CHAPTER 1

POSITIONAL AUGMENTATION: MARKEDNESS CONSTRAINTS FOR PROMINENT POSITIONS

1.1 Introduction

Phonological requirements sometimes hold specifically of material in phonologically prominent or "strong" positions, such as stressed syllables or roots. Here, such requirements are analyzed in the framework of Optimality Theory (Prince & Smolensky 1993; McCarthy & Prince 1993ab, 1995) in terms of markedness constraints[1] that make specific reference to strong positions (abbreviated **M/str(ong)**). It is shown that only certain kinds of requirements ever hold of strong positions, so the inclusion of all logically possible **M/str** constraints in the universal constraint set (CON) would lead to incorrect typological predictions. The theory developed here is able to distinguish between those logically possible **M/str** constraints that are actual constraints and those that are not.

The difference between legitimate and impossible **M/str** constraints stems from two restrictions on constraints of this type — restrictions that are framed in functional or substantive terms. First, as shown in §2.3, all **M/str** constraints in CON are of a type called here *augmentation* constraints: constraints that call for the presence of perceptually prominent characteristics. Augmentation constraints can be relativized to strong positions because, although they are markedness (contrast-neutralizing) constraints, their satisfaction further enhances these already prominent positions by increasing their perceptual salience. Second, **M/str** constraints affecting positions that are strong for psycholinguistic reasons (as opposed to phonetic reasons) are prohibited if their satisfaction would hinder early-stage word recognition (defined in §4.3.1), such as by neutralizing segmental feature contrasts. This is because the privileged status of psycholinguistically strong positions is based on their important role in this aspect of speech processing. One of the results of this restriction is that certain augmentation constraints that can be relativized to the phonetically strong position stressed syllable cannot be relativized to the similarly sized initial syllable, since it is a psycholinguistically strong position.

Because the restrictions on **M/str** constraints are substantive in nature, a theory of possible and impossible **M/str** constraints must also address the question of how the phonology, a formal system that manipulates abstract formal objects, can nevertheless be shaped by substantive considerations. The conception of CON proposed here, called the Schema/Filter model, holds that constraints themselves are freely constructed from formal phonological

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[1] A *markedness constraint* is any constraint that makes reference only to output forms; that is, any constraint for which information about input forms, or the correspondence relation between input and output forms, is irrelevant in determining the degree of violation. Such constraints are sometimes referred to in the OT literature as "phono-constraints", "structural constraints", or "well-formedness constraints".

primitives without reference to substantive considerations; functional grounding enters the phonology through the fact that only a subset of the formally possible constraints are actually included in CON (extending an idea advanced by Hayes (1999a) to model the influence of phonetic grounding on feature-context markedness constraints, such as *[nas][-voi]). In the Schema/Filter model, constraints are freely constructed by the application of a number of general *constraint schemas* to the entire inventory of primitive phonological elements. However, *constraint filters,* which make use of perceptual, articulatory, or other extra-phonological information to screen constraints, permit only some of the formally constructed constraints into CON. The substantive restrictions on **M/str** constraints described above are imposed by two such constraint filters: the Prominence Condition, which rejects any **M/str** constraint unless it calls for the enhancement of perceptual prominence, and the Segmental Contrast Condition, which rejects **M/str** constraints for psycholinguistically strong positions if they inappropriately neutralize contrasts that are important in early-stage word recognition.

While the proposal developed here addresses the specific problem of the difference between possible and impossible **M/str** constraints, the languages examined below also provide several pieces of evidence that phonology is an abstract and formal system despite the influence of substantive considerations on many phonological constraints and elements. For example, the existence of both the constraint ONSET, which requires syllables to have onsets, and the *ONSET/X subhierarchy of constraints, which collectively require syllable onsets to be low in sonority, can be related to the substantive fact that interspersing low-sonority elements between vowels enhances the perceptibility of the vowels. However, ONSET and *ONSET/X are formally distinct in that they evaluate different aspects of syllable structure and in that they can be freely ranked with respect to one another (§2.3.2.3). Another piece of evidence for the formal nature of phonology can be seen in the variety of **M/str** constraints that apply to phonetically strong positions; while it is a particular phonetic characteristic that gives a phonetically strong position its special status, the position can nevertheless be the target of an **M/str** constraint that manipulates properties unrelated to that phonetic characteristic. This fact indicates that although the status of "phonetically strong position" has a substantive basis, it functions as an abstract phonological property (§2.4.3). The Schema/Filter model of CON predicts such results — although this model explicitly includes substantive restrictions on the phonological system, it nevertheless maintains a formal view of phonology.

The following section (§1.2) presents a more detailed overview of the proposal sketched above, indicating where in subsequent chapters each aspect of the proposal is addressed. Then, §1.3 makes explicit the theoretical background presupposed in this dissertation, presenting evidence for the existence of phonologically strong positions (§1.3.1) and arguing that **M/str** constraints, rather than **F/wk** constraints, are the best way to account for phonological requirements on strong positions (§1.3.2).

1.2 Synopsis of the proposal

This section first establishes the empirical context of the proposal developed in this dissertation by presenting the problem posed by **M/str** constraints — they exist, but they must be restricted, or incorrect typological predictions are made (§1.2.1). An overview of the proposal is then given: the Prominence Condition (§1.2.2.1), the Segmental Contrast Condition (§1.2.2.2), and their place in the Schema/Filter model of CON (§1.2.2.3).

