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Consonant gemination in West Greenlandic

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Résumé

Ce mémoire analyse, à l'aide du Sérialisme Harmonique, un processus de gémination consonantique s'opérant à travers des frontières de morphème en groenlandais de l'ouest. Une partie intégrante de cette analyse se base sur les restrictions sur les formes de surface des consonnes géminées et le comportement général des consonnes chez les frontières de morphème. Le processus de gémination discuté implique l'assimilation consonantique régressive quand un affixe qui commence par une consonne se rattache à un *stem* qui se termine par une consonne. Un processus d'effacement consonantique en fin de *stem* s'opère dans le même contexte. Ces deux processus empêchent des groupes consonantiques d'apparaître dans des représentations de surface. Bien que la distribution de ces processus ne soit pas évidente, cette analyse propose une explication basée sur des mores flottantes qui déclenchent l'assimilation. En outre, l'analyse implémente une série d'opérations qui imposent des restrictions sur les représentations de surface des consonne géminées et établit une relation formelle entre ces représentations et leur position dans un morphème. L'objectif de ce mémoire est de proposer un exemple de comment une analyse plus moderne et unifiée de la grammaire du groenlandais pourrait être accomplie par le Sérialisme Harmonique. Alors que la majorité des travaux antérieurs sur la phonologie groenlandaise sont entièrement descriptifs ou impliquent des règles de réécriture ne pouvant pas être formellement reliées, ce mémoire suggère une approche à l'aide d'un cadre théorique sérial et basé sur des contraintes comme une option viable.

Mots-clés : Allongement compensatoire, assimilation consonantique, consonnes, gémination, groenlandais, groenlandais de l'ouest, inuit, phonologie, Sérialisme Harmonique, Théorie de l'Optimalité

Abstract

This thesis proposes an analysis in Harmonic Serialism of a cross-morpheme consonant gemination process in West Greenlandic. Central considerations to the analysis are surface restrictions on geminate consonants as well as general consonant behavior at morpheme boundaries. The gemination process at hand involves regressive consonant assimilation when a consonant-initial affix is introduced to consonant-final stem. This operates alongside a process of stem-final consonant deletion, with both processes serving as mutually exclusive strategies to prevent heterorganic consonant clusters from surfacing in West Greenlandic. While the distribution of these processes is not surface-apparent, it is explained through the proposal of unattached moras that function as triggers for assimilation. Additionally, the analysis implements a set of operations that impose restrictions on the output forms of geminate consonants and establishes a formal relationship between these output forms and their position within a morpheme. The objective of this thesis is to propose an example of how a more modern, unified analysis of West Greenlandic grammar could be modeled in Harmonic Serialism. While the majority of earlier works on West Greenlandic phonology are either purely descriptive in nature or involve rewrite rules that cannot share a formal relation or output goal, this thesis proposes an approach within a serial, constraint-based framework as a viable alternative.

Keywords: Compensatory lengthening, consonant assimilation, consonants, gemination, Greenlandic, Harmonic Serialism, Inuit, Optimality Theory, phonology, West Greenlandic

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List of Abbreviations and Symbols

<table>
<tr><td>-</td><td>Separation within a single morpheme</td></tr>
<tr><td>!</td><td>Fatal violation (in OT tableau)</td></tr>
<tr><td>→</td><td>Becomes</td></tr>
<tr><td>☞</td><td>Optimal candidate</td></tr>
<tr><td>(…)</td><td>Representation of a syllable</td></tr>
<tr><td>(C)</td><td>Optional consonant</td></tr>
<tr><td>(V)</td><td>Optional vowel</td></tr>
<tr><td>*</td><td>Unattested or disallowed form / Reconstructed form / Constraint violation (in OT tableau)</td></tr>
<tr><td>,</td><td>Non-crucial constraint ranking (in text)</td></tr>
<tr><td>/…/</td><td>Underlying representation</td></tr>
<tr><td>[…]</td><td>Surface representation</td></tr>
<tr><td>[…]$_\omega$</td><td>Representation of a prosodic word</td></tr>
<tr><td>]$_\sigma$</td><td>Right edge of syllable</td></tr>
<tr><td>]$_\omega$</td><td>Right edge of prosodic word</td></tr>
<tr><td>|…|</td><td>Intermediate representation</td></tr>
<tr><td>+</td><td>Separation of two morphemes</td></tr>
<tr><td>{…}</td><td>Morphological representation</td></tr>
<tr><td>>></td><td>Crucial constraint ranking (in text)</td></tr>
<tr><td>μ</td><td>Mora</td></tr>
<tr><td>1SG.</td><td>First person singular</td></tr>
<tr><td>3SG.</td><td>Third person singular</td></tr>
</table>

4SG.	"Fourth" person singular (reflexive)
ABS.	Absolutive case
ALIGN	Align both edges
ALIGN-L	Align left edge
ALIGN-R	Align right edge
ALL.	Allative case
$C_{(n)}$	Consonant (number *n* in sequence) / Coda
C_q	Uvular consonant
CAUS.	Causative mood
CODA-COND	Coda Condition
cont	Continuant
DEP	Dependence
EVAL	EVALUATOR
FLOAT-μ	Floating mora
G	Geminate consonant
G=M	Geminate = Moraic
GEM	Geminate
GEMFRIC	Geminate fricative
GEMINT	Geminate integrity
GEN	GENERATOR
GG	Geminate glide
H	High intonation / Debuccalized segment
HS	Harmonic Serialism

ID	Identity
IND.	Indicative mood
IPA	International Phonetic Alphabet
L	Low intonation
LL	Geminate lateral
LX≈PR(*x*)	Lexical item (of category *x*) = Prosodic word
MAX	Maximality
N	Nucleus
n.	Noun
NN	Geminate nasal
O	Onset
Ø	Deleted segment
Ons	Onset
OT	Optimality Theory
OT-CC	Optimality Theory with Candidate Chains
PART.	Participial mood
$PCat_n$	Prosodic category (number *n* in sequence)
P-DEP	Positional dependence
PL.	Plural
POSCORR	Positional correspondence
POSS.	Possessive
PRS-SEG	Parse segment
R	Rime

REL.	Relative (ergative) case
Seg_n	Segment (number *n* in sequence)
SG.	Singular
SYLL-CONT	Syllable contact
V.	Verb
V_n	Vowel (number *n* in sequence)
voi	Voice
VOIOBSGEM	Voiced obstruent geminate
WBP	Weight-by-position
x^{μ}	Floating (unattached) mora
x_{μ}	Attached mora
$x^{ʁ}$	Uvularized (vowel)
σ	Syllable
$_{\sigma}[$	Left edge of syllable
ω	Prosodic word
$_{\omega}[$	Left edge of prosodic word

To my parents, Doug and Diane, and to my best friend, Pénélope.

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All remaining errors are, of course, my own.

1. Introduction

In West Greenlandic, a dialect of the Inuit language widely spoken in Greenland and natively spoken in and around the community of Nuuk, length is a distinctive feature. Every phonemic segment may appear in either singleton or geminate form. Geminate consonants, however, are subject to a number of restrictions; with the exception of nasals, they are voiceless and there is a strong tendency for geminate fricatives to surface as geminate stops. Consonant clusters in Inuit, though common in western dialects, become increasingly rare moving eastward. West Greenlandic stands out as the least permissive Inuit dialect in this regard; consonant clusters are forbidden at the surface level.

When a consonant cluster is created through the introduction of a consonant-initial affix to a consonant-final stem (C_1C_2), one of two mutually exclusive repairs may take place. The first is to produce a geminate consonant by way of *regressive assimilation*. Regressive assimilation works across a morpheme boundary to replace an underlying consonant cluster of the shape C_1C_2 with a surface geminate consonant C_2C_2, which must in turn respect the surface restrictions on geminate consonants. The second possible repair is to simply delete C_1, resulting in a singleton C_2 on the surface. Every affix in West Greenlandic favors one repair over the other, and the rationale for the choice is not immediately obvious. Affixes with diverse shapes and morphosyntactic roles can be found in both camps. One of the major points of the analysis presented in this thesis is to propose a phonological explanation for the behavior of consonants in these situations at morpheme boundaries, modeled in Harmonic Serialism.

Harmonic Serialism (McCarthy, 2010) is a serial variant of Optimality Theory (Prince & Smolensky, 1993/2004), a constraint-based framework stemming from the principle that all allowable surface forms in a given language are produced by the interaction (and conflict) of hierarchically ranked, violable constraints (Kager, 1999, p. xi). While potential surface forms, or output candidates, are evaluated on constraint performance in a single pass in classic Optimality Theory, evaluation in Harmonic Serialism is performed recursively with the goal of gradual harmonic improvement, where each evaluation yields an output in progressively less severe violation of the constraint hierarchy. The winning candidate as determined by each evaluation is used as the input in a new evaluation. This process continues in a loop until no further improvement can be achieved, at which point the input and the winning output are identical.

The mora is central to the theory of prosodic structure that is assumed in the analysis presented in this thesis. Any segment that contributes to syllable weight is considered to be moraic and is therefore associated with a mora (μ). While syllabification can neither be guaranteed nor prohibited in underlying forms due to the Optimality Theoretic principle of Richness of the Base, singleton vowels and geminate consonants are assumed to be underlyingly moraic (Hayes, 1989; Keer, 1999). Once syllabification is established, geminate consonants form the coda of one syllable and the onset of the following syllable (Morén, 1999). Singleton onset consonants and singleton coda consonants are considered non-moraic as they do not contribute to syllable weight in West Greenlandic.

Past scholarship on compensatory lengthening, a family of processes where the deletion of one segment results in the lengthening of a nearby segment, was instructive in building the analysis proposed here. Assimilation of the type $C_1C_2 \rightarrow C_2C_2$ can be analyzed as a type of compensatory lengthening, although C_1 assimilates to C_2 rather than deleting entirely (see Gess, 2011; Topintzi, 2012). In moraic terms, compensatory lengthening is often analyzed as the movement of a mora from one segment to another when the first (moraic) segment is suppressed.

In the analysis presented here, as neither singleton onsets nor singleton codas are considered moraic, an unattached ("floating") mora is posited to be the impetus for assimilation. Decisive in the distinction between an affix that favors assimilation ($C_1C_2 \rightarrow C_2C_2$) and one that favors deletion ($C_1C_2 \rightarrow ØC_2$) is the underlying presence or absence, respectively, of a floating mora in the affix in question.

Following Torres-Tamarit (2012, 2016), the stepwise building of prosodic structures is proposed to regulate the domains in which phonological operations may apply. In the first series of steps, all morphemes in an input string are parsed into separate prosodic words. Initial syllabification is achieved in the second series of steps, where syllable formation is critically restricted to segments parsed within the same prosodic word. This ensures that consonant-final stems are syllabified with a final coda, as only codas may be targeted by assimilation or deletion (McCarthy, 2008). This is due to the Coda Condition, an independently motivated stipulation that codas may not specify their own place feature values (Itô, 1989). The main strategy for resolving a Coda Condition violation in this analysis is deleting the coda altogether. Crucially, however, addressing the presence of floating moras takes precedence over resolving Coda Condition violations.

As floating moras never appear in West Greenlandic surface forms, the system moves to eliminate them as quickly as possible. This is achieved by either deleting the floating mora, which results in no phonetic change to the surface form, or by the preferred strategy of attaching the floating mora to the final coda of the preceding prosodic word. This serves to block this consonant from deletion, as this move would once again result in a floating mora and therefore would not represent harmonic improvement. Instead, the repair of assimilating the coda to the following onset is favored. Once the coda is stripped of its independent place feature values, the result is a geminate consonant that is not in violation of the Coda Condition.

Geminate consonants, once formed, are interpreted by this system as single units. They may straightforwardly undergo changes, such as devoicing (for example /vː/ → [fː]), but they avoid separation due to the principle of geminate integrity, stating that changes must apply equally to both halves of a geminate (Schein & Steriade, 1986). As geminate consonants are under strong pressure to be moraic, they are reinforced by the fact that moraic segments powerfully resist deletion.

The nature of the phonological machinery responsible for suppressing consonant clusters, restricting the surface forms of geminate consonants, and governing the behavior of consonants at morpheme boundaries in West Greenlandic serves as the main focus of this thesis. The modeling of these phenomena in the serial, constraint-based Harmonic Serialism is intended to exhibit the potential of this framework for producing further analyses of West Greenlandic phonology that are more formally unified than sets of independent rewrite rules. Finally, this thesis aims to contribute to the larger conversation on geminates and geminate behavior in Harmonic Serialism; in particular, the consequences of applying the concept of geminate integrity to Harmonic Serialist analyses, raised in Shin (2011), are further explored here, with this theme playing a central role in the analysis.

1.1. Notational conventions

In linguistic representations presented throughout this thesis, certain conventions are observed. Underlying forms are presented between slashes (/…/), surface forms between square brackets ([…]), and morphological forms in small caps between curly braces ({…}). Additionally, morphemes are separated with the symbol + in all representations. Within morphological representations, the symbol - is used to indicate that two components are contained within a single morpheme. Finally, glosses are presented between single quotes and any orthographical representation is italicized. These conventions are illustrated in Table 1 (p. 5), where the words ‘cat’ and ‘cats’ are compared.

Table 1. Example of notation using the English word ‘cat’

a. /kæt/	b. /kæt+z/
[kæt] {CAT} ‘cat’	[kæt+s] {CAT+PL.} ‘cats’

When intermediate forms are presented (i.e. neither underlying nor surface), these are depicted between vertical bars (|…|). In cases where syllabification is defined, syllables are shown between pairs of simple parentheses as follows: (…)(…). Finally, prosodic words are indicated by square brackets followed by a subscript ω, like so: $[\ldots]_{\omega}$.

