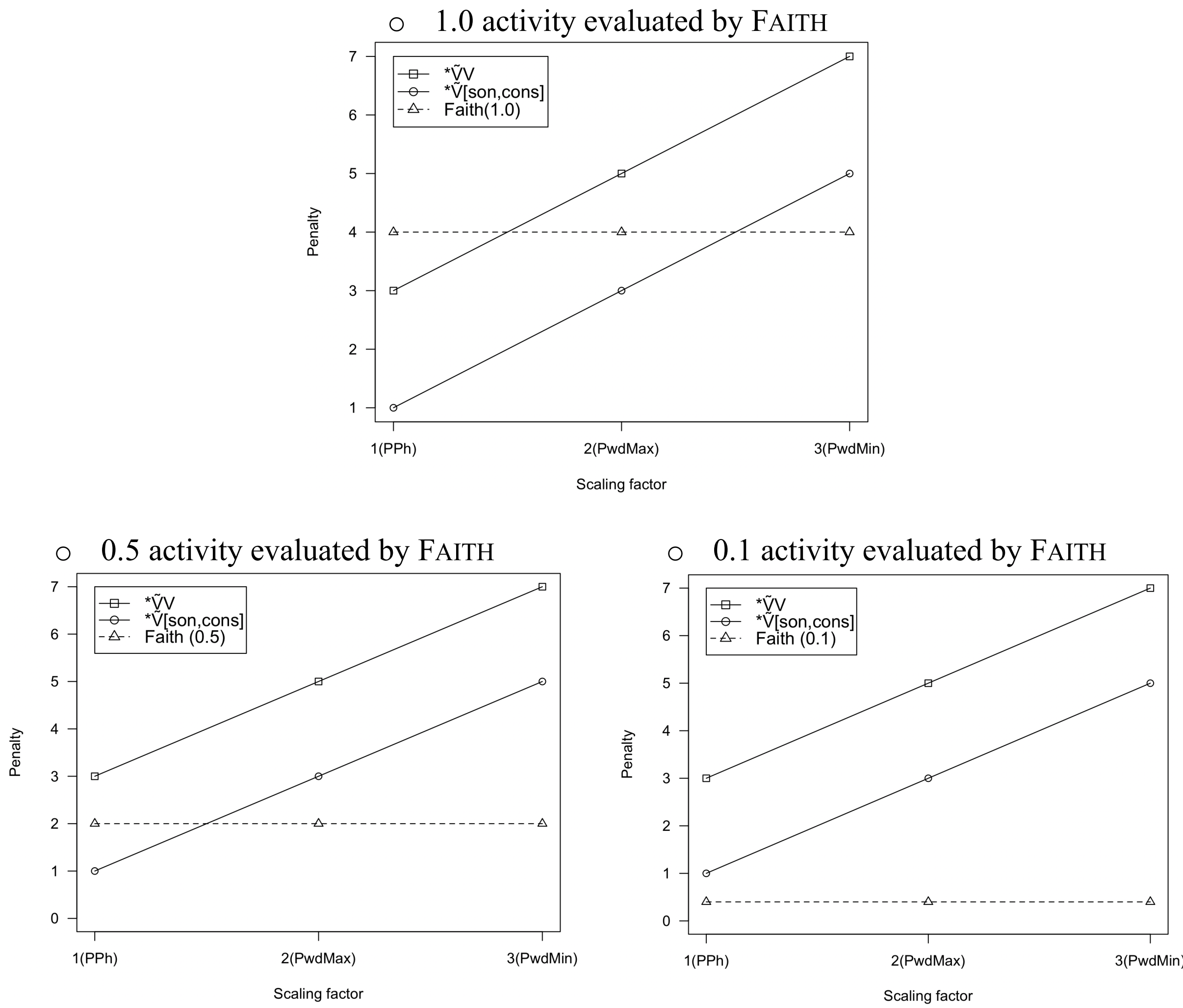


Figure 2: Effects of gradient activation and scalar markedness constraints on harmony

Looking only at the φ level of scaling, we see that the lower levels of activity alter the relative penalties of the three constraints. At 0.5 activity, the P(*ṼV) penalty now exceeds that of FAITH, which continues to exceed the P(*Ṽ[SON,CONS]) penalty. This is identical to the relative harmony pattern predicted for a representation with 1.0 activity at the ωmax level of scaling. At 0.1 activity, the penalty of each markedness constraint exceeds that of FAITH. This is identical to the relative harmony predicted for 1.0 activity at the ωmin level of scaling. In essence, a reduction in underlying activity results in the same effects on global harmony as constraint scaling, producing the surface effect of exceptional prosodification.

