

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 select a non-default prosodic representation. This paper argues that prespecification approaches should be reconsidered, and that such patterns are predicted without morpheme-specific prosody in Gradient Harmonic Grammar (Smolensky and Goldrick 2016), a weighted constraint system with gradiently active symbols. Exceptional prosodification effects result from the interaction of two constraint penalty manipulations: [1] scaling of constraint violations by prosodic context (Hsu and Jesney 2016) and [2] contrastive activity levels in underlying forms. This interaction is illustrated with 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

Lexical exceptions, patterns in which a restricted set of morphemes unexpectedly undergoes or fails to undergo a phonological process, can shed light on key properties of the phonological grammar. This paper discusses what I term *exceptional prosodification effects*, cases in which exceptional lexical items pattern as if they have a different prosodic representation than expected. I focus on several such cases in the distribution of nasal vowels in Standard French. In brief, the language places restrictions on the types of segments that can follow nasal vowels, i.e. possible $\tilde{V}X$ sequences. This distribution is generally sensitive to morpho-syntactic constituency: the larger the juncture between \tilde{V} and X , the more types of segments X are permitted. However, several exceptional items show stronger than expected restrictions on $\tilde{V}X$ sequences at junctures, in each case resembling a regular pattern that applies within a smaller domain.

Exceptional prosodification effects have generally been accounted for in terms of *prosodic prespecification* (a.k.a. *prosodic subcategorization*); some lexical items subcategorize for a non-default prosodic representation (Inkelas 1989; Poser 1990; Zec 2005; Paster 2006; Tyler 2017; Bennett et al. 2018). This paper proposes that prespecification approaches should be reevaluated in light of recent advances in phonological theory. It builds on several arguments advanced in favor of a constraint-based 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, a weighted constraint system 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 predicts that optimal outputs can be determined by the interaction of constraints that refer to independent dimensions of structure (Zuraw and Hayes 2017). In addition, we consider newer claims that lexical variability and

exceptionality receive a parsimonious analysis if the symbols of phonological representations can be gradiently active (Smolensky and Goldrick 2016; Rosen 2016; Zimmermann 2017).

I 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. Instead, these patterns emerge from the interaction of two independently proposed constraint penalty adjustments: [1] scaling of constraint penalties according to the prosodic environments in which they occur (Hsu and Jesney 2016; Inkelas and Wilbanks 2018) and [2] contrastive gradient activation of symbols in underlying forms (Smolensky and Goldrick 2016; Rosen 2016; Zimmermann 2017). Because both factors contribute to the harmony values of output candidates, changes to the underlying activity of otherwise identical input structures can replicate the effects of scaling based on prosodic context.

To preview the analysis, I propose that positional markedness constraints against $\tilde{V}X$ sequences are scaled according to the size of the smallest prosodic constituent that contains such sequences, such that $\tilde{V}X$ sequences contained in smaller domains incur higher penalties. All nasal vowels in the language are derived from an underlying form $/\tilde{V}n/$, but lexical items vary in the underlying activity of the vowel's [NASAL] feature and of $/n/$'s root node. These contrasts in underlying activity alter the penalties of faithfulness constraints, replicating the effects of scalar markedness constraints on relative harmony, generating the exceptional prosodification effects. This approach is able to generate the French pattern from 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, it suggests that contrasts in gradient activity among lexical items can provide a unified analysis for exceptional patterns more generally, both in exceptional prosodification effects and in patterns that do not involve prosodic structure (Rosen 2016; Zimmermann 2017). 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).

The remainder of the paper is structured as follows. Section 2 presents the distribution of nasal vowels in French and its apparent exceptional prosodification effects. Section 3 presents an analysis of the regular sensitivity to prosodic structure using scalar markedness constraints. Section 4 shows how the apparent exceptional prosodification effects arise from the interaction of scalar markedness constraints and contrastive activity levels. Section 5 argues against alternative approaches in terms of prosodic prespecification and cyclic derivations, and Section 6 concludes the paper.

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

This section presents the distribution of nasal vowels ($[\tilde{\epsilon}]$, $[\tilde{o}]$, $[\tilde{u}]$) in Standard French, with a focus on the types of segments X that can follow nasal vowels \tilde{V} . Generally, the larger the boundary between \tilde{V} and X , the more types of segment X are permitted, such that relatively sonorous segments X are dispreferred. This is observed in both static phonotactic generalizations and in alternations observed at morpho-syntactic junctures. I then present exceptional cases where

individual lexical items show stronger than expected restrictions on $\tilde{V}X$ sequences. Crucially, I show that there are only three regular patterns, and that all exceptional lexical items pattern in a way that resembles the regular pattern that applies across a smaller juncture.

2.1 Stem-internal $\tilde{V}X$

With very few exceptions, when both segments $\tilde{V}X$ are contained within a stem, the only sounds that follow nasal vowels are obstruents. Several examples are listed in (1a). Nasal vowels followed by non-glide sonorants are highly underattested, and are restricted to a handful of forms like [ʒãɾ] ‘genre’ and [ãnuʁi] ‘boredom’ (1b). Lastly, nasal vowels do not precede glides or vowels (Dell 1970), as shown by the absence of forms like [*kãju] or [*ʒœɾ] in (1c). 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 V \tilde{V} (ex. [leʒ] ‘Léon’), but not a nasal vowel followed by an oral vowel * $\tilde{V}V$ or sequence of nasal vowels * $\tilde{V}\tilde{V}$.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 syllables (Tranel 1987). Nonetheless, /j/ is permitted in these contexts, and is unattested following nasal vowels.

- (1) a. \tilde{V} before obstruents
- | | | | |
|-------|------------|-------|-----------|
| [ẽpo] | ‘tax’ | [kẽz] | ‘fifteen’ |
| [õd] | ‘wave’ | [dãs] | ‘dance’ |
| [lãg] | ‘language’ | [ãfã] | ‘child’ |
| [tãt] | ‘aunt’ | [lẽʒ] | ‘laundry’ |
- b. \tilde{V} before non-glide sonorants [m, n, l, ɾ] (highly underattested)
- | | | | |
|-------|---------|---------|-----------|
| [ʒãɾ] | ‘genre’ | [ãnuʁi] | ‘boredom’ |
|-------|---------|---------|-----------|
- c. \tilde{V} before glides and vowels (unattested)
- *[kãju], *[ʒœɾ]

2.2 Word-internal $\tilde{V}X$ 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-* [ã(n)] ‘to make X’, *non-* [nõ(n)] ‘non-’, *bien-* [bjẽ(n)] ‘well-’ (Tranel 1981; Hannahs 1995). Before vowel-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.

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

- (2) [ãn-ivkɛ] ‘to intoxicate’ [nõn-ẽskvɪ] ‘unregistered’ [bjẽn-ævœ] ‘joyful’
 [ãn-ɔvkœjɪk] ‘to make proud’ [nõn-inisje] ‘uninitiated’ [bjẽn-eme] ‘well-liked’
- (3) [ã-kese] ‘to cash’ [nõ-fõksjɔnmã] ‘non-function’ [bjẽ-ʒwe] ‘well-played’
 [ã-nɔvliɪk] ‘to ennoble’ [nõ-ɪvœspe] ‘non-respect’ [bjẽ-ɪvœsy] ‘well-received’

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 and glide-initial stems (4a), [i] before other sonorant-initial stems (4b), and [ẽ] before obstruent-initial stems (4c).²

- (4) a. [in-abil] ‘unskillful’ [in-amikal] ‘friendly’ [in-wi] ‘unheard of’
 b. [i-mɔvɔl] ‘immoral’ [i-legal] ‘illegal’
 c. [ẽ-fekð] ‘unfruitful’ [ẽ-pɔsibl] ‘impossible’

The key observation here is that this pattern of allomorph selection creates the distribution of $\tilde{V}X$ sequences observed stem-internally, where nasal vowels can precede obstruents, but not sonorant consonants or vowels.

2.3 $\tilde{V}X$ across word boundaries

The patterning of $\tilde{V}X$ 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 subject of many analyses in generative phonology (see Tranel 1981; 1995 for detailed overviews). Here, I focus specifically on prenominal 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 prenominal adjectives end with a nasal vowel, with no change from their pronunciation in isolation (5a). The second class of adjectives retain their nasal vowel, but surface with a linking (liaison) consonant [n] (5b). The third class also surfaces with linking [n], but with an oral vowel in place of the nasal vowel that would appear in isolation (5c). The observed pattern is conditioned by the identity of the prenominal adjective, rather than the following word (cf. Zymet 2018 for discussion of the effects of the first word in liaison with other consonants).

(5) *Prenominal adjective classes before V-initial words*

- a. No liaison
 [mɪjɔ̃] ‘cute’ + [ɔbʒe] ‘object’ → [mɪjɔ̃ ɔbʒe]
 [malẽ] ‘clever’ + [ɛspwɔk] ‘hope’ → [malẽ ɛspwɔk]
 [lwẽtẽ] ‘distant’ + [avniɪk] ‘future’ → [lwẽtẽ avniɪk]

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 [ẽ] before consonant-initial stems, regardless of sonority (cf. ([inɔfisjalizabl] ‘that cannot be officialized’; [ẽtʁãsfɔmabl] ‘that cannot be transformed’; [ẽmemɔrizabl] ‘that cannot be memorized’).

- b. Nasal vowel with liaison [n]
 [kɔmɛ̃] ‘common’ + [ɔbzɛ] ‘object’ → [kɔmɛ̃ nɔbzɛ]
 [sɛʁtɛ̃] ‘certain’ + [ami] ‘friend’ → [sɛʁtɛ̃ nami]
- c. Oral vowel with liaison [n]
 [bɔ̃] ‘good’ + [ɔbzɛ] ‘object’ → [bɔ̃ nɔbzɛ]
 [ɑ̃sjɛ̃] ‘old’ + [ami] ‘friend’ → [ɑ̃sjɛ̃ nami]

This distinction among prenominal adjective classes is observed only before vowel-initial words. When followed by a consonant-initial word, all of the adjectives above surface with a final nasal vowel before both sonorant and obstruent consonants.

(6) *Prenominal adjective classes before C-initial words*

- a. [miɲɔ̃] ‘cute’ + [lɑ̃gɑz] ‘language’ → [miɲɔ̃ lɑ̃gɑz]
 [miɲɔ̃] ‘cute’ + [pʁɔblɛm] ‘problem’ → [miɲɔ̃ pʁɔblɛm]
- b. [kɔmɛ̃] ‘common’ + [lɑ̃gɑz] ‘language’ → [kɔmɛ̃ lɑ̃gɑz]
 [kɔmɛ̃] ‘common’ + [pʁɔblɛm] ‘problem’ → [kɔmɛ̃ pʁɔblɛm]
- c. [bɔ̃] ‘good’ + [lɑ̃gɑz] ‘language’ → [bɔ̃ lɑ̃gɑz]
 [bɔ̃] ‘good’ + [pʁɔblɛm] ‘problem’ → [bɔ̃ pʁɔblɛm]

Although there are some regularities in correspondence between properties of these adjectives and their patterning before vowel-initial words, none are fully predictable or without exceptions. For instance, while adjectives that trigger liaison with an oral vowel (5c) commonly end in [ɛ̃] (orthographic *-ien*, *-ain*, *-ein*), this vowel quality generalization does not extend to *bon* ([bɔ̃]/[bɔn]).³ Furthermore, the liaison forms of these prenominal adjectives frequently resemble their feminine allomorphs (*-enne*, *-aine*, *-eine* [ɛn]), suggesting an analysis of these forms in terms of gender suppletion (Tranel 1981, 1992). Nonetheless, many prenominal adjectives that end in [ɛ̃] in isolation and have a feminine allomorph ending in [ɛn] either do not trigger liaison for most speakers (Encrevé 1986; Sampson 2001), e.g. [lwɛ̃tɛ̃ avniʁ] ‘distant future’ (5a), or surface with final [ɛ̃n], e.g. [sɛʁtɛ̃ nami] (Steriade 1999).

The liaison with nasal vowel pattern (5b) also applies in the standard dialect to non-adjectival prenominal items like the masculine indefinite article *un*, and possessive pronouns *mon*, *ton*, *son*. However, some speakers apply liaison with an oral vowel 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 adjectives like *ancien* [ɑ̃sjɛ̃] ‘old’ and *lointain* [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

³ For speakers who maintain the contrast between tense and lax versions of the low back vowel, *bon* is realized as [bɔn] before vowel-initial words and [bɔ̃] elsewhere. In these varieties, this contrasts with possessive prefixes like *son* ‘his.MASC,’ realized with uniform vowel quality [sɔ̃]/[sɔn] (see Tranel 1992 for discussion of prior approaches). As my analysis is concerned primarily with the patterning of prenominal adjectives and prefixes, I will not address this additional case of variation.

