

1 *Introduction*

This book investigates phonological vowel patterns, that is, restrictions on which vowel sounds can occur where in a language. Such patterns intersect with two main themes of this work, characterized in (1).

- (1)
 - a. How word position affects the way in which vowels function in a pattern.
 - b. How aspects of the perception and production of speech affect vowel patterns.

Vowel patterns that interact with word position are pervasive in language. For example, many languages show some form of systematic reduction in the range of distinctive vowel qualities in unstressed syllables. This type of pattern occurs in languages such as Russian, Italian, and English. Instances of vowel reduction processes are witnessed when stress shifts under affixation. In Standard American English, primary stress (signified by an accent) is assigned to the first syllable in *phótophraph*, where the vowel is pronounced as [oʊ]. In the related word, *photógraphy*, where stress is assigned to the second syllable, the pronunciation of the vowel in the first syllable is reduced to [ə], designating a mid-central quality that often occurs in unstressed syllables in all forms of English (Ladefoged 1993: 84f.). Other vowel qualities can reduce to [ə] in an unstressed syllable, as in *expláin* [eɪ] versus *explanátion* [ə] or *emphátic* [æ] versus *émphásis* [ə], causing a number of vowel distinctions to be merged in some unstressed contexts.

Instances of vowel quality reduction in unstressed syllables are illustrative of a relation between vowels and positional prominence. Positions in the word that display a prominence maximum or minimum (e.g. stress peak/stress trough) are often focal in patterns that affect vowel properties. Reduction of vowel quality is not the only type of systematic process that is sensitive to positional prominence. As will be illustrated below, several other kinds of vowel patterns are attested in the world's languages that are conditioned by the relative prominence of the position in which the vowel occurs. Investigating the breadth of these systems is essential to test and advance phonological theory.

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This gives rise to the primary investigatory questions that guide this research, given in (2).

- (2)
 - a. Why are only certain kinds of interactions between vowels and positional prominence attested in spoken language?
 - b. What is the range of systematic vowel patterns in spoken language that are sensitive to positional prominence?
 - c. What do these patterns reveal about the theoretical mental constructs that form the basis for the phonological system that governs speech sounds in a language?

Bearing on the question in (2a), prior preliminary investigation has identified a set of patterns that share a common result, namely, they avert distinctive vowel qualities that are only expressed in non-prominent syllables (Walker 2004, 2005). These fall here under the rubric of *prominence-based licensing* phenomena, and investigating their extent in language and their properties is a focus of this book. Growing out from the preliminary investigation is a hypothesis that the vowel patterns under study are in large part perceptually driven: prominence-based licensing patterns serve to reduce perceptual difficulty in language. Vowels that occur in a non-prominent syllable supply fewer cues or less salient cues for listeners to perceive the properties that distinguish them from other vowels; for instance, unstressed syllables tend to be shorter in duration and lower in amplitude than stressed syllables. Foundation for this hypothesis also stems from other studies of vowel patterns with different typological focus (Suomi 1983; Kaun 1995, 2004; Majors 1998; Crosswhite 2001, 2004) and from wide-scope studies on position-sensitive neutralization of speech sounds (e.g. Steriade 1995a, 1999a,b).

The hypothesis that vowel patterns can be influenced by perception predicts that a prominence-based licensing pattern could efface vowel qualities in a non-prominent position, with the result that the communication of particular distinctive properties in a non-prominent syllable would be sacrificed. It also predicts the possibility that a pattern could augment the perceptibility of a distinctive vowel quality by causing it to be produced in a prominent syllable, possibly as well as in a non-prominent syllable. A pattern that singles out vowels in prominent syllables for effacement – in the absence of augmenting a non-prominent vowel quality – is not predicted to occur. Also not predicted is a pattern that singles out only the most perceptible vowel qualities for augmentation or loss. For example, because of its open jaw position, the low vowel [a] tends to be longer and greater in amplitude than non-low vowels, so it is not expected to be singled out in this way. An exception could be expected in word-final position, where contextual laryngeal and aerodynamic weakening effects

can interfere with the perception of low vowels (Barnes 2006). In conformity with these predictions, prominence-based licensing patterns that selectively augment or efface [a] are not found, except when it occurs in word-final position. In contrast, because the high vowels [i] and [u] tend to be shorter than non-high vowels and have a lower amplitude, the perception-driven hypothesis predicts that certain prominence-based licensing patterns could be specific to them, as is indeed attested. However, as will be taken up in chapter 2, it is not always an easy task to determine the relative perceptual difficulty of vowel qualities. Sometimes the vowel qualities involved in a given contrast each have some different advantages and disadvantages, which could lead to variability across languages in which quality is singled out in prominence-based licensing phenomena.