It is important to note another key prediction of the analysis, that lexical items with reduced activity should pattern exceptionally at all levels of prosodic organization in which they occur. For instance, when ωmax scaling is applied to items with 0.5 activity, they are predicted to pattern like items with 1.0 activity at ωmin scaling. Unfortunately, this particular prediction cannot be fully evaluated in French, as the lexical items in question do not have this type of variability in morpho-syntactic attachment. It is possible for the exceptional pre-nominal adjectives like *commun* and *bon* to appear phrase-finally (ṼX not contained within a φ). However, our approach predicts that they should be more likely to surface with a nasal vowel, and indeed they uniformly end with a nasal vowel in phrase-final position.

3.2 Gradient symbols analysis of the regular pattern

We now turn to the representation of nasal vowels, and how the interaction between contrasts in gradient activity and prosodic constraint scaling discussed in the previous subsection can be applied to the analysis of ṼX sequences with a full constraint set.

Smolensky and Goldrick (2016) show that the greater representational power of Gradient Harmonic Grammar allows new analytical solutions to recalcitrant problems faced by prior analyses. Specifically, certain patterns where discrete symbolic approaches find conflicting evidence for representations A and B can be generated from representations that contain both gradiently active A and gradiently active B. There is a clear parallel to this general line of analysis in the problem of nasal vowels and linking [n], as many underlying representations have been proposed for nasal vowels in Standard French, each on the basis of a different set of generalizations. For example, nasal vowels have been claimed to have underlying forms /Vn/ (Schane 1968; Dell 1970), /Ṽ/ (Tranel 1981), /Ṽn/ or /Vn/ depending on lexical item (Selkirk 1972), or /V/ followed by a floating nasal segment unassociated with a timing slot (Prunet 1986). Note that this range of proposed representations essentially reflects the variety of surface forms associated with lexical items that are realized with a nasal vowel in some environment.

The main generalization to be captured is that lexical items that end with nasal vowels in isolation can in some environments vary in their propensity to [1] maintain vowel nasalization and [2] surface with linking [n]. I propose that this can be captured in Gradient Harmonic Grammar by positing a unique symbolic underlying representation /Ṽn/. However, lexical items vary in [1] the underlying activity level of the vowel's [NASAL] feature and [2] the underlying activity level of the nasal consonant's root node.

Variation in these two dimensions of activity in part determine whether the vowel maintains its [NASAL] feature and whether the nasal consonant is deleted in the optimal output. Our analysis will thus consider two faithfulness constraints, IDENT[NASAL] and MAX, whose violations are again proportional to the activity of underlying forms. The penalty of IDENT[NASAL] depends on the input activity of the altered [NASAL] feature, while the penalty of MAX depends on the input activity level of the deleted segment. These faithfulness constraints will interact with the aforementioned scalar markedness constraints $_{P}$(*Ṽ[SON,CONS]) and $_{P}$(*ṼV).

Given this constraint set, we can first establish the weighting and scaling conditions that are necessary to generate the regular pattern of sensitivity to prosodic embedding. In all instances of EVAL, the grammar compares the relative harmony of three relevant output candidates: one that deletes /n/ while maintaining vowel nasalization [Ṽ], one that realizes vowel nasalization and /n/ faithfully [Ṽn], and one that realizes /n/ but not vowel nasalization [Vn]. For an input that contains the sequence /ṼnV/, the following constraint violations are associated with each mapping:

(27)	*Input-out mapping*	*Constraints violated*
	/ṼnV/ → [ṼV]	*ṼV, MAX
	/ṼnV/ → [ṼnV]	*Ṽ[SON,CONS]
	/ṼnV/ → [VnV]	IDENT[NAS]

At each level of constraint scaling, the relative harmony differs among the candidates that correspond to each output form. The weighting conditions can thus be stated as in (28). Again, the step on the prominence scale that affects the scaling of the markedness constraints is shown in parentheses after the name of the constraint. The activity level of non-exceptional lexical items is shown as the variable α. Note that the actual activity levels of /n/ and the vowel's [NASAL] feature need not be identical, as we will shortly see.