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. Similarly, Durand and Lyche (2008) find liaison with prenominal adjectives to be rare in the Phonologie du Français Contemporain (PFC) corpus, which includes scripted, semi directed, and informal speech.⁴ From the criterion of productivity, no liaison is the regular pattern for prenominal adjectives that precede vowel-initial words, while the two liaison with [n] patterns are exceptional. I will adopt this perspective in the remainder of this work.

The crucial generalization here is that each pattern in which a linking consonant surfaces replicates a regular phonotactic generalization that is attested at a word-internal level of constituency. *Commun*-class adjectives that trigger liaison with a preserved nasal vowel (5b) 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 (5c) replicate the stem-internal pattern; nasal vowels do not surface before either vowels or sonorant consonants. Aspects of this generalization have been noted in previous works. Bybee (2001; p. 347) observes that liaison (including with consonants other than [n]) is “very similar to morphologically and lexically conditioned alternations that occur word-internally.” Sampson (2001; p. 255) characterizes the patterning of *bon* class adjectives as a type of partial lexicalization in which adjective+noun sequences 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 $\tilde{V}X$ sequences in Standard French. Each pattern is one that applies regularly at some level of constituent structure. In the regular case, the larger the boundary between \tilde{V} and X, the more types of segment X are permitted. The behavior of all exceptional items resembles a pattern that regularly applies across a smaller boundary. This distribution is summarized below in Table 1.

Pattern 1: \tilde{V} precedes obstruents ($\tilde{V}T$ only)		Pattern 2: \tilde{V} precedes obstruents and sonorant consonants ($\tilde{V}C$ only)		Pattern 3: \tilde{V} precedes all segments (all $\tilde{V}X$ possible)	
REGULAR	Stem-internal $\tilde{V}X$ (no juncture)	REGULAR	$\tilde{V}X$ across prefix boundary	REGULAR	$\tilde{V}X$ across word boundary
EXCEPTIONAL	<i>bon</i> class prenominal adjectives, <i>In</i> - prefix	EXCEPTIONAL	<i>commun</i> class prenominal adjectives		

Table 1: Summary of regular and exceptional distributions of $\tilde{V}X$ sequences

The next section presents a Gradient Harmonic Grammar analysis in which this relationship between the regular and exceptional patterns results from the interaction of scalar markedness constraints and contrasts in underlying activity.

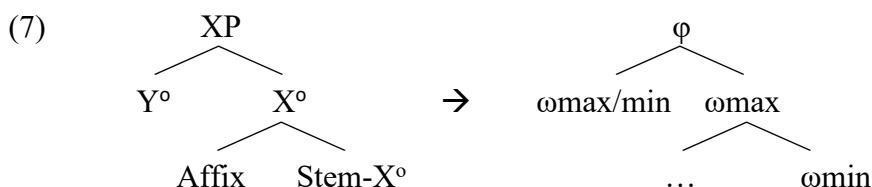
⁴ Sampson’s (2001) production study of liaison with prenominal adjectives exclusively considers potential liaison with [n]. While Durand and Lyche (2008) consider potential liaison contexts with the full range of linking consonants [z, n, t, ʁ, p], the non-productivity of liaison in this context crucially holds of liaison with [n].

3. Interaction of scalar constraints and gradient activity in Gradient Harmonic Grammar

3.1 Restrictions on $\tilde{V}X$ sequences and prosodic structure

We first turn to developing an analysis of the regular sensitivity of restrictions on $\tilde{V}X$ sequences to morpho-syntactic contexts. Following standard claims in Prosodic Phonology, I assume that the domains of segmental restrictions are defined in terms of prosodic constituents (Selkirk 1980; Nespors and Vogel 1986; Côté 2000; Flack 2009; Itô and Mester 2013; among others), which are themselves defined in relation to, though not always isomorphic with, syntactic constituents (Selkirk 1981; 2011; Nespors and Vogel 1986; among others).⁵ In addition, prosodic constituency can be recursive; any prosodic category can dominate an instance of the same category (Elfner 2012; Itô and Mester 2013; Myrberg 2013). Domain-sensitive phonological processes can target specific subcategories of a recursive structure (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).

Given our focus on the patterning of nasal vowels within morphological words and nominal phrases, we will restrict our attention to two prosodic constituents: the prosodic word (ω) and the phonological phrase (ϕ). The syntax-prosody mapping that I will assume is represented in the schematic example in (7).



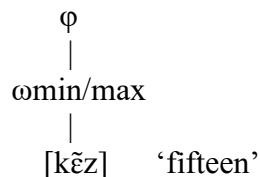
Syntactic phrases (XPs) are mapped to ϕ s (Selkirk 2009; 2011; Elfner 2012). At the word level, both the stem and the complete morphological word are mapped to ω nodes. In affixed words, the stem corresponds to a minimal prosodic word (ω_{\min}) because it does not itself dominate a ω , while the full morphological word corresponds to a maximal prosodic word (ω_{\max}) because it is not itself dominated by a ω . An unaffixed stem (here Y°) 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 ω_{\max} and ω_{\min} , while affixes are not subject to restrictions that apply to ω_{\min} .⁶ Because the recursive ω structure is most faithful mapping from syntactic to prosodic constituency, as previously argued for ϕ -level structure, I will assume that it holds for Standard French in the absence of contrary evidence.

⁵ The claims of Prosodic Phonology stand in contrast with so-called direct reference theories, in which phonological processes have a syntactic constituent or phasal spell-out domain as their domain of application (Kaisse 1985; Odden 1987; Wagner 2005; Pak 2008; among many others). Because my analysis of French assumes an isomorphic mapping between syntax and prosodic structure, it can be easily reformulated to my knowledge using direct reference to syntactic constituents. Nonetheless, I will present my analysis using prosodic domains for ease of comparison with prosodic prespecification alternatives.

⁶ The potential for recursion at the ω level accounts for the strong 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; Nespors and Vogel 1986; Hannahs 1995; Booij 1999; Downing 1999).

We can 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 $\tilde{V}X$ sequences can be stated in terms of the size of the smallest prosodic constituent domain that contains the relevant sequence. First, consider the status of $\tilde{V}X$ sequences that are fully contained within stems. Regardless of whether other affixes are present, all stem material is contained within a ω min. 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.

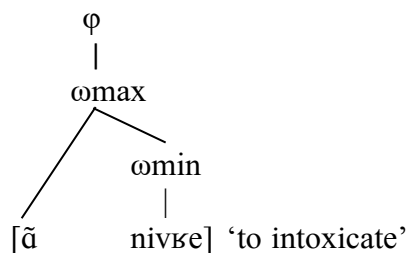
(8) *Predicted prosodic structure:* $((\dots \tilde{V}X \dots)_{\omega\text{min}/\text{max}})_{\varphi}$



$\tilde{V}X$ fully contained in ω min: \tilde{V} precedes obstruents only

Prefixes are syllables dominated directly by ω max, and not contained within the ω min that contains the stem. I assume that [n] associated with prefixes like *en-* and *bien-* before a vowel-initial root is dominated by ω min, since it is syllabified as an onset with the stem-initial vowel. However, an alternative representation in which [n] is dominated by ω max but not ω min will be equally compatible with the proposed analysis. As long as the prefix nasal vowel is not dominated by ω min, the $\tilde{V}n$ sequence in either structure is fully contained within the ω max that dominates the full morphological word, but not the ω min that dominates the stem.⁷

(9) *Predicted prosodic structure:* $((\dots \tilde{V} (X \dots)_{\omega\text{min}})_{\omega\text{max}})_{\varphi}$



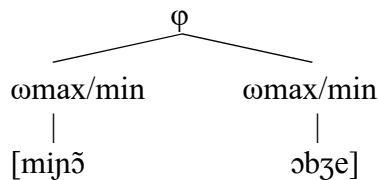
$\tilde{V}X$ fully contained in ω max: \tilde{V} precedes consonants only

Prenominal 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

⁷ The recursive ω representation can be extended to account for other prefix-stem asymmetries in French noted by Hannahs (1995). For example, a glide formation process that causes prevocalic /i/ to surface as [j] can apply at stem-suffix boundaries, e.g. [kɔləni] 'colony' vs. [kɔlənjal] 'colonial.' However, glide formation does not apply across prefix boundaries, e.g. [antjalkɔlik] (cf. *[antjalkɔlik]) 'anti-alcohol.' Following the then-standard assumption that recursive prosodic structures are ill-formed, Hannahs takes this to argue that prefixes form distinct ω s from stems and suffixes, and that glide formation applies within ω . This can easily be accounted for in the recursive ω structure by positing that the restriction against prevocalic [i] is only enforced when both segments are contained within ω min (or alternatively ω onmax, if suffixes are not contained in ω min with the root).

representation predicted by an isomorphic mapping, prenominal adjectives and their following nouns are dominated by distinct ω_{\max} nodes. The $\tilde{V}X$ sequence in a form like [miŋð ɔbʒe] ‘cute objet’ is fully contained only within a ϕ .

(10) *Predicted prosodic structure:* $(((\dots \tilde{V})_{\omega_{\min}})_{\omega_{\max}} ((X \dots)_{\omega_{\min}})_{\omega_{\max}})_{\phi}$



$\tilde{V}X$ fully contained in ϕ : \tilde{V} precedes all segments

In summary, restrictions on possible $\tilde{V}X$ sequences depend on the types of prosodic constituents that contain them. $\tilde{V}X$ sequences that are fully contained in smaller prosodic constituents are subject to more restrictions on possible segments X .

3.2 Scalar domain span constraints

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 scale or hierarchy of some kind, including continuous phonetic values (Flemming 2001; Cho 2011; McAllister Byun 2011; Ryan 2011), perceptual distance (McCollum 2018), 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 2018), lexical category and frequency (Coetzee and Kawahara 2013; Linzen et al. 2013), and degree of nativization (Hsu and Jesney 2017, 2018).

The present type of scalar pattern, in which a phonological process or restriction applies only up to a cutoff point on a hierarchy, has often been analyzed in ranked constraint grammars using sets of stringently related constraints (de Lacy 2002) or fixed constraint rankings. However, there is empirical support in favor of applying weighted scalar constraints to these cases. Hsu and Jesney (2016; 2017) show that in instances where more than one type of constraint is indexed to the same hierarchy, both fixed rankings and stringently related constraints generate unattested “level-skipping” patterns in which a process applies at non-adjacent points on the hierarchy, whereas scalar constraints avoid this overgeneration problem. Constraint scaling also has an advantage of theoretical parsimony, as it accounts for a range of scalar phenomena in different empirical domains using a single type of grammatical mechanism: numerical adjustment of constraint violations.

I will employ a scaling system in which scaling involves the addition of a penalty to the basic weight w of a constraint (Hsu and Jesney 2016; Shih and Inkelas 2016). This amount is determined by a constraint-specific scaling factor s , whose value is multiplied by a numerical value (0, 1, ...

n) determined by the corresponding point on the hierarchy of the constraint violation. The contribution to total harmony of a single violation of a scalar constraint is calculated as follows:⁸

$$(11) \quad H = w + (s \times d)$$

Where w is the weight of the constraint C

s is the scaling factor applied to constraint C

d is the candidate's value along the scale (0, 1, ... n) defined for constraint C

For any scalar constraint, I assume that values of w and s are language-specific, and acquired by the learner. However, the type(s) of scaling factor s associated with a given constraint can plausibly be universally predetermined, based on the type of structure penalized by the constraint and on the contextual influences that can adjust its contribution to harmony.

Here, I propose that markedness constraint violations are scaled according to the size of the smallest prosodic constituent type that fully contains the marked structure. Schematically, a constraint against a marked sequence M is defined such that its total penalty is adjusted based on the size of the smallest prosodic category that contains 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. Our analysis makes use of two scalar markedness constraints.⁹ The first scalar constraint $*\tilde{V}[\text{SON,CONS}]$ penalizes sequences of nasal vowels followed by sonorant consonants. A penalty of the basic weight w is incurred by any nasal vowel followed by a sonorant, regardless of where it occurs in the prosodic structure. In this analysis, I will make use of the scale $(\varphi, \omega_{\text{max}}, \omega_{\text{min}})$, which corresponds to numerical values (0, 1, 2).¹⁰

$$(12) \quad *\tilde{V}[\text{SON,CONS}]$$

For any nasal vowel + sonorant sequence fully contained within a domain $\in (\varphi, \omega_{\text{max}}, \omega_{\text{min}})$, assign a weighted violation score of $w + (s \times d)$,

where $(\varphi = 0, \omega_{\text{max}} = 1, \omega_{\text{min}} = 2)$

⁸ Alternative constraint scaling systems have been proposed. For instance, we can consider scaling systems in which the constraint weight itself is multiplied by a value along the scale, $H = w \times d$ (McPherson and Hayes 2016; McCollum 2018), or in which the value along the scale is an exponent of the base weight, $H = w^d$ (Inkelas and Wilbanks 2018). A key difference between additive scaling and the other systems is that in cases where two constraints are scaled along the same hierarchy ($H_1 = w_1 + (s_1 \times d)$, $H_2 = w_2 + (s_2 \times d)$), their relative weights can invert at an intermediate value on the scale (Hsu and Jesney 2016). I will have to leave it an open question as to whether a single scaling system is to universally preferred, or if different systems are required in different domains of grammar, and proceed with additive scaling.

