Chapter 3: Basic Theoretical Elements

AND THEIR PERCEPTUAL MOTIVATIONS

The preceding chapter identified a number of empirical generalizations, which condition the application of consonant deletion, vowel epenthesis, and vowel deletion. These output generalizations are summarized below.

Generalization 1: Consonants want to be adjacent to a vowel, and preferably followed by a vowel.

Generalization 2: Stops want to be adjacent to a vowel, and preferably followed by a vowel.

Generalization 3: Stops that are not followed by a [+continuant] segment want to be adjacent to a vowel, and preferably followed by a vowel.

Generalization 4: Consonants that are relatively similar to a neighboring segment want to be adjacent to a vowel, and preferably followed by a vowel.

Generalization 5: Consonants that are not at the edge of a prosodic domain want to be adjacent to a vowel, and preferably followed by a vowel.

Generalization 6: Coronal stops want to be followed by a vowel.

The likelihood that a consonant deletes or triggers vowel epenthesis correlates with the degree to which it is subject to these constraints. Likewise, the likelihood that a consonant blocks vowel deletion correlates with the degree to which it would be subject to these constraints if deletion applied.

I argue that these generalizations have a perceptual motivation and follow from a general principle of perceptual salience:

(1) Principle of Perceptual Salience:
All segments are perceptually salient.

I propose that the principle of perceptual salience is encoded in the grammar...
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In this chapter I present the phonetic motivations that underlie the six generalizations above (3.1) and develop a constraint system that derives these generalizations and yields the desired results. The analysis of Sranan serves as a probing case for the phonetics of constraint-based approaches to phonology.

3.1. PERCEPTUAL MOTIVATIONS

I argue that the generalizations observed in patterns of consonant deletion, vowel epenthesis, and vowel deletion have a perceptual motivation: less salient consonants are more likely to delete, whereas vowel deletion in Sranan highlights the contrast of the perceptual salience of vowels and consonants. Vowels are more salient in a number of prosodic domains, whereas consonants are more likely to delete in the presence of vowel fragments or block vowel sequences. This is reflected in the phonetic realization of vowels in patterns of consonant deletion.

The whole system rests on the privileged status of CV transitions. Consonants are optimally salient before a vowel, and non-optimally salient in any position that lacks these transitions. The first generalization – consonants want to be adjacent to a vowel, and preferably followed by a vowel – stems from the major role played by vocalic transitions in the perception of consonants. The privilege of these transitions is summarized as follows by Delattre (1961/1966: 407):

Les transitions de formants jouent, dans la perception de la parole, un rôle autrement plus important que ne le laisserait entendre le choix peu heureux du terme "transition". Au lieu d'être une phase secondaire ou négligeable, comme on l'a longtemps cru, les transitions sont à la clé même de la perception de la consonne.

There is, however, a significant difference between VC and CV transitions. An important body of research points to the privileged status of CV sequences, as opposed to VC ones (e.g. Fujimura et al. 1999). The asymmetry between CV and VC could also explain statistical patterns in CVC words in English. Kessler & Treiman (1997) analyzed the distribution of phonemes in 2001 CVC English words. They found that CV sequences were more frequent than expected by chance – but no associations were observed between the initial consonant and the vowel.

3.2. CV AND VC TRANSITIONS

In English, for example, the presence of a vowel in a sequence like *pig* and *big* helps to distinguish these words from their homophones *pick* and *bick*. The presence of a vowel also affects the phonetic realization of the preceding consonant, as in *pig* vs. *pick*, where the preceding /p/ is realized as [p] in the former but as [t] in the latter.

The first generalization – consonants want to be adjacent to a vowel, and preferably followed by one – reflects the major role played by vocalic transitions in the perception of consonants. The privilege of these transitions is summarized as follows by Delattre (1961/1966: 407):

Les transitions de formants jouent, dans la perception de la parole, un rôle autrement plus important que ne le laisserait entendre le choix peu heureux du terme "transition". Au lieu d'être une phase secondaire ou négligeable, comme on l'a longtemps cru, les transitions sont à la clé même de la perception de la consonne.

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The perceptual advantage of CV transitions over VC ones is reflected in a number of experimental results. First, perceptual experiments have shown that when faced with contradictory transitions ... et al. 1978; Ohala 1990). Consonants are also identified much more rapidly with CV cues than VC ones (Warner 1999).

What is the source of this asymmetry? A number of differences between CV and VC sequences have been established, which all point to the enhanced perceptibility of prevocalic consonants. Ohman (1966) and Kawasaki (1982) have shown that VC formant transitions for different consonants are not as spectrally well-differentiated among themselves as are CV ones. This is due to the presence of nasal airflow, which creates a spectral floor that obscures the differences between consonants. In addition, stop release bursts, an important cue to stops, occur in CV but not necessarily in VC contexts.

The auditory advantage of CV transitions seems to be reinforced by the articulatory patterns in CV vs. VC sequences. This research is reviewed by Krakow (1999) and provides consistent results.

First, there is more coarticulation or overlap between a consonant and a preceding vowel than between it and a following vowel. In other words, there is a greater degree of precision in the production of CC sequences than in VC sequences. This is due to the fact that consonants in CC sequences have a more precise location in the oral cavity, allowing for a clearer distinction between the two elements. In contrast, vowels tend to be more lax and less precise in their production, leading to a greater degree of coarticulation.

Second, prevocalic consonants have a more extreme consonantal articulation than postvocalic ones. They are produced with a tighter constriction; for example, postvocalic laterals show a weaker constriction between the tongue and the palate than prevocalic laterals. This is due to the fact that consonants in CC sequences have a more precise location in the oral cavity, allowing for a clearer distinction between the two elements.

Increased constriction and reduced coarticulation both enhance the contrast between the consonant and the following vowel. They maximize the alternation between a closed consonantal constriction and an open vocalic constriction. This is true for both CC and VC sequences, but is more pronounced in CC sequences due to the greater degree of precision in the production of consonants.

3.1.2. INTERNAL CUES AND THE GREATER VULNERABILITY OF STOPS

Generalization 2: Stops want to be adjacent to a vowel, and preferably followed by a vowel.

The second generalization states that stops, more than other consonants, need an adjacent vowel, preferably a following one. The greater tendency of stops to delete, trigger epenthesis, or block seems to be related to the fact that stops are more vulnerable to the presence of a vowel. This is due to the fact that stops have weak or no internal cues produced during closure. Their salience is largely determined by the degree of modulation in the acoustic signal (see section 3.1.4).

Voiced stops are often not accompanied by vocal fold activity and the corresponding voicing transition. Periodicity in the signal therefore does not constitute a reliable cue to voiced stops (Wright 1996; Steriade 1999c).

The non-internal perceptual cues to stops are rather concentrated in their release burst, whose importance in the perception of stops has been demonstrated in a number of experimental studies. stops are more sensitive to the presence of a vowel than other consonants, and are more likely to be deleted or blocked when they are followed by a vowel. This is due to the fact that stops have weak or no internal cues produced during closure. Their salience is largely determined by the degree of modulation in the acoustic signal (see section 3.1.4).
...
CONTRAST AND MODULATION IN THE ACOUSTIC SIGNAL

Generalization 4: Consonants that are relatively similar to a neighboring segment want to be adjacent to a vowel, and preferably followed by a vowel. The role of similarity or contrast in combinations of segments is explained by the correlation between the amount of acoustic modulation in a sound sequence and its perceptual salience (e.g., Kawasaki 1982). An acoustic channel, therefore, continues to modulate in several dimensions. These dimensions are predominantly acoustic, with a smaller modulation in the same channels. However, it is also known that certain sounds are produced by the acoustic physical properties of the signal, such as formant frequency, relative formant amplitude, overall spectral energy, and periodicity in the signal.

The necessity of modulations in perception is not specific to linguistic signals. Analogies with other perceptual systems are easy to find. For instance, acoustic modulation is viewed as "the essence of any communication channel" (Ohala & Kawasaki 1985: 123). The essence of any communication channel is to be conveyed by the acoustic modulation. This is the case with CLV, CCG, CV, and VC sequences. The results support the hypothesis that acoustic modulation is a large factor in the acoustic signal.

To test this hypothesis, several CLV, CCG, CV, and VC sequences were recorded. The most influential parameter in acoustic modulation was taken to be the distance of these sequences. It was found that the distance of the first parameter in the sequence is the salience of a given sequence. This parameter is generally affected by the distance of the first parameter in the sequence. The results support the hypothesis that acoustic modulation is a large factor in the acoustic signal.

In addition, CLV, CCG, CV, and VC sequences are generally affected by the distance of the first parameter in the sequence.

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The role of acoustic modulation in explaining the cross-linguistic frequency of certain phonotactic patterns and combinations of segments has been investigated in particular by Kawasaki (1982) and Ohala & Kawasaki (1985). They observed that labial consonant + /w/ and alveolar-palatal consonant + /j/ clusters show little spectral modulation. This is also true of sequences of a labial consonant + /w/ and alveolar-palatal consonant + /j/ clusters. In general, we observe more modulation in stop clusters than in fricative clusters, and the role of modulation in perception is explained by the acoustic signal.

The case of dental stops /d/ + /t/ contrasts with the other combinations in the phonotactic position. In accordance with Ohala (1980), the labial consonant + /w/ and alveolar-palatal consonant + /j/ clusters show less spectral modulation than CV clusters. The results support the hypothesis that acoustic modulation is a large factor in the acoustic signal.
Janson (1986), however, contests the validity of Kawasaki’s generalizations concerning CV sequences, specifically the dispreference for sequences of a labial or labialized consonant and a rounded vowel. These sequences are indeed dispreferred and acoustic/auditory lack of modulation is probably the relevant factor.

Janson’s statistical results, however, were reanalyzed by Maddieson & Precoda (1992), who ended up with no clear trend in any direction. They found no preference or dispreference for specific consonants. In other words, CV sequences are all good enough and speakers/listeners may not prize additional modulation higher.

In this dissertation I am concerned with combinations of consonants, which generally show less modulation than CV sequences. I suggest that differences in amplitude and spectral variations here are associated with phonological factors, such as tone and stress, and that the impact of auditory similarity is likely to reveal itself. I believe the patterns described here support this idea.

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articulation, that is, less sonorant and, therefore, more consonantal-like.

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6 This analysis was performed on a corpus provided by Stefanie Shattuck-Hufnagel as part of the course "Laboratory in the physiology, acoustic and perception of speech" taught at MIT by Ken Stevens, Joe Perkell, and Stefanie Shattuck-Hufnagel in the fall of 1999.