1.2.1 The problem: M/str constraints and typological predictions

When a phonological requirement holds specifically of a strong position, we know that there is a markedness constraint, enforcing that requirement, that is relativized to the strong position in question.[2] Examples of such requirements, and the **M/str** constraints that enforce them, are given in (1); these examples are discussed in more detail in chapters 3 and 4.

(1) Markedness constraints for strong positions

(a) Stressed syllables must be heavy

▹ Mohawk: Open stressed syllables are lengthened (Michelson 1988)

k-atirút-haʔ	1A-*pull*-HAB	'I pull'
ʌ-k-atirú:.t-ʌʔ	FUT-1A-*pull*-PUNC	'I'll pull'

M/str constraint: HEAVYσ/ό (§3.2.1)

(b) Stressed syllables must have low-sonority onsets

▹ Pirahã: Stress is attracted to syllables with voiceless-obstruent onsets (Everett & Everett 1984ab, Everett 1988)

bii.sái	'red'	(*Note:* acute accent marks stress;
ʔá.ba.gi	'toucan'	underline indicates high tone)

M/str constraint: [*ONSET/X]/ό (§3.2.2)

[2]See §1.3.2 for why phonological requirements specific to strong positions are analyzed in terms of **M/str** constraints.

(c) Long vowels must have high-sonority nuclei

▹ Yawelmani: Long high vowels are lowered (Kuroda 1967; Kisseberth 1969)

c'oːm-al	'might destroy'	/c'uːm + al/
ṣoːg-al	'might pull out the cork'	/ṣuːg + al/

M/str constraint: [*PEAK/X]/Vː (§3.3)

(d) Initial syllables must have onsets

▹ Arapaho: Words are always consonant-initial (Salzmann 1956)

xooó	'skunk'
héθ	'dog'
nówoʔ	'fish'
*owoʔ	

M/str constraint: ONSET/σ_1 (§4.2.1)

(e) Roots must bear stress

▹ Tuyuca: Default stress is inserted on root-final vowel (Barnes 1996)

/hoo + a/	hoóa	*submerge.oneself*-EV 'I submerge myself'	(default stress inserted into root)

(*Note:* root segments are underlined)

M/str constraint: HAVESTRESS/Root (§4.2.2)

The **M/str** constraints in (1) are attested, and necessary, members of the universal constraint set CON (see chapters 3 and 4 for phonological analyses of these and other languages in which such constraints are active). However, not just any markedness constraint can be relativized to strong positions. For example, if an ordinary featural markedness constraint such as *MIDV ('output forms do not contain mid vowels') were given an **M/str** counterpart specific to stressed syllables, *MIDV/ó, then the ranking shown in (2) would be a possible ranking, predicted to occur in some language.

(2) Hypothetical feature-markedness **M/str** constraint: *MIDV/ó

Input: /tépo/	*MIDV/ó	IDENT[Vht]/ó	IDENT[Vht]	*MIDV
a. tépo	*!			**
☞ b. típo		*	*	*
c. típu		*	**!	

In OT, the possibilities for phonological contrast in a particular language are determined by the relative ranking in that language of markedness constraints, which require outputs to be free of complex or otherwise dispreferred phonological structures, and faithfulness constraints, which require outputs to be like inputs and thereby act to prevent the neutralization of contrasts. Thus, with the ranking shown in (2), mid vowels are generally permitted, because IDENT[Vht] dominates *MIDV. But in stressed syllables, mid vowels are banned, given the ranking of *MIDV/σ́ over the stressed syllable-specific faithfulness constraint IDENT[Vht]/σ́ and the general constraint IDENT[Vht].

The problem here is that languages with contrastive mid vowels only in unstressed syllables are in fact unattested. More generally, it is a characteristic of featural positional neutralization effects (such as the neutralization of mid vowels) that they target weak positions, not strong positions (see, e.g., Steriade 1993, 1995 and Beckman 1998 for discussion). So constraints such as *MIDV/σ́ must not be part of the universal set of constraints.[3] However, once the formal mechanism of relativizing markedness constraints to strong positions is included in the theory — and such a mechanism is necessary, given the existence of the **M/str** constraints in (1) — then without any further restrictions, the option of forming an **M/str** counterpart is open to all markedness constraints.

This dissertation develops a theory of **M/str** constraints that accounts for why some, but not all, of the formally possible **M/str** constraints are legitimate, attested constraints. The proposal is outlined in the following section.

1.2.2 The proposal: Substantive grounding through constraint filters

What sets attested **M/str** constraints like those in (1) apart from unattested and problematic **M/str** constraints like the putative *MIDV/σ́ in (2) is their relationship to perceptual prominence. It is proposed here that legitimate **M/str** constraints are all strong position-specific versions of *augmentation* constraints, that is, markedness constraints that require the presence of perceptually prominent properties such as syllable weight, stress, high tone, high-sonority nuclei, and low-sonority onsets.[4]

This substantively based restriction on **M/str** constraints is implemented as a constraint filter in the Schema/Filter model of CON: the Prominence Condition (§1.2.2.1). Likewise, the additional restriction noted in §1.1 that holds of **M/str** constraints for psycholinguistically strong

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[3]Not every ranking of a constraint set that includes *MIDV/σ́ produces a grammar that allows "reverse positional neutralization" as in (2). But crucially, *some* such rankings do lead to unattested grammars. Since there is no principled way to prohibit the problem rankings, *MIDV/σ́ must not be allowed to exist.