(28) a. *Weighting conditions for ṼX sequences across word boundaries*
IDNAS(α) , *VSON(φ) > *VV(φ) + *MAX(α)

b. *Weighting conditions for ṼX sequences across prefix boundaries*
IDNAS(α), *VV(ωmax) + *MAX(α) > *VSON(ωmax)

c. *Weighting conditions for stem-internal ṼX sequences*
*VV(ωmin) + *MAX(α) , *VSON(ωmin) > IDNAS(α)

One set of activity levels, constraint weights, and scaling factors that satisfies these conditions is shown in the following tableaux. For regular pre-nominal adjectives, the final nasal vowel has a [NASAL] feature with 0.75 activity, followed by /n/ with 0.25 activity.

(29) ṼX contained in φ only: *mignon objet*

/miɲɔ̃$_{[NASAL]0.75}$ n$_{0.25}$ ɔbʒe/	MAX w=4	ID[NAS] w=15	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
☞ (((miɲɔ̃)$_{\omega mn}$)$_{\omega mx}$ ((ɔbʒe)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$	-0.25			-1$_{\varphi}$	-5
(((miɲɔ̃)$_{\omega mn}$)$_{\omega mx}$((nɔbʒe)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$			-1$_{\varphi}$		-5.5
(((miɲɔ)$_{\omega mn}$)$_{\omega mx}$ ((nɔbʒe)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$		-0.75			-11.25

(30) ṼX contained in φ, ωmax: *bien aimé*

/bjɛ̃$_{[NASAL]0.75}$ n$_{0.25}$ ɛme/	MAX w=4	ID[NAS] w=15	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
((bjɛ̃ (ɛme)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$	-0.25			-1$_{\omega max}$	-12
☞ ((bjɛ̃ (nɛme)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$			-1$_{\omega max}$		-8.5
((bjɛ (nɛme)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$		-0.75			-11.25

(31) ṼX contained in φ, ωmax, ωmin: *hypothetical input for 'honneur'*

/ɔ̃$_{[NASAL]0.75}$ n$_{0.25}$œʁ/	MAX w=4	ID[NAS] w=15	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
(((ɔ̃œʁ)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$	-0.25			-1$_{\omega min}$	-19
(((ɔ̃nœʁ)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$			-1$_{\omega min}$		-11.5
☞ (((ɔnœʁ)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$		-0.75			-11.25

3.3 Pre-nominal adjectives and exceptionality

We can now illustrate how the exceptions to the regular pattern can be generated from differences in underlying activity. Recall that the three classes of pre-nominal adjectives differ in whether they surface with linking [n] before vowel-initial words, and the items that surface with [n] further vary in whether or not vowel nasalization is maintained. This translates straightforwardly into a gradient symbolic analysis in terms of variation in the input activity levels of the vowel's [NASAL] feature and the nasal consonant's root node.

Again, we can first consider abstractly the conditions on weighting, scaling, and activity that generate the exceptional pre-nominal adjective patterns. The activity levels of lexical items that generate the *commun objet* pattern (linking [n] with a nasal vowel) are represented by the variable β. The activity levels of items that generate the *bon objet* pattern (linking [n] with a oral vowel) are represented by the variable γ.

(32) a. *Weighting conditions for exceptional pattern 1 (linking* [n] *with nasal vowel)*
IDNAS(β) , MAX(β) + *VV(φ) > *VSON(φ)

b. *Weighting conditions for exceptional pattern 2 (linking* [n] *with oral vowel)*
MAX(γ) + *VV(φ) , *VSON(φ) > IDNAS(γ)

Retaining the constraint weights and scaling factors from the previous subsection, the exceptional pre-nominal adjective patterns are generated by the following activity levels. Exceptional pattern 1, liaison with a nasal vowel, arises from 0.5 activity of the vowel's [NASAL] feature and 0.5 activity of /n/. Exceptional pattern 2, liaison with an oral vowel, arises from 0.25 activity of the vowel's [NASAL] feature and 0.75 activity of /n/. The tableaux corresponding to the three pre-nominal adjective patterns are shown below. All output candidates have the same prosodic representation (9), and tableau (29) showing the regular *mignon objet* no linking [n] pattern is repeated here as (33).