7 It is interesting to observe, though, that the increase in the rime phrase-finally is very similar for both words: 73.8% for Maine and 68.1% for Duke. This suggests that phrase-final lengthening primarily targets the rime, and that there are compensation effects between the nucleus and the coda depending on the position of the boundary. For example, if we concentrate on the coda consonant, unless it is a stop, the nucleus carries most of the lengthening.

8 A negative normalized duration means that the segment is shorter than average; a positive one means that it is longer than average. For more information on the calculation of this measure of deviation from an expected value, taken to be 0, see e.g. the discussion on p. 1710. The amount of lengthening is expressed in terms of a normalized duration, which is a measure of deviation from an expected value, taken to be 0.

9 If we interpret lengthening as a cue to prosodic boundaries, we may think that additional lengthening in the case of the utterance is unnecessary since other more salient cues are available, notably pauses.

104.5% vs. 32.2%.

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Fougeron & Keating (1997) also report an effect of the phrase-final position on articulation, in an experiment involving reiterant speech with /no/ syllables: phrase-final vowels are more open than the ones in other positions. More importantly, no similar strengthening has been reported for consonants, which most probably concern us in our context, that is, the size of the following boundary. This may be related to the fact that maintaining a stop involves more effort than maintaining an /r/ or /l/ by releasing it.

Wightman et al. (1992) is the most detailed study of the correlation between the amount of lengthening and the strength of the following boundary. They use even different break indices or phonological levels (standardly the Intonational Phrase or IP) to account for the amount of lengthening. In this case, the relationship is characterized by a linear regression, as expected from Wightman et al. (1992). For each level, the amount of lengthening is expressed in terms of a normalized duration, which is a measure of deviation from an expected value, taken to be 0.

The average normalized durations of consonants, depending on the level of the following boundary, are given below. These numbers are provided by Fougeron & Keating (1997). They found that the correlation of consonant lengthening is significant only for the last break index of the Intonational Phrase, whereas it is not significant for any other level. This is consistent with the idea that stops are more resistant to lengthening than other consonants.

<table>
<thead>
<tr>
<th>Break index:</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normalized duration of final consonant</td>
<td>-0.5</td>
<td>-0.2</td>
<td>-0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>0.85</td>
<td>0.6</td>
</tr>
</tbody>
</table>

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Pierrehumbert & Talkin (1992) found that initial /h/ is more consonant-like when it is phrase-initial than when it is phrase-medial, the degree of consonantality being measured by the amount of gestural magnitude and increase in consonantality associated with the onset of prosodically significant domains. Fougeron & Keating (1996, 1997), Gordon (1997), Keating et al. (1998), and Fougeron (1999) are concerned with linguopalatal contact and/or nasal flow in initial oral and/or nasal alveolar stops in words, accentual phrases, intonational phrases, and utterances (approximated from the graphs in figure 4).

**CONSONANTAL CONSTRICTION IN DOMAIN-INITIAL POSITION:**

<table>
<thead>
<tr>
<th>Speaker</th>
<th>/n/</th>
<th>/t/</th>
<th>/n/</th>
<th>/t/</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
<td>51</td>
<td>44</td>
<td>54</td>
</tr>
<tr>
<td>2</td>
<td>47</td>
<td>54</td>
<td>52</td>
<td>63</td>
</tr>
</tbody>
</table>

Similar results are obtained for the amount of nasal airflow in comparison to boundary stops, which are less pronounced. The correlation between articulatory strength and nasal airflow is not as strong as that between articulatory strength and gestural magnitude. However, the maxima of nasal flow in domain-initial position:

**NASAL AIRFLOW IN DOMAIN-INITIAL POSITION:**

<table>
<thead>
<tr>
<th>Speaker</th>
<th>/n/</th>
<th>/t/</th>
<th>/n/</th>
<th>/t/</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>48</td>
<td>54</td>
<td>69</td>
<td>63</td>
</tr>
<tr>
<td>2</td>
<td>47</td>
<td>54</td>
<td>59</td>
<td>63</td>
</tr>
</tbody>
</table>

Finally, a word should be said about lengthening in initial position of prosodic domains. Although certain lengthening is present in domain-initial position, particularly in speaker 1, it is less pronounced than in domain-final position. Similarly, nasal airflow is less pronounced than in domain-final position. However, the boundary stops and the nasal airflow maxima are not consistent across speakers and vowels. The maxima of nasal airflow appear to be more directly influenced by the prosodic position than by the prosodic element alone. Thus, it is interpreted as an increase in consonantality, but the correlation between articulatory strength and gestural magnitude is not as strong as that between articulatory strength and nasal airflow.

**CONSONANTAL CONSTRICTION IN DOMAIN-INITIAL POSITION:**

<table>
<thead>
<tr>
<th>Speaker</th>
<th>/n/</th>
<th>/t/</th>
<th>/n/</th>
<th>/t/</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>47</td>
<td>54</td>
<td>52</td>
<td>63</td>
</tr>
<tr>
<td>2</td>
<td>47</td>
<td>54</td>
<td>59</td>
<td>63</td>
</tr>
</tbody>
</table>

In summary, the phonetic processes affecting edges of prosodic domains – articulatory strengthening, lengthening, and reduction of overlap – are necessary for the segmentation of speech. However, the linguistic significance of these processes is not yet entirely clear. The next section discusses the implications of these findings for the parsing of speech.
Fougeron & Keating (1997) also suggest that initial strengthening may play a facilitating role in lexical access. It enhances the contrast between the initial segment and its neighbors. This is important because in the case of a morpheme with a pre-stem, the first letter is very important in determining the pronunciation of the word. 

I would like to suggest a third area in which the phonetic correlates of domain-final and domain-initial positions impact the linguistic system: consonant licensing. Lengthening, increased overlap, and the strength of the adjacent boundary all contribute to the perceptibility of consonants. In many languages, coronal stops are more subject to deletion and assimilation than other stops, which is expected given their position in the word. This is due to the fact that coronal stops often appear before vowels, which makes them more vulnerable to assimilation. 

3.1.6. CORONAL STOPS AND F2 TRANSITIONS

Generalization 6: Coronals want to be followed by a vowel.

Our last generalization, illustrated by deletion and assimilation in Attic Greek (chapter 1), concerns coronal stops, which contrast with other stops in being particularly disfavored in non-prevocalic position. Kang notes that this pattern can be expected in the case of coronals, which are more subject to assimilation in all positions when they are followed by a vowel.

In many languages, coronal stops are more subject to deletion and assimilation than other stops, which is expected given their position in the word. This is due to the fact that coronal stops often appear before vowels, which makes them more vulnerable to assimilation. 

3.2. THEORETICAL APPARATUS

The last section established that the optimal position for a consonant is the CV context, and enumerated a number of factors that influence the perceptibility of consonants. One of these factors is the strength of the adjacent boundary. 

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consonants: the presence of vocalic transitions, the amount of contrast with neighboring segments, the strength of the adjacent boundary (if any), the presence of internal cues, and, for stops, the audibility of the release burst. These phonetic factors impact the grammar by motivating both markedness and faithfulness constraints. The focus is on a family of markedness constraints against non-prevocalic consonants, that... constraints in the synchronic phonological system is intimately linked to the existence of variable processes.

3.2.1. Perception in phonological theory

As with many concepts in science, perception has gone through a cycle in phonological theory. In the opposition between perception and articulation, Jakobson, Fant & Halle (1952: 12) established the primacy of the former: The closer we are in our investigation to the destination of the message (i.e. its perception by the receiver), the more accurately can we gauge the information conveyed by its sound shape. This... pertinence: perceptual, aural, acoustical and articulatory (the latter carrying no direct information to the receiver).

The feature system they developed reflects this bias toward the auditory face of speech. The Sound Pattern of English (1968) constituted a radical departure from this position, as the distinctive features proposed by Chomsky & Halle are primarily articulatory in nature. The articulatory... in Sagey (1986) and Halle (1995) by direct reference to articulators in the definition and organization of features.

The fundamental role played by features in phonological description and analysis cannot but influence the range of topics investigated and the way we look at them. For example, as discussed in Hura et al. (1992), articulatory features showed a clear advantage over acoustic/auditory ones in the treatment of assimilation processes (e.g. palatalization before... examples. The special vulnerability of stops in deletion and epenthesis patterns may also fall into this category.

In contrast with standard phonology, however, research made by or in collaboration with phoneticians continues to stress the role of perception in shaping sound patterns. Among the... works by John Ohala (e.g. 1981, 1983, 1992, 1993, 1995, etc.), as well as Kawasaki (1982) and Kawasaki-Fukumori (1992).

The recent development of Optimality Theory, however, has led to a renewed interest in the phonetic – in particular perceptual – motivations behind phonological patterns. Among the works advocating a perceptual approach to phonological theory, we may add Hamilton (1996), Coflette (1997a, 1999), Padgett (1997), Boersma (1998, 1999), Hume (1999), Y. Kang (1999, 2000), Kochetov (1999) and Hume & Johnson (to appear). The sequential approach to deletion and epenthesis processes developed here... category.

The perceptual approach to phonological theory is characterized by the relaxation of the assumption that the phonological system is intimately linked to the existence of variable processes. This... assumptions with phonological patterns. The focus is on a family of contrastive contrasts between... consonants: the presence of vocalic transitions, the amount of contrast with
Chapter 3: Basic elements and constrained by direct reference to perceptual factors. It adopts more specifically the 'Licensing by cue' approach developed by Steriade (1999a,c).

In two important papers, Steriade (1999a,c) argues against the prosodic or syllabic approach to phonotactic processes, and develops an Optimality-theoretic account directly based on perceptual cues. These accounts provide Strynadka, the phonotactic process that Lithuanian medial clusters are distributed, regardless of the nature of the environment. In this account, the basic elements provided by Steriade and the account of deletion and epenthesis can be interpreted as an extension of it to whole segments rather than features.

Obstruent devoicing and voicing neutralization have been considered classic examples of prosodically-driven feature-changing processes (e.g. Rubach 1990; Lombardi 1991, 1995, 1999; Bethin 1992; ...). The cues to the voicing specification of stops and the contexts where they can be found are summarized below; V1 and V2 correspond to the preceding and following vowel, respectively.