[4]On the presence of an onset, or of a specifically low-sonority onset, as a perceptually prominent property for a syllable, see §2.3.2.3.

positions — positional augmentation constraints for these positions are banned if their satisfaction would impede early-stage word recognition, a domain in which psycholinguistically strong positions play a special role — is implemented as another filter: the Segmental Contrast Condition (§1.2.2.2).

1.2.2.1 The Prominence Condition

The requirement that all **M/str** constraints must be positional augmentation constraints — constraints that call for the presence of perceptually prominent properties in the strong positions that they target — is enforced by the Prominence Condition, a constraint filter that helps to determine the composition of CON by excluding non-prominence-enhancing **M/str** constraints. (For discussion of what it means for a constraint to enhance perceptual prominence, see §2.3.1.)

(3) *Prominence Condition*

> Markedness constraints specific to strong positions are included in CON only if the general markedness constraints from which they are built call for the presence of perceptually prominent properties.

Essentially, an **M/str** constraint passes the Prominence Condition if output candidates that satisfy the constraint are judged by the perceptual system to be more prominent — to elicit a perceptual response of greater magnitude — than candidates that violate the constraint. However, the specific type of perceptual prominence demanded by a particular **M/str** constraint need not be directly related to the intrinsic salience of the given strong position for the **M/str** constraint to pass this filter (§2.3.3, §2.4.2.2).

Discussion of the Prominence Condition and its role as a constraint filter, and evidence that the predictions of this model are correct in that the empirically attested **M/str** constraints do all qualify as prominence-enhancing constraints, are given in Chapter 2.

1.2.2.2 The Segmental Contrast Condition

Although it is a fundamental requirement that all **M/str** constraints must be prominence-enhancing, as enforced by the Prominence Condition, this is not the only requirement that holds of **M/str** constraints. Positions that are strong for phonetic reasons are eligible for any kind of positional augmentation constraint, as seen most strikingly in the wide variety of augmentation phenomena observed in stressed syllables (§3.2). However, positions that are strong for psycholinguistic reasons are generally not eligible for positional augmentation constraints that manipulate segmental contrasts (i.e., vocalic or consonantal features; one important exception is discussed below).

Chapter 4 proposes that the defining characteristic of a psycholinguistically strong position is that it be important in early-stage word recognition (§4.3.1); the psycholinguistically

strong positions initial syllable and root both meet this criterion (§§4.3.2-3). It has been argued by Nooteboom (1981), L. Taft (1984), and others that having a large number of phonological contrasts in positions that are important in early-stage word recognition helps make the task of recognizing words more efficient, because it divides the lexical search space into smaller partitions (§4.3.5). This substantive consideration is the reason for the limited positional augmentation possibilities in psycholinguistically strong positions. While augmentation constraints enforce the presence of properties that help make strong positions more perceptually salient, the consequence of satisfying an **M/str** constraint is in fact the neutralization of a potential contrast (i.e., in favor of the more perceptually prominent member of the opposition). The added benefit of perceptual prominence that a psycholinguistically strong position would gain from augmentation is simply not enough to outweigh the adverse effects on word recognition of contrast neutralization in this position. Therefore, augmentation effects for these positions are essentially limited to non-segmental properties, such as stress, because prosodic features like this have been shown not to be relevant for early-stage word recognition in the way that segmental contrasts are (see §4.3.4).

While in general there are no augmentation phenomena for psycholinguistically strong positions that affect segmental contrasts, there is one exception to this generalization. The initial syllable is subject to positional augmentation effects involving syllable onsets — ONSET/σ_1, which requires the presence of a syllable onset in the initial syllable (§4.2.1.1), and the [*ONSET/X]/σ_1 subhierarchy, which favors low-sonority onsets in this position (§4.2.1.2). This apparent exception to the general ban on segmental-contrast **M/str** constraints for psycholinguistically strong positions has a substantive basis as well. As discussed in more detail in Chapter 4, the task of word "segmentation" in spoken-language processing, i.e., locating word boundaries in running speech, is difficult. Thus, enhancing the salience of the initial edge of a word through augmentation processes that affect the onsets of initial syllables is actually helpful in processing.

The two substantive factors that determine possible positional augmentation constraints for psycholinguistically strong positions (*Ψstr*), abbreviated **M/Ψstr**, are incorporated into the Schema/Filter model by means of another constraint filter, the Segmental Contrast Condition.