(33) ṼX contained in φ only: *mignon objet*

/miɲɔ̃$_{\text{[NASAL]}0.75}$ n$_{0.25}$ ɔbʒe/	MAX w=4	ID[NAS] w=15	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
☞ (((miɲɔ̃)$_{\omega mn}$)$_{\omega mx}$ ((ɔbʒe)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$	-0.25			-1$_{\varphi}$	-5
(((miɲɔ̃)$_{\omega mn}$)$_{\omega mx}$((nɔbʒe)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$			-1$_{\varphi}$		-5.5
(((miɲɔ)$_{\omega mn}$)$_{\omega mx}$ ((nɔbʒe)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$		-0.75			-11.25

(34) Exceptional pattern 1: Resembles regular pattern within ωmax

/kɔmɛ̃$_{\text{[NASAL]}0.5}$ n$_{0.5}$ ɔbʒe/	MAX w=4	ID[NAS] w=15	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
(((kɔmɛ̃)$_{\omega mn}$)$_{\omega mx}$ ((ɔbʒe)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$	-0.5			-1$_{\varphi}$	-6
☞ (((kɔmɛ̃)$_{\omega mn}$)$_{\omega mx}$ ((nɔbʒe)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$			-1$_{\varphi}$		-5.5
(((kɔmy)$_{\omega mn}$)$_{\omega mx}$ ((nɔbʒe)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$		-0.5			-7.5

(35) Exceptional pattern 2: Resembles regular pattern within ωmin

/bɔ̃$_{\text{[NASAL]}0.25}$ n$_{0.75}$ ɔbʒe/	MAX w=4	ID[NAS] w=15	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
(((bɔ̃)$_{\omega mn}$)$_{\omega mx}$ ((ɔbʒe)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$	-0.75			-1$_{\varphi}$	-7
(((bɔ̃)$_{\omega mn}$)$_{\omega mx}$ ((nɔbʒe)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$			-1$_{\varphi}$		-5.5
☞ (((bɔ)$_{\omega mn}$)$_{\omega mx}$ ((nɔbʒe)$_{\omega mn}$)$_{\omega mx}$)$_{\varphi}$		-0.25			-3.75

3.4 Prefix allomorphy and exceptionality

We return to analysis of prefix allomorphy, first discussing the general patterning of prefixes with nasal vowels before turning to exceptional *in-*. In the previous section, we saw that the current constraint set acounts for the surfacing of both input segments of /Ṽn/ before vowel-initial stems like [bjɛ̃n-ɛme] ‘well-liked. However, tableau (36) shows that it incorrectly predicts the same output form before sonorant-initial stems.

(36) *Regular prefix before sonorant-initial stem*

/nɔ̃ $_{\text{[NASAL]}0.75}$ n$_{0.25}$ ʁœspe /	MAX w=4	ID[NAS] w=15	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
((nɔ̃ (ʁœspe)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$	-0.25		-1$_{\omega max}$		-9.5
💣 ((nɔ̃ (nʁœspe)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$			-1$_{\omega max}$		-8.5
((nɔ (nʁœspe)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$		-0.75			-11.25

This can be resolved by including a constraint against sequences of nasal consonants followed by another consonant, *NC. While in principle we may expect this constraint to be scaled like the other markedness constraints, there are no patterns that require a scalar constraint for the present analysis. The activation level of regular prefixes items is represented by the variable α.

(37) *Weighting conditions for regular prefix allomorphy*
IDNAS(α), *NC + *ṼSON(ωmax) > MAX(α) + *ṼSON(ωmax)
IDNAS(α) , *NC + *ṼSON(ωmax) > MAX(α) + *ṼV(ωmax)

(38) *Regular prefix before sonorant-initial stem*

/nɔ̃ $_{\text{[NASAL]}0.75}$ n$_{0.25}$ ʁœspe /	MAX w=4	ID[NAS] w=15	*NC W=2.5	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
☞ ((nɔ̃ (ʁœspe)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$	-0.25			-1$_{\omega max}$		-9.5
((nɔ̃ (nʁœspe)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$			-1	-1$_{\omega max}$		-11
((nɔ (nʁœspe)$_{\omega min}$)$_{\omega max}$)$_{\varphi}$		-0.75	-1			-13.75