(5) CUES TO VOICING CONTRASTS AVAILABLE IN DIFFERENT CONTEXTS (based on Steriade 1999C: 30-31):

<table>
<thead>
<tr>
<th>Cue</th>
<th>Context where it can be found</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closure voicing</td>
<td>Everywhere</td>
</tr>
<tr>
<td>Closure duration</td>
<td>Everywhere</td>
</tr>
<tr>
<td>V1 duration</td>
<td>Only after sonorant</td>
</tr>
<tr>
<td>V2 duration</td>
<td>Only after sonorant</td>
</tr>
<tr>
<td>VOT value</td>
<td>Before sonorant</td>
</tr>
<tr>
<td>F0 value and F1 value in V1</td>
<td>Before sonorant</td>
</tr>
<tr>
<td>Burst duration and amplitude</td>
<td>Not before obstruents</td>
</tr>
<tr>
<td>V1 duration</td>
<td>Always</td>
</tr>
<tr>
<td>Closure duration</td>
<td>Once</td>
</tr>
</tbody>
</table>

We can then establish a hierarchy of contexts, from those that provide the most cues to voicing and in which voicing contrasts are best perceived, to those that provide the least cues. We can then establish a hierarchy of contexts, from those that provide the most cues to voicing and in which voicing contrasts are best perceived, to those that provide the least cues. We can then establish a hierarchy of contexts, from those that provide the most cues to voicing and in which voicing contrasts are best perceived, to those that provide the least cues.
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We conclude that the behavior of voicing features does not depend on the syllabic position but on the nature of the following segment.

\[ \alpha \text{voice/—O, —# >> PRESERVE [voice]} \]

The ranking \[ \alpha \text{voice/—R} \] nicely and simply accounts for the Lithuanian pattern. I refer the reader to Steriade's paper for a discussion of similar and other cases.

### 3.2.2. MARKEDNESS CONSTRAINTS

The evidence presented in chapters 1 and 2 supports the hypothesis that the behavior of phonological elements is shaped by their perceptibility, and applies it to segment deletion and epenthesis. I ... and its implementation could extend to other phonological elements.) These constraints obey the general format in (8):

\[
G \text{ENERAL FORMAT OF PERCEPTIBILITY-BASED MARKEDNESS CONSTRAINTS:}
\]

\[
S - X A \text{ segment } S \text{ appears in a context } X \text{ where it is perceptually salient.}
\]

Here I consider only cases where \( S \) is a consonant. I take vocalic transitions to be crucial in a consonant's perceptibility, and I assume that consonants are maximally salient in prevocalic position, and minimally salient in postvocalic position. This does not apply to the non-optimal position. I propose the following two basic constraints, which reflect the general part of generalization 1.

\[
\text{12 The double arrow "}\leftrightarrow\" \text{ is used throughout to refer to adjacency, the simple arrow } \_ \text{ indicates precedence.}\]

\[
\text{13 These constraints were used independently by Fleischhacker (2000a,b), and the one in (9a) also by Steriade (1999d).}\]

\[
\text{We could also imagine a constraint } C \leftarrow V \text{ "a retroflex consonant is preceded by a vowel". This does not correspond to the general situation, but it may apply to cases of retroflex} \]

\[
\left(\text{a) - (2) CONCLUSIONS OF THE STUDY FOR MORPHOEME 1.1. 2. The double arrow } \leftrightarrow \text{ is used throughout to refer to adjacency, the simple arrow } \_ \text{ indicates precedence.}\right)
\]

\[
\text{I consider any cases where } S \text{ is a consonant. I take vocalic transitions to be salient.}\]

\[
\text{s - x a segment } S \text{ appears in a context } X \text{ where it is perceptually salient.}\]

\[
\text{FACTORS AFFECTING CONSONANT PERCEPTIBILITY:}\]

\[
\begin{align*}
\text{a. Class of consonants} & \quad \text{(ex: stops, strident fricatives, nasals, coronal stops, etc.)} \\
\text{b. Similarity with adjacent segments, expressed in terms of agreement or contrast in some feature F} & \quad \text{(ex: agreement or contrast in place of articulation, continuancy, voicing, etc.)} \\
\text{c. Presence of an adjacent boundary} & \quad \text{(ex: Followed by an Intonational Phrase Boundary, preceded by a} \\
\text{Prosodic Word Boundary, etc.)} \\
\text{d. Presence of an Intonational Phrase Boundary} & \quad \text{expressed in terms of agreement of p} \\
\text{d. Presence of an Intonational Phrase Boundary} & \quad \text{expressed in terms of agreement of p} \\
\text{e. Class of consonants} & \quad \text{expressed in terms of agreement of p} \\
\text{f. Class of consonants} & \quad \text{expressed in terms of agreement of p} \\
\text{g. Class of consonants} & \quad \text{expressed in terms of agreement of p} \\
\end{align*}
\]

\[
\text{CONSTRAINTS ENCODING THE SPECIAL STATUS OF STOPS (Generalization 2):}\]

\[
\begin{align*}
\text{a. Stop} & \quad \leftrightarrow \text{V} \text{ A stop is adjacent to a vowel.} \\
\text{b. Stop} & \quad \_ \text{V} \text{ A stop is followed by a vowel.} \\
\end{align*}
\]

To account for generalizations 2-6, I design the alternatives in (11)-(15), which reflect the special status of stops in (2).

\[
\text{CONSTRAINTS ENCODING THE SPECIAL STATUS OF STOPS (Generalization 2):}\]

\[
\begin{align*}
\text{a. Stop} & \quad \leftrightarrow \text{V} \text{ A stop is adjacent to a vowel.} \\
\text{b. Stop} & \quad \_ \text{V} \text{ A stop is followed by a vowel.} \\
\end{align*}
\]

\[
\text{FACTORS AFFECTING CONSONANT PERCEPTIBILITY:}\]

\[
\begin{align*}
\text{a. Class of consonants} & \quad \text{(ex: stops, strident fricatives, nasals, coronal stops, etc.)} \\
\text{b. Similarity with adjacent segments, expressed in terms of agreement or contrast in some feature F} & \quad \text{(ex: agreement or contrast in place of articulation, continuancy, voicing, etc.)} \\
\text{c. Presence of an adjacent boundary} & \quad \text{(ex: Followed by an Intonational Phrase Boundary, preceded by a} \\
\text{Prosodic Word Boundary, etc.)} \\
\text{d. Presence of an Intonational Phrase Boundary} & \quad \text{expressed in terms of agreement of p} \\
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\text{f. Class of consonants} & \quad \text{expressed in terms of agreement of p} \\
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\text{g. Class of consonants} & \quad \text{expressed in terms of agreement of p} \\
\end{align*}
\]
Chapter 3: Basic elements

15
(15) CONSTRAINTS ENCODING THE ROLE OF SIMILARITY (Generalization 4):

a. C(AGREE=F) ↔ V A consonant that agrees in some feature F with a neighboring segment is adjacent to a vowel.

b. C(AGREE=F) → V A consonant that agrees in some feature F with a neighboring segment is followed by a vowel.

(14) CONSTRAINTS ENCODING THE ROLE OF BOUNDARIES (Generalization 5):

a. C[i] ↔ V A consonant that is next to a boundary i is adjacent to a vowel.

b. C[i] → V A consonant that is next to a boundary i is followed by a vowel.

(13) CONSTRAINTS ENCODING THE SPECIAL STATUS OF CORONAL STOPS (Generalization 6):

C(cor stop) → V A coronal stop is followed by a vowel.

In addition, for the constraints in (14) we must distinguish the preceding from the following boundaries, since they affect the phonotactics differently. This is not unexpected since, as we saw, left and right edges are not enhanced through the same mechanisms. (14) is decomposed in the two subcases below:

(16) CONSTRAINTS ENCODING THE EFFECT OF THE FOLLOWING BOUNDARY:

a. C]i ↔ V A consonant that is followed by a boundary i is adjacent to a vowel.

b. C]i → V A consonant that is followed by a boundary i is followed by a vowel.

(17) CONSTRAINTS ENCODING THE EFFECT OF THE PRECEDING BOUNDARY:

a. i[C ↔ V A consonant that is preceded by a boundary i is adjacent to a vowel.

b. i[C → V A consonant that is preceded by a boundary i is followed by a vowel.

These specifications can be freely combined to create more complex constraints. For example, the constraints in (12) involve such a combination since they are specified for stops and the nature of the following segments. The agreement and contrast specifications can be combined with the preceding and following segments. The agreement and contrast specifications can be freely combined to create more complex constraints. For example, the constraints in (12) involve such a combination since they are specified for stops and the nature of the following segments. The agreement and contrast specifications can be freely combined with the preceding and following segments. The agreement and contrast specifications can be freely combined with the preceding and following segments. The agreement and contrast specifications can be freely combined with the preceding and following segments.
The ranking condition in (19) enables us in particular to establish the following dominance relation between the two constraints in (9):

(20) DOMINANCE RELATION BETWEEN THE CONSTRAINTS IN (9):
\[ C \leftrightarrow V \gg C \_ V \]

This ranking, as it will become clear later, is crucial for the analyses to follow. It is derived in the following way. Consider the following strings of segments, where \( § \) represents a pause. The consonants with a letter subscript violate both \( C \leftrightarrow V \) and \( C \_ V \); those with a number subscript violate only \( C \_ V \). No consonants may violate \( C \leftrightarrow V \) without simultaneously violating \( C \_ V \).

(21) \[
\begin{align*}
&V C_1 C_2 C_v \ldots V \quad C_1 C_2 C_v \ldots V \\
&\text{§§} \\
&V C_f C_v \ldots
\end{align*}
\]

Everything else being equal, I assume that consonants that lack vocalic transitions are less perceptible than consonants that benefit from transitions from at least one vowel. The letter-subscripted consonants are therefore less perceptible than the number-subscripted ones. So the consonants that violate \( C \leftrightarrow V \) are either equally or less perceptible than those that violate \( C \_ V \). This meets the conditions in (19) for establishing the dominance relation \( C \leftrightarrow V \gg C \_ V \). This is the only possible ranking between the two constraints; the reverse order is excluded since it is not the case that the consonants that violate \( C \_ V \) are all equally or less perceptible than the consonants that violate \( C \leftrightarrow V \). The ranking in (20) can be extended to all the constraints derived by specifying one or more of the arguments in (10): for all \( C_j \), where \( C_j \) is any specified consonant, the ranking \( C_j \leftrightarrow V \gg C_j \_ V \) necessarily holds, e.g. stop \( \leftrightarrow V \gg \text{stop}_V \), \( C(\text{AGREE} = \text{F}) \leftrightarrow V \gg C(\text{AGREE} = \text{F}) \_ V \), etc.