(4) *Segmental Contrast Condition*

If a constraint is of the form **M/Ψstr**, then it must meet one of the following two conditions:

I. Satisfaction of the **M** constraint from which the **M/Ψstr** constraint is built does not alter features that are distinguished in early-stage word recognition.

or

II. **Ψstr** is σ_1, and satisfaction of the **M/Ψstr** constraint serves to demarcate the left edge of σ_1.

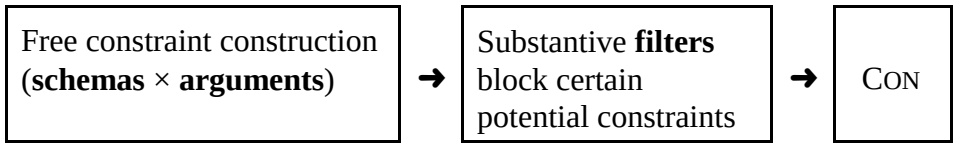
In brief, condition (I) of the Segmental Contrast Condition allows an **M/Ψstr** constraint to be included in CON if its winning and losing candidates (that are otherwise identical) activate the same set of lexical entries; this allows for constraints like HAVESTRESS/Root, since stress placement is not directly relevant in early-stage word recognition, but bans constraints like [*PEAK/X]/Root, which would call for high-sonority syllable nuclei in roots, thus neutralizing certain vowel-feature contrasts. Condition (II) allows an **M/Ψstr** constraint to be included in CON if it affects the left edge of the initial syllable, as described above. Since the Segmental Contrast Condition is a disjunction, a given **M/Ψstr** constraint need only pass one of (I) and (II) to be eligible for inclusion in CON. Thus, this filter models the two ways in which substantive considerations affect the inventory of possible **M/Ψstr** constraints.

The difference between phonetically and psycholinguistically strong positions, the importance of psycholinguistically strong positions for early-stage word recognition, and the Segmental Contrast Condition are discussed in §2.4. Psycholinguistic evidence supporting these proposals is reviewed in §4.3, where more detailed justification is also given for the particular formulation of the Segmental Contrast Condition in (4).

1.2.2.3 The Schema/Filter model of CON

The two filters described above, the Prominence Condition and the Segmental Contrast Condition, are proposed as part of a model of CON that allows for free constraint construction from general constraint schemas, like IDENT, ALIGN, or **C**/*str* (a constraint schema that relativizes a constraint to a strong position), but also includes substantive restrictions on the phonological system in the form of constraint filters. This model, developed in §2.2, is summarized in the diagram in (5) below.

(5) The Schema/Filter model of CON



C/*str*:	{*MIDV × ό}	~~*MIDV/ό~~	HEAVYσ/ό
	{HEAVYσ × ό}	HEAVYσ/ό	...
	...	...	

The **M/str** constraints *MIDV/ό and HEAVYσ/ό shown in (5) are both formally possible constraints, since the combination of any constraint with a strong position like ό is a legitimate operation in the constraint-construction module. However, the Prominence Condition will pass only HEAVYσ/ό, ruling out *MIDV/ό, since only the former is a prominence-enhancing markedness constraint.

Including constraint filters in the model allows domains external to the formal phonology, such as articulation, perception, and processing, to impose substantive considerations that have a fundamental impact on the contents of the universal constraint set CON, while the constraints themselves remain formal objects, formally constructed.

1.3 Strong and weak positions in phonological analysis

There is one final topic to be addressed before this introductory chapter is concluded: the theoretical background[5] that is important for understanding the questions examined in this dissertation. The crucial points are evidence for the phonological distinction between strong and weak positions (§1.3.1) and justification for choosing **M/str** constraints over **F/wk** constraints (faithfulness constraints for weak positions), a logically possible alternative approach to augmentation constraints on strong positions (§1.3.2).

1.3.1 Phonological evidence for strong positions

The distinction between strong and weak positions has a long history in modern phonological investigation. Different behavior in strong and weak positions was originally identified in the context of positional neutralization, a phenomenon in which typologically marked structure is tolerated in certain ("strong") positions but neutralized in other ("weak") positions.[6]

Trubetzkoy (1939:235-6) recognizes a phenomenon that he calls "structurally conditioned" neutralization, in which neutralization occurs only in specific positions in the word, because other positions form a "phonological peak" in the word that is able to resist neutralization. To paraphrase Trubetzkoy's (1939) discussion slightly, he proposes two classes of such peaks: first, the location of stress or accent, whether contrastive or fixed, and second, word edges, as opposed to medial positions.

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[5]Familiarity with the basic framework of Optimality Theory (Prince & Smolensky 1993; McCarthy & Prince 1993ab) and the Correspondence Theory implementation of faithfulness (McCarthy & Prince 1995) is assumed.

[6]Strictly speaking, the kinds of phonological processes that are the main topic of this dissertation — prominence-enhancing processes that affect *strong* positions exclusively — could also be called "positional neutralization," since they cause strong positions to have certain (prominent) properties, thereby neutralizing a potential contrast between the presence and the absence of the property in question. However, the discussion here will follow the traditional use of the term positional neutralization to refer to the types of featural neutralization — neutralization to the unmarked value, with no particular connection to prominence — that affect *weak* positions exclusively. Processes that affect strong positions exclusively, argued here always to be prominence-enhancing, will be called *positional augmentation*.