(39) *Regular prefix before obstruent-initial stem*

/nɔ̃$_{[\text{NASAL}]0.75}$ n$_{0.25}$ fɔ̃ksjɔ̃ /	MAX w=4	ID[NAS] w=15	*NC w=2.5	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
☞ ((nɔ̃ (fɔ̃ksjɔ̃)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$	-0.25					-1
((nɔ̃ (nfɔ̃ksjɔ̃)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$			-1	-1$_{\omega\text{max}}$		-11
((nɔ (nfɔ̃ksjɔ̃)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$		-0.75	-1			-13.75

(40) *Regular prefix before vowel-initial stem*

/nɔ̃$_{[\text{NASAL}]0.75}$ n$_{0.25}$ inisje/	MAX w=4	ID[NAS] w=15	*NC w=2.5	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
((nɔ̃ (inisje)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$	-0.25				-1$_{\omega\text{max}}$	-12
☞ ((nɔ̃ (ninisje)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$				-1$_{\omega\text{max}}$		-8.5
((nɔ (ninisje)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$		-0.75				-11.25

Here, it is worth addressing Tranel's (1981) arguments against the rule-based approaches of Schane (1968) and Dell (1973) that propose a mapping of underlying /VN/ forms to nasal vowels preceding consonants VN → Ṽ / __ C. Tranel argues that the rule cannot be justified because a number of stems are realized with VN sequences, such as [syspɛns] 'suspense,' [bins] 'disorder,' [amnisti] 'amnesty.' As similarly noted by Smolensky and Goldrick (2016), this pattern can explained in a gradient symbols framework if the fixed nasal consonants in these forms have higher activity than the alternating nasal consonants found in prefix forms, such that within stems deletion is never a more harmonic output than maintaining the NC sequence.

We now turn to the patterning of *in-*. Here, we consider four possible output mappings of /Ṽn/, which either realize both segments faithfully, delete the nasal consonant, alter the vowel's [NASAL] feature, or make both changes. In addition, we consider the markedness constraints violated depending on whether /Ṽn/ precedes a vowel, sonorant consonant, or obstruent.

(41)

Input-out mapping	*Constraints violated*
/ṼnV/ → [ṼV]	*ṼV, MAX
/ṼnV/ → [ṼnV]	*Ṽ[SON,CONS]
/ṼnV/ → [VnV]	IDENT[NAS]
/ṼnV/ → [VV]	IDENT[NAS], MAX
/ṼnC$_{[\text{SON}]}$/ → [ṼC$_{[\text{SON}]}$]	*Ṽ[SON,CONS], MAX
/ṼnC$_{[\text{SON}]}$/ → [ṼnC$_{[\text{SON}]}$]	*NC, *Ṽ[SON,CONS]
/ṼnC$_{[\text{SON}]}$/ → [VnC$_{[\text{SON}]}$]	*NC, IDENT[NAS]
/ṼnC$_{[\text{SON}]}$/ → [VC$_{[\text{SON}]}$]	IDENT[NAS], MAX
/ṼnC$_{[\text{-SON}]}$/ → [ṼC$_{[\text{-SON}]}$]	MAX
/ṼnC$_{[\text{-SON}]}$/ → [ṼnC$_{[\text{-SON}]}$]	*NC, *Ṽ[SON,CONS]
/ṼnC$_{[\text{-SON}]}$/ → [VnC$_{[\text{-SON}]}$]	*NC, IDENT[NAS]
/ṼnC$_{[\text{-SON}]}$/ → [VC$_{[\text{-SON}]}$]	IDENT[NAS], MAX

From this, we can establish the weighting conditions that generate the *in-* pattern with three allomorphs, [ɛ̃] before obstruent-initial stems, [i] before sonorant-initial stems, and [in] before vowel-initial stems. The activity levels needed to generate this pattern are represented by the variable δ in the following weighting conditions:

(42) *Weighting conditions for exceptional patterning of* in-
MAX(δ) + IDNAS(δ) , ṼSON(ωmax), MAX(δ) + *ṼV > IDNAS(δ)
IDNAS(δ)+*NC, *NC + ṼSON(ωmax), MAX(δ) + ṼSON(ωmax) > MAX(δ) + IDNAS(δ)

Maintaining all of the previously used constraint weights and scaling factors, one concrete set of activity levels that generates this pattern is 0.5 activity of the vowel's [NASAL] feature and 0.5 activity of /n/.[3]