1.2. Definitions of ***root***, ***stem***, ***morpheme***, and ***word***

In the interest of clarity and uniformity, the terms *root*, *stem*, *morpheme* and *word* should be precisely defined before proceeding further. I use the term *root* to refer to the most elemental component of a noun or verb bearing no affixes. A *stem* refers to a unit that is built recursively from a root with the addition of every derivational affix; a root combined with *n* derivational affixes corresponds to *n + 1* stems. A *morpheme* is the most basic morphological unit; all roots and all affixes constitute separate morphemes. Finally, a *word* is a complete rendering of a stem combined with all of its inflectional affixes (if any).

As an illustration, consider the word *siniataarpoq* ‘s/he sleeps intensely’ in Figure 1 (p. 6), composed of the root /sinik/ ‘sleep (v.)’, the derivational affix /ataaʁ/ ‘intensely, in a big way’, and the inflectional affix /vuq/ ‘IND.3SG.’.

Figure 1. Illustration of the concepts *root*, *stem*, *morpheme*, and *word* as defined in this thesis

<table>
<tr><td colspan="3">← Word →</td></tr>
<tr><td>/sinik/</td><td>/ataaʁ/</td><td>/vuq/</td></tr>
<tr><td>• Morpheme
• Root
• Stem</td><td>• Morpheme
• (Derivational) affix</td><td rowspan="2">• Morpheme
• (Inflectional) affix</td></tr>
<tr><td colspan="2">← Stem →</td></tr>
</table>

Given these definitions, a reference to the stem-final consonants in this word would include both /k/ in /sinik/ and /ʁ/ in /ataaʁ/, with the exclusion of /q/ in /vuq/.

1.3. Representation of data

Regarding the issues that were addressed in transposing the data, all representations of written forms using the Kleinschmidt orthography in older works have been transcribed into the modern orthography. Additionally, all transcriptions have been modified to standard IPA. This standardization particularly concerns [t^s] and [ɬ], which appear frequently.[1] The symbols /g/ and /r/, used for convenience in some works (see for example Rischel, 1974, pp. 20, 23), have been replaced with /ɣ/ and /ʁ/ respectively in the interest of a more faithful and accurate transcription, including the superscript /$^{\text{ʁ}}$/ following a uvularized vowel. Distinctions between allophonic

[1] Rischel uses [¢] and [L], respectively (1974, pp. 58-60, 122).

vowels (see §3.1.1) have been maintained throughout this thesis, even when the source material ignores these distinctions. In cases where surface [s] corresponds to /ʃ/ rather than /s/, this distinction is also preserved despite the lack of surface [ʃ] in the modern standard language, as certain phonological phenomena can consistently be traced to the presence of an etymological /ʃ/ (Rischel, 1974, p. 21). These issues are revisited in more detail in the phonemic inventory of West Greenlandic presented in Chapter 3.

1.4. Organization of this thesis

West Greenlandic is described generally and situated within the broader Inuit language in Chapter 2. This chapter includes an overview of the scholarship on West Greenlandic and the language sources used in this thesis. Chapter 3 presents a morphophonological survey of West Greenlandic in theory-neutral terms with a focus on processes affecting consonants. The theoretical framework I assume, Harmonic Serialism, is introduced in Chapter 4 along with precedents relating to prosody, gemination, and lengthening processes. Chapter 5 presents an analysis of the relationship between consonant gemination processes and morpheme boundaries as introduced in Chapter 3. Finally, Chapter 6 concludes the thesis with a discussion of the major points of the analysis and residual issues.

2. West Greenlandic in context

This chapter serves to establish basic facts about the Greenlandic dialects of the Inuit language to provide context for the remainder of this work. First, the Greenlandic dialects are situated within the Inuit language in §2.1. In §2.2, the Greenlandic dialects are presented and compared, with a particular focus on West Greenlandic. This is followed by a brief overview of the history of scholarship on West Greenlandic and the effects of this scholarship on work in the present day in §2.3. The chapter concludes with a discussion of the West Greenlandic data used in this thesis in §2.4.

2.1. Greenlandic within the Inuit language

The dialect continuum of the Inuit language spans from Alaska across the Canadian Arctic to its easternmost extreme in Greenland.[2]

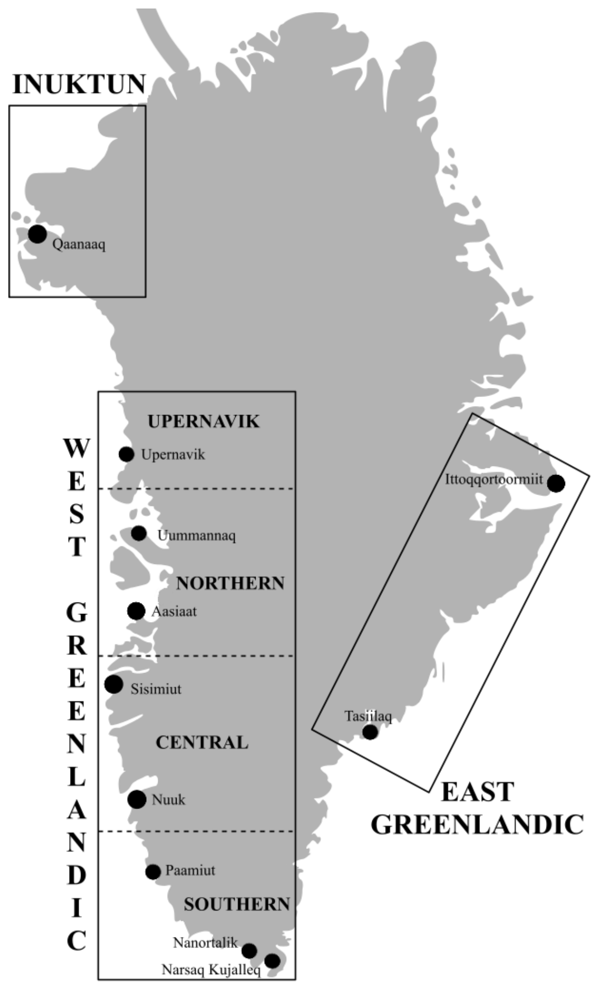
The Inuit language in Greenland is divided into three widely accepted dialects, henceforth collectively referred to as "Greenlandic": Inuktun (also variously described as Thule dialect, North Greenlandic, and "Polar Eskimo"), West Greenlandic (Kalaallisut), and East Greenlandic (Tunumiisut). Of the 90,000 estimated speakers of Inuit, nearly 50,000 are speakers of a Greenlandic dialect (Dorais, 2017, pp. 16-17, 218). West Greenlandic is the official, standardized Greenlandic dialect and it is understood throughout the country. These dialects are discussed in the following section.

[2] The classification of Inuit as a single language is supported by Dorais (2017), where he cites a generally high degree of mutual intelligibility across the Inuit dialects as well as the pronounced difference between Inuit, Aleut, and the Yupik languages (see Dorais, 2017, pp. 4-11).

2.2. Greenlandic dialects

The distribution of dialects and subdialects within Greenland is shown in Figure 2 (p. 9).

Figure 2. Distribution of Inuit dialects in Greenland



Note. Based on Dorais (2017, p. 220). Settlements are indicated with black points.

Inuktun (§2.2.1), East Greenlandic (§2.2.2), and West Greenlandic (§2.2.3) are discussed in this section, both in terms of their features as well as their current status within Greenland. The recognized subdialects of West Greenlandic are considered in §2.2.3.

2.2.1. Inuktun

Inuktun (Leonard, 2010) is spoken by roughly 800 people concentrated around the settlement of Qaanaaq in the extreme northwest of the country (Dorais, 2017, pp. 195, 218). Inuktun differs significantly from the other two major Greenlandic dialects; its conservative phonology places it closer to Eastern Canadian Inuit dialects such as South Baffin and Aivilik (Dorais, 2017, p. 54; Fortescue, 1983, pp. 8, 17). Indeed, the main justifications for the inclusion of Inuktun as a "Greenlandic dialect" are its geographical location within the territory of Greenland as well as the influence exerted on it by West Greenlandic (Dorais, 2017, pp. 45, 195).

2.2.2. East Greenlandic

East Greenlandic, also known as Tunumiisut, is spoken by approximately 3,500 people on the eastern coast of the country (Dorais, 2017, p. 218). Two former subdialects, unique to the major settlements of Tasiilaq and Ittoqqortoormiit respectively, are no longer distinguishable (Dorais, 2017, p. 195). While East Greenlandic is phonologically quite similar to West Greenlandic, it is known for its vocabulary which diverges greatly from other Inuit dialects. This divergence is believed to be in large part due to a historically pervasive taboo against using words with a particular connection to an individual after their death, though this practice seems to have stopped around the time of the communities' conversion to Christianity at the beginning of the 20th century (Dorais, 2017, pp. 195, 214). When words were removed from the lexicon for this reason, they were replaced with newly coined words that persist to the present day. There is, however, a tremendous amount of phonological and lexical variation in East Greenlandic depending on the individual speaker, due to a greater or lesser influence felt from the official dialect (Robbe & Dorais, 1986, pp. xix-xx).

2.2.3. West Greenlandic

West Greenlandic is the most widely spoken Greenlandic dialect and the range of its native speakers also covers the largest geographical area of the three main dialects. Given its large distribution, there are also a number of subdialects of West Greenlandic. There are at least four commonly recognized subdialects, in order geographically from north to south: Upernavik, Northern West Greenlandic, Central West Greenlandic, and Southern West Greenlandic.

The Upernavik subdialect, spoken in the settlement of the same name, exhibits a phonology closer to East Greenlandic, notably the presence of geminate stops where geminate fricatives would be found in Central West Greenlandic. It is also what Rischel describes as an "i-dialect": the realization of /u/ as [i] is "dominant" in Upernavik (Fortescue, 1983, pp. 5-8; Rischel, 1975/2009, pp. 184-187).[3] Northern West Greenlandic is spoken in the areas surrounding Uummannaq and Aasiaat. It is mainly distinguished from the Central variety by a few minor phonetic differences: for example, /ɣ/ is realized as [ŋ] in general, and /l/ is flapped intervocalically (Fortescue, 1983, p. 6). Central West Greenlandic, spoken in and around Sisimiut and Nuuk, is the standard subdialect against which the others are generally compared, functioning as the official language of the country. Finally, Southern West Greenlandic is the subdialect spoken to the south of Nuuk, although both Fortescue and Rischel consider this to be two subdialects: the first around the area of Paamiut, and the second at Narsaq Kujalleq, on the southernmost tip of the island (Fortescue, 1983, p. 5; Rischel, 1975/2009, p. 183). The Paamiut subdialect is distinguished by a degree of shortening of geminate consonants, as well as a more pronounced distinction between /s/ and /ʃ/ which has largely disappeared elsewhere (Fortescue,

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[3] Rischel uses the example of /in**u**k/ 'human being', realized as [in**i**k] in Upernavik (cf. [in**u**k] in Central West Greenlandic) (Rischel, 1975/2009, p. 185).

1983, p. 8). In many respects, however, it can be grouped with Central West Greenlandic, and for Rischel it represents a “fuzzy boundary” between the Central and Southern varieties (1975/2009, p. 183). Despite the geographic discontinuity, the Narsaq Kujalleq subdialect shares many of the features seen in Upernavik (Rischel, 1975/2009, p. 186). It also exhibits some unique surface forms: /xx/ and /ff/ are both realized as [kk], while /ll/ is realized as [ɖɖ] or [ʈʈ] (Fortescue, 1983, pp. 5-8).

Central West Greenlandic is the native language of approximately 45,000 people as well as the dominant language of education, media, government, and everyday communication across Greenland. It is spoken and understood by virtually all native Greenlanders in addition to their local dialects or subdialects, and it is the only dialect with official status or a standardized written form (Dorais, 2017, pp. 217-218; Fortescue, 1984, p. ii). Never having been prohibited by the Danish state during the colonial period, Central West Greenlandic has existed alongside Danish as a language of instruction since at least the 1840s, with its position superseding that of Danish since the 1970s (Berthelsen, 1990, pp. 334-338). While foreign media continues to be typically translated into Danish, domestic radio, television, and print media are primarily in Central West Greenlandic (Petersen, 1990, p. 305). Oqaasileriffik, the Language Secretariat of Greenland, monitors the development and usage of Central West Greenlandic, receiving funding from the Greenlandic government (Naalakkersuisut, 2013; Oqaasileriffik, 2018b). For the purposes of conciseness, “West Greenlandic” is henceforth used to refer to Central West Greenlandic unless otherwise specified.

2.3. Scholarship on West Greenlandic

This section serves as a brief survey of the history of scholarship on Greenlandic, mainly focusing on the contributions of Samuel Kleinschmidt in the 19^{th} century and the path that scholarship has taken in recent decades.

2.3.1. Early scholarship and Kleinschmidt's grammar

Early descriptions of Greenlandic, dating from the mid-18^{th} and early 19^{th} centuries, were the products of Danish missionaries. The early publications used Latin grammar as a point of departure and sought to explain how the structures of Greenlandic corresponded and compared to the categories that existed in Latin. While the information in these publications is not necessarily inaccurate, the presentation is often either needlessly complex or simply unilluminating as a result of the Eurocentric conception of language description. For example, a paradigm dating from 1801 (reproduced by Sadock) presents the declension of the noun *nuna* 'land' following the Latin case system. In this paradigm, the form *nuna* is listed as dative and accusative as well as the "intransitive" realization of the nominative case, while forms deviating from the six cases in Latin are ignored (Sadock, 2016, pp. 57-60).

Samuel Kleinschmidt, a linguist born in Greenland to German and Danish parents who learned to speak Greenlandic in childhood, recognized this inadequacy and published a grammar in 1851 that broke with this tradition. In his grammar, he presented a description of the structure of Greenlandic that did not fit neatly into paradigms used for European languages. One of his greatest contributions was the description of Greenlandic morphosyntax: he posited what is now known as an ergative-absolutive alignment of arguments. He also noted that nominative-accusative constructions, while somewhat restricted in distribution, exist *alongside* ergative-absolutive constructions in Greenlandic (Sadock, 2016, pp. 60, 64-65). Kleinschmidt's approach to the problems posed by describing Inuit grammar remains influential to the present day.