Subsequent work on positional neutralization has increased the inventory of strong positions. For example, Steriade (1993) recognizes, in addition to initial and final syllables and stressed syllables, released consonants and long vowels. Steriade (1993, 1995, 1997) also makes the important point that in some cases, the identity of the features whose neutralization can be resisted by a particular strong position depends on the phonetic characteristics of the strong position (for more on this and related matters, see §2.4). McCarthy & Prince (1995) and Alderete (1999b, 2001) present evidence for the importance of the morphological root (as opposed to affixes) as a strong position. Smith (1998, 1999, 2001) proposes that the noun can also be considered a strong position with respect to positional neutralization effects, perhaps because the noun is more canonically rootlike — more likely to be a free form — than the verb. Discussion of differences between strong and weak positions can also be found in, for example, Vennemann (1972), Hooper (1976), Jun (1995), Padgett (1995), Zoll (1996, 1997a, 1998), and Lombardi (1999).

Beckman (1997, 1998; see also Casali 1996, 1997) proposes that a particular position may qualify for special status as a strong position, and therefore have the potential to resist positional neutralization effects, for one of two reasons. Either, as in Steriade's (1993, 1995, 1997) proposals, the position has special phonetic salience, or else the position has a special role in psycholinguistic processing. That is, it is special status outside the domain of phonology proper that gives rise to special phonological status as a strong position.

The strong positions to be examined in this dissertation are listed in (6), grouped, according to Beckman's (1998) terminology, into phonetically and psycholinguistically strong positions (see also §2.3.3, §2.4.2).[7]

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[7]Not all of the strong positions that have been proposed in the literature are given equal attention here. Word-final position is explicitly recognized as a strong position in some accounts of positional neutralization, such as Trubetzkoy (1939) and Steriade (1993); see also Hyman's (1998) discussion of the word-medial "prosodic trough" in Bantu languages, where he shows that possible phonological contrasts are more limited in medial than in final position, and Zhang (2000), who argues that contour tones can be licensed specifically in final syllables. However, investigation to date has not found any convincing cases of *augmentation* in final position. Since positional augmentation is the focus of this dissertation, this position is not further considered here.

Other strong positions proposed in the phonological literature for which augmentation constraints can plausibly be identified are the noun and certain prosodic heads (other than the main-stress syllable, which is extensively discussed in §3.2). One possible case of noun augmentation is discussed in §4.2.2.2. Systematic examination of augmentation in prosodic heads other than the main-stress syllable (head of the prosodic word, PrWd) is a topic for future investigation, although prosodic heads at several levels do appear to have the status of strong positions. For example, phrasal heads are sometimes seen to resist positional neutralization, as in ChiMwi:ni (Selkirk 1986). Also, foot heads (secondary-stress syllables) are observed both to resist neutralization, as in English, where they can license non-reduced vowels, and to undergo

(6) Strong positions

(a) Phonetically strong positions	(b) Psycholinguistically strong positions
Stressed syllable	Initial syllable
Onset/released consonant[8]	Root
Long vowel	

§2.4 shows that this distinction between the two classes of strong positions is a fundamental division that affects the ways in which constraints, both markedness and faithfulness, can be relativized to strong positions. The distinction between phonetically and psycholinguistically strong positions is therefore relevant for both kinds of position-sensitive phenomena, positional neutralization and positional augmentation.

In summary, investigation of positional neutralization has shown that phonologically strong and weak positions must be distinguished. The positional augmentation phenomena treated in this dissertation provide another class of cases in which strong and weak positions show distinct patterns of phonological behavior. Further discussion of positional neutralization, and its relationship to the positional augmentation phenomena under investigation here, is provided in Chapter 5. §5.2 reviews the three approaches that have been taken in OT toward positional neutralization (positional faithfulness constraints, positional featural markedness constraints, and COINCIDE constraints), showing that no account of positional neutralization can be used "as-is" to account for positional augmentation effects as well. §5.3 argues that positional augmentation is a phenomenon that is empirically distinct from positional neutralization, so it is not surprising that the two require distinct formal treatments. §5.3 also shows that the factorial typology of a system that includes both positional neutralization and positional augmentation constraints is consistent with observed empirical patterns.

1.3.2 Positional augmentation constraints as M/str, not "F/wk"

This dissertation examines a particular set of phenomena in which strong and weak positions are distinguished: phonological requirements that are enforced of strong positions, but not of weak positions. This section demonstrates that such position-specific requirements can be enforced within OT only through constraints that are themselves relativized to positions, and

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augmentation, as in Sukuma, where they attract tones (Kang 1997), and iambic-lengthening languages, where they must be heavy.

[8]This strong position will be referred to as "onset" for expository convenience, but as argued by, e.g., Kingston (1985, 1990), Lombardi (1991, 1999), and Padgett (1995), it is best defined as a consonant that is released. (See also Steriade 1993, 1995, 1997 for discussion of this position.)

defends the choice of **M/str** constraints (markedness constraints relativized to strong positions) over **F/wk** constraints (faithfulness constraints relativized to weak positions) for this purpose.

Fundamental to the nature of phonological analysis in OT is the interaction between markedness (**M**) and faithfulness (**F**) constraints (see also §1.2.1). **F** constraints demand the preservation of features, segments, and other phonological structures or configurations in the mapping from input to output forms (likewise for correspondence relations other than input-output). Thus, if a given **F** constraint is not dominated by any conflicting constraints, there will be a contrast in the language involving the phonological feature or structure to which that **F** constraint makes reference. The surface phonological contrast comes about because inputs having the feature or structure in question will correspond to outputs that also have it, whereas inputs lacking the feature or structure will correspond to outputs that also lack it.