The rankings in (22) can be established in the same way. They follow straightforwardly from the perceptual facts described in section 3.1: stops are less perceptible than other consonants in ... symbol \(^\wedge\). Consonants that are adjacent to no boundary are the least perceptible, which establishes the ranking in (22f).

Before leaving this section, a final word about the Sonority Sequencing Principle, which was crucially involved in the case studies in chapters 1 and 2. The phonetic nature of sonority is not a subject of this book. However, the fact that sonority sequences correspond to sonority peaks is an important issue that should be taken up in the future. There is a lot of formal similarity and covariations in the view of the complexity involved in the sonority-internal and sonority-external constraints proposed in ... (1995) for a similar situation. But multidimensionality is certainly an issue that should be addressed in the future.

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3.2.3. FAITHFULNESS CONSTRAINTS

The markedness constraints against non-prevocalic consonants interact with faithfulness constraints to yield the attested patterns. Since I deal here only with epenthesis and deletion, I use the following two basic constraints (from McCarthy & Prince 1995):

\[(24) \text{BASIC FAITHFULNESS CONSTRAINTS:}\]

\[a. \text{MAX} \text{do not delete}\]

\[b. \text{DEP} \text{do not epenthesise}\]

It has been noticed several times, however, that these general faithfulness constraints do not allow us to reduce the set of optimal candidates to the desired singleton (Lamontagne 1996; Steriade ... case of consonant deletion, and discuss epenthesis later. Suppose an input of the form /VC1C2V/ and a grammar G characterized by the two constraint rankings C_V >> MAX and DEP >> MAX. This grammar yields obligatory deletion of one of the two consonants, to ensure that all consonants in the output are followed by a vowel. But it cannot determine which consonant to delete. As illustrated in the tableau below, the outputs [VC1V] and [VC2V] are equivalent with respect to G. Here and in the rest of this dissertation I use thick lines between columns to indicate that the constraint at the left dominates that at the right, e.g. between DEP and MAX in (25). Thin lines between two constraints indicate ranking indeterminacy between them, e.g. between C_V and DEP.

\[(25) \text{FAILURE TO IDENTIFY THE CORRECT DELETION SITE:}\]

\[\text{Input: } /VC1C2V/ \text{ C_V DEPMAX Output:} \]

\[a. \text{VC1C2V} \ast \text{!}\]

\[b. \text{VC1VC2V} \ast \text{!}\]

\[c. \_ \text{VC1V}\ast\]

\[d. \_ \text{VC2V}\ast\]

G then needs to be augmented to be able to pick between candidates c. and d.

I propose that this is done by using context-sensitive faithfulness constraints, whose ranking is perceptually motivated. Other proposals that are meant to solve this problem include Relativized Contiguity (Lamontagne 1996) and targeted constraints (Wilson 2000), which I will review in turn.

Lamontagne proposes that the choice between VC1V and VC2V is to be made by context-sensitive faithfulness constraints whose ranking is perceptually motivated. He defines two general types of contiguity constraints, called DOMAIN-CONTIGUITY (D-CONTIG) and JUNCTURE-CONTIGUITY (J-CONTIG), which evaluate contiguity between segments within a domain or across adjacent domains, respectively, where domains correspond to prosodically well-defined units such as syllables, feet, or words. D-CONTIG penalizes the existence of segments that are contiguous within a domain in the output, but not contiguous in the input. J-CONTIG penalizes the existence of segments that are contiguous across a boundary in the output, but not contiguous in the input. Which of the two constraints to apply depends on the specific segments involved.

Consider the same /VC1C1VC2V/ input and the two possible outputs [VC1C1VC2V] and [VC1C2VC2V]. The [VC1C1VC2V] output violates D-CONTIG(syllable): C1 and Vb are contiguous within a syllable in the output, but they are not contiguous in the input. But the same output does not violate J-CONTIG(syllable), since Vb and C1, which are contiguous across a syllable boundary in the output, are also contiguous in the input. The candidate [VC1C2VC2V] is the mirror image of [VC1C1VC2V]. It violates J-CONTIG(syllable) (since Vb and C2 are contiguous across a syllable boundary in the output but not contiguous in the input) but not D-CONTIG(syllable). Which of [VC1C1VC2V] and [VC1C2VC2V] turns out to be optimal depends on the language-specific ranking between J-CONTIG(syllable) and D-CONTIG(syllable). If D-CONTIG(syllable) dominates J-CONTIG(syllable), [VC1C2VC2V] wins out and it is the first consonant that deletes. Diola Fongny instantiates this ranking, e.g. /let-ku-jaw/ _ [lekujaw] 'they won't go'. If J-CONTIG(syllable) outranks D-CONTIG(syllable), [VC1C1VC2V] is selected. As an example of this ranking, Lamontagne cites Wiyot (Teeter 1964), e.g. /pucarag+lolisw-/ _ [pucaragoris‡w-] 'whistle a tune' (where /g/ corresponds to /©/ in Teeter's transcription).

Lamontagne's solution works; the problem I see with it is that it considers the deletion of C1 and C2 equally likely. In fact they are not; Wilson (2000) and Steriade (1999b) note that it is typically the first consonant that deletes, as in Diola Fongny, and both relate this fact to the fact that consonant deletion – involve independent factors, in particular a preference for keeping stems.
consonants over affixal ones, or less sonorous consonants (which form better onsets) over more sonorous ones. Turkish (Keyser & Clements 1983) is given as an illustration of morphologically-based deletion, Pa¤li (Hankamer & Aissen 1974) as one of sonority-based deletion.

As for Wiyot, the evidence it provides is unclear. Teeter (1964: 26) does suggest that illicit combinations of two consonants across morpheme boundaries are repaired by deletion of the second ... other than /h/ was only found in the example cited above (/pucarag+lolisw-/ _ [pucaragoris‡w-] 'whistle a tune'), on which I cannot comment.

Granting the unconclusiveness of the Wiyot case, the theory should predict that, everything else being equal, it is the postvocalic consonant rather than the prevocalic one that deletes in a VCCV pattern. This leads to the following prediction: iff a is less marked than b according to the absolute markedness statement and a is sufficiently similar to b.

A more concrete example will make this system clearer. Take again our hypothetical VC1C2V case and assume the targeted constraint _NOWEAK-C, which militates against segmental root nodes in the output (the absolute markedness statement corresponds to *STRUC(Rt)). Wilson states that consonants in preconsonantal position are perceptually weak (on which we agree), that is they are difficult to distinguish from ^. Prevocalic consonants, however, are associated with strong cues. The constraint _NOWEAK-C only compares candidates that are perceptually comparable, i.e. VC1C2V and VC2V, but crucially not VC1C2V and VC1V. In this limited competition, VC2V fares better on *STRUC(Rt) and wins. The crucial consequence of the targeted constraint is to evacuate the candidate VC1V, which is in the end what we aim at.

Wilson's proposal crucially relies on perceptual salience and auditory similarity, which are I believe the relevant factors. It is C1 that deletes because it is perceptually weaker than C2 (recall the comparison between consonants in CV and VC contexts in section 3.1.1). But my main concern about targeted constraints is the dichotomized split they impose on perceptibility? This issue has immediate empirical consequences. Take a more complex three-consonant cluster VC1C2C3V.

Under simplification, it is typically C2 that deletes, which is the consonant that does not benefit from any vocalic transitions. C3 is the perceptually strongest consonant (everything else being equal), C1 being in an intermediate situation between C2 and C3. We may safely assume that VC1C2C3V and VC1C3V are comparable under _NOWEAK-C, and that VC1C2V is excluded from the comparison. But what about VC2C3V? Should it be considered similar enough to VC1C2C3V? The answer is no if we want VC1C3V to end up as the only optimal candidate; because if we include VC2C3V in the comparison, both VC1C3V and VC2C3V will fare equally. The crucial question here is whether the candidate VC1C3V is considered to be similar enough to VC1C2C3V. The example cited above shows that this is indeed the case.

Consider now a case where C1 cannot delete for some independent reason. The candidate VC1C2V is still relevant, but it is not equivalent to VC1C3V. The constraint _NOWEAK-C only compares candidates that are perceptually comparable, i.e. VC1C2V and VC2V, but crucially not VC1C2V and VC1V. In this limited competition, VC2V fares better on *STRUC(Rt) and wins. The crucial consequence of the targeted constraint is to evacuate the candidate VC1V, which is in the end what we aim at.

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Consider now a case where C1 cannot delete for some independent reason, e.g. C1 is a vowel.
This approach to correspondence is partially consistent with the basic intuition behind faithfulness constraints: the idea that the input should be modified minimally.

Thus, the result we intended to derive is supported: one that is V -> CV is dropped in VC1V and not VC1V, as shown in the table below. This is precisely what Steriade’s (1999b,d, 2000b, to appear) approach to faithfulness constraints achieves. Steriade proposes that faithfulness or correspondence constraints are projected from the markedness constraints that govern the deletion of a consonant in a given context. These comparisons are derived from statements about the absolute distinctiveness or perceptibility of contrasts. Each contrast x-y/—K (contrast between x and y in context K) is associated with a specific distinctiveness index and projects a corresponding faithfulness constraint of the form CORRESP.(x-y/—K). If it can be determined from the P-map that a contrast x-y/—K is more perceptible than a contrast w-z/—Q, then CORRESP.(x-y/—K) dominates CORRESP.(w-z/—Q).

Let us go back to our VC1C2V example again. We have determined that in this context C2 is perceptually more salient than C1 (everything else being equal). In other words, the contrast between C and V in the context C—V is more distinctive or perceptible than the contrast between C and V in the context V—C. Translated in terms of the correspondence constraint MAX-C, this comparison derives the ranking MAX-C/C—V >> MAX-C/V—C. This ranking determines that, everything else being equal, deletion of a postvocalic consonant is always favored over that of a prevocalic one. That is, VC1C2V is reduced to VC2V and not VC1V, as shown in the tableau. This is the result we intended to derive.