Improved perceptual cues are not the only enhancements that a prominent position affords. Articulations may be stronger and longer, for instance, in stressed syllables and in initial and final positions. However, the nature of these effects varies across languages and sometimes even across speakers of the same language. This could suggest either that certain prominent positions facilitate production or that the occurrence of stronger and longer articulations causes a position to function as prominent. Articulatory enhancements are likely to lead to certain improved perceptual cues, so these effects can be interactive. Moreover, particular prominent positions are suggested to be psycholinguistically prominent, that is, they play an important role in processing of speech for purposes of recognition or production. For example, word-initial positions show increased salience or facilitation in word recognition and retrieval, and they display evidence of a special status in the phonological encoding of sounds for speech production. Again, these effects may be interactive such that certain types of heightened psycholinguistic salience could facilitate or be facilitated by enhanced perceptual cues and articulation.

All of these factors, perception, articulation, and processing, can contribute to the relative markedness of a vowel, and possibly other factors can contribute as well. A guiding idea pursued in this work is that the positions that function as prominent in vowel patterns are ones that tend to facilitate the perception, production, and processing of speech (Steriade 1995a, 1999a,b; Beckman 1997, 1999; Crosswhite 2001, 2004; Smith 2005). The emphasis here will be chiefly on perception, although, as just described, this interacts with articulation and processing. Given the hypothesis that the patterns under study largely serve to reduce perceptual difficulty, it is expected that distinctive qualities in marked vowels will be likely to occur in prominent positions or come to occur in them, and they will otherwise be prone to effacement. Prominent positions

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that recur in vowel patterns across languages include stressed syllables, initial syllables, morphological roots and stems, and, with some mixed effects, final syllables. Although positional prominence is postulated to be grounded in concrete properties, the positions in question typically function as prominent in phonology in an abstract and categorical manner. For example, a stressed syllable is generally singled out in a prominence-sensitive phonological pattern without regard to fluctuations in its physical or psycholinguistic prominence due to variation in speaker or occasion. Furthermore, while all of the syllables in question may be potentially eligible to function as prominent in some respect, which particular position is selected to serve as prominent can vary from language to language, and sometimes even varies from pattern to pattern within a language. In characterizing prominence-based licensing phenomena, the *prominent or licensing syllable* is the one that serves as prominent for that pattern and *non-prominent or non-licensing syllables* are syllables that form the complement to the prominent syllable, even if they include syllables that may function as prominent in other respects or in other languages. Thus, for instance, the stressed syllable may serve as prominent for a given prominence-based licensing pattern, in which case all unstressed syllables will function as non-prominent for licensing in that pattern, including, if unstressed, initial, final, and root/stem syllables.

In order to shed light on the question in (2b), this work undertakes a typological investigation of prominence-based licensing vowel patterns across languages. Over 25 distinct patterns are studied, providing a broad empirical basis for developing and testing the theory. The aim is to investigate a range of patterns in the form of case studies, with varying degrees of depth.

It is significant that distinctive vowel qualities that are expressed solely in non-prominent syllables are prevented through diverse processes. A sampling of different types of vowel patterns that are sensitive to prominence is provided in (3). They include deletion (where a vowel is dropped), reduction (where a distinction in vowel quality is lost), metathesis (where a vowel and consonant change order), and assimilation (where a vowel becomes more like another in the word; also known as a harmony pattern). In transcriptions in this book I generally follow IPA conventions, although I indicate stress with accent marks rather than the diacritic [ˈ]. Tones are indicated by numbers following the syllable: ‘1’ low, ‘5’ high, ‘51’ falling, and ‘15’ rising.

(3) a. Vowel deletion:

In northern dialects of Modern Greek, [i] and [u] are deleted when they are unstressed in certain contexts. For example, the high vowel in the first syllable of [pín-a-mi] ‘we were drinking’ is deleted when unstressed in [é-pn-a] ‘I was drinking’ (Joseph 1990).

b. Vowel reduction:

In Belarusian, a Slavic language, the vowels /e/ and /o/ lower to [a] in an unstressed syllable, as evidenced in the following word pairs [rěki] / [raká] ‘rivers/river,’ [nóyi] / [náyá] ‘legs/leg’ (Krivitskii and Podluzhnyi 1994; Crosswhite 2001).

c. Vowel–consonant metathesis:

In certain Romance dialects of northern Italy, [i] in a final unstressed syllable shows an apparent metathesis with a preceding consonant to create a diphthong in the stressed syllable. Examples from old Piedmontese are given alongside their forms in Standard Italian (SI): [káin] (SI [káni]) ‘dog (m pl),’ [dráip] (SI [dráppi]) ‘cloth (m pl)’ (Rohlf 1966). Since the vowel that undergoes metathesis here is a suffix, this could be considered a process of infixation.

d. Assimilation of a vowel in a non-prominent position to one in a prominent position:

In Macuxi, a Carib language, the central vowel [i] undergoes assimilation for backness and rounding with a stem vowel in casual speech. The prefix /pi-/ ‘noun class A marker’ is produced with the vowel [i] in [pí-riw̃] ‘arrow (of someone),’ but it displays assimilation in [pu-moĩ] ‘egg (of someone)’ and [pi-sĩ] ‘leg (of someone)’ (Carson 1982). (Numbers indicate lexical pitch accents here.)

e. Assimilation of a vowel in a prominent position to one in a non-prominent position:

i. In the Romance dialect of central Veneto, a high vowel in an unstressed syllable causes mid vowels [e] and [o] to raise to [i] and [u], respectively, when they occur in a preceding stressed syllable. This is evidenced by the word pairs [kanté̃se] / [kantísimo] ‘sing (1sg/1pl impf. subj.),’ [kantór] / [kantúri] ‘choir singer (m sg/pl)’ (Belloni 1991; Brunelli 2000a; Walker 2005).

ii. Lango, a Nilotic language, presents a case involving the morphological root. A vowel in the final syllable of the root assimilates in its tongue root advancement to a suffix vowel with an advanced tongue root, as seen in the pair [cɔlɛ̃ɔl] / [cɔlɛ̃ɔl-nĩ] ‘beer/your (sg) beer’ (Wooock and Noonan 1979; Kaplan 2008a).

Observe that the patterns in (3a), (3b) and (3d) cause effacement of a vowel quality in a non-prominent position, and patterns (3c) and (3e) cause augmentation of a vowel quality that originated in a non-prominent position.

In addition to phonological processes that can produce vowel alternations in related forms, prominence-based licensing patterns involving vowels can exist as static distributions over the lexicon. These include position-sensitive patterns that show a static lack of contrast, where certain vowel qualities are absent in non-prominent positions, and static sequential dependencies, where certain qualities can occur in a vowel in a non-prominent position only when those qualities are also present in a vowel in a proximate prominent position. Some

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examples of static patterns are given in (4). Both of these examples involve the word-initial syllable as the prominent position and they are drawn from Altaic languages, which are suffixing. The word-initial syllable thus remains constant across words with the same stem.

- (4) a. Static lack of contrast
 In Ola Lamut, non-high round vowels [o], [o:], [ɔ], and [ɔ:] occur only in word-initial syllables. Words like the following are attested: [olək] ‘lie, deception,’ [ɔran] ‘reindeer,’ [o:lə-] ‘to become weak,’ [ɔ:ta] ‘sea wave,’ whereas words with non-high round vowels in a non-initial syllables are absent (Li 1996).
- b. Static sequential dependencies
 In Classical Mongolian, non-high round vowels [ø] and [o] occur in non-initial syllables of the root only when all preceding syllables contain non-high round vowels, as in [kømøske] ‘eyebrow(s),’ [nomoyodqa] ‘to tame.’ In addition, non-high unround vowels can follow round ones, as in the final syllable of the preceding examples and in [køke] ‘blue’, [qola] ‘far, distant’ (Svantesson 1985; Walker 2001b).

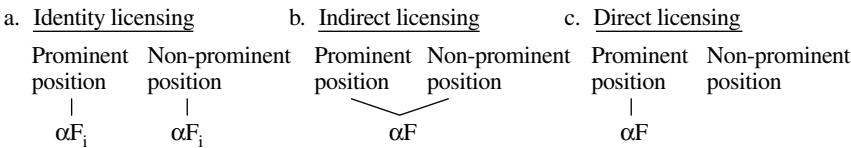
I will refer later to sequential dependencies, like the one exemplified in (4b), as ‘passive licensing.’ Not all sequential dependencies are static. The one in Classical Mongolian happens to be static, because the initial syllable does not change under the attachment of affixes (which are suffixes in this language), and non-high round vowels never occur in suffixes. However, there are languages that show passive licensing patterns with alternations. In C’Lela, a Benue-Congo language, high vowels occur in certain suffixes when word final only if they follow a root with a high vowel, and this restriction causes alternations in the suffix vowel. What distinguishes these patterns from ones with active assimilation is that when the conditions for the sequential dependency are not met, the vowel in the non-prominent position is neutralized to another quality rather than undergoing assimilation with the vowel in the prominent position.