2.3.2. Kleinschmidt's orthography

Another one of Kleinschmidt's significant achievements was the development and introduction of what would become the standard orthography for Greenlandic for over a century. One of Kleinschmidt's main focuses was the inconsistent notation used by his predecessors who undertook linguistic work and transcription of the language (Rischel, 1974, pp. 25-26). For example, an inability to appropriately distinguish phonemes, such as /k/ from /q/, pervaded early written works on Greenlandic. Important distinctions in meaning were also regularly ignored or overlooked (Berge, 2005, p. 1098; Petersen, 1990, p. 301).

In devising his system, Kleinschmidt demonstrated both an awareness of the language's phonology as well as a sensitivity to its morphological structures and etymology (Holtved, 1964, p. 144; Rischel, 1974, p. 8). As distinction in meaning was one of Kleinschmidt's foremost concerns, he introduced a series of diacritics to represent the length of segments, a contrastive feature in Greenlandic (Rischel, 1974, pp. 26-27). The orthography renders derived geminate consonants as clusters; the first consonant in the cluster is structurally motivated but phonetically absent, while the second consonant represents the surface form. For example, Kleinschmidt's *sini**gp**oq* 's/he sleeps' is composed of the root /sinik/ and the inflectional affix /vuq/. Due to the phonological processes that occur, the surface form is [sini**pp**oq], but the final velar from /sinik/ is retained in Kleinschmidt's spelling in the abstract form *g* (Rischel, 1974, p. 52). Geminate consonants occurring outside of this context are instead realized as *V́C*, with the acute accent simply indicating that the following consonant is long. An example of this type of geminate can be seen in Kleinschmidt's ***túp**iorpoq* [tu**pp**io$^{\text{ʁ}}$ppoq] 's/he makes a tent', where no separate underlying consonant is specifically referenced (Rischel, 1974, p. 57). Kleinschmidt's understanding of phonological processes is illustrated with the adoption of forms such as these, although some forms seem to originate from stylistic or arbitrary "personal" decisions rather than purely linguistic ones (Rischel, 1974, pp. 53-55).

2.3.3. Modern scholarship on Greenlandic

Kleinschmidt's orthography is of considerable interest for observing the state of Greenlandic in his time. However, the lack of a transparent correspondence between the written and spoken forms, having continued to diverge over the course of a century, meant that familiarity with morphological and etymological forms became more of a necessity and this ultimately began to affect literacy (Petersen, 1990, p. 301). Due to this shift, a new orthography that more faithfully reflects the spoken language was developed and adopted in 1973 (Berthelsen, 1990, p. 338). The unorthodox system of diacritics was replaced with a more transparent and cross-linguistically prevalent doubling of letters representing long segments, while the letter *ĸ*, a solution unique to the Greenlandic alphabet for rendering /q/, was replaced with *q*. Most significantly, the representation of geminate consonants was made to be more consistent with their phonetic realization in the modern language, rather than their underlying phonological forms (Dorais, 2017, pp. 216-217).

Since the time of Kleinschmidt, observational work on Greenlandic without a firm theoretical allegiance was undertaken by William Thalbitzer at the turn of the 20th century, while structuralism became the dominant framework used in works published mid-century, notably by Morris Swadesh and Knut Bergsland (Rischel, 1974, p. 6). Scholars at the University of Copenhagen, and later Ilisimatusarfik (the University of Greenland), played a pivotal role in developing the study of Greenlandic as well as Inuit linguistics as a whole in the latter half of the 20^{th} century (Dorais, 2017, p. 230). A number of influential works based in generative grammar were published during this period by scholars such as Charles Pyle, Robert Underhill, and Jerrold Sadock (Rischel, 1974, pp. 6-7).

2.4. West Greenlandic in this thesis

Topics in West Greenlandic Phonology: Regularities Underlying the Phonetic Appearance of Wordforms in a Polysynthetic Language (Rischel, 1974) is by far the most in-depth overview of the phonology of West Greenlandic, and it has served as a very important reference for this work, informing a significant portion of the assumptions that are made and providing much of the data that are analyzed. It uses rule-based generative phonology as its theoretical framework. Though much of the data was gathered in the Ilulissat area of West Greenland, the author stresses that the problems addressed in the book are "common to all the (non-peripheral) dialects of West Greenlandic," and that the subdialect spoken in Ilulissat does not differ from Central West Greenlandic significantly enough to cause difficulty in incorporating the data gathered there into a more general corpus (pp. 4-5). Other important reference materials for this project include *A Grammar of Kalaallisut (West Greenlandic Inuttut)* (Sadock, 2003), which was mainly consulted for its insights on morphophonology and consonant changes across morpheme boundaries (pp. 12-19), and *Inuit uqausiqatigiit / Inuit Languages & Dialects* (Dorais, 2017), which provided data for the Greenlandic dialects as well as a thorough situating of these dialects within the broader Inuit language both synchronically and diachronically (pp. 107-108, 164-165, 197-200). The *Comparative Eskimo Dictionary with Aleut Cognates* (Fortescue, Jacobson, & Kaplan, 2010) was also extensively consulted for these purposes.

The tools produced by Oqaasileriffik, the Language Secretariat of Greenland, and its Oqaaserpassualeriffik division deserve particular attention in this overview. The online dictionary on the Oqaasileriffik website is sourced from a number of existing dictionaries, but it has been richly expanded with IPA transcription and an elaborate morpheme search feature (Oqaasileriffik, 2018a). Three other tools were of particular utility to this project. First, Word Analyser recognizes and displays the constituent morphemes of a West Greenlandic input, which may sometimes be difficult to recognize due to a combination of phonological processes and other transformations (Oqaaserpassualeriffik, 2018b). A related tool, Word Generator, allows the user to input a West Greenlandic root and select desired inflectional or derivational changes to generate an output, returning an error when impossible forms are requested (Oqaaserpassualeriffik, 2018c). Finally, the tool for automatic conversion from Kleinschmidt's orthography to modern orthography was useful in performing this straightforward but sometimes time-consuming task (Oqaaserpassualeriffik, 2018a). As of 2019, this collection of tools is being continually tested and refined as part of a machine translation project funded by the Greenlandic government (McGwin, 2017; Molich, 2019, p. 4).

3. West Greenlandic morphophonology

This chapter details the morphophonology of West Greenlandic with a specific focus on the processes of consonant gemination and related factors. A segment inventory of West Greenlandic is presented in §3.1, followed by a description of syllable structure in the language in §3.2. Purely phonological aspects of gemination-related phenomena are described in §3.3, while §3.4 is centered on morphological considerations. Finally, the chapter concludes with §3.5. The facts established here serve as a basis for an analysis of the relationship between consonant gemination processes and morpheme boundaries in West Greenlandic, presented in Chapter 5.

3.1. Segment inventory

3.1.1. Vowel inventory

In West Greenlandic, there are four phonemic vowels: /a/, /i/, /u/, and an abstract vowel I render as /ə/ (Underhill, 1976, p. 350).[4] The diphthong [a͡i] is realized on the surface only word-finally; /ai/ and /au/ in any other position surface as [aa] (Rischel, 1974, p. 74). The other vowels may appear in any position (Sadock, 2003, p. 20). All vowels undergo lowering and/or retraction when they precede a uvular consonant (C_q) (Sadock, 2003, pp. 20-21). This is illustrated for each of the vowels (/ə/ uniformly patterning with /i/ in this instance) in Table 2 (p. 19), following Hagerup's phonetic transcriptions of the allophones (Hagerup, 2011, pp. 21-27).

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[4] Underhill uses the notation /ï/ for the abstract vowel. My choice of /ə/ is motivated by the correspondence with *ə in the proto-language and the fact that this segment does not always surface as [i] due to a lack of feature specification (Compton & Dresher, 2011, pp. 223-224).

Table 2. Vowel allophones preceding uvular consonants

/**a**C_q/ → [**ɑ**C_q]	/**i**C_q/ → [**ɐ**C_q]	/**u**C_q/ → [**o**C_q]
/aaʃ**aq**/	/im**iq**/	/nan**uq**/
[aas**ɑq**]	[im**ɐq**]	[nan**oq**]
‘summer’	‘water’	‘bear’

3.1.2. Consonant inventory

There are 15 phonemic consonants in West Greenlandic, represented in Table 3 (p. 19). The basis for this inventory is derived from Fortescue’s descriptions (1984, pp. 333-335). The inclusion of an underlying palatal stop, based on a proposal by Compton, is motivated by the distinct synchronic patterning of forms which contained this segment in the reconstructed proto-language (Compton, 2009, pp. 84, 89; Fortescue et al., 2010, pp. xvi-xvii).[5] /ʃ/ has largely been supplanted by [s] on the surface, but it is included in the phonemic inventory due to its distinct alternation patterns from /s/ (Rischel, 1974, pp. 21, 243).

Table 3. West Greenlandic consonant phoneme inventory

	Labial	(Post)alveolar	Palatal	Velar	Uvular
Stops	/p/	/t/	/c/	/k/	/q/
Fricatives	/v/	/s/ /ʃ/		/ɣ/	/ʁ/
Nasals	/m/	/n/		/ŋ/	
Liquids		/l/			
Semivowels			/j/		

[5] Note that there is no surface *[c] in the modern language. This topic is revisited in §3.3.2.

Length is a distinctive feature in West Greenlandic (Fortescue, 1984, pp. 339-340). All segments have singleton and geminate variants, though the surface forms of geminates do not always resemble their underlying forms. This is particularly notable in the case of the palatal consonants which never surface as geminates (Sadock, 2003, pp. 1-2). In addition, all geminate consonants are voiceless with the exception of nasals (Sadock, 2003, p. 20). As a result, fricatives invariably undergo devoicing and, in many cases, also fortition.

As one moves eastward, the Inuit dialects generally become increasingly restrictive in regard to heterorganic consonant clusters, with West Greenlandic being among the least permissive (Dorais, 2017, pp. 52, 238-239). No consonant clusters besides geminates and [tt^s] are permitted at surface level.[6] Words ending in a consonant may only end in /p/, /t/, /k/, and /q/. Word-initially, these same consonants are joined by /s/, /m/, and /n/ (Sadock, 2003, p. 20). A word-internal syllable beginning with a consonant may have any singleton as its onset and it may be followed by any vowel with the sole exception being the unattested combination *[ji] (Fortescue, 1984, p. 338).[7]

3.2. Syllable structure

Syllables in West Greenlandic have the structure (C)V(V)(C) (Fortescue, 1984, p. 338). Unusually for an Inuit dialect, sequences of up to four vowels may surface in West Greenlandic (Dorais, 2017, p. 205). Weakly articulated consonants optionally (but often) surface between heterogeneous vowels in such surface clusters. Etymological and trans-dialectal evidence suggests that, rather than being a result of epenthesis, these are often underlying consonants that

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[6] An argument against the existence of surface-level uvular-initial clusters is presented in §3.3.1.
[7] Rischel suggests that the absence of *[ji] is merely a distributional accident (Rischel, 1974, p. 119). This sequence appears commonly in dialects where the proto-form *ð became /j/, such as Eastern Canadian Inuktitut (Fortescue et al., 2010, pp. 438-439).

lenite or delete intervocalically. For example, /v/ is often deleted after /u/ as a general rule. For the word [takuaa] or [takuʷaa] ‘s/he sees it’, Dorais suggests an underlying form /takuvaa/ based on the surface forms [takuvaa] and [taɣivaa] that appear in other Inuit dialects (Dorais, 1986, p. 25; 2017, pp. 204-205). We can see a similarly weakened surface [j] in forms such as [qiiʲa] ‘freeze (of person)’, compared with the Eastern Canadian Inuktitut and North Alaskan Iñupiaq cognate [qiija] ‘be cold’ (Fortescue et al., 2010, p. 337). These data suggest that surface clusters of more than two vowels in West Greenlandic underlyingly contain an intervocalic /v/ or /j/ that is reduced or deleted on the surface when following a homorganic vowel, i.e. the sequences /uv/ and /ij/ (Rischel, 1974, pp. 119-121). On a related note, /ɣ/ also has a tendency to weaken intervocalically and in some words alternates with [v] or [ʷ]. The acceptance of multiple forms in these words, such as [uu**ɣ**aq] ~ [uu**ʷ**aq] ‘fjord cod’ and [suluppaa**ɣ**aq] ~ [suluppaa**v**aq] ‘redfish’, suggests that reanalyses of these words with lenited velars coexist with the original analyses in the modern language (Rischel, 1974, p. 242).

In terms of weight and prosody, the use of a concept closely resembling moras for West Greenlandic dates back to Kleinschmidt’s 1851 grammar, where he posited a system of timing based on the unequal weight of vowels and consonants (Jacobsen, 2000, p. 41).[8] Stress plays no role in West Greenlandic prosody, and while the language likewise has neither lexical tones nor pitch, all words in the language end with an underlying intonation contour of high-low-high (HLH), with each tone attached to a vowel mora (Arnhold, 2007, p. 5). The regular application of this pattern to moras rather than syllables has been cited as the strongest argument for a moraic analysis of West Greenlandic (Nagano-Madsen, 1988, p. 79; Rischel, 1974, p. 80). In

[8] The concept of the mora is defined more generally in §4.2.3.

addition to this prosodic evidence, phonetic measurements show a clear quantity distinction between single consonants on one hand and vowels and geminate consonants on the other, suggesting that coda consonants are not moraic in West Greenlandic (Nagano-Madsen, 1990, p. 131). On the basis of this evidence, I assume that vowels and geminate consonants are moraic, while long vowels are bimoraic (Mase & Rischel, 1971, p. 193; Nagano-Madsen, 1990, pp. 124-125). The possible syllable configurations are presented with the corresponding number of moras in Table 4 (p. 22), where **G** corresponds to the first component of a geminate consonant.