### Deletion Site with Context-Sensitive Faithfulness

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Output</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC1C2V</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>VC1V</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>VC2V</td>
<td>_</td>
<td></td>
</tr>
</tbody>
</table>

To account for the implication of three-consonant clusters VC1C2C3V, we need to extend the ranking of MAX-C constraints to include the constraint against deletion of interconsonantal consonants MAX-C/C—C. Such consonants are less perceptible than those that benefit from vocalic transitions. Consequently, MAX-C/C—C is ranked lower than the constraints against deletion of pre- and post-vocalic consonants:

### Ranking of Context-Sensitive MAX Constraints

MAX-C/C—V >> MAX-C/V—C >> MAX-C/C—C

This ranking ensures that if nothing prevents it, C2 is the consonant that deletes in VC1C2C3V sequences. But it also follows from it that if deletion of C2 is ruled out by some independent constraint, it is C1 that deletes, not C3 (provided the appropriate ranking of the markedness constraint that motivates deletion, say MAX-C/V—C above MAX-C/C—C). This situation is illustrated in the tableau below. Let us have a three-consonant cluster in the input and two unviolable constraints: C ↔ V demanding that every consonant be adjacent to a vowel, and KEEP2, which could be any constraint that governs the deletion of a consonant in a given context.

### Deletions of the Least Perceptible Consonant Possible:

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC1C2C3V KEEP2</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>VC1C3V KEEP2</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>VC2C3V KEEP2</td>
<td>_</td>
<td></td>
</tr>
<tr>
<td>VC1C2V KEEP2</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

This approach to correspondence is perfectly coherent with the basic intuition behind faithfulness constraints: the idea that the input should be modified minimally.
The innovation here is to define what counts as minimal in terms of perceptual distinctiveness. The relative ranking of a faithfulness constraint correlates with the extent to which its violation would be less perceptible than its preservation. One obvious that this issue deserves a more elaborate discussion, but I can only hope that it will be taken up in the future.

The reasoning that has led to the ranking in (27) can be extended to variables other than the vocalic context of consonants, and can motivate similar rankings. Given two constraints \( \text{MAX}-\text{C}_1 \) and \( \text{MAX}-\text{C}_2 \), \( \text{MAX}-\text{C}_1 \gg \text{MAX}-\text{C}_2 \) if the contrast between \( \text{C}_2 \) and \( \text{^C} \) is less perceptible than the contrast between \( \text{C}_1 \) and \( \text{^C} \), in other words if \( \text{C}_2 \) itself is less perceptible (everything else being equal) than \( \text{C}_1 \).

Section 3.1 identified a number of factors that increase or decrease the perceptibility of consonants. One of them was the presence of a vowel in the same syllable with the consonant. The constraints and the rankings that can be derived are given in (29), together with the generalization that they encode:

(29) **Perceptibility-based Faithfulness Constraints**:

a. **Generalization 1:**
   \[ \text{MAX}-\text{C/—V} \gg \text{MAX}-\text{C/V—} \gg \text{MAX}-\text{C} \]
   - Do not delete a consonant that is followed by a vowel.
   - Do not delete a consonant that is preceded by a vowel.
   - Do not delete a consonant that is followed by a vowel.

b. **Generalization 2:**
   \[ \text{MAX}-\text{C(-stop)} \gg \text{MAX}-\text{C} \]
   - Do not delete a consonant that is not a stop.

c. **Generalization 3:**
   \[ \text{MAX-stop/—[+cont]} \gg \text{MAX-stop} \]
   - Do not delete a stop that is followed by a [+continuant] segment.

d. **Generalization 4:**
   \[ \text{MAX-C/CONTRAST=F} \gg \text{MAX-C} \] (where \( \text{F} \) is any feature)
   - Do not delete a consonant that contrasts in some feature \( \text{F} \) with an adjacent segment.

e. **Generalization 5:**
   \[ \text{MAX-C\text{-\{i\}} \gg \text{MAX-C} \] (where \( \text{i} \) is any prosodic boundary)
   - Do not delete a consonant that is adjacent to a prosodic boundary.

Each ranking identifies a factor that affects the salience of consonants. In the general case consonants are endowed with enhancing factors and are correspondingly associated with specific higher-ranked \( \text{MAX} \) constraints, which dominate the general \( \text{MAX} \). These include:

1) Consonants that are adjacent to a prosodic boundary;
2) Consonants that bear a positive \( [+] \) specification for some manner feature; stops and blends in particular;
3) Stops that are followed by a [+continuant] segment;
4) Consonants that are followed by a vowel (and supported by a relevant syllable, etc.).

The ranking of faithfulness constraints according to the principle of minimal perceptual disruption or modification of the input also applies to constraints other than \( \text{MAX} \) constraints. In particular, the faithfulness constraint for dependency preservation \( \text{DEP-V} \) is less disruptive in certain contexts. The constraint and the rankings that can be derived are given in (30), together with the generalization that they encode:

(30) **Dependence-based Faithfulness Constraints**:

a. **Generalization 1:**
   \[ \text{MAX}-\text{C/—V} \gg \text{MAX}-\text{C/V—} \gg \text{MAX}-\text{C} \]
   - Do not delete a stop that is followed by a [+continuant] segment.

b. **Generalization 2:**
   \[ \text{MAX}-\text{C(-stop)} \gg \text{MAX}-\text{C} \]
   - Do not delete a consonant that is not a stop.

c. **Generalization 3:**
   \[ \text{MAX-stop/—[+cont]} \gg \text{MAX-stop} \]
   - Do not delete a stop that is followed by a [+continuant] segment.

d. **Generalization 4:**
   \[ \text{MAX-C/CONTRAST=F} \gg \text{MAX-C} \] (where \( \text{F} \) is any feature)
   - Do not delete a consonant that contrasts in some feature \( \text{F} \) with an adjacent segment.

e. **Generalization 5:**
   \[ \text{MAX-C\text{-\{i\}} \gg \text{MAX-C} \] (where \( \text{i} \) is any prosodic boundary)
   - Do not delete a consonant that is adjacent to a prosodic boundary.

The constraint and the rankings that can be derived are given in (31), together with the generalization that they encode:

(31) **Consonant Deletion Constraints**:

a. **Generalization 1:**
   \[ \text{MAX}-\text{C/—V} \gg \text{MAX}-\text{C/V—} \gg \text{MAX}-\text{C} \]
   - Do not delete a stop that is followed by a [+continuant] segment.

b. **Generalization 2:**
   \[ \text{MAX}-\text{C(-stop)} \gg \text{MAX}-\text{C} \]
   - Do not delete a consonant that is not a stop.

c. **Generalization 3:**
   \[ \text{MAX-stop/—[+cont]} \gg \text{MAX-stop} \]
   - Do not delete a stop that is followed by a [+continuant] segment.

d. **Generalization 4:**
   \[ \text{MAX-C/CONTRAST=F} \gg \text{MAX-C} \] (where \( \text{F} \) is any feature)
   - Do not delete a consonant that contrasts in some feature \( \text{F} \) with an adjacent segment.

e. **Generalization 5:**
   \[ \text{MAX-C\text{-\{i\}} \gg \text{MAX-C} \] (where \( \text{i} \) is any prosodic boundary)
   - Do not delete a consonant that is adjacent to a prosodic boundary.
contexts than in others, but the effect of the segmental and prosodic context does not appear to be as clear and systematic as with consonant deletion. In a /VC1C2V/ sequence, there is only one possible site for vowel epenthesis (if the motivation is to have every consonant adjacent to a vowel): [VC1 VC2V]. Consider now a three-consonant sequence /VC1C2C3V/, not tolerated on the surface. There are two possible outputs: [VC1 VC2C3V] and [VC1C2 VC3V]. Each of them is widely attested crosslinguistically, and the choice between them seems to be largely independent from perceptual factors, unlike consonant deletion. The famous contrast between different Arabic dialects (Broselow 1980, 1992; Selkirk 1981; Itofl 1986, 1989; Lamontagne 1996; Zawaydeh 1997, among others) illustrates this variation in epenthesis sites: given an underlying structure like /C1C2C3V/, languages, epenthesis systematically targets morphemic boundaries, e.g. French (chapter 2) and Chukchi (Kenstowicz 1994b).

(30) VOWEL EPENTHESES IN CAIRENE AND IRAQI ARABIC:

a. Cairene /ul+t+l+u/ _[ulitlu]'I said to him'

b. Iraqi/gil+t+l+a/ _[gilitla]'I said to her'

The factors underlying the distinction between Cairene and Iraqi are not entirely clear and I will not attempt to enlighten the issue. The contrast has been accounted for with directional syllabification (Itofl 1986, 1989), reanalyzed in terms of alignment in Optimality-theoretic terms (Mester & Padgett 1993). Broselow (1992) proposed an alternative analysis, which bases the contrast on the sonority of the onsets and codas. I will simply adopt the alignment strategy when the issue arises.

This is not to say that perceptual factors are always irrelevant to the choice of the epenthesis site. Fleischhacker (2000a,b,c) conducted a crosslinguistic study of epenthesis in word-initial consonant clusters, in particular in loanword adaptation. I focus here only on two-consonant sequences. Some languages systematically insert the vowel in the same location, either before the two consonants ([CC/VC]), e.g. Iraqi Arabic, or inside the cluster ([CC/CV], e.g. Korean). But in an interesting subset of languages, e.g. Egyptian Arabic and Sinhalese (see Fleischhacker 2000a), this choice is determined by the nature of the cluster: initial epenthesis (prothesis) with sibilant+stop ([C/VC]) clusters but medial epenthesis (anaptyxis) in stop+sonorant ([CV/C]) clusters.

No languages display the opposite pattern. What is also found are languages that use prothesis with ST clusters but leave TR clusters intact. Brodzka and Ito (1996) observe, then, is a clear tendency to favor anaptyxis with stop+sonorant sequences and prothesis with sibilant+stop ones.