Relevant to question (2c), which asks what these patterns reveal about the theoretical mental constructs, a goal of this work is to develop a formal account that captures the commonalities among prominence-based licensing systems. The proposal is that the patterns share an imperative modeled in the form of a family of prominence-based licensing constraints, a construct that elaborates on prior concepts of segmental and subsegmental licensing constraints, conditions, or properties in language (e.g. Itô 1988, 1989; Goldsmith 1989, 1990; Lombardi 1994, 1995). The constraints are united under a generalized prominence-based licensing constraint schema. They bar certain types of phonological structure – such as certain vowel properties – that occur solely in a weak position, a type of positional markedness requirement (Zoll 1998a). In

line with the foregoing discussion, the phonological structure in question is prone to be marked in some way.

With respect to subsegmental features – which characterize different vowel qualities – an important component of this proposal is the claim that features are licensed provided that some member of the chain to which the feature belongs is affiliated with a given licensing position. A chain for a feature consists of the feature and any duplicated coindexed occurrences of it in a structure. This allows the possibility of *identity* licensing, where licensing for a feature in a non-prominent position is achieved by a duplicated feature in a prominent position, as represented schematically for a feature specification $[\alpha F]$ in (5a). (‘ α ’ is a variable over values $\{+, -\}$ for $[F]$.) Identity licensing has the potential to operate at a distance over unaffected intervening material. Other possible licensing configurations are *indirect* licensing, in (5b), where a feature has associations with a prominent position and a non-prominent position, and *direct* licensing, in (5c), where a feature is contained wholly within a prominent position. (The labels ‘direct’ and ‘indirect’ follow Steriade 1995b).

(5)



The licensing constraints are situated within the set of assumptions that constitute Optimality Theory (OT; Prince and Smolensky 2004). A basic principle of this outcome-centered framework is that systematic properties of a language are represented in terms of constraints that are imposed over the phonological output. Licensing constraints can block phonological structures that violate them or they can drive patterns where changes occur that prevent a violation. They thus are well suited to address both prominence-based licensing phenomena that involve active processes, as well as ones that exist as static distributions in a language. Further, because constraints in OT are ranked and violable, prominence-based licensing constraints may be violated within a language in order to satisfy competing constraints with which they conflict.

The OT model differs from process-centered frameworks in which grammars are organized around the individual processes that manipulate phonological forms, such as vowel deletion or vowel reduction, rather than being organized around the well-formedness of outputs of the grammar. A core result of this study is that the reduction of perceptual difficulty in prominence-based

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licensing patterns is accomplished by various processes across languages. This is consistent with the emphasis of OT on *common outcomes achieved by diverse means* (McCarthy 2002; Prince and Smolensky 2004). Alternative formal perspectives on these phenomena that concentrate on the means (process) and not the end (outcome) miss the insight that they are linked by a common factor with a shared form of linguistic knowledge.

Whereas the function of prominence-based licensing constraints constitutes the formal pivot that unites the vowel patterns under focus in this work, positional prominence also figures in the analysis in the context of positional faithfulness constraints (e.g. Casali 1997, 1998; Beckman 1997, 1999; Lombardi 1999, 2001). Positional faithfulness constraints bar changes in the properties of segments or other phonological constituents when they occur in a specific privileged position, such as a stressed syllable. These constraints play a role in the treatment of position-sensitive trigger control for assimilation and in position-sensitive resistance to neutralization. To be clear about the terminology used here, a *trigger* refers to a segment to which another assimilates, and a *target* refers to a segment that undergoes an assimilation. In many (but not all) assimilations driven by prominence-based licensing, a vowel in a privileged position is the trigger and a vowel in a non-prominent position is a target. This intersects with the theme concerning how word position affects the way vowels function in a pattern.

Pushing beyond vowel patterns that are driven by prominence-based licensing, the scope of the investigation is extended to vowel patterns that involve what is characterized in this work as *maximal licensing*. In maximal licensing patterns, certain vowel properties are driven to be expressed in every vowel in a word, not just in a prominent position. Maximal licensing constraints are proposed that can drive vowel harmony that is potentially unbounded in its extent of operation within a word. Like prominence-based licensing phenomena, maximal licensing tends to restrict marked structure, such as vowel qualities that show comparative perceptual difficulty or that occur in a weak context. The themes that underscore prominence-based licensing are thus more widely applicable.