Table 4. Syllable configurations by number of moras

Syllable	(C)V	(C)VC	(C)VG	(C)VV	(C)VVC	(C)VVG
Moras	1		2			3

3.3. Gemination

3.3.1. Regressive assimilation

Derived (i.e. non-underlying) geminate consonants result from two processes. The first of these is regressive assimilation, a process that prevents a coda from differing in feature specifications from a following onset (Rischel, 1974, p. 34). Any such cluster ultimately surfaces as a geminate version of the second consonant (C_2). A basic illustration of this concept is given in Table 5 (p. 23) with the affected consonant clusters in bold type.

Table 5. Regressive assimilation in West Greenlandic

(a) /kamik/	(b) /kami**k**+**t**aaq/	(c) /kami**k**+**m**ut/	(d) /kami**k**+**s**i+vuq/
[kamik] {BOOT-ABS.SG.} 'boot'	[kami**t**+**t**ɑɑq] {BOOT+NEW} 'new boot'	[kami**m**+**m**ut] {BOOT+ALL.SG.} 'to the boot'	[kami**s**+**s**i+voq] {BOOT+BUY+IND.3SG.} 's/he buys a boot'

Note. Adapted from Rischel (1974, p. 35). The absolutive singular, referred to by Dorais as the "basic" form (Dorais, 2017, p. 207), is given here as the base form of all noun stems.

When the underlying first consonant of a cluster is uvular, the preceding vowel undergoes a process of uvularization in addition to being lowered as described in §3.1.1 (Mase & Rischel, 1971, p. 188; Rischel, 1974, p. 39). This is illustrated in Table 6 (p. 23).

Table 6. Uvularized vowel preceding non-uvular geminate

/inni**ʁ**+**m**i/
[innɐʶ**m**+**m**i] {FIRE+LOC.SG.} 'in the fire'

While the geminate is represented in the orthography as *rC₂* – *inne**rm**i* for the form given in Table 6 (p. 23) – rather than C_2C_2 as used for other geminates, phonetic data strongly suggest that the surface form comprises a uvularized vowel and a geminated C_2 rather than a heterorganic consonant cluster beginning with a uvular consonant (Mase & Rischel, 1971, pp. 240-241; Rischel, 1974, pp. 163-164). In other words, the surface form of /inniʁmi/ is indeed [innɐʶ**mm**i] rather than *[innɐ**ʁm**i]. As an additional illustration, Mase and Rischel indicate that when prompted, native speakers have a strong tendency to syllabify /iʁniq/ 'son' as [(ɐʶn)(nɐq)] rather than *[(ɐʁ)(nɐq)] (Mase & Rischel, 1971, p. 177).

As mentioned above in §3.3, some consonants have surface geminates that differ from their singleton forms. The basic principle is that single voiced continuants devoice in their geminate forms, also usually changing in manner of articulation. Continuants that alternate with geminate stops are shown in Table 7 (p. 24), where **C** represents any underlying consonant.

Table 7. Consonant alternations in geminate forms

(a) **/C + ɣ/ → [kk]**	(b) **/C + ʃ/ → [tt]**	(c) **/C + v/ → [pp]**
/uppi**t**+**ɣ**ama/ [uppi**k**+**k**ama] {FALL+CAUS.1SG.} 'because I fell'	/sini**k**+**ʃ**uq/ [sini**t**+**t**oq] {SLEEP+PART.3SG.} 'the one who sleeps'	/sini**k**+**v**uq/ [sini**p**+**p**oq] {SLEEP+IND.3SG.} 's/he sleeps'

Another common alternation is the substitution of the lateral /l/ by the voiceless lateral fricative [ɬ] where gemination occurs, shown in Table 8 (p. 24). This allophonic change is categorical in the language and due to the great number of affixes beginning with /l/, it occurs frequently as a result of regressive assimilation.

Table 8. Alternation of laterals in geminate forms

/C + l/ → [ɬɬ]
/malə**k**+**l**i/ [mali**ɬ**+**ɬ**i] {WAVE+BUT} 'but a wave'

Within the context of this discussion, it is worth highlighting the specific example of the affix /vvik/, meaning 'time or place'. This case is of interest due to the unclear nature of its underlying form; it is sometimes represented as /vik/, triggering regressive assimilation and geminating in consonant-final stems only, or as /vvik/ where the voiceless allophone of the geminate fricative appears invariably (Fortescue, 1984, pp. 319, 346; Rischel, 1974, pp. 219-220). In a case such as the one shown in Table 9 (p. 25), the two possibilities are equally plausible, with the latter undergoing a mandatory simplification of its three-consonant cluster but having the same outcome.[9]

Table 9. Possible underlying forms of the word *siniffik*

(a) /sini**k**+**v**ik/	(b) /sini**k**+**vv**ik/
[sini**f**+**f**ik] {SLEEP+PLACE} 'bed'	[sini+**ff**ik] {SLEEP+PLACE} 'bed'

Additionally, the coexistence of certain common forms with both endings is well attested, specifically with vowel-final stems where regressive assimilation would not be expected to take place. This is illustrated in Table 10 (p. 25).

Table 10. Divergent surface forms of /niʁi+(v)vik/

(a) /niʁi+vik/	(b) /niʁi+vvik/
[nɐχχi**vik**] {EAT+PLACE} 'table'	[nɐʁi**ffik**] {EAT+PLACE} 'eating place, restaurant'

It is a general pattern that, when such forms coexist, the forms ending in [vik] are more specific or idiomatic in meaning, while the forms ending in [ffik] can be more transparently analyzed as a combination of the consitutent parts of the stem (Rischel, 1974, p. 220). In this vein, Fortescue suggests that /vik/ is "fossilized" and that only /vvik/ can be used productively (Fortescue, 1984, p. 346). This appears to be true in a sense, but I would argue that the only form of the affix that exists underlyingly is /vvik/ and that any form ending in [vik] occurs as a result of reanalyzation, or in other words, where the entire stem is now perceived as a standalone root. This explanation is able to account for the semantic shift as well as the seeming

[9] Consonant clusters of the type $C_1+C_2C_2$ categorically become C_2C_2 (Rischel, 1974, p. 217).

contradiction of the geminate following a vowel-final stem. Furthermore, this example seems to be evidence against a regressive assimilation process of the type /C + v/ → [ff]. While [ff] is in fact the surface realization of /vv/, this does not hold for phonological processes that cross morpheme boundaries, where the transformation shown in Table 7(c) (p. 24) instead occurs (Fortescue et al., 2010, p. 440).

3.3.2. Stem-internal gemination

The gemination occurring in the syllable preceding the reanalyzed affix material in Table 10 (p. 25), that is [nɐ**χχ**ivik] rather than *[nɐ**ʁ**ivik],[10] is a preservation of quantity characteristic of a second process producing non-underlying geminate consonants which may be referred to as "stem-internal gemination." Stem-internal gemination is considerably less regular than regressive assimilation and seems to be gradually becoming fossilized (Rischel, 1974, pp. 298-300; Sadock, 2003, p. 12). However, some generalizations can still be made regarding its occurrence in the modern language.[11] Stem-internal gemination occurs when certain *inflectional* affixes are added to certain noun stems ending in the sequence /…V**C**Vq/ or /…V**C**Vk/,[12] resulting in /…V**CC**V/ followed by the material added by the affix (Sadock, 2003, p. 15).[13] Consider the example in Table 11 (p. 27), where the consonant /m/ is simply doubled in this environment.

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[10] The fact that the geminated consonant devoices but does not alternate with a stop is revisited in §3.3.3; in this case, /niʁi+vvik/ is reanalyzed as a standalone root /niʁʁivik/ with an underlying geminate /ʁʁ/.

[11] Rischel concedes that it is difficult to determine the usefulness of an experiment he conducted using nonsense words to gauge the regularity of stem-internal gemination in West Greenlandic due to the complex interactions of phonology and morphology in the language. Noting that his informant occasionally produced geminated consonants in this exercise, he leaves the question open (Rischel, 1974, p. 300).

[12] Nouns ending in /k/ that exhibit gemination are uncommon and Rischel posits that their occurrence is lexically determined (Rischel, 1974, p. 282). I argue in §3.4.2 that a distinction between underlying stem-final /k/ and /ɣ/ causes this difference in behavior.

[13] It is important to note that this process is not restricted to roots, but may also affect noun stems containing affixes.

Table 11. Stem-internal gemination in inflected forms of /imaq/

(a) /i**m**aq/	(b) /i**m**aq+t/	(c) /i**m**aq+mut/
[i**m**aq] {SEA-ABS.SG.} 'sea'	[i**mm**a+t] {SEA+ABS.PL.} 'seas'	[i**mm**a+mut] {SEA+ALL.SG.} 'to the sea'

However, due to surface restrictions on geminate consonants, non-nasal geminates must be voiceless. In Tables 12-14 (p. 27), note that the voicing and manner of articulation of the consonants in question differ in their geminate forms.

Table 12. Stem-internal /ɣɣ/ → [kk] in inflected forms of /iiɣaq/

/ɣɣ/ → [kk]		
(a) /ii**ɣ**aq/	(b) /ii**ɣ**aq+t/	(c) /ii**ɣ**aq+mut/
[ii**ɣ**ɑq] {WALL-ABS.SG.} 'wall'	[ii**kk**a+t] {WALL+ABS.PL.} 'walls'	[ii**kk**a+mut] {WALL+ALL.SG.} 'to the wall'

Table 13. Stem-internal /ʁʁ/ → [qq] in inflected forms of /miiʁaq/

/ʁʁ/ → [qq]		
(a) /mii**ʁ**aq/	(b) /mii**ʁ**aq+t/	(c) /mii**ʁ**aq+mut/
[mɐɐ**ʁ**ɑq] {CHILD-ABS.SG.} 'child'	[mɐɐ**qq**a-t] {CHILD+ABS.PL.} 'children'	[mɐɐ**qq**a-mut] {CHILD+ALL.SG.} 'to the child'

Table 14. Stem-internal /ll/ → [ɬɬ] in inflected forms of /malək/

/ll/ → [ɬɬ]		
(a) /ma**l**ək/	(b) /ma**l**ək+t/	(c) /ma**l**ək+mut/
[ma**l**ik] {WAVE-ABS.SG.} 'wave'	[ma**ɬɬ**i+t] {WAVE+ABS.PL.} 'waves'	[ma**ɬɬ**i+mut] {WAVE+ALL.SG.} 'to the wave'

Also of note are the palatal consonants whose geminate forms surface as [tt^s]. In the case of /c/, which never surfaces in the modern language, the realization of the singleton is [s]. The modern [s] corresponds to a palatal consonant in both the proto-language and also in the related Yupik languages (Fortescue et al., 2010, pp. xvi-xvii). [14] These alternations are illustrated in Tables 15 and 16 (p. 28).

Table 15. Stem-internal /cc/ → [tt^s] in inflected forms of /nacaq/

/cc/ → [tt^s]		
(a) /na**c**aq/	(b) /na**c**aq+t/	(c) /na**c**aq+mut/
[na**s**aq] {CAP-ABS.SG.} ‘cap’	[na**tt^s**a+t] {CAP+ABS.PL.} ‘caps’	[na**tt^s**a+mut] {CAP+ALL.SG.} ‘to the cap’

Table 16. Stem-internal /jj/ → [tt^s] in inflected forms of /pujuq/

/jj/ → [tt^s]		
(a) /pu**j**uq/	(b) /pu**j**uq+t/	(c) /pu**j**uq+mut/
[pu**j**oq] {SMOKE-ABS.SG.} ‘smoke’	[pu**tt^s**u+t] {SMOKE+ABS.PL.} ‘clouds’	[pu**tt^s**u+mut] {SMOKE+ALL.SG.} ‘to the smoke’

Stem-internal gemination is a process which can be at least partially explained as compensatory, where one consonant is lengthened in response to the deletion of another, i.e. the stem-final coda (Mase & Rischel, 1971, pp. 194-195; Rischel, 1974, p. 299).[15] Consider the contrast between Tables 17 and 18 (p. 29).

[14] Compare West Greenlandic *nasaq* ‘cap’ with Alutiiq Alaskan Yupik *nacaq* ‘hairnet, cap’ and Central Alaskan Yupik *nacaq* ‘hat, hood’ (Fortescue et al., 2010, p. 224).
[15] A general discussion of compensatory lengthening follows in §4.2.

Table 17. Stem-internal gemination in inflected forms of /qiŋaq/

(a) /qi**ŋ**aq/	(b) /qi**ŋ**aq+t/	(c) /qi**ŋ**aq+p/
[qi**ŋ**ɑq] {NOSE-ABS.SG.} 'nose'	[qi**ŋŋ**a+t] {NOSE+ABS.PL.} 'noses'	[qi**ŋŋ**a+p] {NOSE+REL.SG.} 'nose'

Table 18. Lack of stem-internal gemination in inflected forms of /nuna/

(a) /nu**n**a/	(b) /nu**n**a+t/	(c) /nu**n**a+p/
[nu**n**a] {LAND-ABS.SG.} 'land'	[nu**n**a+t] {LAND+ABS.PL.} 'lands'	[nu**n**a+p] {LAND+REL.SG.} 'land'

The loss of the final /q/ from the stem following affixation in Table 17 (p. 29) triggers the gemination of the nearest consonant (Mase & Rischel, 1971, p. 194). Since there is no loss of material to the stem in Table 18 (p. 29), no gemination occurs in the affixed forms. In cases where the other criteria for gemination are met but the nearest consonant is separated from the site of deletion by more than one vowel mora, gemination does not occur (Rischel, 1974, pp. 299-300). In Table 19 (p. 29), gemination takes place because the nearest consonant to the deleted material is separated by only one vowel mora (-t**a**q → -ttat, -ttap). Gemination is not possible in Table 20 (p. 30), where two vowel moras separate the nearest consonant from the deleted /q/ (-t**aa**q → -taat, -taap).