Fleischhacker’s explanation for this contrast relies on perception and the idea of minimal disruption of the perceptual properties of the input: “the epenthesis site is chosen to maximize auditory distance between the input and the modified input.” A similar hierarchy of perceptibility of the vowel is reflected in the following ranking of DEP-V constraints:

(31) RANKING OF CONTEXT-SENSITIVE DEP CONSTRAINTS:

DEP-V/S—T >> DEP-V/#— >> DEP-V/T—R

The behavior of sibilant+sonorant sequences is more variable and depends in particular on the sonority level of the sonorant; I omit these cases and refer the reader to Fleischhacker (2000a) for discussion. For the position of the word-initial context with respect to auditory similarity and the corresponding ranking in (31), I follow Fleischhacker (2000b). Fleischhacker (2000a) does not compare the context #— with T—R and S—T, and does not use the corresponding constraint DEP-V/#—; she obtains the expected results by means of faithfulness constraints independent from the ranking in (31). For purposes of expository simplicity, I use the approach exposed in Fleischhacker (2000b).
Patterns with anaptyxis in TR clusters and prothesis in ST ones follow directly from this ranking, epenthesis being motivated by the high ranking of the markedness constraint $C \leftrightarrow V$. The Lakhota/Central Yup'ik case – anaptyxis in TR but ST allowed – derives straightforwardly from $C \leftrightarrow V$ being ranked above $D\text{EP-V/T—R}$ but below $D\text{EP-V/#—}$: only the least obtrusive instances of epenthesis are tolerated. The Haitian/Catalan case – prothesis in ST but TR allowed – appears more problematic, but could be explained by the perceptual contrast in sonorancy absent from ST ones. I suggest that this makes the latter more marked, subject to the constraint $C(\text{AGREE}=[\text{son}]) \leftrightarrow V$ (13), while TR clusters are only affected by the general and lower-ranked $C \leftrightarrow V$ (22c). The ranking in (32) yields the Haitian/Catalan pattern.

(32) RANKING YIELDING PROTHESIS IN ST AND NO EPENTHESIS IN TR:

$$C(\text{AGREE}=[\text{son}]) \leftrightarrow V \gg D\text{EP-V/#—} \gg D\text{EP-V/T—R} \gg C \leftrightarrow V$$

As for patterns with systematic anaptyxis or prothesis, Fleischhacker assumes that they arise from independent requirements, possibly a preference for consonants being followed (rather than preceded) by a vowel (systematic anaptyxis), or a $\text{CONTIGUITY}$ constraint (systematic prothesis).

We may briefly venture beyond initial epenthesis, to which Fleischhacker's study is restricted, and reflect on the observed tendency in several languages to epenthize next to a sonorant but leave it unmarked otherwise. Consider the example in (33), from Hale & White Eagle (1980), which also shows the absence of epenthesis in the $[k\beta]$ sequence.

(33) DOREY'S LAW IN WINNEBAGO:

$$/ha+ra+ki+\beta+ru+d/ \rightarrow /haraki\betaa\text{na}\alpha/$$

Irish (Carnie 1994; Ni' Chiosa'in 1996, 1999; Green 1997) displays epenthesis between any sequence of a sonorant followed by a voiced obstruent (34a), while clusters composed of a sonorant and a voiceless obstruent (34b) or two obstruents (34c) surface intact.

(34) VOWEL EPENTHESIS IN IRISH:

a. /gorm/ → /gor\̃\textquoteleft m/ 'blue'

b. /kork/ → /kork/ 'Cork (place name)'

c. /ßaxt/ → /ßaxt/ 'seven'

In Upper Chinukw (a Tsimshian/Salish language), Hupka (2000) proposes a rule of schwa epenthesis that applies specifically in sequences composed of a consonant and a sonorant (or a glottal stop) where the language lacks a vowel in the coronal position. The exact contexts for schwa epenthesis, however, are not clearly defined in the paper.

I believe these cases of asymmetry between clusters containing a sonorant and clusters composed only of obstruents can be understood in terms of the perceptual account of epenthesis proposed by Fleischhacker and the perceptual account of schwa epenthesis in Irish.

In this long section, I have argued for the adoption of perceptually-motivated faithfulness constraints, whose ranking reflects the degree of disruption of the auditory properties of the input. This is consistent with the proposal that the auditory-visual interface is part of the perceptual explanation for the prominence of initial epenthesis. This constraint is present in several languages, both in the domain of sonorants and in the domain of obstruents, and it is subject to the constraint $C \leftrightarrow V$. The fact that voicing favors epenthesis is also independently noticed in Fleischhacker (2000a: 15-16).

In this long section, I have argued for the adoption of perceptually-motivated faithfulness constraints, whose ranking reflects the degree of disruption of the auditory properties of the input. This is consistent with the proposal that the auditory-visual interface is part of the perceptual explanation for the prominence of initial epenthesis. This constraint is present in several languages, both in the domain of sonorants and in the domain of obstruents, and it is subject to the constraint $C \leftrightarrow V$. The fact that voicing favors epenthesis is also independently noticed in Fleischhacker (2000a: 15-16).
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The rankings in (35a-e) express the generalization that consonants that are less perceptible should be avoided more than consonants that are more perceptible. Those in (35f-j) encode the fact that factors, and they both result in less perceptible consonants being less likely to surface than more perceptible ones.

(35) EQUIVALENCE BETWEEN MARKEDNESS AND MAX-C CONSTRAINTS:

<table>
<thead>
<tr>
<th>Markedness constraints</th>
<th>MAX-C constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. C ↔ V &gt;&gt; C _ V</td>
<td>f. MAX-C/C—V &gt;&gt; MAX-C/V—C &gt;&gt; MAX-C</td>
</tr>
<tr>
<td>Common motivation: prevocalic consonants are most perceptible, postvocalic ones are less perceptible, those that are not adjacent to any vowel are least perceptible</td>
<td></td>
</tr>
<tr>
<td>b. stop _ V &gt;&gt; C _ V</td>
<td>g. MAX-C(-stop) &gt;&gt; MAX-C</td>
</tr>
<tr>
<td>Common motivation: stops are less perceptible than other consonants (in non-prevocalic position)</td>
<td></td>
</tr>
<tr>
<td>c. stop(¬ [+cont]) _ V &gt;&gt; C _ V</td>
<td>h. MAX-stop/—[+cont] &gt;&gt; MAX-stop</td>
</tr>
<tr>
<td>Common motivation: stops that are followed by a [+continuant] segment are more perceptible than other stops</td>
<td></td>
</tr>
<tr>
<td>d. C(AGREE=F) _ V &gt;&gt; C _ V</td>
<td>i. MAX-C/CONTRAST=F &gt;&gt; MAX-C</td>
</tr>
<tr>
<td>Common motivation: consonants that agree/contrast in some feature F with an adjacent segment are less/more perceptible than consonants that do not</td>
<td></td>
</tr>
<tr>
<td>e. C_i _ V &gt;&gt; C_j _ V</td>
<td>j. MAX-C_i &gt;&gt; MAX-C</td>
</tr>
<tr>
<td>Common motivation: consonants that are adjacent to a prosodic boundary are more perceptible than consonants that are not.</td>
<td></td>
</tr>
</tbody>
</table>

One may worry about the redundancy present in this system. For example, is it necessary to integrate the effect of adjacent vowels (a and f), manner of articulation (b and g), the continuancy value of segments following stops (c and h), contrast/similarity (d and i), or the prosodic boundary (e and j) in both markedness and MAX-C constraints? I believe so, this system being both empirically adequate and maximally coherent. On the one hand, doing away with the context-specific MAX-C and DEP-V constraints yields an empirically inadequate system, which cannot derive the correct outputs, because it cannot predict which consonant deletes and where epenthesis occurs. Incorporating both of them into the ranking of DEP-V constraints would require it to meet potentially conflicting requirements: maximizing similarity between input and output and “saving” weak consonants. These requirements are better satisfied in a context that also incorporates PROSODIC MARKERS, which can help to resolve the issue. On the other hand, an empirical adequacy challenge is that the perceptual faithfulness constraints were proposed to capture the data, and it is unclear whether these constraints are necessary given the presence of other constraints.

Note on the P-map and the “Too-many-solutions problem”

Before closing this section, I should add a few comments concerning the scope of Steriade’s proposal regarding perceptually-motivated constraints, and my position with respect to it. First, note that the P-map is a tool for visualizing the relative strengths of constraints. The map shows that different processes, such as vowel deletion, have different effects on the output, with some processes being more important than others. The P-map is a useful tool for understanding the relative importance of constraints, and it can help to identify which processes are most critical for a given language.

The equivalence between Markedness and MAX-C constraints is a powerful tool for understanding the behavior of language. It allows us to predict which processes will be more likely to occur in a given language, and it can help to explain why certain processes are more common than others. However, it is important to remember that not all processes are equally important, and that other factors, such as the phonetic properties of the input, can also play a role in determining which processes will be used. Additionally, the P-map is a static representation of the system, and it does not take into account the dynamic nature of speech. As such, it is important to use this tool in conjunction with other approaches for understanding the behavior of language.
idea is easy to grasp: in current versions of OT, any phonotactic constraint can be met by the use of any possible repair strategy, depending on the ranking of the various faithfulness constraints. For instance, in languages that instantiate each of these solutions, depending on which of the faithfulness constraint is ranked lowest:

(36) \textit{Phonotactic constraint:} no word-final voiced obstruents

Input: /\textit{tab}/

\begin{enumerate}
  \item \textit{[tap]} if the lowest faithfulness constraint is IDENT-[voice]
  \item \textit{[tam]} IDENT-[nasal] / [son]
  \item \textit{[taw]} IDENT-[approximant]
  \item \textit{[tab]} DEP-V
  \item \textit{[ta]} MAX-C
  \item \textit{[bat]} LINEARITY
\end{enumerate}

Steriade’s observation, however, is that only devoicing (36a) is attested as a response to a constraint against final voiced obstruents. This is completely unexpected in the current state of the theory. What is going on in the output in the example is a situation in which the output conforms to the phonotactics: \textit{[tab]}-\textit{[tam]}, \textit{[tab]}-\textit{[tab]}\textit{\textbackslash}, \textit{[tab]}-\textit{[ta]}, etc. To show this, however, we have to compare the distinctiveness of contrasts that differ over multiple dimensions. For example, to conclude that the pair \textit{[tab]}-\textit{[tap]} is more similar than the pair \textit{[tab]}-\textit{[tab]}\textit{\textbackslash}, we have to determine that the contrast between \textit{b} and \textit{p} in the context \textit{a}—# is less distinctive than the contrast between \textit{\textbackslash} and \textit{\textbackslash} in the context \textit{b}—#. From this comparison we derive the following constraint ranking:

\begin{enumerate}
  \item DEP-V / C—# >> IDENT-[voice] / V—#
\end{enumerate}

This is clearly a more complex case than the one used to solve the consonant deletion problem above and which resulted in the ranking in (27), extended to those in (29). These rankings are based on comparisons of distinctiveness of contrasts that involve different dimensions. The contrast between \textit{b} and \textit{p} in the context \textit{a}—# is less distinctive than the contrast between \textit{\textbackslash} and \textit{\textbackslash} in the context \textit{b}—#, which gives us the following constraint ranking:

\textit{Phonetic constraints:} no word-final voiced obstructions

\begin{enumerate}
  \item DEP-V / C—# >> IDENT-[voice] / V—#
\end{enumerate}
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### 3.2.4. LIMITING THE ROLE OF PHONETIC GROUNDING

The perception-based approach developed here implies a view of the relationship between phonetics and phonology by which the former directly constrains the latter. This functionalist perspective is grounded in the idea that the perception of speech sounds is influenced by both phonetic and phonological factors. In this framework, phonological processes are viewed as being directly constrained by phonetic information.