⁹ A reviewer suggests an alternative constraint set in which there is a single markedness constraint $*\tilde{V}X$ that has two scaling factors: one for the sonority of the segment X, and one for the smallest prosodic constituent containing the sequence, i.e. a penalty calculation of $H = w + (s_1 \times d_1) + (s_2 \times d_2)$. While such an analysis appears to be feasible, I will use the two constraint proposed for explanatory ease, and leave to future work the issue of which constraint system is ultimately preferable.

¹⁰ The assumption that the numerical values on the scale are evenly spaced by values of one is plausibly grounded in the fact that size of the smallest prosodic constituent type that contains a structure can be restated in terms of the number of prosodic constituent types that contain it (i.e. depth of embedding) due to the principle of Headedness (Selkirk 1996), i.e. each PCat _{i} must be dominated by a PCat _{$i+1$} . However, I will leave open the questions of whether uneven spacing is possible, and in which domains it can arise. For one analysis that employs a scale with uneven spacing, see Pater's (2016) account of sonority-driven stress.

The second scalar constraint $*\tilde{V}V$ penalizes sequences of nasal vowels followed by another vowel. A non-scalar version of this constraint is similarly used to motivate the appearance of linking [n] in the analysis of B. Smith (2015). While both constraints $*\tilde{V}[\text{SON,CONS}]$ and $*\tilde{V}V$ have constraint-specific values for their base weights w and scaling factors s , they will refer to the same scale ($\varphi = 0, \omega_{\max} = 1, \omega_{\min} = 2$).

- (13) $*\tilde{V}V$
 For any nasal vowel + vowel sequence fully contained within a domain $\in (\varphi, \omega_{\max}, \omega_{\min})$, assign a weighted violation score of $w + (s \times d)$,
 where ($\varphi = 0, \omega_{\max} = 1, \omega_{\min} = 2$)

Sample penalty calculations associated with $*\tilde{V}[\text{SON,CONS}]$ violations in the three relevant prosodic contexts are given below, assuming base weight $w = 1$ and scaling factor $s = 2$.

- (14) *Sample calculations of penalties of $*\tilde{V}[\text{SON,CONS}]$*
 Weight $w = 1$
 Scale = ($\varphi = 0, \omega_{\max} = 1, \omega_{\min} = 2$)
 Scaling factor $s = 2$
- | | |
|--|--|
| $\tilde{V}[\text{SON,CONS}]$ across word boundary: | violation of $w + s(\varphi) = 1 + (2 \times 0) = 1$ |
| $\tilde{V}[\text{SON,CONS}]$ across prefix boundary: | violation of $w + s(\omega_{\max}) = 1 + (2 \times 1) = 3$ |
| $\tilde{V}[\text{SON,CONS}]$ within stem: | violation of $w + s(\omega_{\min}) = 1 + (2 \times 2) = 5$ |

We can now address the weighting and scaling conditions that generate the French nasal vowel distribution. For illustrative purposes, I will assume 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 activity allows different input structures to be considered. In this example, the scalar markedness constraints $*\tilde{V}[\text{SON,CONS}]$ and $*\tilde{V}V$ interact with two faithfulness constraints: $\text{MAX}[\text{NASAL}]$, 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).¹¹

One set of weights and scaling factors that generates the regular pattern is shown in the tableaux (15)-(17). The input for each tableau contains an underlying $\tilde{V}V$ sequence. For ease of presentation, I will only consider output candidates that resemble one of the three attested surface patterns found in this context: (a) faithful surfacing of $\tilde{V}V$, (b) insertion of [n] following \tilde{V} , and (c) insertion of [n] and change from a nasal to oral vowel. Each tableau reflects a different prosodic representation, illustrated with a regular prenominal adjective (15), regular prefix (16), and a stem (17). Although each set of output candidates violates the same constraints, scaling applied to the markedness constraints alters the relative harmony in each context. For the convenience of the

¹¹ In principle, we may expect that positional faithfulness constraints can also be scaled, such that violation penalties increase in more deeply embedded domains. For instance, Hsu and Jesney (2016) argue that both markedness and faithfulness constraints must be scaled in order to account for the typology of segmental restrictions at larger prosodic boundaries (Flack 2009). However, given the absence of evidence for increased tolerance of marked structures in more embedded domains in the French pattern, I will not apply positional scaling to faithfulness constraints in this analysis.

reader, penalty calculations for the scalar markedness constraints are shown in the second line of each relevant cell.

Consider tableau (15), in which the prenominal adjective and noun surface in separate ω_{\max} constituents. The optimal, faithful candidate violates only $*\tilde{V}V$; Because the smallest prosodic constituent that contains the $\tilde{V}V$ sequence is a ϕ , the constraint's scaling factor s is multiplied by the corresponding value of the scale ($\phi = 0$). This results in a total $*\tilde{V}V$ penalty of $w + s(\phi) = 3 + (6 \times 0) = 3$. The second candidate, which maintains vowel nasalization and epenthesizes a nasal consonant, violates both DEP (incurring a penalty $w = 4$) and $*\tilde{V}[\text{SON,CONS}]$ (incurring a penalty $w + s(\phi) = 1 + (3 \times 0) = 1$). The third candidate removes vowel nasalization and epenthesizes a nasal consonant, violates only the faithfulness constraints DEP ($w = 4$) and MAX[NASAL] ($w = 6$).

Compare this with tableau (16), in which the nasal vowel is associated with a prefix, and is contained in the same ω_{\max} as the stem. Because the $\tilde{V}V$ sequence in the faithful candidate is contained within a ω_{\max} , its violation of $*\tilde{V}V$ is scaled to the next value on the scale ($\omega_{\max} = 1$), resulting in a total penalty of $w + s(\omega_{\max}) = 3 + (6 \times 1) = 9$. The second candidate's violation of $*\tilde{V}[\text{SON,CONS}]$ is adjusted to the same value on the scale, incurring a penalty of $w + s(\omega_{\max}) = 1 + (3 \times 1) = 4$. Although both candidates now incur greater total penalties, the first candidate sees a relatively larger increase that is sufficient to make the second candidate the optimal one. Finally, tableau (17) compares output candidates for a hypothetical input stem / $\tilde{\text{ɔ}}\text{æ}/$. Because all segments in the output candidates are contained within a ω_{\min} , the first two candidates' violations of $*\tilde{V}V$ and $*\tilde{V}[\text{SON,CONS}]$ are scaled to the highest value on the scale ($\omega_{\min} = 2$). The increased penalty of $*\tilde{V}[\text{SON,CONS}]$ results in another change in relative harmony, such that the third candidate becomes optimal.

(15) $\tilde{V}X$ fully contained in ϕ : *mignon objet* 'cute object'

/mijnɔ̃ ɔbzɛ/	MAX[NAS] w=6	DEP w=4	$*\tilde{V}[\text{SON,CONS}]$ w=1, s=3	$*\tilde{V}V$ w=3, s=6	H
$\mathcal{F}(((\text{mijn}\tilde{\text{ɔ}})_{\omega_{\min}})_{\omega_{\max}}((\text{ɔbz}\tilde{\text{e}})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$				-1_{ϕ} = $-1(3 + 6 \times 0_{\phi})$	-3
$(((\text{mijn}\tilde{\text{ɔ}})_{\omega_{\min}})_{\omega_{\max}}((\text{n ɔbz}\tilde{\text{e}})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$		-1	-1_{ϕ} = $-1(1 + 3 \times 0_{\phi})$		-5
$(((\text{mijn}\text{ɔ})_{\omega_{\min}})_{\omega_{\max}}((\text{n ɔbz}\tilde{\text{e}})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$	-1	-1			-10

(16) $\tilde{V}X$ fully contained in ω_{\max} : *bien aimé* 'well-liked'

/bjɛ̃ ɛme/	MAX[NAS] w=6	DEP w=4	$*\tilde{V}[\text{SON,CONS}]$ w=1, s=3	$*\tilde{V}V$ w=3, s=6	H
$((\text{bj}\tilde{\text{ɛ}}(\text{ɛme})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$				$-1_{\omega_{\max}}$ = $-1(3 + 6 \times 1_{\omega_{\max}})$	-9
$\mathcal{F}((\text{bj}\tilde{\text{ɛ}}(\text{n ɛme})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$		-1	$-1_{\omega_{\max}}$ = $-1(1 + 3 \times 1_{\omega_{\max}})$		-8
$((\text{bj}\tilde{\text{ɛ}}(\text{n ɛme})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$	-1	-1			-10

(17) $\tilde{V}X$ fully contained in ω_{\min} : Hypothetical input stem / $\tilde{3}\alpha\epsilon\beta$ /

$/\tilde{3}\alpha\epsilon\beta/$	MAX[NAS] w=6	DEP w=4	* \tilde{V} [SON,CONS] w=1, s=3	* $\tilde{V}V$ w=3, s=6	H
$((\tilde{3}\alpha\epsilon\beta)_{\omega_{\min}})_{\omega_{\max}}\varphi$				$-1_{\omega_{\min}}$ $= -1(3 + 6 \times 1_{\omega_{\min}})$	-15
$((\tilde{3}\alpha\epsilon\beta)_{\omega_{\min}})_{\omega_{\max}}\varphi$		-1	$-1_{\omega_{\min}}$ $= -1(1 + 3 \times 2_{\omega_{\min}})$		-11
$\varphi((\tilde{3}\alpha\epsilon\beta)_{\omega_{\min}})_{\omega_{\max}}\varphi$	-1	-1			-10

An more abstract visualization of these effects of markedness scaling on relative harmony is represented in Figure 1. The total penalties incurred by various constraint violations are shown on the y-axis, while the x-axis represents values on the scale. For sake of illustration, non-faithful candidates are assumed to violate a single FAITH constraint. In this example, the base weight of FAITH, $w = 4$, exceeds that of * \tilde{V} [SON,CONS], $w = 1$, and * $\tilde{V}V$, $w = 3$. When the smallest prosodic constituent that fully contains the $\tilde{V}X$ sequence is a φ , these weights are unaffected by the scaling factor, as φ corresponds to 0 on the scale ($\varphi = 0$, $\omega_{\max} = 1$, $\omega_{\min} = 2$). Nasal vowel + oral vowel sequences and nasal vowel + sonorant consonant sequences surface faithfully. If the $\tilde{V}X$ sequence is contained within a ω_{\max} , the scaled penalty of * $\tilde{V}V$, $3 + (2 \times 1) = 5$, 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 * \tilde{V} [SON,CONS], $1 + (2 \times 1) = 3$, nasal vowels remain permitted before sonorant consonants. Finally, for $\tilde{V}X$ sequences contained in a ω_{\min} , the scaled penalties of * $\tilde{V}V$, $3 + (2 \times 2) = 7$, and * \tilde{V} [SON,CONS], $1 + (2 \times 2) = 5$ both exceed the penalty of FAITH, predicting that both marked sequences will be repaired.

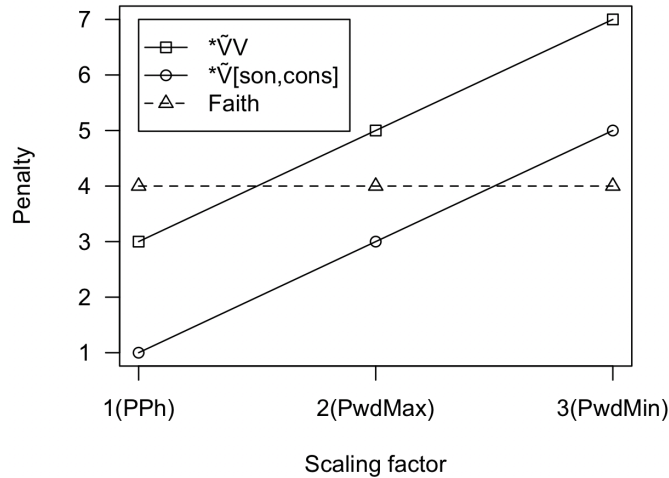


Figure 1: Prosodic context sensitivity generated by scalar markedness constraints.