M constraints, on the other hand, require output forms to avoid dispreferred phonological features and structures (dispreferred for, e.g., articulatory or perceptual reasons). So if an **M** constraint banning a particular phonological feature or structure dominates an **F** constraint that would otherwise protect the feature or structure in question, then output forms in the language will predictably lack that feature or structure, which means that it does not form the basis of a phonological contrast.

For example, consider the following commonly invoked constraints (given informal characterizations for now; see also §2.3.2.3 concerning ONSET).

(7)	(a) **M:**	ONSET	Syllables begin with consonants (Prince & Smolensky 1993, after Itô 1986, 1989)
	(b) **F:**	DEP-SEG	Epenthesis is prohibited (McCarthy & Prince 1995)

In a language where ONSET dominates DEP-SEG (**M** >> **F**), all syllables will have onsets, so the language will have no contrast between C-initial and V-initial syllables (8a). Conversely, in a language where DEP-SEG dominates ONSET (**F** >> **M**), there will be a surface contrast between output forms that have V-initial syllables and those that do not (8b).[9]

[9]The purpose of this example is not to present a detailed discussion of syllable inventory typology (for which see, e.g., Prince & Smolensky 1993), but rather to illustrate the interaction of **M** and **F** constraints with respect to phonological contrast. Therefore, it has been deliberately oversimplified for expositional clarity. For example, the ranking of the **F** constraint MAX-SEG, which militates against segmental deletion, is also relevant in both model languages shown in (8). To have a language as in (8a) that avoids onsetless syllables by epenthesizing onsets (rather than by deleting potentially onsetless vowels), MAX-SEG must dominate DEP-SEG. To have a language as in (8b) that preserves onsetless syllables (again, rather than one that eliminates them through vowel deletion), MAX-SEG must dominate ONSET.

(8) **M**, **F**, and phonological contrast

(a) **M** >> **F**: no contrast; /V/ → [CV] and /CV/ → [CV]

(i) /V/	ONSET	DEP-SEG
a. V	*!	
☞ b. CV		*
(ii) /CV/	ONSET	DEP-SEG
☞ a. CV		
b. V	*!	

(b) **F** >> **M**: contrast persists; /V/ → [V] and /CV/ → [CV]

(i) /V/	DEP-SEG	ONSET
☞ a. V		*
b. CV	*!	
(ii) /CV/	DEP-SEG	ONSET
☞ a. CV		
b. V		*!

When a particular phonological contrast is attested in a language only in certain structural positions, however, general **M** and **F** constraints alone are insufficient to account for the pattern. One relevant example would be a language in which syllables in some strong position *str* always have onsets, but syllables outside *str* may have onsets or not. In other words, syllables in *str* have no contrast between V and CV syllables (as in (8a)), but syllables outside *str* do have that contrast (as in (8b)). Languages of this type include Dutch, which requires onsets specifically in stressed syllables (§3.2.2.1), and Arapaho, which requires onsets specifically in initial syllables (§4.2.1.1).

To account for a phonological contrast that surfaces only outside a strong position *str*, it is necessary to have a ranking of the form **F** >> **M** <u>outside</u> *str* but **M** >> **F** <u>inside</u> *str*. Formally, there are three ways in which this sort of differential ranking can be accomplished. One option is literally to recognize distinct constraint rankings that operate inside and outside the position in question. However, choosing this option would force us to abandon the hypothesis that there is a

single, consistent constraint ranking for an entire language; this option will therefore not be further considered here. (See Fukazawa, Kitahara, and Ota (1998) for arguments in favor of maintaining a single total ranking for the grammar of a language.[10])

The two remaining options are to invoke a version of the **M** constraint that is specific to the strong position (**M/str(ong)**), or to invoke a version of the **F** constraint that is specific to the complement of the strong position (**F/w(ea)k**). Constraints that make reference to particular positions have often been proposed in the literature in situations of positional neutralization (contrast neutralization in weak positions); see Chapter 5 for a discussion of such proposals and the formal nature of the positional constraints involved. The crucial insight behind the use of positional constraints is that they assess violations only when the state of affairs that they prohibit occurs in the position to which they are relativized; in effect, they ignore anything that happens outside that position.[11]

The first of these positional-constraint strategies, the one using **M/str** constraints, is the approach actually adopted here. It solves the problem of strong position-specific markedness effects by including in the grammar versions of **M** constraints that make specific reference to individual strong positions, such as ONSET/ σ́ for Dutch or ONSET/σ_1 for Arapaho.

Thus, the relevant ranking for Arapaho, which requires onsets specifically in initial syllables, is as follows (see also (1d) above and §4.2.1.1).

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[10]Anttila (2002) takes the opposite position from Fukazawa, Kitahara, and Ota (1998), arguing in favor of distinct subgrammars (separate rankings) for, e.g., different sets of lexical items within a language. However, such a proposal is not applicable for the majority of the cases considered in this dissertation, since the differing phonological behavior occurs, not in distinct lexical items, but in distinct structural positions within individual lexical items.