Hyman (to appear) and Hale & Reiss (2000) in particular point to the existence of synchronic phenomena that are phonetically unnatural. Sound patterns interact with independent factors, such as phonological constraints, to produce the observed variation. As Hale & Reiss (2000) put it:

> [A grammar that has an arbitrary component and a nonarbitrary one] is empirically nondistinct from the theory we propose (...), which postulates that all grammatical computations are arbitrary with respect to phonetic substance. (...) Since we must adopt a model in which the addition to the theory of a special subcomponent to account for alleged "non-arbitrary" phenomena violates Occam's Razor. [their emphasis] (p. 161)

Phonology is not and should not be grounded in phonetics since the facts which phonetic grounding is meant to explain can be derived without reference to phonology. Duplication of the principles of acoustics and acquisition constitutes a violation of Occam's razor and thus must be avoided. (p. 162)

As is often the case, I suggest that the solution lies neither in the all-phonetic approach nor in the all-arbitrary one. I see no reason why acknowledging the existence of phonetically unnatural processes would affect my argument. I argue that perception plays a direct role in the application of deletion and epenthesis processes. I also believe that grammars have to accommodate arbitrary phenomena. An obvious question, then, is: How do kids learning German or Russian, but schwainsertion in French would be directly constrained by perception?

Alternatively, phonetically-motivated constraints in phonology could be viewed as default ones, that is constraints that are more readily available to learners. Note that variable phenomena cannot be dismissed from synchronic grammars as change in progress. The French schwa has been variable for centuries.
Arbitrary constraints would only emerge as a fall-back option when required by data that are not amenable to a functional account. It is not implausible to think that children will generally master functionally-motivated processes before arbitrary ones. This remains to be investigated.

This discussion makes it clear that I am not claiming that all segmental phonology is phonetically-driven; I am only arguing for the existence of perceptually-based constraints in phonology. In other words, phonetics will not be reduced to default options, much of phonology may be functionally-motivated, with the arbitrary part playing a subsidiary role.

3.2.5. Variation in Optimality Theory

As mentioned in the previous section, variation and frequency/likelihood are omnipresent in the processes investigated in this dissertation. This requires that we spend some time discussing the treatment of these aspects in phonological theory, particularly in Optimality Theory.

Variation has been a neglected area of phonological theory. Optional rules have been used to express non-categorical processes, but notions of frequency/likelihood or preference have been largely ignored. However, the categorialism of OT is not exclusive; it is possible to extend the formalism of OT to include non-categorical processes. The question is whether the formalism of OT is capable of handling variation.

As mentioned in the previous section, variation and frequency/likelihood are omnipresent in the processes investigated in this dissertation. This requires that we spend some time discussing the treatment of these aspects in phonological theory. A more powerful solution becomes available if we adopt Anttila’s view of grammars as partial orders, which allows the possibility of variation between well-formedness of a grammar or output.

As Anttila’s (1997) view of grammars as partial orders is adopted, the order of preference of the forms is preserved. The reason for this is that, in Anttila’s approach, the constraint ranking is not fixed; it can change depending on the input. This allows for the possibility of variation.

Coflette (1999) and Auger (2000) have shown that Anttila’s view of grammars as partial orders can be used to account for different patterns of well-formedness.

An additional assumption of Anttila is that the frequency of use or the relative well-formedness of a form should reflect the probability that it be generated by the constraint ranking. This is how variation (and optionality) is generated by the system.

The system is characterized by the system’s ability to vary, given certain inputs. This is how variation (and optionality) is accounted for by the system. The system is characterized by the system’s ability to vary, given certain inputs. This is how variation (and optionality) is accounted for by the system.
3.3. APPLICATIONS

3.3.1. LENAKEL Vowel Epenthesis

Vowel epenthesis in Lenakel is a good example to provide a first illustration of the functioning of the constraint system I propose. It specifically highlights the role of the markedness constraints. Vowel epenthesis is not a universal phenomenon. In traditional American English, for instance, no vowels are inserted before a consonant cluster. Yet the pattern is relatively simple and immune from independent intricacies.

The Lenakel epenthesis pattern can be described as follows (Lynch 1978; Blevins 1995; Kager 1999). An epenthetic vowel [ɪ] or [ɛ], depending on the preceding consonant, is automatically inserted between the second and third consonant word-internally, and between the two consonants at word edges. (Laufer and Pater 1999: 150) The process of Lenakel epenthesis, as shown in the following examples (Laufer and Pater 1999: 150), is not dependent on the finality of the cluster. More specifically, consonant clusters are preserved in their sequence in the underlying form, thereby giving rise to the epenthesis pattern.

No epenthesis occurs in clusters involving glides, along with /w/ and /ɬ/; [j] is assumed to only surface as a reflex of /i/ in certain positions. In the case of /C+ɬ/ clusters, epenthesis occurs in Lenakel, as shown in the following examples (Laufer and Pater 1999: 150).

There are several exceptions to this pattern: glide+consonant sequences are tolerated word-finally:

There is one exception to this pattern: glide+consonant sequences are tolerated word-finally: 

I adapt Lynch’s (1978) transcription in the following way, in conformity with the IPA: [y] is replaced by [j]; [ɬ‡] is described as a flap and is replaced by [ɬ]; [v] is described as a high central glide noted [ɬ] and this is the symbol I adopt.

In fact, Lynch (1978: 15) describes this exception as follows: “when two consonants come together at the beginning or the end of a word, [ɪ] is inserted between them provided that neither is a glide”. This is a direct consequence of a constraint that orders the insertion of an epenthetic vowel over a constraint that orders the insertion of an epenthetic vowel over a hyper-contrastive consonant feature (i.e. the [vocoid] feature).

The analysis of Lenakel vowel epenthesis shows that the constraints involved can be divided into two classes: (i) a hyper-contrastive vowel feature constraint, and (ii) a hyper-contrastive consonant feature constraint. The former is true in the case of /C+ɬ/ clusters, while the latter is true in the case of /C+C/ clusters.

The constraints involved in the analysis of Lenakel vowel epenthesis can be divided into two classes: (i) a hyper-contrastive vowel feature constraint, and (ii) a hyper-contrastive consonant feature constraint. The former is true in the case of /C+ɬ/ clusters, while the latter is true in the case of /C+C/ clusters.
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with their neighboring consonants invariably trigger epenthesis. To account for these generalizations I design the following markedness constraints:

(41) RELEVANT MARKEDNESS CONSTRAINTS:

a. \( C \cap \not\emptyset \leftrightarrow V \)
   A PW-internal consonant (which is adjacent to no prosodic boundary) is adjacent to a vowel.

b. \( PW[C \leftrightarrow V \)
   A consonant that is preceded by a PW boundary is adjacent to a vowel.

c. \( C \mid PW(AB\text{-}\text{AGREE}=\hat{\text{vocoid}}) \leftrightarrow V \)
   A consonant that is followed by a PW boundary and that agrees in [vocoid] with a neighboring segment is adjacent to a vowel.

d. \( C \mid PW \leftrightarrow V \)
   A consonant that is followed by a PW boundary is adjacent to a vowel.

By the dominance condition in (19), we can establish the inherent rankings in (42) between these constraints; the reader may also refer to the rankings in (22).

(42) INHERENT RANKINGS BETWEEN THE MARKEDNESS CONSTRAINTS IN (41):

a. \( C \cap \not\emptyset \leftrightarrow V \gg PW[C \leftrightarrow V \)

b. \( C \cap \not\emptyset \leftrightarrow V \gg C \mid PW \leftrightarrow V \)

c. \( C \mid PW(AB\text{-}\text{AGREE}=\hat{\text{vocoid}}) \leftrightarrow V \gg C \mid PW \leftrightarrow V \)

Our task is now to rank \( \text{DEP-V} \) within this web of markedness constraints. The three constraints in (41a-c) are unviolated in the language and must dominate all constraints against vowel epenthesis. But \( \text{DEP-V} \) outranks \( C \mid PW \leftrightarrow V \), since epenthesis does not apply word-finally in the clusters that are not subject to the higher-ranked \( C \mid PW(AB\text{-}\text{AGREE}=\hat{\text{vocoid}}) \leftrightarrow V \). This mini-grammar is given in graphic form in (43) and illustrated in the tableau in (44), with examples from (37) and (38). In this and all following graphics thick lines are ... rankings determined on the basis of the available data, whereas thin lines indicate fixed inherent rankings.

The issue of the site of epenthesis obviously arises here. In internal three-consonant clusters, the vowel is inserted between the second and the third consonant; the vowel is inserted between the second and the third consonant.

I assume that the final consonant is a non-glide. If glide+glide sequences are tolerated as well, the generalization would be that it is agreement in [\(-\text{vocoid}\)] specifically rather than [vocoid] that systematically triggers epenthesis.

The issue in this first step and consider only the candidates with the correct placement of the epenthetic vowel. This problem will be addressed below. Finally, in /aik/, the last example in the tableau, I assume that the faithful candidate [aik] is excluded by a constraint against hiatus, which must at least dominate \( C \mid PW \leftrightarrow V \).
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These two cases lies in the nature of the cluster. The two segments in the sequence [pk˙] (44b) share the same value for the feature [vocoid]. The final [k˙] agrees in[vocoid] with the preceding consonant and is not adjacent to a vowel, in violation of the higher-ranked constraint C\(\text{PW} \leftrightarrow\text{V}\), which dominates DEP-V.

Unlike [pk˙], the sequence [jk˙] (44d) displays a contrast in the feature [vocoid] and only yields a violation of the general lower-ranked constraint C\(\text{PW} \leftrightarrow\text{V}\). This is illustrated in the tableau below with forms that violate C\(\text{PW} \leftrightarrow\text{V}\) and forms that violate DEP-V. The ranking between DEP-V and the lower-ranked C\(\text{PW} \leftrightarrow\text{V}\) remains undetermined, since we find variation between forms that violate DEP-V (\[...VCCV...\]) and forms that violate C\(\text{PW} \leftrightarrow\text{V}\) (\[...VCVCV...\]). This is illustrated in the tableau below with forms from (39) and (40).