Having now established the role of scalar markedness constraints in generating the three basic patterns, the next section turns to how the exceptional patterns arise from contrasts in gradient activity.

4. Interaction of scalar constraints and gradient activity in Gradient Harmonic Grammar

4.1 Gradient Harmonic Grammar

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. In the present analysis, I assume that gradient activity is a property of both segments and features.

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 segments can lead to different optimal outputs, while maintaining a uniform set of constraints and constraint weights. Following Smolensky et al. (2014) and Smolensky and Goldrick (2016), I assume that input structures can have gradient activity values between 0 and 1, while all structures in output candidates, being discrete segments, have an activity level of 1 (but cf. Zimmermann 2017 for arguments for gradient activation in outputs). Because markedness constraints refer only to output structures, which must be fully active, their evaluation is not dependent on the underlying activity of the relevant structure. However, differences in gradient activity affect the penalties of faithfulness constraint violations, which are proportional to the activity of the non-correspondent structure. For example, the following definitions are used for faithfulness constraints DEP and MAX (based on Zimmermann 2017).

- (18) DEP
Assign a violation X for every segment whose output activity X is absent in the input.
- (19) MAX
Assign a violation X for every segment whose input activity X is absent in the output.

The basic interaction is illustrated in the simplified example below. Both tableaux contain the same input segments /pak/, but differ in the activity of /k/, 0.75 in (20) and 0.25 in (21). Because markedness constraints refer only to output structures, the candidate [pak] incurs the same penalty in both tableaux for violation of NOCODA, regardless of the underlying activity of /k/. However, the violation of the faithfulness constraint 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 (20), 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 (20), 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 (21), 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.

(20)

$/p_1a_1k_{0.75}/$	DEP w=2	MAX w=4	NoCODA w=1	H
pak	-0.25		-1	-1.5
pa		-0.75		-3

(21)

$/p_1a_1k_{0.25}/$	DEP w=2	MAX w=4	NoCODA w=1	H
pak	-0.75		-1	-2.5
pa		-0.25		-1

From this example, we see that a contrast in the gradient activity levels of two otherwise identical input structures can change the relative harmony values of competing output candidates by affecting the evaluation of faithfulness constraints. In the previous section, it was shown that the scaling of positional markedness constraints similarly alters the relative harmony of segmentally identical output candidates in different prosodic contexts. Because both gradient activity and constraint scaling contribute to total harmony values in Gradient Harmonic Grammar, we expect to find patterns in which contrasts in gradient activity levels of otherwise identical inputs replicate the effects of scaling based on prosodic context. In the remainder of the section, I show that this predicted type of interaction successfully accounts for the distribution of nasal vowels in French, and its apparent exceptional prosodification effects. We now turn to the representation of nasal vowels, and how the interaction between contrasts in gradient activity and prosodic constraint scaling can be applied to the analysis of $\tilde{V}X$ sequences with a full constraint set.

4.2 Gradient symbols analysis of the regular pattern

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), $/\tilde{V}/$ (Tranel 1981), $/\tilde{V}n/$ 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 propensities to maintain vowel nasalization and to surface with linking [n]. I propose that this can be captured in Gradient Harmonic Grammar by

positing a unique symbolic underlying representation / $\tilde{V}n$ / for nasal vowels in the language.¹² However, lexical items can vary in two ways: the underlying activity of the vowel's [NASAL] feature, and the underlying activity of the nasal consonant's root node.¹³

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 relevant faithfulness constraints: MAX, violated by deleted root node activity, and MAX[NASAL], violated by loss of underlying nasalization.

- (22) MAX[NASAL]
Assign a violation X for every [NASAL] feature whose input activity X is absent in the output.

The penalty of MAX[NASAL] depends on the input activity of the deleted [NASAL] feature, while the penalty of MAX depends on the input activity of the deleted segment.¹⁴ These faithfulness constraints will interact with the aforementioned scalar markedness constraints $*\tilde{V}$ [SON,CONS] and $*\tilde{V}V$.

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 [$\tilde{V}V$], one that realizes vowel nasalization and /n/ faithfully [$\tilde{V}nV$], and one that realizes /n/ but not vowel nasalization [VnV]. For an input that contains the sequence / $\tilde{V}nV$ /, the following constraint violations are associated with each mapping:

- | | | |
|------|---|-----------------------------|
| (23) | <i>Input-out mapping</i> | <i>Constraints violated</i> |
| | $/\tilde{V}nV/ \rightarrow [\tilde{V}V]$ | $*\tilde{V}V$, MAX |
| | $/\tilde{V}nV/ \rightarrow [\tilde{V}nV]$ | $*\tilde{V}$ [SON,CONS] |
| | $/\tilde{V}nV/ \rightarrow [VnV]$ | MAX[NASAL] |

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 (24). In this

¹² The proposed / $\tilde{V}n$ / representation can also be connected to the claim of Hajek (1997) that contrastive nasal vowels in a language develop from a prior stage in which contrastive vowel nasality appears only before nasal consonants / $\tilde{V}N$ /. On this view, Modern French has not completely lost this underlying /n/, but rather due to systematically lower activity in the regular case only realizes it in exceptional forms. The proposal is also potentially linked to other claims that nasal vowels always consist of underlying root nodes / VN /, based on dialectal variation (Nakuma 1998) or loanword adaptation patterns (Paradis and Prunet 2000). I thank Nicholas Rolle for this discussion.

¹³ In Smolensky and Goldrick's (2016) analysis of liaison, linking consonants arise as blends of underlying consonants in the final position of W1 and initial position of W2. However, I abstract away from those details for this analysis, concerned uniquely with nasal vowels and linking [n]. This is justified by key differences between [n] and other liaison consonants [z, t, ʁ, p]. First, [n] surfaces in more predictable contexts; it only occurs following a W1 that ends with a \tilde{V} (or a W1 that has a final \tilde{V} allomorph, as in the case of *bon*), whereas other linking consonants can follow oral vowels. Similarly, the studies of Malécot (1975) and Mallet (2008) show liaison with [n] to be significantly more productive across all environments than liaison with other consonants.

¹⁴ There is an important question to be addressed in gradient symbolic theory of whether there are any necessary relationships between the activity levels of whole segments and those of their associated features. For instance, can the activity of features like [NASAL] exceed the activity of their associated root nodes? Conversely, does lower activity of a root node require lower activity of its dependent features? Unfortunately, I must leave these questions to future work.

notation, the name of each constraint stands for its base weight. The step on the scale that affects the each scalar markedness constraint is indicated in parentheses; For example, $*\tilde{V}[\text{SON,CONS}]_{(\varphi)}$ should be read as ‘the penalty incurred by a $*\tilde{V}[\text{SON,CONS}]$ violation contained within a prosodic phrase.’ The activity level of non-exceptional lexical items is shown as the variable α , shown in parentheses after the name of each faithfulness constraint. Note that the actual activity levels of /n/ and the vowel’s [NASAL] feature need not be identical, as we will shortly see.

- (24) a. *Weighting conditions for $\tilde{V}X$ sequences across word boundaries*
 $\text{MAX}[\text{NASAL}]_{(\alpha)}, *\tilde{V}[\text{SON,CONS}]_{(\varphi)} > *\tilde{V}V_{(\varphi)} + \text{MAX}(\alpha)$
- b. *Weighting conditions for $\tilde{V}X$ sequences across prefix boundaries*
 $\text{MAX}[\text{NASAL}]_{(\alpha)}, *\tilde{V}V_{(\omega\text{max})} + \text{MAX}(\alpha) > *\tilde{V}[\text{SON,CONS}]_{(\omega\text{max})}$
- c. *Weighting conditions for stem-internal $\tilde{V}X$ sequences*
 $*\tilde{V}V_{(\omega\text{min})} + \text{MAX}(\alpha), *\tilde{V}[\text{SON,CONS}]_{(\omega\text{min})} > \text{MAX}[\text{NASAL}]_{(\alpha)}$

For structures in which output $\tilde{V}X$ sequences would span a word boundary, the lowest level of scaling (φ) applies to the markedness constraints. Here, the penalties of $\text{MAX}[\text{NASAL}]_{(\alpha)}$, violated by input-output mapping $/\tilde{V}nV/ \rightarrow [VnV]$, and $*\tilde{V}[\text{SON,CONS}]_{(\varphi)}$, violated by $/\tilde{V}nV/ \rightarrow [\tilde{V}nV]$, both exceed the combined penalties of $*\tilde{V}V_{(\varphi)} + \text{MAX}(\alpha)$, violated by the optimal mapping $/\tilde{V}nV/ \rightarrow [\tilde{V}V]$. At the next level of scaling (ωmax), the combined penalty of $*\tilde{V}V_{(\omega\text{max})} + \text{MAX}(\alpha)$ must now exceed that of $*\tilde{V}[\text{SON,CONS}]_{(\omega\text{max})}$, making $/\tilde{V}nV/ \rightarrow [\tilde{V}nV]$ the optimal mapping. This indicates that $*\tilde{V}V$ needs to have a greater scaling factor s than that of $*\tilde{V}[\text{SON,CONS}]$. Finally, the highest level of scaling (ωmin) must cause the penalties of $*\tilde{V}[\text{SON,CONS}]_{(\omega\text{min})}$ and the combined penalties of $*\tilde{V}V_{(\omega\text{min})} + \text{MAX}(\alpha)$ to exceed that of $\text{MAX}[\text{NASAL}]_{(\alpha)}$.

One set of hand-determined activity levels, constraint weights, and scaling factors that satisfies these conditions is shown in the following tableaux. Each of the three prosodic contexts are illustrated below with a regular prenominal adjective (25), a regular prefix (26), and stem (27). Just as before, the output candidates in each tableau differ in the prosodic context in which $\tilde{V}X$ sequences surface, resulting in different penalties for the scalar markedness constraints. In each case, the input structure $/\tilde{V}n/$ has the same underlying activity: the [NASAL] feature of $/\tilde{V}/$ has 0.75 activity, while /n/ has 0.25 activity. In all tableaux, deletion of /n/ incurs a MAX penalty of its base weight ($w=4$) multiplied by the segment’s underlying activity, $4(0.25) = 1$, while loss of [NASAL] incurs an $\text{MAX}[\text{NASAL}]$ penalty of $15(0.75) = 11.25$.

(25) $\tilde{V}X$ contained in φ : *mignon objet*

$/\text{mijn}\tilde{\text{d}}_{[\text{NASAL}]0.75} \text{n}_{0.25} \text{ɔbʒe}/$	MAX $w=4$	MAX[NAS] $w=15$	$*\tilde{V}[\text{SON,CONS}]$ $w=5.5, s=3$	$*\tilde{V}V$ $w=4, s=7$	H
$\varphi \text{ (((mijn}\tilde{\text{d}})_{\omega\text{mn}})_{\omega\text{mx}} ((\text{ɔbʒe})_{\omega\text{mn}})_{\omega\text{mx}})_{\varphi}$	-0.25			-1_{φ} $= -1(4 + 7 \times 0_{\varphi})$	-5
$\text{(((mijn}\tilde{\text{d}})_{\omega\text{mn}})_{\omega\text{mx}}((\text{nɔbʒe})_{\omega\text{mn}})_{\omega\text{mx}})_{\varphi}$			-1_{φ} $= -1(5.5 + 3 \times 0_{\varphi})$		-5.5
$\text{(((mijn}\tilde{\text{d}})_{\omega\text{mn}})_{\omega\text{mx}} ((\text{nɔbʒe})_{\omega\text{mn}})_{\omega\text{mx}})_{\varphi}$		-0.75			-11.25

(26) $\tilde{V}X$ contained in ω_{\max} : *bien aimé*

$/bj\tilde{\epsilon}_{[NASAL]0.75} n_{0.25} \epsilon me/$	MAX w=4	MAX[NAS] w=15	$*\tilde{V}[SON,CONS]$ w=5.5, s=3	$*\tilde{V}V$ w=4, s=7	H
$((bj\tilde{\epsilon} (\epsilon me)_{\omega_{\min}})_{\omega_{\max}})_{\phi}$	-0.25			$-1_{\omega_{\max}}$ $= -1(4 + 7 \times 1_{\omega_{\max}})$	-12
$\varphi ((bj\tilde{\epsilon} (n\epsilon me)_{\omega_{\min}})_{\omega_{\max}})_{\phi}$			$-1_{\omega_{\max}}$ $= -1(5.5+3 \times 1_{\omega_{\max}})$		-8.5
$((bj\epsilon (n\epsilon me)_{\omega_{\min}})_{\omega_{\max}})_{\phi}$		-0.75			-11.25

(27) $\tilde{V}X$ contained in ω_{\min} : *hypothetical input for 'honneur'*

$/\tilde{\delta}_{[NASAL]0.75} n_{0.25} \text{œ} \text{ʁ}/$	MAX w=4	MAX[NAS] w=15	$*\tilde{V}[SON,CONS]$ w=5.5, s=3	$*\tilde{V}V$ w=4, s=7	H
$((\tilde{\delta} \text{œ} \text{ʁ})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$	-0.25			$-1_{\omega_{\min}}$ $= -1(4 + 7 \times 2_{\omega_{\min}})$	-19
$((\tilde{\delta} n \text{œ} \text{ʁ})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$			$-1_{\omega_{\min}}$ $= -1(5.5+3 \times 2_{\omega_{\min}})$		-11.5
$\varphi (((\tilde{\delta} n \text{œ} \text{ʁ})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$		-0.75			-11.25

As a segue to the upcoming analysis of exceptionality, we can consider the patterns that could arise from inputs associated with different underlying activity levels, given the principle of Richness of the Base (Prince and Smolensky 1993). We begin by noting that there is no set of input activity levels that allows a $*\tilde{V}V$ sequence to surface within a ω_{\max} or ω_{\min} , i.e. the first candidate of (26), (27) is never optimal, consistent with the observation that word-internal $\tilde{V}V$ sequences are unattested in French. This is because the scaled penalty of $*\tilde{V}V$ exceeds that of $*\tilde{V}[SON,CONS]$ in these contexts, and because any candidate that deletes underlying /n/ also incurs a MAX violation.