(43) In- *before vowel initial stem*

/ɛ̃$_{[\text{NASAL}]0.5}$ n$_{0.5}$ abil/	MAX w=4	ID[NAS] w=15	*NC w=2.5	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
((ɛ̃ (abil)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$	-0.5				-1 $_{\omega\text{max}}$	-13
((ɛ̃ (nabil)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$				-1 $_{\omega\text{max}}$		-8.5
☞ ((i (nabil)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$		-0.5				-7.5
((i (abil)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$	-0.5	-0.5				-9.5

(44) In- *before sonorant-initial stem*

/ɛ̃$_{[\text{NASAL}]0.5}$ n$_{0.5}$ legal/	MAX w=4	ID[NAS] w=15	*NC w=2.5	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
((ɛ̃ (legal)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$	-0.5			-1 $_{\omega\text{max}}$		-10.5
((ɛ̃ (nlegal)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$			-1	-1 $_{\omega\text{max}}$		-11
((i (nlegal)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$		-0.5	-1			-10
☞ ((i (legal)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$	-0.5	-0.5				-9.5

(45) In- *before obstruent-initial stem*

/ɛ̃$_{[\text{NASAL}]0.5}$ n$_{0.5}$ pɔsibl/	MAX w=4	ID[NAS] w=15	*NC w=2.5	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
☞ ((ɛ̃ (pɔsibl)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$	-0.5					-2
((ɛ̃ (npɔsibl)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$			-1	-1 $_{\omega\text{max}}$		-10.5
((i (npɔsibl)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$		-0.5	-1			-10.5
((i (pɔsibl)$_{\omega\text{min}}$)$_{\omega\text{max}}$)$_{\varphi}$	-0.5	-0.5				-9.5

[3] The current constraint set does not explain the change in vowel height between the underlying and surface forms. A possible solution here is to posit an underlying form that includes a high front nasal vowel /ĩ/ that never surfaces faithfully due to a highly weighted constraint against surface [ĩ] (cf. Schane 1968; Tranel 1974 for similar rule-based accounts).

3.5 No lexical exceptionality in phrase-final position

Lastly, our proposed grammar should account for the fact all pre-nominal adjectives surface in φ-final positions with a final nasal vowel and no [n]. It must be the case then that none of the exceptional activation patterns alter the relative penalties of MAX, IDENT[NASAL], and *Ṽ[SON,CONS] when the latter is scaled to φ.

(46) *Weighting conditions to ensure no exceptionality in phrase-final position*
*VSON(φ), IDNAS(α) > MAX(α)
*VSON(φ), IDNAS(β) > MAX(β)
*VSON(φ), IDNAS(γ) > MAX(γ)

The concrete activity levels previously proposed are consistent with these conditions, as shown in the following tableaux for phrase-final *commun* and phrase-final *bon*.

(47) Phrase-final *commun*

/…kɔmɛ̃$_{[NASAL]0.5}$ n$_{0.5}$/	MAX w=4	ID[NAS] w=15	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
☞ … kɔmɛ̃)$_{ωmin}$)$_{ωmax}$)$_φ$	-0.5				-2
… kɔmɛ̃n)$_{ωmin}$)$_{ωmax}$)$_φ$			-1$_φ$		-8.5
… kɔmyn)$_{ωmin}$)$_{ωmax}$)$_φ$		-0.5			-7.5

(48) Phrase-final *bon*

/…bɔ̃$_{[NASAL]0.25}$ n$_{0.75}$/	MAX w=4	ID[NAS] w=15	*Ṽ[SON,CONS] w=5.5, s=3	*ṼV w=4, s=7	*H*
☞ … bɔ̃)$_{ωmin}$)$_{ωmax}$)$_φ$	-0.75				-3
… bɔ̃n)$_{ωmin}$)$_{ωmax}$)$_φ$			-1$_φ$		-8.5
… bɔn)$_{ωmin}$)$_{ωmax}$)$_φ$		-0.25			-3.25

3.6 Summary

To summarize the results of this section, we have shown that the complex distribution of nasal vowels in Standard French, which is sensitive to both prosodic organization and lexical exceptionality, can be generated in Gradient Harmonic Grammar with a uniform /Ṽn/ underlying form for lexical items with a nasal vowel allomorph, and without lexical exceptionality in prosodic organization. No prior analysis of the pattern without gradient symbols is able to satisfy both of these desiderata. The full set of conditions on the interaction of scalar constraints and varying levels of activity are summarized in (49).