At word edges epenthesis is always medial. Let us now consider the issue of the site of epenthesis. I assume that the word-internal placement of epenthesis between the second and third consonants in three-consonant clusters is due to an alignment constraint that is evaluated gradiently in terms of the number of segments that intervene between a consonant and the edge of a PW.

\[\begin{align*}
\text{ALIGN-L (C, PW)} & \quad \text{A consonant aligns with the left edge of a PW.} \\
\text{ALIGN-R (C, PW)} & \quad \text{A consonant aligns with the right edge of a PW.}
\end{align*}\]

Let us now consider the issue of the site of epenthesis. I assume that the word-internal placement of epenthesis is always medial. Let us now consider the issue of the site of epenthesis. I assume that the word-internal placement of epenthesis is always medial.
A somewhat unexpected but welcome result of the system of markedness constraints we have developed is that they automatically derive the Lenakel/Chukchi pattern of epenthesis in edge position, irrespective of the preferred site word-internally – is not exceptional and is also found for example in Chukchi.

(51) DETE RMINING THE LOCUS OF EPENTHESIS AT WORD EDGES:

<table>
<thead>
<tr>
<th></th>
<th>i (0)</th>
<th>i (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VDEP-V C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.3.2. SRANAN CONSONANT DELETION

Alber & Plag (1999) discuss vowel deletion and consonant epenthesis in the formation of Sranan, an English-based creole language spoken in Surinam. Consonant clusters in the source language were preserved or epenthesized in the Sranan adaptation. Alber & Plag do not extend these generalizations from the data. They note that the source language consonant clusters can be deleted by conditioning rules, here the stop or non-stop stop. A closer look at the data from Italian two-step shows that the tendency to delete the first consonant is exhibited in the Sranan adaptation. This generalization is observed in clusters of the form CVCCV and CVCCVCC. The generalization is absent in clusters of the form CVCCVC.

In (52) we have English forms containing stop+vowel (b), and stop+nasal (c).

<table>
<thead>
<tr>
<th>English word</th>
<th>Sranan adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>cur</td>
<td>ko</td>
</tr>
<tr>
<td>b</td>
<td></td>
</tr>
<tr>
<td>c</td>
<td></td>
</tr>
</tbody>
</table>

(52) Sranan adaptations of stop+fricative and stop+nasal clusters:

a. cur
b. go

c. goodnight

(53) Sranan adaptations of fricative+stop and nasal+stop clusters:

a. master
b. na
c. si
d. soft

e. reme
f. somthing

(54) Sranan adaptations of stop+stop clusters:

a. doctor
b. sit down

In (52) we have English forms containing stop+vowel (b), and stop+nasal (c). In all cases only the second consonant is retained in Sranan. (53) shows examples of fricative+stop and nasal+stop. In all cases, the second consonant is retained in Sranan. (54) shows examples of stop+stop. In all cases, only the second consonant is retained in Sranan.

Alber & Plag do not extract these generalizations from the data. They notice variation in the position of the deleted consonant, but cannot account for it and simply leave the issue open. This pattern, however, occurs naturally and exemplifies the position of the deleted consonant that can account for it and variation in the position of the deleted consonant that cannot account for it. They note that the source language consonant clusters can be deleted by conditioning rules, here the stop or non-stop stop. A closer look at the data from Italian two-step shows that the tendency to delete the first consonant is exhibited in the Sranan adaptation. This generalization is observed in clusters of the form CVCCV and CVCCVCC. The generalization is absent in clusters of the form CVCCVC.
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The distinctions in (52)-(54) follow straightforwardly from the perceptually-motivated faithfulness constraints in (29a-b), repeated below. The deletion of stops is also more likely than that of non-stops because of the weakness of their internal cues.

(29) Relevant Faithfulness Constraints in Sranan:

a. MAX-C/-V >> MAX-C/V— >> MAX-C

b. MAX-C(-stop) >> MAX-C

By assuming the simple ranking in (55), we derive the data in (52)-(54), as shown in the tableau in (56).

(55) Ranking Between the Faithfulness Constraints:

MAX-C(-stop)  >>  MAX-C/—V  >>  MAX-C/V—

In all these examples, the faithful output (in terms of the size of number of consonants, irrespective of other phonological processes) violates C_V and one of the consonants deletes. When the cluster contains a stop and a non-stop (56-a), the stop is more likely than that of non-stops because of the weakness of their internal cues. The deletion of post-vocalic stops is also more likely than non-stops because of the weakness of their internal cues.

In Chapter 2, I have introduced the theoretical apparatus designed to account for the empirical generalizations presented in chapters 1 and 2 concerning deletion and epenthesis. In this chapter I have introduced the theoretical apparatus designed to account for the empirical generalizations presented in chapters 1 and 2 concerning deletion and epenthesis.

3.4. Conclusions

In this chapter I have introduced the theoretical apparatus designed to account for the empirical generalizations presented in chapters 1 and 2 concerning deletion and epenthesis. In this chapter I have introduced the theoretical apparatus designed to account for the empirical generalizations presented in chapters 1 and 2 concerning deletion and epenthesis.
APPENDIX: ADDITIONAL PATTERNS SHOWING THE SPECIAL STATUS OF STOPS

I provide here additional patterns that exclusively or more specifically target stops. I present these patterns to further illustrate the special status of these consonants and their increased productivity of consonant deletion and metathesis in complex clusters. Among them Colloquial Latin (Niedermann 1953) and Dihovo Macedonian (Groen 1977).

There is one case of consonant deletion (Farsi) and, more interestingly, two cases of metathesis. Metathesis has not been mentioned as a possible repair strategy for complex consonant clusters. It is also interesting to note how stops are positioned in the repair of Farsi. The Russian literature on the special status of stops in Russian has shown both a vowel and a stop to replace a complex consonant cluster in a special position. In Russian, the stop is the consonant that is deleted, while the vowel is added in the position that follows the consonant.

A. Metathesis in Lithuanian

In Lithuanian, verbs that end in a fricative-stop cluster undergo metathesis when followed by a consonant-initial suffix (Kenstowicz 1971; Ambrazas 1985: 60; Mathiassen 1996: 26):

\[
\begin{align*}
\text{(1) Top-Fricative Metathesis in Lithuanian:} & \\
\text{URs} + \text{Vowel} + \text{Consonant} & \\
/\text{-sk}/ & \text{dresk-/} \quad \text{dreskia} & \text{he/they tear(s)} \\
/\text{-zg}/ & \text{mezg-/} \quad \text{mezga} & \text{he/they knot(s)} \\
/\text{-Ωg}/ & \text{derg-/} \quad \text{dergij} & \text{he/they scrape(s)}
\end{align*}
\]

I interpret this process in the following way. When the last stop of the stem precedes a vowel, it benefits from the strong contextual cues present in the transition to the vowel. If the last stop preceded a vowel, then it would not be in an intervocalic position. On the other hand, fricatives remain perceptually salient even in inter-consonantal position.

B. Metathesis in Singapore English

In Singapore English (Mohanan 1992), final /-sp/ metathesizes to /-ps/. For example, *crisp* is pronounced [krips], *grasp* [graspers]. As in Lithuanian above, this process allows both consonants to remain perceptually salient: /p/ gains vocalic transitions from the preceding vowel, while /s/ is strong enough by itself.

C. Consonant deletion in Farsi

Colloquial Persian (Darzi 1991; Mohootian 1997) productively simplifies certain consonant clusters, in particular word-finally. We can distinguish three distinct deletion processes:

1. Deletion of /÷/ and /h/. This occurs in numerous positions, especially in clusters.
2. Deletion of /r/ after an obstruent word-finally, e.g. /fekr/ → /fek/ 'thought.' I suspect this process is motivated by the SSP.
3. Deletion of stops in inter- and post-vocalic positions, especially in clusters.

In Farsi, we can distinguish these three distinct deletion processes, in particular word-finally. We can distinguish these three processes from the preceding vowel, while /s/ is strong enough by itself.

In Singapore English, both consonants are retained, gaining vocalic transitions from the preceding vowel. In Farsi, we can distinguish three distinct deletion processes:

1. Deletion of /÷/ and /h/.
2. Deletion of /r/ after an obstruent word-finally.
3. Deletion of stops in inter- and post-vocalic positions, especially in clusters.

In Farsi, we can distinguish these three distinct deletion processes, in particular word-finally. We can distinguish these three processes from the preceding vowel, while /s/ is strong enough by itself.
But according to Darzi (1991), the process extends at least to /d/ after /z/ (4), /t/ preceded by non-coronal fricatives (5), as well as stops at places of articulation other than coronal (6). 

(4) /d/
DELETION AFTER /z/:
- /mozd/ [moz]'wage'
- /dozd/ [doz] 'thief'

(5) /t/
DELETION AFTER A NON-CORONAL FRICATIVE:
- /hæft/ [hæf] 'seven'
- /gereft/ [geref] '(he) got'
- /loxt/ [lox] 'naked'
- /saxt/ [sax] '(he) built'

(6) NON-CORONAL STOP DELETION:
- /xoxk/ [xoß] 'dry'

First, the process appears to be restricted to stops. No cases of fricative or nasal deletion are reported, except in the isolated example /tßeßm/ 'eye', pronounced [tßeß] (Mahootian 1997: 336). Phrases like /esm/ 'name', /el'm/ 'science', /hokm/ 'order' even if the SSP is violated, as in the last two examples.

Stop deletion, however, is clearly dependent on contrast between the stop and the preceding consonant. But Darzi and Mahootian differ on the amount of contrast that is necessary to block deletion. 'According to Mahootian, only coronal stops that are homorganic with the preceding consonant delete. So a contrast in place of articulation prevents simplification. In addition, stops are dropped only when the preceding consonant is coronal, whereas in English, the process extends at least to non-coronal stops.

In addition, stops are dropped only after consonants that contrast minimally in manner of articulation: nasals, which contrast only in [sonorant], and non-coronal stops, which contrast only in [coronal].

The role of coronality is not clear. Is it the case that non-coronal consonants may not drop in the variety described by Mahootian, or are non-coronal stops disregarded because they are much less frequent, as is the case in English (see chapter 1, section 1.2.3). Recall that Darzi does allow deletion of non-coronal stops.