This book is organized as follows. Chapter 2 explores possible functional grounding for asymmetries in positional prominence and vowel markedness with basis in the way that speech is perceived, produced, and processed. The discussion pulls together an overview of prior research on these topics. The positions under focus that can serve as prominent for some phonological purpose are stressed syllables, initial syllables, final syllables, and morphological roots and stems. In counterpoint, contexts that can serve as weak are unstressed

syllables, final syllables, and affixes. Final syllables thus show a dual behavior across languages, and even within them. The relative markedness of specific vowel qualities, especially in weak position, draws discussion, with particular focus on contrasts for vowel height. Predictions for prominence-based licensing phenomena are delineated.

Chapter 3 introduces the formal framework for the analysis of prominence-based licensing patterns involving vowels. The chapter opens with background on the concept of licensing of segmental properties in phonological theory. A schema for generalized prominence-based licensing constraints is introduced that has the capacity to promote each of the three proposed licensing configurations: direct, indirect, and identity. Formal and substantive restrictions on the arguments within a licensing constraint are considered. A limited set of additional constraints that interact with prominence-based licensing constraints is presented, and demonstrations are provided to show how different constraint interactions, corresponding to different constraint rankings, can play out to obtain the three licensing configurations. The chapter closes with discussion of a means to obtain morpheme-specific effects in prominence-based licensing.

Chapter 4 examines typological predictions that are made by prominence-based licensing constraints in conjunction with a set of other constraints that are relevant to a typology that includes licensing-driven assimilation. In OT, the predicted typology of patterns is derived from all possible rankings of the constraint set, known as a ‘factorial typology.’ Typological properties are explored using factorial typologies that were algorithmically generated using OTSoft, Version 2.1 (Hayes *et al.* 2003). The generalizations that are discovered as properties of the formal system are identified. Primary interactions of a prominence-based licensing constraint with some additional constraints, besides those applicable to assimilation patterns, are also considered. Sample licensing patterns in languages discussed in later chapters are listed to illustrate particular predictions.

Chapters 5, 6, and 7 focus on the description and analysis of vowel patterns that involve prominence-based licensing. Chapter 5 addresses vowel patterns that are characterized by indirect licensing, chapter 6 deals with patterns that include identity licensing configurations, and chapter 7 deals with vowel patterns that show only direct licensing. Each of these chapters introduces a core constraint ranking structure for the patterns under focus. Following that, a series of case studies is presented, comprised language data to illustrate the patterns, discussion of relations to the overarching themes, and formal analyses.

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A number of related topics cross-cut these chapters, including sources of strength, weakness, and control, local and non-local interactions, markedness-driven blocking, interactions with the lexical status of material, and morpheme-specific triggering and blocking, among others.

Romance dialects spoken in Italy and Spain form an area of concentration in chapters 5, 6, and 7, although they are by no means the only languages under study. The Romance ‘dialects’ in question are in fact minor Romance languages; they are descended from Latin and not varieties of Standard Italian or Spanish. Romance dialects were selected for study because they cast light on how satisfaction of prominence-based licensing constraints can play out in different ways within related languages. An important type of vowel pattern that a number of Romance dialects display is known as *metaphony*, where a post-tonic high vowel causes raising of a preceding stressed vowel.¹ (A post-tonic vowel is one that occurs following a stressed vowel.) An example is the raising harmony in the central Veneto dialect, introduced in (3e). Metaphony is significant for the typology of prominence-based licensing patterns, because it involves a vowel in a prominent position undergoing assimilation to a vowel in a non-prominent position, sometimes at a distance. Metaphonic patterns can therefore serve to discriminate the different roles of positional markedness and positional faithfulness constraints and facilitate investigation of locality.

Another topic that spans these chapters is the evolution of umlaut in German. Like Romance metaphony, umlaut in Old High German began as an assimilation that was triggered by a post-tonic vowel and affected a stressed vowel; in umlaut the assimilation chiefly involves fronting. In the progress from Old High German to Modern Standard German, umlaut traversed through each of the three proposed licensing configurations, starting with indirect licensing, followed by identity licensing, and ending with direct licensing in the language spoken today. This provides a lens on a scenario of diachronic evolution in a prominence-based licensing pattern.

Chapter 8 turns to maximal licensing patterns where a weak vowel trigger causes harmony that propagates in an unbounded fashion rather than targeting a vowel in a prominent position. Maximal licensing harmony can be triggered by a vowel in a weak position and/or by a vowel that displays some weak property or combination of properties. First, two patterns are examined where the trigger resides in a strong position, which is the locus of contrast for a particular weak property. A comprehensive case study is then developed for the Servigliano dialect, which includes two maximal licensing patterns with triggers that are weak by virtue of their properties and/or their position. In all,