Table 19. Stem-internal gemination in inflected forms of /quliʁutaq/

(a) /quliʁu**t**aq/	(b) /quliʁu**t**aq+t/	(c) /quliʁu**t**aq+p/
[qulɐʁu**t**ɑq] {EDGE-ABS.SG.} 'edge (of boot)'	[qulɐʁu**tt**a+t] {EDGE+ABS.PL.} 'edges (of boot)'	[qulɐʁu**tt**a+p] {EDGE+REL.SG.} 'edge (of boot)'

Table 20. Lack of stem-internal gemination in inflected forms of /nutaaq/

(a) /nu**t**aaq/	(b) /nu**t**aaq+t/	(c) /nu**t**aaq+p/
[nu**t**ɑɑq] {NEW-THING-ABS.SG.} 'new thing'	[nu**t**aa+t] {NEW-THING+ABS.PL.} 'new things'	[nu**t**aa+p] {NEW-THING+REL.SG.} 'new thing'

The exact circumstances under which this process takes place (as mentioned at the beginning of this subsection, only in noun stems of a certain shape) are examined in closer detail in §3.4.2.

3.3.3. Underlying geminate consonants

It is worth mentioning briefly that underlying geminate consonants take a different form than derived geminates. Non-nasal underlying geminates, while still required to surface without voicing, are not held to any restrictions regarding manner of articulation. This is shown in Table 21 (p. 30), where underlying geminate fricatives surface as geminate fricatives (Bergsland, 1955, p. 12; Rischel, 1974, pp. 246-247).

Table 21. Consonant alternations in underlying geminates

(a) **/vv/ → [ff]**	(b) **/ɣɣ/ → [xx]**	(c) **/ll/ → [ɬɬ]**	(d) **/ʁʁ/ → [χχ]**	(e) **/cc/ → [ttˢ]**
/ti**vv**asiq/ [ti**ff**asɐq] 'drum dance'	/ki**ɣɣ**aq/ [ki**xx**ɑq] 'mountain pass'	/i**ll**u/ [i**ɬɬ**u] 'house'	/ta**ʁʁ**aq/ [tɑ**χχ**ɑq] 'shadow'	/illu+**cc**iaq/ [iɬɬu**ttˢ**iɑq] 'fair-sized house'

3.4. Stem and affix shape

3.4.1. Affix-conditioned stem shape

A stem-final consonant is invariably affected by affixation in one of two ways: regressive assimilation, as described in §3.3.1, or deletion. While some generalizations can be made, for example that all vowel-initial affixes trigger deletion, the reason for this choice is not always apparent on the surface and must sometimes be lexically specified (Rischel, 1974, pp. 198-200; Sadock, 2003, pp. 12-13). To illustrate this point, it is useful to compare a list of affixes that trigger deletion, presented in Table 22 (p. 32), with a list of affixes that trigger assimilation, presented in Table 23 (p. 33). The affixes in these lists are split into four categories corresponding to their role and the type of stems that may host them. These categories are *nominal* and *verbal modifier*, comprising affixes that respectively attach to nouns and verbs to modify them; *nominalizer*, comprising affixes that attach to verbs to transform them into nouns; and *verbalizer*, comprising affixes that attach to nouns to transform them into verbs. These lists are by no means exhaustive, but they are designed to capture the assertion that affix shape and morphosyntactic role do not have a convincing bearing on the behavior the affixes display.[16]

[16] These lists are sourced from Fortescue (1980, 1984), Sadock (2003), Fortescue et al. (2010), and Oqaasileriffik (2018a). Many of the examples were produced with the aid of Word Analyser (Oqaaserpassualeriffik, 2018b).

Table 22. Partial list of affixes that trigger final-consonant deletion

Affix	Gloss	Category	Example	
(a) /kuluuq/	‘big’	Nominal modifier	/nanu**q**+**k**uluuq/ {BEAR+BIG}	[nanu+**k**ulooq] ‘big bear’
(b) /liaq/	‘traveler to’	Nominal modifier	/nuu**ɣ**+**l**iaq/ {NUUK+TRAVELER}	[nuu+**l**iɑq] ‘traveler to Nuuk’
(c) /liaʁ/	‘go to’	Verbalizer	/nuu**ɣ**+**l**iaʁ+vuq/ {NUUK+GO-TO+IND.3SG.}	[nuu+**l**iɑʶp+poq] ‘s/he goes to Nuuk’
(d) /liʁsaaʁutə/	‘account of’	Nominal modifier	/iluaʁtu**q**+**l**iʁsaaʁutə/ {HOLY-THING+ACCOUNT}	[iluɑʶttu+**l**ɐʶssɑɑʁut] ‘legend’
(e) /liviɣ/	‘container’	Nominal modifier	/immu**ɣ**+**l**iviɣ/ {MILK+CONTAINER}	[immu+**l**ivik] ‘milk jug’
(f) /llamaɣ/	‘one experienced at’	Nominalizer	/mirsu**q**+**ll**amaɣ/ {SEW+ONE-EXPERIENCED}	[mɐʶssu+**ɬɬ**amak] ‘one experienced at sewing’
(g) /miniq/	‘piece of’	Nominal modifier	/ivvia**q**+**m**iniq/ {BREAD+PIECE}	[iffia+**m**inɐq] ‘piece of bread’
(h) /niɣ/	‘become, have arrived’	Verbalizer	/aataa**q**+**n**iɣ+vuq/ {HARP-SEAL+HAS-ARRIVED+IND.3SG.}	[aataa+**n**ip+poq] ‘the harp seals have arrived’
(i) /piluɣ/	‘bad’	Nominal modifier	/inu**ɣ**+**p**iluɣ/ {PERSON+BAD}	[inu+**p**iluk] ‘bad person’
(j) /siuʁ/	‘look for’	Verbalizer	/nanu**q**+**s**iuʁ+voq/ {BEAR+LOOK-FOR+IND.3SG.}	[nanu+**s**ioʶp+poq] ‘s/he looks for a bear’
(k) /tit/	‘make, force’	Verbal modifier	/naala**ɣ**+**t**it+vaa/ {OBEY+MAKE+IND.3SG.}	[naala+**t**ip+paa] ‘s/he made him/her obey’
(l) /tuqaq/	‘old’	Nominal modifier	/qimmi**q**+**t**uqaq/ {DOG+OLD}	[qimmi+**t**oqɑq] ‘old dog’

Table 23. Partial list of affixes that trigger final-consonant assimilation

Affix		Gloss	Category	Example	
(a)	/kumatu/	'always want to'	Verbal modifier	/ika**t**+**k**umatu+vuq/ {PLAY+ALWAYS-WANT-TO+IND.3SG.}	[ika**k**+**k**umatu+voq] 's/he is playful'
(b)	/liuq/	'make, produce'	Verbalizer	/immu**ɣ**+**l**iuq+vuq/ {MILK+MAKE+IND.3SG.}	[immu**ɬ**+**ɬ**ioʶp+poq] 's/he makes milk'
(c)	/miit/	'be on/in'	Verbalizer	/umiaccia**q**+**m**iit+vuq/ {BOAT+BE-ON+IND.3SG.}	[umiattˢiɑʶ**m**+**m**iip+poq] 's/he is on a boat'
(d)	/miuq/	'inhabitant of'	Nominal modifier	/nuu**ɣ**+**m**iuq/ {NUUK+INHABITANT}	[nuu**m**+**m**ioq] 'inhabitant of Nuuk'
(e)	/niaq/	'one who tries to'	Nominalizer	/atua**ʁ**+**n**iaq/ {READ+ONE-WHO-TRIES}	[atuɑʶ**n**+**n**iɑq] 'one who tries to read'
(g)	/niaʁ/	'hunt'	Verbalizer	/iqalu**ɣ**+**n**iaʁ+vuq/ {FISH+HUNT+IND.3SG.}	[ɐqalu**n**+**n**iɑʶp+poq] 's/he hunts fish'
(f)	/niʁu/	'more'	Verbal modifier	/aqi**t**+**n**iʁu+vuq/ {BE-SOFT+MORE+IND.3SG.}	[ɑqi**n**+**n**ɐʁu+voq] 'it is softer'
(h)	/piaq/	'real'	Nominal modifier	/nuu**ɣ**+**p**iaq/ {NUUK+REAL}	[nuu**p**+**p**iɑq] 'the real Nuuk'
(i)	/siaq/	'bought, found'	Nominal modifier	/kuki**ɣ**+**s**iaq/ {CLAW+BOUGHT}	[kuki**s**+**s**iɑq] 'bought claw'
(j)	/sunni/	'smell of'	Nominal modifier	/inu**ɣ**+**s**unni/ {HUMAN+SMELL}	[inu**s**+**s**unni] 'human odor'
(k)	/taq/	'(thing) pertaining to'	Nominal modifier	/nuu**ɣ**+**t**aq/ {NUUK+PERTAINING}	[nuu**t**+**t**ɑq] 'pertaining to Nuuk'
(l)	/tuuma/	'like to eat/use'	Verbalizer	/inu**ɣ**+**t**uuma+vuq/ {HUMAN+LIKES-TO-EAT+IND.3SG.}	[inu**t**+**t**uuma+voq] 's/he is a cannibal'

I propose a phonological explanation for the choice between assimilation and deletion of a stem-final consonant in §5.2.2, and I set this topic aside for now in the interest of a more theory-neutral presentation of facts.

3.4.2. Survey of noun root shape

To analyze the mechanisms at play with regard to the interaction between noun stems and affixes, it is helpful to discuss the permissible the endings of noun *roots*, from which all noun stems are necessarily built. On the surface, uninflected noun roots may end in a vowel, [t], [k], or [q], but the picture seems to be more complex when affixes are introduced. One divergence from the general pattern seems to appear with roots ending in [t]. While Sadock classes these as exceptional from other consonant-final nouns (Sadock, 2003, p. 12), it seems much more likely that [t]-final roots actually end in underlying /tə/. The root /aŋutə/ (surface form [aŋut]) 'father' is used as an example in Table 23 (p. 34), demonstrating that the underlying final vowel surfaces in affixed forms.[17] Additional corroboration for this underlying form is seen in other dialects, for example the Eastern Canadian Inuktitut [aŋuti] (Fortescue et al., 2010, p. 38).

Table 24. Behavior of /ə/-final root in /aŋutə/

(a) /aŋutə/	(b) /aŋutə+p/	(c) /aŋutə+mut/
[aŋut] {FATHER-ABS.SG.} 'man, father'	[aŋuti+p] {FATHER+REL.SG.} 'father'	[aŋuti+mut] {FATHER+ALL.SG.} 'to the father'

[17] As shown in Table 24 (p. 29), this vowel exhibits distinct behavior from an ordinary vowel, most evidently where it surfaces as zero word-finally in (a). A complete description of the behavior of /ə/, however, is beyond the scope of this discussion, and the interested reader is directed to Underhill (1976) and Compton and Dresher (2011) for more information. For my purposes here, it is sufficient to group /ə/-final stems with other vowel-final stems, distinct from consonant-final stems.

Many nouns ending in [k] and [q] – called "strong" roots in the literature (Fortescue, 1984, p. 206; Sadock, 2003, pp. 16-17) – require vowel-initial allomorphs of the absolutive plural and relative singular affixes.[18] I suggest that in this subset of nouns ending in [k] and [q], the final consonants are in fact underlyingly fricatives, or /ɣ/ and /ʁ/ respectively. This is supported by the fact that these consonants alternate with fricatives in the absolutive plural and relative singular forms. These fricatives simply surface as stops because word-final fricatives are not allowed. This is illustrated in Tables 25 and 26 (p. 35).[19]

Table 25. Behavior of /ɣ/-final root in /kukiɣ/

(a) /kukiɣ/	(b) /kukiɣ+it/	(c) /kukiɣ+up/
[kukik] {CLAW-ABS.SG.} 'claw'	[kuki+it] {CLAW+ABS.PL.} 'claws'	[kuki+up] {CLAW+REL.SG.} 'claw'

Table 26. Behavior of /ʁ/-final root in /iʁniq/

(a) /iʁniq/	(b) /iʁniq+it/	(c) /iʁniq+up/
[ɐʶnnɐq] {SON-ABS.SG.} 'son'	[ɐʶnnɐʁ+it] {SON+ABS.PL.} 'sons'	[ɐʶnnɐʁ+up] {SON+REL.SG.} 'son'

Regarding the lack of surface fricatives in the forms of the /ɣ/-final roots, this could be a result of the intervocalic fricative deletion discussed in §3.2 that has been completely lexicalized in these common forms, such that the fricative never surfaces. This proposed process is illustrated for the form [kukiit] in Figure 3 (p. 36).

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[18] That is, the absolutive plural affix attached to these forms is represented as [it] rather than the typical [t], while the relative singular affix is represented as [up] rather than [p] (Fortescue, 1984, pp. 353-354).
[19] Compare [kuki+**up**] and [ɐʶnnɐʁ+**up**] with [aŋut**i+p**] in Table 24 (p. 34).

Figure 3. Schematization of intervocalic velar fricative deletion in /kukiɣ+it/ → [kukiit]

/kukiɣit/	→	|kukiØit|	→	[kukiit]
Underlying form		*Fricative deletion*		*Surface form*

Regarding the remainder of nouns ending in [k] and [q], the so-called "weak" roots, it would seem that they simply end in an underlying /k/ and /q/ as expected. It is precisely this type of stem that is targeted by stem-internal gemination, as shown in Tables 26 and 27 (p. 36).

Table 27. Behavior of /k/-final root in /malək/

(a) /malək/	(b) /malək+t/	(c) /malək+p/
[malik] {WAVE-ABS.SG.} 'wave'	[małłi+t] {WAVE+ABS.PL.} 'waves'	[małłi+p] {WAVE+REL.SG.} 'wave'

Table 28. Behavior of /q/-final root in /nanuq/

(a) /nanuq/	(b) /nanuq+t/	(c) /nanuq+p/
[nanoq] {BEAR-ABS.SG.} 'bear'	[nannu+t] {BEAR+ABS.PL.} 'bears'	[nannu+p] {BEAR+REL.SG.} 'bear'

Finally, a subset of the roots ending in [k] deserves a brief mention, namely those ending in [ak]. At first glance, the insertion of an additional [a] before the affix material as shown in Table 29 (p. 36) may appear to be a distinct pattern.