We can also observe that changes to the input activities of /n/ and the [NASAL] feature of / \tilde{V} / will result in outputs that resemble various exceptional patterns. First, consider hypothetical inputs with varying activities of [NASAL] on / \tilde{V} /. For all increased activity values that cause the penalty of MAX[NASAL] to exceed $*\tilde{V}[SON,CONS](\omega_{\min})$, in this example any value greater than ~ 0.766 , stem-internal nasal vowels will not denasalize before sonorant consonants. While this is not the regular pattern, such inputs would generate the very limited but attested forms like [zãʁ] ‘genre’ and [ãnuʁi] ‘boredom.’ Reductions in the activity of [NASAL] will cause underlying nasal vowels to denasalize before sonorants across larger prosodic boundaries. For example, if the MAX[NASAL] penalty falls below the $*\tilde{V}[SON,CONS](\omega_{\max})$ penalty (at values lower than ~ 0.566), denasalization will occur on prefix nasal vowels preceding sonorant-initial words, as observed for the exceptional prefix *in-*. If the MAX[NASAL] penalty falls below the $*\tilde{V}[SON,CONS](\phi)$ penalty (values lower than ~ 0.366), denasalization before sonorants will take place across word boundaries, as observed for prenominal adjectives like *bon*. A final possible pattern arises from increases in the activity of /n/. For any activity level that causes the combined MAX and $*\tilde{V}V(\phi)$ penalties to exceed that of

$*\tilde{V}[\text{SON,CONS}](\varphi)$, for instance /n_{0.5}/, the realization of [n] becomes obligatory to prevent $\tilde{V}V$ sequences from surfacing across word boundaries. This resembles the patterning of both exceptional classes of prenominal adjectives. In the next sections, I show that the overall French pattern can be generated by such systematic differences in activity levels between regular and exceptional items.

4.3 Prenominal 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 prenominal 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 prenominal adjective patterns. The weighting conditions that generate the regular pattern, discussed in the previous subsection, are repeated in (28a). 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 .

- (28) a. *Weighting conditions for regular prenominal adjective pattern (no liaison)*
 $\text{MAX}[\text{NASAL}](\alpha) , * \tilde{V}[\text{SON,CONS}](\varphi) > * \tilde{V}V(\varphi) + \text{MAX}(\alpha)$
- b. *Weighting conditions for exceptional pattern 1 (linking [n] with nasal vowel)*
 $\text{MAX}[\text{NASAL}](\beta) , \text{MAX}(\beta) + * \tilde{V}V(\varphi) > * \tilde{V}[\text{SON,CONS}](\varphi)$
- c. *Weighting conditions for exceptional pattern 2 (linking [n] with oral vowel)*
 $* \tilde{V}V(\varphi) + \text{MAX}(\gamma) , * \tilde{V}[\text{SON,CONS}](\varphi) > \text{MAX}[\text{NASAL}](\gamma)$

The key observation is that each of the three patterns differ in relative penalty between a faithfulness constraint and at least one other constraint. Taking the regular pattern's weights and activity levels as a starting point of comparison, exceptional pattern 1 is obtained by an *increase in the underlying activity of /n/*, where the increased MAX penalty is sufficient to reverse the relative penalties of $* \tilde{V}[\text{SON,CONS}](\varphi)$ and $\text{MAX}(\beta) + * \tilde{V}V(\varphi)$. Again taking the regular pattern as the starting point, exceptional pattern 2 is obtained by a *decrease in the underlying activity of the vowel's [NASAL] feature*, where the proportional decrease in $\text{MAX}[\text{NASAL}]$ penalty is sufficient to make it lower than the penalties of both $\tilde{V}[\text{SON,CONS}](\varphi)$ and $* \tilde{V}V(\varphi) + \text{MAX}(\gamma)$.

Retaining the constraint weights and scaling factors from the previous subsection, the exceptional prenominal adjective patterns are generated by the activity levels in the three tableaux below. All output candidates in each tableau have the same prosodic representation (10); all violations of $* \tilde{V}[\text{SON,CONS}]$ and $* \tilde{V}V$ incur the same penalties. Tableau (25) showing the regular *mignon objet* no linking [n] pattern is repeated here as (29). Exceptional pattern 1 is generated by an increase in the activity of /n/ from 0.25 to 0.5; the resulting increase in penalty of MAX from $4(0.25) = 1$ to $4(0.5) = 2$ alters the relative harmony of the candidate that deletes underlying /n/ versus the one that realizes it in the output. Exceptional pattern 2 is generated by a decrease in the

activity of [NASAL] from 0.75 to 0.3, proportionally reducing the penalty of MAX[NASAL]. It is important to note that the exact activity values chosen here are not crucial; there is always a range of activity values that can be used to generate each of the three weighting conditions.

(29) Regular prenominal adjective pattern:

$/m\dot{i}n\delta_{[NASAL]0.75} n_{0.25} \text{ob}z\epsilon/$	MAX w=4	MAX[NAS] w=15	* \tilde{V} [SON,CONS] w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	H
$\mathcal{P}(((m\dot{i}n\delta)_{\omega mn})_{\omega mx} ((\text{ob}z\epsilon)_{\omega mn})_{\omega mx})_{\phi}$	-0.25			-1_{ϕ} $= -1(4 + 7 \times 0_{\phi})$	-5
$((((m\dot{i}n\delta)_{\omega mn})_{\omega mx}((\text{nob}z\epsilon)_{\omega mn})_{\omega mx})_{\phi}$			-1_{ϕ} $= -1(5.5+3 \times 0_{\phi})$		-5.5
$((m\dot{i}n\delta)_{\omega mn})_{\omega mx} ((\text{nob}z\epsilon)_{\omega mn})_{\omega mx})_{\phi}$		-0.75			-11.25

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

$/k\text{om}\tilde{\epsilon}_{[NASAL]0.75} n_{0.5} \text{ob}z\epsilon/$	MAX w=4	MAX[NAS] w=15	* \tilde{V} [SON,CONS] w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	H
$((k\text{om}\tilde{\epsilon})_{\omega mn})_{\omega mx} ((\text{ob}z\epsilon)_{\omega mn})_{\omega mx})_{\phi}$	-0.5			-1_{ϕ} $= -1(4 + 7 \times 0_{\phi})$	-6
$\mathcal{P}(((k\text{om}\tilde{\epsilon})_{\omega mn})_{\omega mx} ((\text{nob}z\epsilon)_{\omega mn})_{\omega mx})_{\phi}$			-1_{ϕ} $= -1(5.5+3 \times 0_{\phi})$		-5.5
$((k\text{omy})_{\omega mn})_{\omega mx} ((\text{nob}z\epsilon)_{\omega mn})_{\omega mx})_{\phi}$		-0.75			-11.25

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

$/b\delta_{[NASAL]0.3} n_{0.5} \text{ob}z\epsilon/$	MAX w=4	MAX[NAS] w=15	* \tilde{V} [SON,CONS] w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	H
$((b\delta)_{\omega mn})_{\omega mx} ((\text{ob}z\epsilon)_{\omega mn})_{\omega mx})_{\phi}$	-0.5			-1_{ϕ} $= -1(4 + 7 \times 0_{\phi})$	-6
$((b\delta)_{\omega mn})_{\omega mx} ((\text{nob}z\epsilon)_{\omega mn})_{\omega mx})_{\phi}$			-1_{ϕ} $= -1(5.5+3 \times 0_{\phi})$		-5.5
$\mathcal{P}(((b\delta)_{\omega mn})_{\omega mx} ((\text{nob}z\epsilon)_{\omega mn})_{\omega mx})_{\phi}$		-0.3			-4.5

In summary, we see that allowing lexical items to vary in the activity levels assigned to underlying $/\tilde{V}n/$ is able to predict the three patterns observed with prenominal adjectives before vowel-initial words. In the remainder of the section, I will first extend the analysis to the regular and exceptional patterns of prefix allomorphy, before returning to the patterning of prenominal adjectives before consonant-initial words and in phrase-final positions.

4.4 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 Section 3.2, the current set of weights, scaling factors, and regular activity levels were shown to account for the surfacing of both input segments of prefix / \tilde{V} n/ before vowel-initial stems like [bj \tilde{e} n- ϵ me] ‘well-liked.’ However, tableau (32) shows that it incorrectly predicts the same output form to be optimal before sonorant-initial stems like [k α spe] ‘respect.’ This is because $*\tilde{V}$ [SON,CONS] is violated by both candidates that retain a nasal vowel (regardless of whether /n/ is deleted), but deletion of /n/ incurs an additional MAX violation.

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

/n $\tilde{\alpha}$ [_{NASAL}]0.75 n _{0.25} k α spe /	MAX w=4	MAX[NAS] w=15	$*\tilde{V}$ [SON,CONS] w=5.5, s=3	$*\tilde{V}$ V w=4, s=7	H
((n $\tilde{\alpha}$ (k α spe) _{ωmin}) _{ωmax}) _{ϕ}	-0.25		-1 _{ωmax} = -1(5.5+3 \times 1 _{ωmax})		-9.5
\bullet^* ((n $\tilde{\alpha}$ n (k α spe) _{ωmin}) _{ωmax}) _{ϕ}			-1 _{ωmax} = -1(5.5+3 \times 1 _{ωmax})		-8.5
((n α n (k α spe) _{ωmin}) _{ωmax}) _{ϕ}		-0.75			-11.25

This can be resolved by including a constraint against sequences of nasal consonants followed by another consonant, $*NC$, which independently accounts for the underattestation of NC sequences in Standard French (Schane 1968; Dell 1970).¹⁵ 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 activity levels associated with regular prefixes is represented by the variable α . Given the existing weights, scaling factors, and activity levels, the inclusion of $*NC$ at $w = 3.5$ ensures that /n/ is not realized before a sonorant consonant. As shown in tableaux (34)-(36), this correctly generates the patterning of regular prefixes before sonorant-initial, obstruent-initial, and vowel initial stems. The inclusion of $*NC$ will again be necessary in selecting the correct output forms of the exceptional prefix *in-* and pronominal adjectives before sonorant-initial stems (Section 4.5).

¹⁵ 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 $VN \rightarrow \tilde{V} / _ C$. Tranel argues that the rule cannot be justified because a limited number of roots contain VN sequences, e.g. [sypens] ‘suspense,’ [bins] ‘disorder,’ [amnisti] ‘amnesty.’ I will suggest two possible explanations for these patterns. First, it is plausible that root-internal NC sequences are protected by a high-weighted root faithfulness constraint (McCarthy and Prince 1995) or a scalar faithfulness constraint that incurs greater penalties within roots (Hsu and Jesney 2016). Alternatively, Smolensky and Goldrick (2016) suggest that such patterns can be explained if the fixed nasal consonants in these forms have higher activity than the alternating nasal consonants found in prefixes (see Section 5.1 for discussion of how such distinctions could be grounded), such that within roots deletion cannot create a more harmonic output than maintaining the NC sequence.