[11]One class of position-sensitive constraints, namely COINCIDE constraints (Zoll 1996, 1997a, 1998), is somewhat different in this respect. This is because COINCIDE constraints are not themselves relativized to a position. Instead, they take a strong position as one of the elements over which they quantify in computing violations. See §5.2.3 for discussion.

(9) Onsets required specifically in initial syllables (data from Salzmann 1956; syllabification according to Salzmann's description)

(a) Medial syllables need not have onsets

/xooó/	ONSET/σ_1	DEP-SEG	MAX-SEG	ONSET
☞ a. xoo.ó				*
b. xoo.Có		*!		
c. xoo			*!	

(b) Initial syllables must have onsets (hypothetical input)

/owo?/	ONSET/σ_1	DEP-SEG	MAX-SEG	ONSET
(☞) a. Co.wo?		*		
(☞) b. wo?			*	
c. o.wo?	*!			*

In medial syllables, high-ranking ONSET/σ_1 is by definition not applicable (is vacuously satisfied), so the relevant constraints are DEP-SEG, MAX-SEG >> ONSET; that is, **F** >> **M**. This is the ranking for contrast, so non-initial syllables have a contrast between syllables without onsets (9a) and syllables with onsets (e.g., [no.wo?] in (1d) above).

The lack of contrast specifically in initial syllables is enforced by the high rank of ONSET/σ_1. This position-specific markedness constraint dominates at least one of the faithfulness constraints MAX-SEG or DEP-SEG, so that within the strong position initial syllable, the relevant ranking is **M**(/**str**) >> **F**, the ranking for neutralization. Potential V-initial input forms therefore surface unfaithfully, to be C-initial (9b).

It should be noted here that there are no examples in Salzmann (1956) showing overt alternations, which would indicate specifically what the grammar of Arapaho actually does when confronted with an onsetless syllable in word-initial position — that is, whether the input /owo?/ would actually map to [Co.wo?] (9b, candidate *a*) or to [wo?] (9b, candidate *b*) (or even to something else, such as the metathesis candidate [wo.o?]). This is why the two unfaithful candidates in tableau (9b) are both labeled with a parenthesized '(☞)'. Nevertheless, we know that a **M** >> **F** ranking does exist for initial syllables, since initial syllables show no contrast

between V and CV syllables.[12] The σ_1-specific constraint ONSET/σ_1 clearly dominates at least one faithfulness constraint, whichever particular **F** constraint that may be.

Thus, under the approach adopted here, phonological requirements that hold specifically within strong positions are analyzed by means of **M/str** constraints ranked as shown in (10).

(10) Positional augmentation ranking with **M/str** constraints

M/str >> **F** >> **M**
└**M** >> **F** in *str*┘ Result: No contrast in *str*
└**F** >> **M** outside *str*┘ Result: Contrast outside *str*

The other ranking permutations of these three general constraint types produce typologically attested patterns as well.[13]

(11) Other rankings for **M/str** constraints, and predicted outcomes

(a) **M** >> **F** (rank of **M/str** irrelevant) Result: No contrast in any position

(b) **F** >> { **M**, **M/str** } Result: Contrast in all positions

The second way to use position-specific constraints in analyzing phonological processes that specifically affect material in strong positions would be to invoke **F/wk** constraints, that is, faithfulness constraints that make specific reference to *weak* positions. This alternative is equivalent in its broad typological predictions to the **M/str** approach, but it is conceptually less attractive.

Like the **M/str** approach, the **F/wk** approach to positional augmentation formally allows for a differential ranking relationship inside and outside a strong position. Given a constraint set

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[12]By the OT principle of richness of the base (Prince & Smolensky 1993), according to which there can be no language-specific restrictions on input forms, the grammar of Arapaho must map any *universally* possible input shape (including a word that starts with a vowel) to an output that is compatible with the surface phonotactics of Arapaho. In other words, the fact that Arapaho never has vowel-initial words means that its constraint ranking must be one that would force a vowel-initial word to surface unfaithfully (with an initial onset) *if* the grammar were given such an input. This is why we must conclude that ONSET/σ_1 dominates at least one faithfulness constraint — so that even a hypothetical input like /owoʔ/ will not surface with a word-initial vowel.

[13]On cases of complementary distribution, where different allophones appear inside and outside of a particular strong position, see §5.3.

that includes general **M** constraints, general **F** constraints, and **F/wk** constraints, the following ranking generates a language with positional augmentation (contrast neutralization in strong positions only); comparison with the **M/str** approach in (10) above shows that the general pattern produced is equivalent.

(12) Positional augmentation ranking with **F/wk** constraints

F/wk >> **M** >> **F**	
⌊**M** >> **F** in *str*⌋	Result: No contrast in *str*
⌊**F** >> **M** outside *str*⌋	Result: Contrast outside *str*

Furthermore, as seen in (13), the permuted rankings of the general constraint types shown in (12) produce the same set of typologically attested language types as the **M/str** system (compare (11)).