Table 29. Behavior of roots ending in [ak]

(a) /ipaɣ/	(b) /ipaɣ+it/	(c) /ipaɣ+up/
[ipak] {GRAIN-ABS.SG.} 'grain'	[ipa+at] {GRAIN+ABS.PL.} 'grains'	[ipa+ap] {GRAIN+REL.SG.} 'grain'

In fact, the pattern in Table 29 (p. 36) is consistent with the automatic prevention of the surface realization of non-word-final diphthongs, in this case /a͡i/ and /a͡u/ respectively. This is achieved by assimilating V_1 to V_2 in such a V_1V_2 sequence, yielding V_2V_2, a repair that occurs categorically in West Greenlandic (Rischel, 1974, p. 237). A representation of the process leading to [ipaat] is shown in Figure 4 (p. 37): the vowel-initial allophone of the plural affix is chosen to follow a fricative, the velar fricative lenites to zero intervocalically, and the diphthong is simplified to a long vowel.

Figure 4. Schematization of intervocalic velar fricative deletion followed by long vowel neutralization in /ipaɣit/ → [ipaat]

/ipaɣit/	→	|ipaØit|	→	[ipaat]
Underlying form		*Fricative deletion*		*Long vowel neutralization*

To summarize, I have described four distinct consonant endings for noun roots: /ɣ/, /ʁ/, /k/, and /q/. They appear in Table 30 (p. 37).

Table 30. Illustration of consonant noun root endings with examples

Ending	**Stem**	+ ABS.PL.	+ REL.SG.	+ ALL.SG.
-ɣ/	/kukiɣ/ [kukik] 'claw'	/kukiɣ+it/ [kuki+it] 'claws'	/kukiɣ+up/ [kuki+up] 'claw'	/kukiɣ+mut/ [kukim+mut] 'to the claw'
-ʁ/	/iʁniʁ/ [ɐʶnnɐq] 'son'	/iʁniʁ+it/ [ɐʶnnɐʁ+it] 'sons'	/iʁniʁ+up/ [ɐʶnnɐʁ+up] 'son'	/iʁniʁ+mut/ [ɐʶnnɐʶm+mut] 'to the son'
-k/	/malək/ [malik] 'wave'	/malək+t/ [maɬɬi+t] 'waves'	/malək+p/ [maɬɬi+t] 'wave'	/malək+mut/ [malim+mut] 'to the wave'
-q/	/nanuq/ [nanoq] 'bear'	/nanuq+t/ [nannu+t] 'bears'	/nanuq+p/ [nannu+p] 'bear'	/nanuq+mut/ [nannu+mut] 'to the bear'

Note. Adapted from Sadock (2003, p. 17).

The contrast between /malək/ and /nanuq/, especially with regard to the allative singular affix /mut/, gives important insight into the state of stem-internal gemination in the modern language. As Rischel points out (1974, p. 282), there are very few /k/-final stems (i.e. stems ending in surface [k] that undergo stem-internal gemination), and taking /malək/ as an example, they are in the process of being reanalyzed as /ɣ/-final stems. To elaborate further, the absolutive plural form [maɬɬit] behaves like a /k/-final stem, while the allative singular form [malimmut] behaves like a /ɣ/-final stem. Further confirmation of this tendency is provided by the acceptability of the alternate form [maliit] of the absolutive plural (as though derived from /maləɣ+it/), compared with the impossibility of *[maɬɬimut] in the allative singular (as though derived from /malək+mut/) (Oqaaserpassualeriffik, 2018b); clearly this evolution is only moving in one direction.

With stem-internal gemination restricted to /q/-final stems, it seems doubtful that stem-internal gemination is a productive synchronic process, especially as native speakers do not reliably incorporate the phenomenon into unfamiliar words (Rischel, 1974, p. 300). Furthermore, the idea of /q/-final stems undergoing compensatory lengthening simply to replace a deleted mora is questionable; since no other stems undergo this process, it is clear that not all stem-final consonants have the same properties. For this reason, stem-internal gemination seems to be a spurious basis for proposing moraic codas for West Greenlandic as a whole.

3.4.3. Survey of verb root shape

As stem-internal gemination is restricted to certain classes of nouns to the exclusion of verbs (Fortescue, 1984, pp. 345-346), there is relatively little to say about the shape of verb roots as compared to noun roots. The most notable feature of verb roots is that, when ending in a consonant, the identity of the final consonant is indeterminate. This is because verb roots cannot stand alone without an inflectional affix, necessarily causing assimilation of the root-final consonant (Fortescue, 1980, p. 261). The root-final consonant in this case can only be identified as uvular or non-uvular, depending on whether the preceding vowel is retracted and uvularized (Bjørnum, 2012, p. 35). To illustrate this, various consonant-final verb roots are combined with the inflectional affix /vuq/ ‘IND.3SG.’ in Table 31 (p. 39).

Table 31. Assimilation of final consonants in verb roots

(a) /allaɣ+vuq/	(b) /sinik+vuq/	(c) /atuaʁ+vuq/
[aɬɬa**p+p**oq] {WRITE+IND.3SG.} ‘s/he writes’	[sini**p+p**oq] {SLEEP+IND.3SG.} ‘s/he sleeps’	[atuɑʶ**p+p**oq] {READ+IND.3SG.} ‘s/he reads’

Note. Partially adapted from Bjørnum (2012, p. 35).

As several verb roots have homophonous nominal counterparts, however, the final consonant of a verb root can be at least informally inferred by the form of the bare noun (Sadock, 2003, p. 5).[20]

3.4.4. Replacive affixation

A brief final note should be made about what Rischel calls “replacive affixation” (Rischel, 1974, p. 192). In essence, this is simply affix-conditioned allomorphy where the stems take on more idiosyncratic and unpredictable forms. These forms usually exist interchangeably with more “regular” forms, as shown in Tables 32 and 33 (p. 40). The forms created by more conventional word-building appear first, and the “replacive” forms second.

[20] An example frequently appearing in this text is *sinik* ‘sleep (v.)/(n.)’. The form *sinik* is widely used to represent the verb root, but notably, the dictionary of Oqaasileriffik instead lists *sinip*, apparently by analogy with *sinippoq* ‘s/he sleeps’ (Oqaasileriffik, 2018a).

Table 32. “Replacive” affixation affecting the stem /ipu/

(a) /ipu/	(b) /ipu+liʁ+paa/
[ipu] {SHAFT-ABS.SG.} ‘shaft’	[ipu+lɐʶp+paa] ~ **[ippɐʶppaa]** {SHAFT+PROVIDE-WITH+POSS.4SG.} ‘provides it with his (own) shaft’

Table 33. “Replacive” affixation affecting the stem /nuka/

(a) /nuka/	(b) /nuka+ni/
[nuka] {YOUNGER-SIBLING-ABS.SG.} ‘younger sibling’	[nuka+ni] ~ **[nukki]** {YOUNGER-SIBLING+POSS.4SG.} ‘his/her own younger sibling’

This pattern is not synchronically productive, occurring with relatively few (albeit fairly common) stems and affixes, where the forms have clearly been lexicalized (Rischel, 1974, p. 197). This being the case, the “replacive” forms do not factor into my analysis in this work.

3.5. Conclusion

In this chapter, deletion of stem-final consonants in the presence of an affix has been established as their “default” behavior. The secondary process that is possible is regressive assimilation, where stem-final consonant (C_1) meets an affix-initial consonant (C_2) to form a geminate of the type C_2C_2, where C_2 may alternate with a different form to adhere to restrictions on geminate consonants. Though the occurrence of this process (instead of simple deletion of C_1) is not predictable by the appearance of surface forms, a phonological explanation forms a major component of the analysis of consonant gemination processes and morpheme boundaries in Chapter 5.

Additionally, stem-internal gemination has been introduced as a partly compensatory process that occurs as a result of affix material changing the configuration of a stem. The loss of a consonant at the end of a stem is followed by the gemination of a consonant maximally one vowel mora to the left of the site of deletion. This process, as opposed to regressive assimilation, is not categorical, and its status as a productive phenomenon is controversial as this feature of the language undergoes fossilization.

The following chapter presents the theoretical underpinnings of this thesis as well as a discussion of previous analyses of gemination processes in various languages to provide the necessary background for the analysis in Chapter 5.

4. Theoretical background

This chapter aims to give an overview of the theoretical approaches to phonology that inform the analysis presented in Chapter 5. I begin with a basic overview of Optimality Theory and Harmonic Serialism in §4.1. A discussion of syllable structure and moraic theory follows in §4.2. Geminate consonants are discussed in §4.3 and compensatory lengthening in §4.4; these two sections also describe approaches to accounting for these phenomena in different variants of Optimality Theory.

4.1. Optimality Theory and Harmonic Serialism

This section begins with a basic overview of classic Optimality Theory in §4.1.1. This is followed in §4.1.2 by a description of Harmonic Serialism, a variant of Optimality Theory which serves as the theoretical framework for the analysis in Chapter 5.

4.1.1. Optimality Theory

Optimality Theory (OT) (Prince & Smolensky, 1993/2004) is a program within generative grammar stemming from the principle that all allowable surface forms in a given language are produced by the interaction (and conflict) of hierarchically ranked, violable constraints (Kager, 1999, p. xi). This ranking is language-specific but the constraints themselves are, at least ideally, universal.[21] Significantly, the parallel evaluation of constraints replaces the serial application of rewrite rules. The consequence of this is that there are no intermediate representations in OT (Kager, 1999, p. 20). Additionally, this means that OT is a comparison-based approach and does not contain any transformational mechanism (McCarthy, 2002, p. 3).

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[21] Certain types of constraints, such as alignment constraints (see §5.3.1), allow for non-universal limitations, such as the domain in which they apply. These language-specific permutations are tolerated provided that they adhere to a universal constraint *format* (Kager, 1999, p. 119; McCarthy, 2008a, p. 15).

Two functions form the main machinery of OT. The generator, or GEN by convention, is responsible for producing the output candidates by generating "[all] logically possible analyses" of a given input (Kager, 1999, p. 19). As this suggests, any hypothetical input assessed by GEN yields an infinite number of output candidates (McCarthy, 2008a, pp. 17-18). The evaluator, or EVAL, compares these output candidates against the universal constraint set (CON) and is responsible for selecting the optimal output, the candidate incurring the least "severe" violations (Kager, 1999, pp. 3, 19; McCarthy, 2002, p. 3). Candidates that are eliminated by EVAL regardless of the ranking of constraints are typically disregarded altogether in presentation, vastly reducing the field of potential outputs to those which are immediately relevant (McCarthy, 2002, p. 35; 2008a, p. 81). Rankings in OT are conventionally represented in tableaux such as Table 34 (p. 43).

Table 34. Example tableau in Optimality Theory

/…/	CONSTRAINT$_1$	CONSTRAINT$_2$
a. Candidate A	*!	
b. ☞ Candidate B		*

Note. Adapted from Kager (1999, p. 13).

The first cell in a tableau indicates the input. The relevant output candidates appear in the leftmost column, and the constraints are displayed across the top row with the highest-ranked constraint on the left. Every constraint violation is indicated by an asterisk. When a violation serves to exclude a candidate (referred to as a "fatal violation"), the asterisk is followed by an exclamation point (Prince & Smolensky, 1993/2004, p. 24). In Table 34 (p. 43), Candidate A fatally violates CONSTRAINT$_1$, leaving Candidate B as the optimal candidate, indicated by the symbol "☞".

There are two classes of constraints in OT that are fundamentally opposed to one another. Faithfulness constraints militate for the least possible variation between two levels of representation, typically the input and the output, while well-formedness (or markedness; the terms are used interchangeably in this text) constraints represent restrictions on licit output forms based on universal language tendencies (Kager, 1999, pp. 2-5). This means that an optimal output may need to sacrifice faithfulness to comply with the phonotactic constraints of the language, or it may have less harmonic (i.e. more marked) characteristics in the interest of preserving faithfulness. On this note, it should be emphasized that the optimal candidate is by no means a "perfect" candidate – one that violates no constraints – and it is in fact impossible for such a candidate to exist (Kager, 1999, p. 16; Prince & Smolensky, 1993/2004, p. 4).

There can be no language-specific restrictions on inputs in OT, a principle codified as Richness of the Base (Prince & Smolensky, 1993/2004, p. 205). All surface forms must be explainable in terms of constraint interaction at the output level, as no evaluation takes place at the input level (Kager, 1999, p. 19; McCarthy, 2002, p. 70). This serves to eliminate the redundancy in traditional rule-based phonology between phonological operations and restrictions on input structure – known as the Duplication Problem – by simply admitting no such restrictions and relegating all repairs of illicit structures to the output (Kager, 1999, p. 20; McCarthy, 2002, pp. 71-72).

With regard to rankings, the ranking of two constraints is considered *crucial* when it affects the results of the evaluation (McCarthy, 2008a, p. 43). On the other hand, non-crucially ranked constraints may be rearranged with no effect on the outcome; these are separated by a dotted line rather than a solid line in a tableau (Prince & Smolensky, 1993/2004, p. 33). For example, the ranking of CONSTRAINT$_1$ and CONSTRAINT$_2$ in Table 35 (p. 45) is non-crucial.

Table 35. OT tableau demonstrating non-crucial constraint ranking

/…/	CONSTRAINT$_1$	CONSTRAINT$_2$	CONSTRAINT$_3$
a. Candidate A	*	*	*!
b. ☞ Candidate B	*	*	

Note, in Table 35 (p. 45), that since all candidates under review violate both CONSTRAINT$_1$ and CONSTRAINT$_2$, the ranking of these constraints is irrelevant. This would also be true if none of the candidates were to violate either constraint. On the other hand, since CONSTRAINT$_3$ distinguishes Candidate A from Candidate B, this ranking must be crucial. In text, this hierarchy is represented as CONSTRAINT$_1$, CONSTRAINT$_2$ >> CONSTRAINT$_3$, where a comma indicates a non-crucial ranking and double angle brackets indicate a crucial ranking.