(33) *Weighting conditions for regular prefix allomorphy*

a. $/\tilde{V}n/ \rightarrow [\tilde{V}n]$ before vowel-initial stems

$$*\tilde{V}V(\omega_{\max}) + \text{MAX}(\alpha), \text{MAX}[\text{NASAL}](\alpha) > *\tilde{V}[\text{SON,CONS}](\omega_{\max})$$

b. $/\tilde{V}n/ \rightarrow [\tilde{V}]$ before sonorant-initial stems

$$*\text{NC} + \text{MAX}[\text{NASAL}](\alpha), *\text{NC} + *\tilde{V}[\text{SON,C}](\omega_{\max}) > \text{MAX}(\alpha) + *\tilde{V}[\text{SON,C}](\omega_{\max})$$

c. $/\tilde{V}n/ \rightarrow [\tilde{V}]$ before obstruent-initial stems

$$*\text{NC} + \text{MAX}[\text{NASAL}](\alpha), *\text{NC} + *\tilde{V}[\text{SON,CONS}](\omega_{\max}) > \text{MAX}(\alpha)$$

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

$/n\tilde{\text{d}}_{[\text{NASAL}]0.75} n_{0.25} \text{inisje}/$	MAX w=4	MAX[NAS] w=15	*NC w=3.5	* \tilde{V} [SON,CONS] w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	H
$((n\tilde{\text{d}} (\text{inisje})_{\text{omin}})_{\text{omax}})_{\phi}$	-0.25				$-1_{\omega_{\max}}$ $= -1(4+7 \times 1_{\omega_{\max}})$	-12
$\varphi ((n\tilde{\text{d}} (\text{ninisje})_{\text{omin}})_{\text{omax}})_{\phi}$				$-1_{\omega_{\max}}$ $= -1(5.5+3 \times 1_{\omega_{\max}})$		-8.5
$((n\text{d} (\text{ninisje})_{\text{omin}})_{\text{omax}})_{\phi}$		-0.75				-11.25

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

$/n\tilde{\text{d}}_{[\text{NASAL}]0.75} n_{0.25} \text{ɕæspe} /$	MAX w=4	MAX[NAS] w=15	*NC w=3.5	* \tilde{V} [SON,CONS] w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	H
$\varphi ((n\tilde{\text{d}} (\text{ɕæspe})_{\text{omin}})_{\text{omax}})_{\phi}$	-0.25			$-1_{\omega_{\max}}$ $= -1(5.5+3 \times 1_{\omega_{\max}})$		-9.5
$((n\tilde{\text{d}} (n\text{ɕæspe})_{\text{omin}})_{\text{omax}})_{\phi}$			-1	$-1_{\omega_{\max}}$ $= -1(5.5+3 \times 1_{\omega_{\max}})$		-12
$((n\text{d} (n\text{ɕæspe})_{\text{omin}})_{\text{omax}})_{\phi}$		-0.75	-1			-14.75

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

$/n\tilde{\text{d}}_{[\text{NASAL}]0.75} n_{0.25} \text{fõksjõ} /$	MAX w=4	MAX[NAS] w=15	*NC w=3.5	* \tilde{V} [SON,CONS] w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	H
$\varphi ((n\tilde{\text{d}} (\text{fõksjõ})_{\text{omin}})_{\text{omax}})_{\phi}$	-0.25					-1
$((n\tilde{\text{d}} (nfõksjõ)_{\text{omin}})_{\text{omax}})_{\phi}$			-1	$-1_{\omega_{\max}}$ $= -1(5.5+3 \times 1_{\omega_{\max}})$		-12
$((n\text{d} (nfõksjõ)_{\text{omin}})_{\text{omax}})_{\phi}$		-0.75	-1			-14.75

Again, we can see that changes to the underlying activity of / $\tilde{V}n$ / can result in the selection of different output candidates. This can be illustrated with attested dialectal variation involving the prefix *non-*, which is produced by some speakers with an oral vowel before vowel-initial words (Hannahs 1995), e.g. [n $\tilde{ɔ}$ - æ spe] ‘non-respect,’ [n $\tilde{ɔ}$ -f $\tilde{ɔ}$ ksj $\tilde{ɔ}$] ‘non-function,’ [n $\tilde{ɔ}$ n-inisje] ‘non-initiated’. Maintaining the same set of weights, this dialect is generated by a lower activity of [NASAL] for *non-*. For example, the reader may verify that this pattern arises by lowering the activity of [NASAL] to 0.5.

We now turn to the exceptional patterning of *in-*, which surfaces as [in] before vowel-initial and glide-initial stems, [i] before other sonorant-initial stems, and [ɛ̃] before obstruent-initial stems. This pattern is unique in that it is the only one that includes an output form that deletes both /n/ and the vowel’s [NASAL] feature. We thus consider four possible output mappings of / $\tilde{V}n$ /, 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 / $\tilde{V}n$ / precedes a vowel, sonorant consonant, or obstruent. I will have to leave aside the question of why the oral vowel + /n/ deletion candidate / $\tilde{V}n$ / \rightarrow [V] only surfaces on *in-*, and never for prenominal adjectives, given that such a candidate is predicted to be optimal under certain combinations of activity levels. Tentatively, this difference may be accounted for by a type of root faithfulness that prevents such repairs in prenominal adjectives, but not prefixes.

(37)	<i>Input-out mapping</i>	<i>Constraints violated</i>
	/ $\tilde{V}nV$ / \rightarrow [$\tilde{V}V$]	* $\tilde{V}V$, MAX
	/ $\tilde{V}nV$ / \rightarrow [$\tilde{V}nV$]	* \tilde{V} [SON,CONS]
	/ $\tilde{V}nV$ / \rightarrow [VnV]	MAX[NASAL]
	/ $\tilde{V}nV$ / \rightarrow [VV]	MAX[NASAL], MAX
	/ $\tilde{V}nC_{[SON]}$ / \rightarrow [$\tilde{V}C_{[SON]}$]	* \tilde{V} [SON,CONS], MAX
	/ $\tilde{V}nC_{[SON]}$ / \rightarrow [$\tilde{V}nC_{[SON]}$]	*NC, * \tilde{V} [SON,CONS]
	/ $\tilde{V}nC_{[SON]}$ / \rightarrow [VnC _[SON]]	*NC, MAX[NASAL]
	/ $\tilde{V}nC_{[SON]}$ / \rightarrow [VC _[SON]]	MAX[NASAL], MAX
	/ $\tilde{V}nC_{[-SON]}$ / \rightarrow [$\tilde{V}C_{[-SON]}$]	MAX
	/ $\tilde{V}nC_{[-SON]}$ / \rightarrow [$\tilde{V}nC_{[-SON]}$]	*NC, * \tilde{V} [SON,CONS]
	/ $\tilde{V}nC_{[-SON]}$ / \rightarrow [VnC _[-SON]]	*NC, MAX[NASAL]
	/ $\tilde{V}nC_{[-SON]}$ / \rightarrow [VC _[-SON]]	MAX[NASAL], 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:

(38)	<i>Weighting conditions for exceptional patterning of in-</i>
	a. / $\tilde{V}n$ / \rightarrow [Vn] before vowel-initial stems
	MAX(δ) + MAX[NASAL](δ), * \tilde{V} [SON,C](ω max), MAX(δ) + * $\tilde{V}V$ > MAX[NASAL](δ)

- b. $\tilde{V}n/ \rightarrow [V]$ before sonorant-initial stems
 $\text{MAX}[\text{NASAL}](\delta) + *NC, *NC + \tilde{V}[\text{SON,C}](\omega_{\max}), \text{MAX}(\delta) + * \tilde{V}[\text{SON}](\omega_{\max}) >$
 $\text{MAX}(\delta) + \text{MAX}[\text{NASAL}](\delta)$
- c. $\tilde{V}n/ \rightarrow [\tilde{V}]$ before obstruent-initial stems
 $\text{MAX}[\text{NASAL}](\delta), *NC + \tilde{V}[\text{SON,CONS}](\omega_{\max}), *NC + \text{MAX}[\text{NASAL}](\delta), \text{MAX}(\delta) +$
 $\text{MAX}[\text{NASAL}](\delta) > \text{MAX}(\delta)$

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/.¹⁶

(39) *In- before vowel initial stem*

$\tilde{e}_{[\text{NASAL}]0.5} \text{ n}_{0.5} \text{ abil/}$	MAX w=4	MAX[NAS] w=15	*NC w=3.5	* $\tilde{V}[\text{SON,CONS}]$ w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	H
$((\tilde{e} (\text{abil})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$	-0.5				$-1_{\omega_{\max}}$ $= -1(4+7 \times 1_{\omega_{\max}})$	-13
$((\tilde{e} (\text{nabil})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$				$-1_{\omega_{\max}}$ $= -1(5.5+3 \times 1_{\omega_{\max}})$		-8.5
$\varphi ((i (\text{nabil})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$		-0.5				-7.5
$((i (\text{abil})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$	-0.5	-0.5				-9.5

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

$\tilde{e}_{[\text{NASAL}]0.5} \text{ n}_{0.5} \text{ legal/}$	MAX w=4	MAX[NAS] w=15	*NC w=3.5	* $\tilde{V}[\text{SON,CONS}]$ w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	H
$((\tilde{e} (\text{legal})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$	-0.5			$-1_{\omega_{\max}}$ $= -1(5.5+3 \times 1_{\omega_{\max}})$		-10.5
$((\tilde{e} (\text{nlegal})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$			-1	$-1_{\omega_{\max}}$ $= -1(5.5+3 \times 1_{\omega_{\max}})$		-12
$((i (\text{nlegal})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$		-0.5	-1			-11
$\varphi ((i (\text{legal})_{\omega_{\min}})_{\omega_{\max}})_{\phi}$	-0.5	-0.5				-9.5

¹⁶ 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 /i/ that never surfaces faithfully due to a highly weighted constraint against surface [i] (cf. Schane 1968; Tranel 1974 for similar rule-based accounts). However, I will abstract away from this issue in the presented constraint-based analysis.

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

$/\tilde{\epsilon}_{[NASAL]0.5} \text{ n}_{0.5} \text{ p}\tilde{\text{s}}\text{i}\text{b}\text{l}/$	MAX w=4	MAX[NAS] w=15	*NC w=3.5	* $\tilde{\text{V}}$ [SON,CONS] w=5.5, s=3	* $\tilde{\text{V}}\text{V}$ w=4, s=7	H
$\varphi ((\tilde{\epsilon} (\text{p}\tilde{\text{s}}\text{i}\text{b}\text{l})_{\text{omin}})_{\text{omax}})_{\varphi}$	-0.5					-2
$((\tilde{\epsilon} (\text{np}\tilde{\text{s}}\text{i}\text{b}\text{l})_{\text{omin}})_{\text{omax}})_{\varphi}$			-1	-1_{omax} $= -1(5.5+3 \times 1_{\text{omax}})$		-12
$((\tilde{\text{i}} (\text{np}\tilde{\text{s}}\text{i}\text{b}\text{l})_{\text{omin}})_{\text{omax}})_{\varphi}$		-0.5	-1			-11
$((\tilde{\text{i}} (\text{p}\tilde{\text{s}}\text{i}\text{b}\text{l})_{\text{omin}})_{\text{omax}})_{\varphi}$	-0.5	-0.5				-9.5

4.5 *No lexical exceptionality of adjectives in phrase-final position, before C-initial words*

Lastly, the proposed grammar should account for the fact that the aforementioned adjectives with final $\tilde{\text{V}}$ and final $\tilde{\text{V}}\text{N}$ or VN alternants (e.g. [b $\tilde{\text{d}}$]/[b $\tilde{\text{ɔ}}\text{n}$], [k $\tilde{\text{ɔ}}\text{m}\tilde{\epsilon}$]/[k $\tilde{\text{ɔ}}\text{m}\tilde{\epsilon}\text{n}$]) always surface with final $\tilde{\text{V}}$ in φ -final position or when they precede consonant-initial words. Turning first to the case of φ -final prenominal adjectives, the key difference between this structure and those we have seen before is that it is not possible for the $/\tilde{\text{V}}\text{n}/ \rightarrow [\tilde{\text{V}}]$ mapping to violate * $\tilde{\text{V}}\text{V}$ in phrase-final position. The necessary weighting condition here is that the penalty of MAX needs to be lower than that of MAX[NASAL](φ) + *NC and * $\tilde{\text{V}}$ [SON,CONS](φ) + *NC, for both the regular and exceptional activity patterns.