(13) Other rankings for **F/wk** constraints, and predicted outcomes

(a) **M** >> { **F**, **F/wk** }	Result: No contrast in any position
(b) **F** >> **M** (rank of **F/wk** irrelevant)	Result: Contrast in all positions

Nevertheless, there is an important difference between the two approaches that becomes apparent as soon as the nature of the individual positional constraints required under each system is examined. Specifically, in order for **F** constraints to be relativized to weak positions, those weak positions must be formally identifiable by the part of the grammar that is responsible for producing position-specific constraints. In some cases, weak positions are identifiable in their own right: the weak counterpart to the strong position root would be the affix (morphologically identified); the weak counterpart to the strong position stressed syllable would be the unstressed syllable (metrically/prosodically identified).

However, for other strong positions, the corresponding weak position is not something that can be identified *except as the complement of the strong position*. One such case is the "non-initial syllable," which would have to be identified by the position-specific **F** constraint in an **F/wk**-based approach to the Arapaho facts discussed above. The "position" non-initial syllable can only be identified as "any syllable that is not the initial syllable." In other words, it is more straightforward and conceptually appealing to allow the grammar access to strong positions which it then uses to form positional constraints, than to suppose that the grammar first locates strong positions, then identifies their complements, and finally forms positional constraints with reference to the complements of the strong positions.

For this reason, it is proposed here that position-specific constraints can only refer to strong positions, never to weak positions. Under this principle, **F/wk** constraints are simply not available as a way to account for phonological requirements that hold specifically of strong

positions. (On the implications of this proposal for theories of classical positional neutralization, see Chapter 5).

It is also important to recognize that choosing an **F/wk** approach rather than an **M/str** approach to positional augmentation phenomena would not avoid the fundamental problem of excluding empirically unattested types of strong position-specific neutralization (see §1.2.1 above). It would still be necessary for the model to allow some **F/wk** constraints while excluding others. For example, the **F/wk** constraint DEP-SEG/ŏ would be needed in the analysis of Dutch, to protect unstressed syllables from the epenthesis of onset consonants that takes place specifically in stressed syllables (§3.2.2.1). But allowing featural **F/wk** constraints like FAITH[Vht]/ŏ would incorrectly predict cases of reverse positional neutralization — the neutralization of featural contrasts unrelated to the enhancement of perceptual prominence — when such constraints were ranked as in (14) (compare the **M/str** case in (2)).

(14) Problematic **F/wk** constraints

IDENT[Vht]/ŏ >> *MIDV >> IDENT[Vht] → mid V in ŏ only (unattested)

Input: /tépo/	IDENT[Vht]/ŏ	*MIDV	IDENT[Vht]
a. tépo		**!	
☞ b. típo		*	*
c. típu	*!		**

Thus, a system using **F/wk** constraints instead of **M/str** constraints would still require a theory of possible and impossible **F/wk** constraints, to explain why, e.g., DEP-SEG/ŏ would be a legitimate **F/wk** constraint but IDENT[Vht]/ŏ would not. The solution developed here, that phonological phenomena specifically targeting strong positions can only be those that give the strong positions greater perceptual prominence, would still have to be part of the theory of possible **F/wk** constraints, just as it is incorporated in the current model of **M/str** constraints in the form of the Prominence Condition. However, under the **F/wk** approach, the positional constraints themselves would actually refer neither to the strong positions, nor to the prominent properties that are, descriptively speaking, the "goal" of the strong position-specific phonological processes in question. It would therefore be more difficult to propose a substantively grounded filter that could rule out the problematic **F/wk** constraints, because constraints of that type would be less directly related to perceptual prominence and strong positions.

In summary, under the **M/str** approach to positional augmentation, the grammar need only make reference to strong positions, rather than having to make reference indirectly to the complements of strong positions. Furthermore, a central component of the theory of positional augmentation effects — that phonological processes may exclusively target strong positions only when those processes result in greater perceptual prominence for the strong positions — is more

straightforwardly modeled as a constraint filter under the **M/str** approach. Therefore, this is the approach that is implemented here.

1.4 Outline of the dissertation

The dissertation is structured as follows. Chapter 2 presents the theoretical model of positional augmentation: the Prominence Condition and the Segmental Contrast Condition, which restrict the inventory of **M/str** constraints, in the context of the Schema/Filter model of CON. This chapter shows that the predictions of the model match the patterns found in empirical investigations of positional augmentation. Namely, the markedness constraints that have empirically attested **M/str** counterparts are all shown to be augmentation (prominence-enhancing) constraints, so the Prominence Condition correctly predicts that they can have **M/str** versions. Also, the importance of psycholinguistically strong positions (*Ψstr*) for early-stage word recognition is shown to further restrict the set of possible **M/Ψstr** constraints, as predicted by the Segmental Contrast Condition.

Chapters 3 and 4 present case studies exemplifying **M/str** constraints for phonetically and psycholinguistically strong positions respectively. Chapter 4 also addresses additional matters pertaining to positional augmentation in psycholinguistically strong positions, including a review of evidence from psycholinguistic studies that justifies the particular formulation of the Segmental Contrast Condition given here.

Chapter 5 reviews OT proposals that address the special resistance of strong positions to positional neutralization, showing that any theory of phonological requirements for strong positions must be distinct from extant theories of positional licensing or resistance to featural neutralization in those positions.

Finally, Chapter 6 presents concluding remarks and considers further implications of the proposals developed in the preceding chapters.