(49) a. *Weighting conditions for regular pattern of prosodic structure sensitivity*
IDNAS(α) , *VSON(φ) > *VV(φ) + *MAX(α)
IDNAS(α), *VV(ωmax) + *MAX(α) > *VSON(ωmax)
*VV(ωmin) + *MAX(α) , *VSON(ωmin) > IDNAS(α)

b. *Weighting conditions for exceptional patterning of pre-nominal adjectives*
IDNAS(β) , MAX(β) + *VV(φ) > *VSON(φ)
MAX(γ) + *VV(φ) , *VSON(φ) > IDNAS(γ)

c. *Weighting conditions for regular prefix allomorphy*
IDNAS(α), *NC + *ṼSON(ωmax) > MAX(α) + *ṼSON(ωmax)
IDNAS(α) , *NC + *ṼSON(ωmax) > MAX(α) + *ṼV(ωmax)

d. *Weighting conditions for exceptional pattern of prefix* in-
MAX(δ) + IDNAS(δ) , ṼSON(ωmax), MAX(δ) + *ṼV > IDNAS(δ)
IDNAS(δ)+*NC, *NC+ṼSON(ωmax), MAX(δ)+ṼSON(ωmax) > MAX(δ)+IDNAS(δ)

e. *Weighting conditions to ensure no exceptional adjectives in phrase-final position*
*VSON(φ), IDNAS(α) > MAX(α)
*VSON(φ), IDNAS(β) > MAX(β)
*VSON(φ), IDNAS(γ) > MAX(γ)

4. Conclusions

This paper has shown that the adoption of scalar constraints and gradient symbolic structures in a weighted consraint grammar can provide novel analyses and explanations for challenging cases of lexical exceptionality. In Gradient Harmonic Grammar, apparent exceptional prosodification effects arise from the fact that contrasts in activity across lexical items can produce the same effects on output selection as constraint scaling. The existence of this type of interaction across apparently separate dimensions of structure is a key prediction of a weighted constraint grammar in which all constraint violations contribute to total harmony.

It should be noted that our proposal predicts other possible interactions between contrasts in gradient activity and prosodic constraint scaling. In the Standard French case, the activity levels associated with exceptional lexical items have the same effect on total harmony as an increase in the prosodic scaling factor. The result is that exceptional items pattern as if they are contained within more prosodic categories than expected from the default syntax-prosody mapping. This approach also predicts the existence of patterns where exceptional items pattern as if they are contained within *fewer* prosodic categories than expected. This type of pattern has been described by Poser (1990) for Aoyagi prefixes in Standard Japanese, a class of prefixes whose tonal patterns suggest that they introduce a type of φ boundary within morphological words. While Poser analyzes these apparent cases of "word-internal phrase boundary" as the result of prosodic prespecification, our proposal shows that an alternative analysis without prespecification may be possible.

This paper, along with recent analyses by Smolensky and Goldrick (2016), Zimmermann (2017), and Rosen (*to appear*), has shown that contrastive gradient activation can account for many cases of lexical exceptionality and variability across lexical items in their propensity to undergo a variety of processes. Taken together, the results of these proposals allow for a more parsimonious theory of possible phonological representations. Contrasts in the gradient activation of symbolically identical underlying forms obviate the need to propose additional structures or prespecifications for each individual exceptional pattern.

Lastly, our proposal invites a broader reconsideration of current approaches to syntax-prosody mapping parameters. For instance, the observation that the exponents of functional heads and phrases are often exempt from phonological generalizations that hold for exponents of lexical ones has been taken to indicate that functional heads and projections are ignored by syntax-prosody mapping constraints (Selkirk 1996; Truckenbrodt 1999). The present study suggets that some of these patterns can be explained in a syntax-prosody mapping that does not distinguish between lexical and functional projections if the exponents of functional items differ systematically in their activity from the exponents of lexical ones. This follows recent works that similarly question the need for mapping parameters to distinguish between these two types of categories (Elfner 2012; Tyler 2017), permitting a more restrictive theory of syntax-prosody correspondence.

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