(42) *Weighting conditions to ensure no exceptionality in phrase-final position*

$$*\tilde{\text{V}}[\text{SON}](\varphi) + *NC, \text{MAX}[\text{NASAL}](\alpha) + *NC > \text{MAX}(\alpha)$$

$$*\tilde{\text{V}}[\text{SON}](\varphi) + *NC, \text{MAX}[\text{NASAL}](\beta) + *NC > \text{MAX}(\beta)$$

$$*\tilde{\text{V}}[\text{SON}](\varphi + *NC), \text{MAX}[\text{NASAL}](\gamma) + *NC > \text{MAX}(\gamma)$$

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*.

(43) *Phrase-final commun*

$/\dots \text{k}\tilde{\text{ɔ}}\text{m}\tilde{\epsilon}_{[NASAL]0.75} \text{ n}_{0.5}/$	MAX w=4	MAX[NAS] w=15	*NC w=3.5	* $\tilde{\text{V}}$ [SON,CONS] w=5.5, s=3	* $\tilde{\text{V}}\text{V}$ w=4, s=7	H
$\varphi \dots \text{k}\tilde{\text{ɔ}}\text{m}\tilde{\epsilon})_{\text{omin}})_{\text{omax}})_{\varphi}$	-0.5					-2
$\dots \text{k}\tilde{\text{ɔ}}\text{m}\tilde{\epsilon}\text{n})_{\text{omin}})_{\text{omax}})_{\varphi}$				-1_{φ} $= -1(5.5+3 \times 0_{\varphi})$		-8.5
$\dots \text{k}\tilde{\text{ɔ}}\text{m}\text{y}\text{n})_{\text{omin}})_{\text{omax}})_{\varphi}$		-0.75				- 11.25

(44) Phrase-final *bon*

$/\dots b\tilde{\sigma}_{[NASAL]0.3} n_{0.5}/$	MAX w=4	MAX[NAS] w=15	*NC w=3.5	* \tilde{V} [SON,CONS] w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	<i>H</i>
$\varphi \dots b\tilde{\sigma}_{(\ominus min)_{(\ominus max)_{\varphi}}}$	-0.5					-2
$\dots b\tilde{\sigma}n_{(\ominus min)_{(\ominus max)_{\varphi}}}$				-1_{φ} $= -1(5.5+3 \times 0_{\varphi})$		-8.5
$\dots b\sigma n_{(\ominus min)_{(\ominus max)_{\varphi}}}$		-0.3				-4.5

Finally, the analysis must ensure that all of these prenominal adjectives surface with final \tilde{V} before all consonant-initial words, regardless of the sonority of the initial consonant. The following tableaux examine the predicted patterning of each class of adjectives before a sonorant-initial word [nunuʁ] ‘teddy bear’ and obstruent-initial [gaks̄s̄] ‘boy,’ and show that the $/\tilde{V}n/ \rightarrow [\tilde{V}]$ mapping is optimal for in these contexts given the existing weights, scaling factors, and activity levels.

(45) a. Regular adjective before sonorant-initial word

$/mij\tilde{\sigma}_{[NASAL]0.75} n_{0.25} \text{ nunu}\varnothing /$	MAX w=4	MAX[NAS] w=15	*NC w=3.5	* \tilde{V} [SON,CONS] w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	<i>H</i>
$\varphi (((mij\tilde{\sigma})_{\ominus mn})_{\ominus mx} ((\text{nunu}\varnothing)_{\ominus mn})_{\ominus mx})_{\varphi}$	-0.25			-1_{φ} $= -1(5.5+3 \times 0_{\varphi})$		-6.5
$((mij\tilde{\sigma}n)_{\ominus mn})_{\ominus mx} ((\text{nunu}\varnothing)_{\ominus mn})_{\ominus mx})_{\varphi}$			-1	$-1_{\ominus mn}$ $= -1(5.5+3 \times 1_{\ominus mn})$		-15
$((mij\sigma n)_{\ominus mn})_{\ominus mx} ((\text{nunu}\varnothing)_{\ominus mn})_{\ominus mx})_{\varphi}$		-0.75	-1			-14.75

b. Regular adjective before obstruent-initial word

$/mij\tilde{\sigma}_{[NASAL]0.75} n_{0.25} \text{ gaks}\tilde{\sigma} /$	MAX w=4	MAX[NAS] w=15	*NC w=3.5	* \tilde{V} [SON,CONS] w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	<i>H</i>
$\varphi (((mij\tilde{\sigma})_{\ominus mn})_{\ominus mx} ((\text{gaks}\tilde{\sigma})_{\ominus mn})_{\ominus mx})_{\varphi}$	-0.25					-1
$((mij\tilde{\sigma}n)_{\ominus mn})_{\ominus mx} ((\text{gaks}\tilde{\sigma})_{\ominus mn})_{\ominus mx})_{\varphi}$			-1	$-1_{\ominus mn}$ $= -1(5.5+3 \times 1_{\ominus mn})$		-15
$((mij\sigma n)_{\ominus mn})_{\ominus mx} ((\text{gaks}\tilde{\sigma})_{\ominus mn})_{\ominus mx})_{\varphi}$		-0.75	-1			-14.75

(46) a. *Commun*-class exceptional adjective before sonorant-initial word

$/k\text{om}\tilde{\epsilon}_{[\text{NASAL}]0.75} n_{0.5} \text{nunux}/$	MAX w=4	MAX[NAS] w=15	*NC w=3.5	* \tilde{V} [SON,CONS] w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	H
$\mathcal{E}(((k\text{om}\tilde{\epsilon})_{\text{omn}})_{\text{omx}}((\text{nunux})_{\text{omn}})_{\text{omx}})_{\varphi}$	-0.5			-1_{φ} $= -1(5.5+3\times 0_{\varphi})$		-7.5
$((k\text{om}\tilde{\epsilon}n)_{\text{omn}})_{\text{omx}} ((\text{nunux})_{\text{omn}})_{\text{omx}}_{\varphi}$			-1	-1_{omn} $= -1(5.5+ 3\times 1_{\text{omn}})$		-15
$((k\text{omyn})_{\text{omn}})_{\text{omx}} ((\text{nunux})_{\text{omn}})_{\text{omx}}_{\varphi}$		-0.75	-1			-14.75

b. *Commun*-class exceptional adjective before obstruent-initial word

$/k\text{om}\tilde{\epsilon}_{[\text{NASAL}]0.75} n_{0.5} \text{gaxs\ddot{o}}/$	MAX w=4	MAX[NAS] w=15	*NC w=3.5	* \tilde{V} [SON,CONS] w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	H
$\mathcal{E}(((k\text{om}\tilde{\epsilon})_{\text{omn}})_{\text{omx}}((\text{gaxs\ddot{o}})_{\text{omn}})_{\text{omx}})_{\varphi}$	-0.5					-2
$((k\text{om}\tilde{\epsilon}n)_{\text{omn}})_{\text{omx}} ((\text{gaxs\ddot{o}})_{\text{omn}})_{\text{omx}}_{\varphi}$			-1	-1_{omn} $= -1(5.5+ 3\times 1_{\text{omn}})$		-15
$((k\text{omyn})_{\text{omn}})_{\text{omx}} ((\text{gaxs\ddot{o}})_{\text{omn}})_{\text{omx}}_{\varphi}$		-0.75	-1			-14.75

(47) a. *Bon*-class exceptional adjective before sonorant-initial word

$/b\ddot{o}_{[\text{NASAL}]0.3} n_{0.5} \text{nunux}/$	MAX w=4	MAX[NAS] w=15	*NC w=3.5	* \tilde{V} [SON,CONS] w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	H
$\mathcal{E}(((b\ddot{o})_{\text{omn}})_{\text{omx}}((\text{nunux})_{\text{omn}})_{\text{omx}})_{\varphi}$	-0.5			-1_{φ} $= -1(5.5+3\times 0_{\varphi})$		-7.5
$((b\ddot{o}n)_{\text{omn}})_{\text{omx}} ((\text{nunux})_{\text{omn}})_{\text{omx}}_{\varphi}$			-1	-1_{omn} $= -1(5.5+3\times 1_{\text{omn}})$		-15
$((b\ddot{o}n)_{\text{omn}})_{\text{omx}} ((\text{nunux})_{\text{omn}})_{\text{omx}}_{\varphi}$		-0.3	-1			-8

b. *Bon*-class exceptional adjective before obstruent-initial word

$/b\tilde{d}_{[NASAL]0.3} n_{0.5} ga\kappa s\tilde{d} /$	MAX w=4	MAX[NAS] w=15	*NC w=3.5	* \tilde{V} [SON,CONS] w=5.5, s=3	* $\tilde{V}V$ w=4, s=7	<i>H</i>
$\mathcal{E}(((b\tilde{d})_{\text{omn}})_{\text{omx}} ((ga\kappa s\tilde{d})_{\text{omn}})_{\text{omx}})_{\phi}$	-0.5					-2
$((b\tilde{d})_{\text{omn}})_{\text{omx}} ((ga\kappa s\tilde{d})_{\text{omn}})_{\text{omx}}_{\phi}$			-1	-1 _{omn} =-1(5.5+3×1 _{omn})		-15
$((b\tilde{d})_{\text{omn}})_{\text{omx}} ((ga\kappa s\tilde{d})_{\text{omn}})_{\text{omx}}_{\phi}$		-0.3	-1			-8

4.6 Summary

In this section, I have shown that the complex 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 $/\tilde{V}n/$ underlying form for lexical items with a nasal vowel allomorph, and without lexical exceptionality in prosodic organization. Regular and exceptional items differ only in activity levels associated with underlying nasal vowels. Proportional changes to faithfulness constraint penalties mimic the effects of scalar markedness constraints on total harmony, creating the exceptional prosodification effects.

It is important to emphasize that although constraint scaling and gradient activity influence the calculation of harmony in similar ways, the functions of the two mechanisms in the grammar should not be conflated. Under the assumption that outputs contain only quantized (discrete) structures with full activity, differences in input gradient activity do not affect the evaluation of markedness constraints. The relative ill-formedness of output structures that vary in their context within a hierarchy can only be accounted for by markedness scaling, which imposes relative harmony thresholds for the surfacing of marked structures in different contexts. While changes in input activity can result in the exceptional surfacing of marked forms, they cannot alter the relative thresholds determined by scalar markedness constraints.

5. Alternative approaches

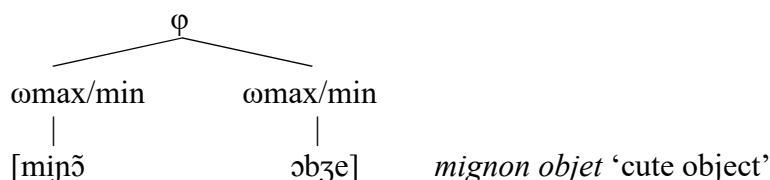
5.1 Prosodic prespecification analysis of exceptional patterns

Broadly speaking, early works in generative phonology take two basic approaches to the analysis of lexical exceptionality involving nasal vowels and nasal liaison (for more detailed overviews, see Tranel 1981; 1992; Prunet 1986). The *different rules approach* posits that the exceptional items are subject to either distinct rules or rule orderings. For instance, Schane (1968; 1973) proposes an underlying $/Vn/$ form for both *bon* and *commun* classes preverbal adjectives, but marks forms like *commun* as exceptions to a requirement that vowels are not nasalized before $C_{[NASAL]}V$ 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 $/\tilde{V}/$ underlying form for both classes, and that only the *bon* class undergoes a minor rule of vowel denasalization in the context $__nV$. Alternatively, the *different underlying segments approach* claims that exceptional items have distinct underlying segments.

For example Selkirk (1972) maintains a single set of rules, but posits that *commun*-type items with non-alternating vowel quality have / $\tilde{V}n$ / underlying forms, in contrast to / Vn / for the *bon* class.

The key drawback of both of these analyses is that the resemblance of each exceptional pattern to a regular pattern that applies in a smaller domain is purely accidental. As an alternative, Hsu (2015) presents a prosodic prespecification analysis that directly accounts for this relationship between the regular and exceptional patterns. In this approach, prenominal adjectives have three possible prosodic representations. Regular prenominal adjectives bear no prespecification, and are mapped to their own maximal prosodic word nodes in accordance with the default syntax-prosody correspondence.

(48) *No prespecification*



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

(49)



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 ω_{min} 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.

(50)



An advantage of this approach is that all three classes of prenominal adjectives can receive a uniform segmental underlying form in final position. For instance, the same representation proposed for the final segment of *mignon*, / \tilde{V} / 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.