Domination between crucially ranked constraints is strict; between two candidates, the candidate with the most violations of the highest-ranked constraint is necessarily excluded, even if the opposing candidate violates a greater number of lower-ranked constraints (Kager, 1999, pp. 22-23). By the same token, multiple violations of a lower-ranked constraint are considered less severe than a single violation of a higher-ranked constraint. These concepts are illustrated in Table 36 (p. 45).

Table 36. OT tableau demonstrating strict domination

/…/	CONSTRAINT$_1$	CONSTRAINT$_2$	CONSTRAINT$_3$	CONSTRAINT$_4$
a. Candidate A		*	*!	
b. ☞ Candidate B		*		***
c. Candidate C	*!			

Note. Adapted from Kager (1999, pp. 22-23).

Although Candidate C in Table 36 (p. 45) violates fewer constraints than the other candidates, it cannot recover from the violation of the highest-ranked constraint that no other candidate violates. Likewise, Candidate B's three violations of $\textsc{Constraint}_4$ are still less severe than Candidate A's single violation of $\textsc{Constraint}_3$, and therefore Candidate B is optimal.

4.1.2. Harmonic Serialism

Harmonic Serialism (HS) is a variant of OT that uses derivations in conjunction with constraint interaction to handle opaque phonological processes. In contrast to OT as formalized in §4.1.1, the candidate set proposed by GEN is not infinite in HS, but rather based on the principle of language-specific "gradual harmonic improvement" (McCarthy, 2007, pp. 60-61). Additionally, GEN and EVAL operate recursively in HS rather than just once: following the initial evaluation, the winning output candidate becomes the input from which a new candidate set is generated and evaluated and this process repeats until the input and the output are identical (known as "convergence"), at which point harmonic improvement is no longer possible. The winner of this final evaluation corresponds with the surface form (McCarthy, 2010, pp. 1001-1003).

While the definition of "gradualness" may vary in different HS analyses, the prevailing sense is that each candidate provided by GEN may differ from the input by maximally one operation affecting faithfulness. This is an *operation*-based definition of gradualness, in contrast to a *faithfulness*-based definition of gradualness, where only one violation of a faithfulness constraint may be incurred per step (McCarthy, 2007, p. 61; Torres-Tamarit, 2012, p. 53). It is important to note that a single operation may engender the violation of multiple constraints; this point is further elaborated upon in the context of the analysis in §5.2.4.

This basic sketch of OT and HS is sufficient for the immediate needs of this chapter. I will now turn to representations of syllable structure, which are important to the discussions of gemination and compensatory lengthening. The application of OT to these phenomena is also considered.

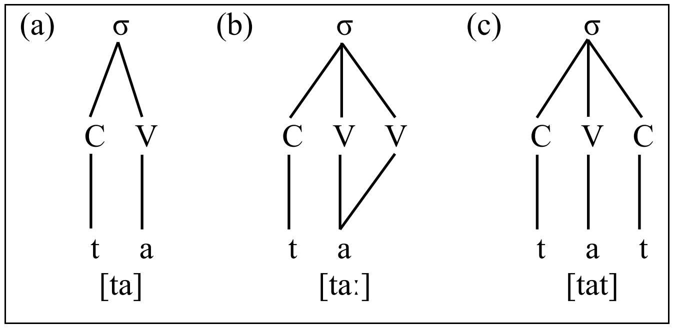
4.2. Syllable structure

The following subsections briefly describe the most widely used models for representing syllable structure: CV theory and X theory, which are segmental models, and moraic theory, a non-segmental model.

4.2.1. CV theory

CV theory considers segments to be projections of nodes on a prosodic tier whose identity – either a non-syllabic C or a syllabic V – is determined by the role played by the segment to which it is associated (McCarthy, 1979, pp. 14, 20-26). This distinction of syllabic or non-syllabic elements allows for slightly more nuance than a strict separation of consonants and vowels; for instance, /n/ linked to a C node or a V node represents the difference between non-syllabic [n] and syllabic [n̩], respectively (Levin, 1985, pp. 34-35; Topintzi, 2006a, p. 13). Syllabification is represented by the connection of prosodic sequences to syllable nodes. This is illustrated in Figure 5 (p. 48).

Figure 5. Illustration of syllables using the CV theory of prosodic structure



Note. Adapted from Hayes (1989, p. 253).

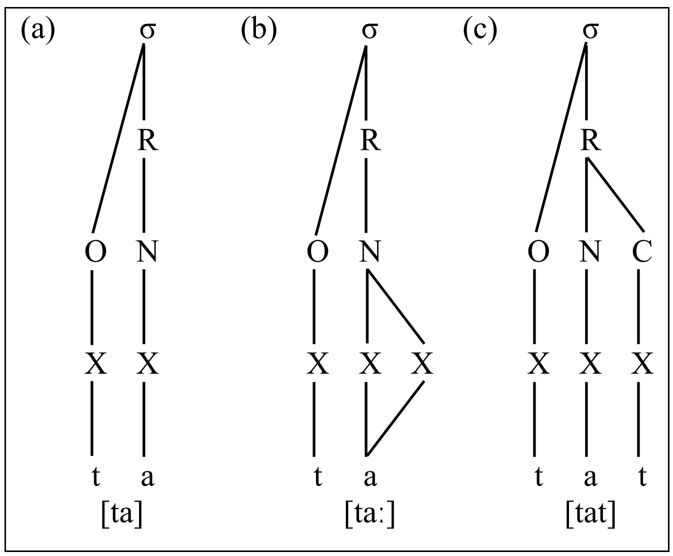
While there are more prosodic nodes than segments in an example like Figure 5(b) (p. 48), the number of segments always corresponds predictably to the number of prosodic nodes; in this case, there are two V nodes for each long vowel without exception (Hayes, 1989, p. 254).

Although CV theory permits slight deviations from a strict consonant-vowel dichotomy, it is still too specific to adequately describe certain phonological processes. For example, in Ancient Greek, the form /esmi/ surfaced as either [emmi] or [eemi], with the deletion of /s/ yielding a lengthened neighboring segment (Rialland, 1993, pp. 62-63; Topintzi, 2006a, p. 13). CV theory can unproblematically explain the variant /esmi/ → [emmi], given that /s/ and [m] can both be associated to a C node. However, stating /esmi/ → [eemi] in CV theory is not possible, because the association of [e] with an empty C position would incorrectly represent an approximant rather than the desired vowel (Hayes, 1989, p. 265; Topintzi, 2006a, p. 13).

4.2.2. X theory

X theory emerged as a means of redressing the inadequacies of CV theory.[22] It employs non-specific metrical units (Xs) on its prosodic tier that encode no information about syllabicity, or indeed, any features of the segments to which they are linked (Levin, 1985, pp. 59-62). An expanded syllable structure organizes the timing units into onsets (O), nuclei (N), and codas (C) (Hayes, 1989, p. 253). The rime node (R) is described as the only component of the syllable structure that may be assigned weight (Hyman, 1985, pp. 6-7; Topintzi, 2010, p. 7). An example of X theory is presented in Figure 6 (p. 49).

Figure 6. Illustration of syllables using X theory



Note. Reproduced from Hayes (1989, p. 253).

This framework allows the explanation of a process like /esmi/ → [eemi] without difficulty, as the syllabicity of each segment does not need to be maintained here (Rialland, 1993, p. 62). While this is an improvement over the results of CV theory, X theory is limited by

[22] As an in-depth analysis of these problems is beyond the scope of this limited discussion, I seek only to establish the main facts here. See Levin (1985) for a detailed overview of the arguments against CV theory.

the fact that it remains a segmental approach to prosodic structure. The syllable structure encoded into the representations shown in Figure 6 (p. 49) ultimately faces a similar issue to the overly specific labeling in CV theory: even if the timing unit itself places no restrictions on a segment, the segment's surface form is determined by the associated syllabic constituent (Beltzung, 2008, p. 205). The application of segmental prosodic theories to compensatory lengthening processes is particularly instructive regarding their limitations; this discussion is revisited in §4.4.2.

4.2.3. Moraic theory

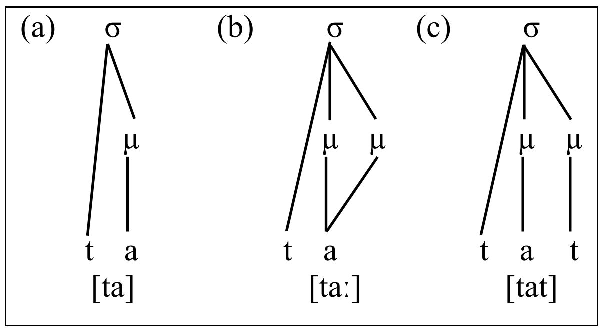
In moraic theory, the prosodic tier consists of moras (μ) linked exclusively to weight-bearing segments (Hayes, 1989; Hyman, 1985).[23] Segments that do not bear weight are attached directly to the syllable node (Hayes, 1989, p. 254). As the mora's central function is determining syllable weight, rather than counting segments, this represents a departure from the other theories described here. However, this follows naturally from the fact that no known phonological processes are based simply on segment count, while processes that involve counting prosodic units are well attested (Hayes, 1989, p. 254; McCarthy & Prince, 1996, pp. 1-2, 6-7).

The notion of syllable weight, or the distinction between "heavy" and "light" syllables in languages with phonemic segment length, is expressed straightforwardly through mora count, where heavy syllables contain two or more moras and light syllables contain one (Hayes, 1989, p. 254; Hyman, 1985, pp. 5-6). Importantly, the definition of what constitutes a bimoraic syllable

[23] I follow Hayes (1989, p. 254) among others in collapsing the Weight Unit theory in Hyman (1985) into moraic theory, as the structural differences are slight and unimportant to this discussion. Hyman even notes that a mora-based approach would reach the same conclusions as his own (1985, p. 122).

is language-specific. While (C)V syllables are universally light and (C)VV syllables are universally heavy, the point where languages diverge is the classification of (C)VC syllables (Hayes, 1989, p. 255; Hyman, 1985, p. 6). In this view, the nucleus is universally moraic, the moraic status of the coda is defined language-specifically, and the onset is typically excluded from moraic theory due to the relative rarity of its influence on syllable weight (Hyman, 1985, p. 6; Topintzi, 2006a, pp. 16-18).[24] A representation of a hypothetical language with moraic codas is shown in Figure 7 (p. 51).

Figure 7. Illustration of syllables using the moraic theory of prosodic structure

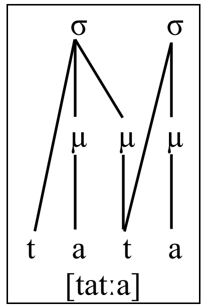


Note. Reproduced from Hayes (1989, p. 254).

Word-medial geminate consonants forming the coda of one syllable and the onset of the following syllable – the only type existing in West Greenlandic – link to both a mora and the following syllable node. This configuration is shown in Figure 8 (p. 52).

[24] There is a significant amount of evidence for moraic onsets in a small number of languages: see Topintzi (2006a) and (2010). As there is no reason to assume the existence of weightful onsets in West Greenlandic, I avoid taking a strong position on the issue here and leave these proposals aside for ease of exposition.

Figure 8. Moraic representation of a syllable containing a geminate consonant



Note. Adapted from Morén (1999, p. 7).

On a final note, specifically regarding the application of moraic theory to OT, underlying geminate consonants are the only consonants that are underlyingly moraic. Singleton consonants are assigned their moraic status (if any) at the output level, as this is where syllabification occurs (Hayes, 1989, pp. 256-257; Keer, 1999, pp. 9-10).

Given the advantages listed above, I assume a moraic analysis of prosodic structure for the remainder of this work. Now I will proceed to a discussion on geminate consonants and the processes that produce and affect them.

4.3. Geminate consonants

Geminate consonants are consonants that are phonologically longer than their singleton counterparts (Dmitrieva, 2012, p. 7; Keer, 1999, pp. 19-20; Ladefoged & Maddieson, 1996, p. 92). When comparing geminate consonants, certain types are more marked and therefore less prevalent than others. Voiceless obstruents are the most common type of geminate, and in general, geminates become less favored as they increase in sonority (Jaeger, 1978, pp. 320-321; Kawahara, 2006, p. 146). Regarding obstruents, Jaeger (1978) writes: “If a language has both voiced and voiceless obstruents, but geminates [only] part of its obstruent system, it will have long voiceless rather than long voiced obstruents” (p. 320). Kawahara (2006) extends this proposal to sonorants with the hierarchy shown in Figure 9 (p. 53), predicting that markedness (and by extension the prevalence) of a given type of geminate correlates with increasing sonority.

Figure 9. Geminate types by markedness, correlating with sonority

Obstruents >>	Nasals >> Laterals >> Glides
	Sonorants
← *Decreasing markedness* ← *Decreasing sonority*	*Increasing markedness* → *Increasing sonority* →

Note. Adapted from Kawahara (2006, p. 160).

It is claimed that this hierarchy is universal, and furthermore that any language with sonorant geminates must also necessarily have obstruent geminates (Kawahara, 2006, pp. 147-148; Taylor, 1985, p. 122). Notably, Kawahara does not assign *voiced* obstruents a place in the hierarchy, simply reaffirming that they are always more marked than voiceless obstruents but also noting that they may be more marked than some sonorants (Kawahara, 2006, pp. 152, 154). I do not take a strong position on whether this hierarchy is truly universal, but I accept it as reflecting general typological tendencies along with the claim that some sonorants are more marked than others.

In any language, geminates may behave in one of two ways: as a single segment, or as two adjacent identical segments (Keer, 1999, p. 19).[25] This configuration is language-specific and categorical; no language has a contrast between the two types (Keer, 1999, p. 20). The claim

[25] Keer (1999) refers to single-segment geminates as “single melody” geminates. The two terms are equivalent for my purposes.

for representing geminates as a single segment is supported by a fundamental difference in the way phonological processes in these languages handle geminate consonants as opposed to sequences of independent consonants. The most important universal principle is termed "geminate integrity." According to this principle, no language using epenthesis to break up consonant clusters allows this process to split a tautomorphemic geminate into two parts (Keer, 1999, pp. 19-20, 23-24; Schein & Steriade, 1986, p. 691).