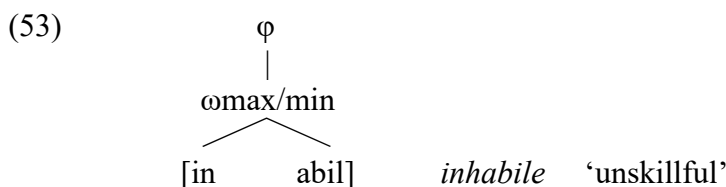
(51) Exceptional prespecification 1: *commun objet* 'common object'

/kɔmẽ ɔbzɛ/ SUBCAT: [__ []] _{ωmin}] _{ωmax}	MAX[NAS] w=6	DEP w=4	* \tilde{V} [SON,CONS] w=1, s=3	* $\tilde{V}V$ w=3, s=6	H
((kɔmẽ (ɔbzɛ) _{ωmin}) _{ωmax}) _φ				-1 _{ωmax} = -1(3+6×1 _{ωmax})	-9
φ ((kɔmẽ (nɔbzɛ) _{ωmin}) _{ωmax}) _φ		-1	-1 _{ωmax} = -1(1+3×1 _{ωmax})		-8
((kɔmɛ (nɔbzɛ) _{ωmin}) _{ωmax}) _φ	-1	-1			-10

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

/bɔ̃ ɔbzɛ/ SUBCAT: [__ []] _{ωmin}	MAX[NAS] w=6	DEP w=4	* \tilde{V} [SON,CONS] w=1, s=3	* $\tilde{V}V$ w=3, s=6	H
((bɔ̃ ɔbzɛ) _{ωmin}) _{ωmax}) _φ				-1 _{ωmin} = -1(3+6×2 _{ωmin})	-15
((bɔ̃ nɔbzɛ) _{ωmin}) _{ωmax}) _φ		-1	-1 _{ωmin} = -1(1+3×2 _{ωmin})		-11
φ ((bɔ̃ nɔbzɛ) _{ωmin}) _{ωmax}) _φ	-1	-1			-10

The exceptional allomorphy of the prefix *in-* is accounted for with the same prosodic prespecification of *bon*-class adjectives: *in-* is prespecified to be contained in the ω_{min} node of what 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 ω_{min} .



(54) Exceptional prespecification of *in-*: *inhabile* ‘unskillful’

$/\tilde{\epsilon} \text{ abil}/$ SUBCAT: [$_ _ []$] ω_{\min}	MAX[NAS] w=6	DEP w=4	* \tilde{V} [SON,CONS] w=1, s=3	* $\tilde{V}V$ w=3, s=6	H
$((\tilde{\epsilon} \text{ abil})_{\omega_{\min}})_{\omega_{\max}}\phi$				$-1_{\omega_{\min}}$ $= -1(3+6 \times 2_{\omega_{\min}})$	-15
$((\tilde{\epsilon} \text{ nabil})_{\omega_{\min}})_{\omega_{\max}}\phi$		-1	$-1_{\omega_{\min}}$ $= -1(1+3 \times 2_{\omega_{\min}})$		-11
$\phi ((\text{inabil})_{\omega_{\min}})_{\omega_{\max}}\phi$	-1	-1			-10

In summary, the prosodic prespecification analysis and Gradient Harmonic Grammar proposal differ in the locus of variation between regular and exceptional lexical items. The two approaches are compared in Table 2 below. The prespecification analysis posits a uniform structure for all nasal vowels, but requires exceptional items (b), (c), (e) to surface in an exceptional prosodic structures. In contrast, the gradient activity analysis assumes no item-specific variation in syntax-prosody mapping; but posits that lexical items can vary in the activity levels associated with underlying final nasal vowels. All regular patterns (a), (d), (f) can be generated by the same set of activity levels, $/[\text{NASAL}]_{0.75}/$ and $/n_{0.25}/$, while each exceptional pattern is associated with different specifications of activity. It is worth repeating here that exact activity values are not crucial, as long as they fall within ranges that satisfy the correct weighting conditions.¹⁷

	Morpho-syntactic context	Prosodic prespecification analysis	Gradient activity analysis	
a.	Regular Adj (no liaison)	Separate ω	Separate ω	$/[\text{NAS}]/$ activity = 0.75 $/n/$ activity = 0.25
b.	<i>Commun</i> -class Adj (liaison with nasal vowel)	Adjunct to ω_{\max}		$/[\text{NAS}]/$ activity = 0.75 $/n/$ activity = 0.5
c.	<i>Bon</i> -class Adj (liaison with oral vowel)	Part of ω_{\min}		$/[\text{NAS}]/$ activity = 0.3 $/n/$ activity = 0.5
d.	Regular prefix	Adjunct to ω_{\max}	Adjunct to ω_{\max}	$/[\text{NAS}]/$ activity = 0.75 $/n/$ activity = 0.25
e.	Exceptional prefix	Part of ω_{\min}		$/[\text{NAS}]/$ activity = 0.5 $/n/$ activity = 0.5
f.	Stem	Part of ω_{\min}	Part of ω_{\min}	$/[\text{NAS}]/$ activity = 0.75 $/n/$ activity = 0.25

Table 2. Comparison of prespecification and gradient activity analyses

Like the gradient activity analysis, the prosodic prespecification approach successfully captures the generalization that each exceptional pattern resembles the regular pattern at a different level of prosodic constituency. However, it introduces additional complexity to the phonological grammar. First, it requires underlying representations to contain information about surface prosodic structure. This is unexpected given the absence of evidence for prespecification of surface syllable structure, generally considered to be the lowest level of prosodic constituency (Hayes

¹⁷ Although the preceding analysis has used distinct activity levels for the *commun*-class prenominal adjective pattern (b) and the *in-* prefix pattern (e), it is possible to generate both patterns using the same exceptional activity levels. For instance, the reader may verify in tableaux (30), (43), (46) that the *commun*-class prenominal adjective pattern can also be generated with activity levels $/[\text{NASAL}]_{0.55}/$ and $/n_{0.5}/$.

1989; Blevins 1995; Elfner 2006).¹⁸ Second, in order to enforce morpheme-specific syntax-prosody mismatches in a constraint-based theory, the grammar must include constraints that enforce morpheme-specific prespecifications like SUBCAT (Tyler 2017, Bennett et al. 2018), which can compel violations of MATCH constraints. While these claims may ultimately receive sufficient independent justification from other phonological patterns, the analysis proposed in this paper 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 (55). Although some speakers permit stem-internal geminates in forms like [gʁammɛʁ] ‘grammar,’ optional degemination seems to be a property specific to prefixes.

- (55) [tʁɑ̃(s)saɑʁjɛ̃] ‘trans-Saharan’
 [di(s)sɑ̃blabl] ‘dissimilar’
 [sy(ʁ)ʁealism] ‘Surrealism’ (Tranel 1976)

If the optional degemination process reflects the basic prosodic organization of prefixes, the prespecification analysis leads to a paradox, as *in-* is predicted to obey all prosody-sensitive generalizations that apply to stems, but not to regular prefixes. Although I will not pursue an analysis of the optional degemination pattern here, it suffices to note that the gradient activity analysis allows for patterns in which exceptional activity causes a morpheme to behave exceptionally with respect to one prosody-sensitive restriction, but not another one.

Finally, it is important to note that the gradient activity analysis resembles the prosodic prespecification and different underlying segments approaches in that the difference between regular and exceptional patterns arises from differences in the content of the underlying representations associated with each class. However, the gradient activity analysis is superior by the following criteria. First, the gradient activity analysis allow for a reduction in the types of symbols that a learner would need to posit for underlying forms in their language; the learner needs to posit only the structures that are necessary for the regular pattern, and acquire item- or class-specific differences in activity levels. Second, systematic differences in activity levels across lexical items can be plausibly grounded in numerically quantifiable substantive factors that are known to influence lexical exceptionality (Inkelas 2015, Smolensky and Goldrick 2016), such as morpheme frequency, perceptual cue strength, and informativity. On the other hand, it is difficult to envision how these factors should determine the different segmental representations or prespecified prosodic structures that have been proposed to account for lexical exceptions.

5.2 Lexical constraint indexation

¹⁸ It should be noted that syllables pattern differently from larger prosodic categories in key ways. For example, the internal organization of syllables follows distinct well-formedness principles from those of larger categories (Nespor and Vogel 1986; 12-13). In addition, while prosodic constituents at the ω level and above generally correspond to syntactic constituents, syllables do not (Selkirk 2011). While it could turn out that the possibility of prespecification is simply another difference between these prosodic category types, I know of no principled reason to expect this distinction to exist.

In constraint-based grammars, morpheme-specific phonological patterns can also be captured by positing lexically indexed constraints (Pater 2000, 2009) that apply only to exceptional morphemes that possess a relevant index. For instance, the exceptional patterning of *commun*-class and *bon*-class prenominal adjectives can be accounted for in a ranked-constraint grammar by including lexically indexed versions of $*\tilde{V}V$ and $*\tilde{V}[\text{SON,CONS}]$ that outrank the constraints that prevent denasalization and [n] insertion on regular adjectives. While such an approach could generate the distribution of nasal vowels in French, the resemblance of exceptional patterns to regular patterns applying in smaller domains is again entirely coincidental, as with the different rules and different underlying segments analyses.

It is worth noting here that gradient activity analyses of exceptionality can generate both exceptional blocking and exceptional triggering patterns (cf. Pater 2009 for discussion of indexed constraints). Exceptional blocking arises in conditions where a markedness penalty exceeds the penalty of a faithfulness constraint when the input contains items with regular activity, but exceptional items incur a greater faithfulness penalty that exceeds the markedness penalty: $w(F(e)) > w(M) > w(F(r))$. Exceptional triggering occurs if the faithfulness penalty at the regular activity level exceeds that of markedness, but exceptional items incur a faithfulness penalty that falls below the markedness penalty: $w(F(r)) > w(M) > w(F(e))$.

To my knowledge, any exceptional pattern that arises through a difference in gradient activity can also be generated in an indexed constraint analysis. Although the issue requires further study, we can note several ways in which the approaches differ in their restrictiveness. In the Gradient Harmonic Grammar proposal, each change in the underlying gradient activity of a segment or feature is predicted to affect the violations of *all and only* the faithfulness constraints that refer to that structure. On the contrary, there is in principle no necessary connection between the indices assigned to a morpheme, that morpheme's phonological properties, and the inventory of indexed constraints (see C. Smith 2018 for similar discussion). This leads to distinct empirical predictions. The gradient activity analysis of exceptionality readily predicts the existence of patterns in which exceptional morphemes pattern exceptionally with respect to multiple processes or constraints referring to the same structure (see Zimmermann 2017 for one such case), while such clustering of exceptional processes can only be accidental in an indexed constraint approach. A conclusive evaluation of these broader predictions awaits further investigation.

5.3 Cyclic constraint evaluation

Finally, I consider whether the patterning of French nasal vowels 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 $\tilde{V}X$ 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, again with the simplifying assumption that there is a single FAITH constraint. At the stem level, both markedness constraints $*\tilde{V}V$ and $*\tilde{V}[\text{SON,CONS}]$ outrank FAITH; Outputs of the stem-level cycle thus only contain nasal vowels preceding obstruents. On the word cycle, FAITH outranks $*\tilde{V}[\text{SON,CONS}]$. Sequences 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.

- (56) Stem-level ranking: $*\tilde{V}V, *\tilde{V}[\text{SON,CONS}] \gg \text{FAITH}$
Word-level ranking: $*\tilde{V}V \gg \text{FAITH} \gg *\tilde{V}[\text{SON,CONS}]$
Phrase-level ranking: $\text{FAITH} \gg *\tilde{V}V, *\tilde{V}[\text{SON,CONS}]$

Although the regular patterning of $\tilde{V}X$ sequences at different levels of morpho-syntactic constituency is readily accounted for, it becomes difficult to generate the patterning of exceptional items. To account for the resemblance between exceptional patterns and regular patterns that apply in earlier cyclic domains, 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 idiosyncrasy. 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.

6. Conclusion

This paper has shown that the adoption of scalar constraints and gradient symbolic structures in a weighted constraint 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 the 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, the proposal suggests that an alternative analysis without prespecification may be possible. More broadly, the proposal predicts the existence of similar interactions between lexical exceptionality and other patterns of context-sensitivity that can be modeled through constraint scaling, such as lexical category (J. Smith 2011; Linzen et al. 2013) or degree of nativization (Hsu and Jesney 2017, 2018).

This paper, along with recent analyses by Smolensky and Goldrick (2016), Rosen (2016), and Zimmermann (2017), 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.

Finally, the 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 suggests 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, as potentially expected if activity levels are grounded in factors like frequency or informativity. 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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