Note that the above definition affords geminates spanning two morphemes a special status; in languages representing geminates as pairs of segments, geminates may behave differently across a morpheme boundary. This can be seen in examples from Palestinian Arabic, where vowel epenthesis is used to break up specific types of consonant clusters; the process is blocked from applying to a morpheme-internal geminate, shown in Table 37(a) (p. 54), but it is obligatory in the case of the heteromorphemic sequence /t+t/ in Table 37(b) (p. 54) (Keer, 1999, pp. 23-24; McCarthy, 1986, p. 258).

Table 37. Epenthesis restricted to heteromorphemic geminates in Palestinian Arabic

(a) /ʔimm/	(b) /fut+t/
[ʔimm] *[ʔimi**m**] 'mother'	[fut**i**t] *[futt] 'I entered'

When subjected to a given phonological process, geminate consonants may behave differently to singleton consonants in the same environment. Using Keer's terminology, there are three ways that a geminate may be affected in this situation: inalterability, where the process fails to affect the geminate at all; fission, where the geminate is broken into two segments and only the first segment undergoes the process; and full alterability, where the process affects both geminates and singletons in exactly the same way (Keer, 1999, pp. 3-4, 56). This is schematized using a hypothetical nasalization process in Table 38 (p. 55), where the existence of a process /ãba/ → [ãma] is a prerequisite for all languages in question.

Table 38. Geminate behavior in different hypothetical grammars where /ãba/ → [ãma]

(a) Inalterability	(b) Fission	(c) Full alterability
/ãbba/ → [ãbba]	/ãbba/ → [ãmba]	/ãbba/ → [ãmma]

The existence of geminate fission is problematic for one of the central claims of traditional accounts of geminate inalterability, namely that "geminate structures cannot allow one half of the cluster to undergo a rule that the other half does not undergo" (Schein & Steriade, 1986, p. 691). However, Keer notes that geminate fission is always driven by onset faithfulness[26] and has limited distribution cross-linguistically (Keer, 1999, pp. 4, 20).

Regarding the status of West Greenlandic geminates, there are no synchronic epenthetic processes to break up geminate consonants and heterorganic consonant clusters are forbidden on the surface regardless of their position relative to a morpheme boundary (Fortescue, 1984, pp. 337, 353). For these reasons, it is safe to conclude that West Greenlandic geminates behave as single segments rather than two adjacent but distinct segments. This discussion is revisited in §5.2.4 for the purposes of the analysis.

4.3.1. Geminate consonants in Optimality Theory

From an Optimality Theoretic viewpoint, gemination can be used as a strategy to avoid some constraint violation. One important constraint that may bring about gemination in certain languages is the Coda Condition (henceforth CODA-COND), a well-formedness constraint stating

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[26] In other words, in a case of geminate fission, /C_1C_1/ always becomes [C_2C_1] and never *[C_1C_2], where C_1 represents the original consonant forming the geminate and C_2 represents any other consonant.

that a coda consonant cannot specify its own place of articulation (Itô, 1989, p. 224; Prince & Smolensky, 1993/2004, pp. 121-122). This is formalized in Figure 10 (p. 56).

Figure 10. Definition of the constraint CODA-COND

CODA-COND
*Place]$_{\sigma}$

Note. Reproduced from Kager (1999, p. 131).

This constraint, in practice, often prohibits consonant clusters by favoring assimilation of a coda with the following onset. CODA-COND, a well-formedness constraint, is in conflict with ID[place], a faithfulness constraint which demands that every place of assimilation specified in the input be reflected in the output candidate, defined in Figure 11 (p. 56).

Figure 11. Definition of the constraint ID[place]

ID[place]
Correspondents in input and output have identical place features.

Note. Reproduced from Kager (1999, p. 132).

For a language that uses assimilation to avoid heterorganic consonant clusters, such as West Greenlandic, CODA-COND dominates ID[place] in the constraint ranking. This is shown in Table 39 (p. 56), where the word /qimmiq/ 'dog' is combined with the first-person plural possessive marker /put/, yielding the correct output [(qim)(mɐʶp)(put)] 'our dog'.[27, 28]

Table 39. OT tableau of /qimmiq+put/

/qimmiq+put/	CODA-COND	ID[place]
a. (qim)(mɐʶq)(put)	*!	
b. ☞ (qim)(mɐʶp)(put)		*

[27] The allophonic vowel change /i/ → [ɐ] and the uvularization of the vowel may be disregarded for the purposes of this discussion.
[28] It should be noted that determining which consonants in a given input should be parsed as codas is problematic for classic OT, as inputs are necessarily non-syllabified. This is discussed in further detail in §4.4.3.2.

As discussed in §4.3, a given phonological process may affect geminates and singletons differently. Keer proposes a generalized schema in OT to reflect these differences; he uses languages with a process AXB → AYB as an example. The dummy constraints in Figure 12 (p. 57) can be used to capture both geminate inalterability and geminate alterability.

Figure 12. Dummy constraints for modeling geminate behavior

(a) **MARKAXB**
No segment X in the context A_B.

(b) **FAITH(X, Y)**
No input segment X may correspond with any output segment Y.

(c) **MARKY**
No segment Y.

(d) **MARKYY**
No geminate segment Y.

Note. Adapted from Keer (1999, pp. 14-17).

With the constraint ranking shown in Table 40 (p. 57), geminate inalterability obtains; YY is categorically forbidden and the geminate XX resists the process that affects the singleton X. On the other hand, the result of Table 41 (p. 58) is geminate alterability; no X may appear in the context A_B and the process affects both singleton and geminate in the same way.

Table 40. OT tableau demonstrating geminate inalterability

	/AXXB/	MARKYY	MARKAXB	FAITH(X, Y)	MARKY
a. ☞	AXXB				
b.	AYYB	*!		*	*

Note. Reproduced from Keer (1999, p. 16).

Table 41. OT tableau demonstrating geminate alterability

/AXXB/	MARKAXB	FAITH(X, Y)	MARKY	MARKYY
a. AXXB	*!			
b. ☞ AYYB		*	*	*

Note. Reproduced from Keer (1999, p. 17).

Finally, regarding the typology of geminates, the hierarchy in Figure 9 (p. 53) can be straightforwardly translated into a series of constraints, presented together in Figure 13 (p. 58) in order of increasing markedness.

Figure 13. Definitions of the constraints *VOIOBSGEM, *GEMNASAL, *GEMLATERAL, and *GEMGLIDE

(a) ***VOIOBSGEM**
No voiced obstruent geminates.

(b) ***GEMNASAL (*NN)**
No geminate nasals.

(c) ***GEMLATERAL (*LL)**
No geminate laterals.

(d) ***GEMGLIDE (*GG)**
No geminate glides.

Note. Adapted from Kawahara (2006, p. 148).

4.4. Compensatory lengthening

Compensatory lengthening is a type of process where the deletion of a segment results in the lengthening of another nearby (but not necessarily adjacent) segment to preserve the input prosodic structure (Beltzung, 2008, p. 1; Hayes, 1989, p. 260). If the lengthened segment is adjacent to the site of deletion, the process is considered *local*, while it is considered *non-local* if one or more segments intervene. These processes are language-specific and are directly informed by the language's syllabification rules (Hayes, 1989, p. 264). For compensatory lengthening to occur, the deletion must be confined to the segmental tier; if the associated prosodic node is also deleted, compensatory lengthening is not expected as no “stranding” of prosodic elements occurs (Hayes, 1989, pp. 263-264). Triggers and targets for these processes may be either consonants or vowels, but there are clear cross-linguistic asymmetries and tendencies that must be considered.[29] A basic mapping of the different configurations is presented in Table 42 (p. 59).

Table 42. Cross-linguistic overview of compensatory lengthening process types

Trigger	Target	Direction	Frequency	Example[30]
C	V	Regressive	Common	bl**az**mer → [bl**a**ːmer] ‘to blame’ (Old French)
		Progressive	Limited	**ru**xa → [**u**ːxa] ‘clothes’ (Samothraki Greek)
V	V	Regressive	Common	w**i**z**i** → [v**i**ːz] ‘water’ (Hungarian)
		Progressive	Limited	k**a**s**a**pan → [k**sa**ːpan] ‘sand’ (Macuxi)
C	C	Regressive	Limited	wɛ**sf**i → [wɛ**s**ːi] ‘awl’ (Gurage)
		Progressive	Common	bɔ**rʃ**a → [bɔ**ʃ**ːa] ‘rainy season’ (Bengali)
V	C	Regressive	Very rare	ba**li**te → [ba**ł**ːte] ‘the bales’ (Bulgarian)
		Progressive	Limited	l**i**+**k**ubo → [**k**ːubo] ‘path’ (Luganda)

Note. Adapted from Gess (2011, p. 1513); Topintzi (2012, p. 8).

[29] Here, “trigger” refers to the deleted segment, while “target” refers to the segment undergoing lengthening.
[30] Examples are reproduced from Topintzi (2012, p. 8) as reported in Gess (2011) throughout the text, supplemented with glosses and more precise transcriptions from the latter text. The gloss for the Luganda example is reproduced from Clements (1986, p. 62). For all other original sources, refer to Gess (2011).

In West Greenlandic, we see only regressive compensatory lengthening with consonant triggers and consonant targets: this includes both regressive assimilation synchronically and stem-internal gemination diachronically.

This section is divided into discussions of local (§4.4.1) and non-local (§4.4.2) compensatory lengthening processes. Optimality Theoretic approaches to compensatory lengthening are then considered in §4.4.3.

4.4.1. Local compensatory lengthening

Local compensatory lengthening refers to compensatory lengthening where the trigger and the target are adjacent. Examples from Latin of a lengthening process following deletion of /s/ are given in Table 43 (p. 60).

Table 43. Local compensatory lengthening in Latin

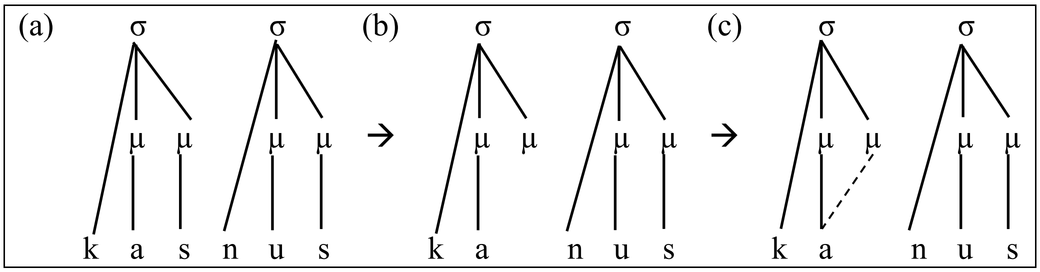
(a) *kasnus → [ka:nus]	(b) *kosmis → [ko:mis]	(c) *fideslia → [fide:lia]
'gray'	'courteous'	'pot'

Note. Adapted from Hayes (1989, p. 260); Ingria (1980, p. 474).

In standard moraic theory, when the segment /s/ is deleted, its moraic node is left unassociated. The neighboring segment on the left then links itself to the vacant mora while retaining its link to another mora, thereby lengthening. As a result, all moras are associated to segments.[31] This process is demonstrated in Figure 14 (p. 61), using the example of Table 41(a) (p. 60).

[31] As discussed in §4.2.3, note that according to Hayes (1989), onsets may not participate in this process as targets since onsets are never associated to moras. For counterarguments, see Topintzi (2006a), especially Chapter 5. Onsets as triggers are discussed in §4.4.2.

Figure 14. Schematization of segment deletion and mora reassociation in Latin **kasnus* → [kaːnus]



Note. Adapted from Hayes (1989, p. 262).

Following the deletion of the segment /s/, the previously associated mora is left stranded in Figure 14(b) (p. 61). As /a/ is able to spread to the empty mora, shown by the dotted line in Figure 14(c) (p. 61), no resyllabification is required, and the end result is [kaːnus].

4.4.2. Non-local compensatory lengthening

Non-local compensatory lengthening refers to compensatory lengthening where the target and the trigger are not adjacent, but in adjacent syllables (Gess, 2011, p. 1513). In these cases, the weight of the foot is preserved rather than the weight of the syllable, as these processes require some degree of resyllabification (Fox, 2000, pp. 100-101).

Perhaps the most widely-cited example of non-local compensatory lengthening comes from Ancient Greek: post-consonantal /w/ deleted in many dialects, resulting in the lengthening of the preceding vowel (Steriade, 1982, pp. 117-118). Two examples are given from Ionic Greek in Table 44 (p. 61).

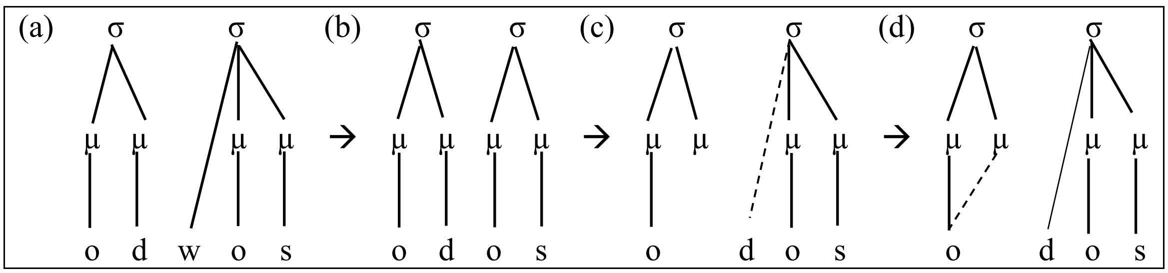
Table 44. Non-local compensatory lengthening in Ancient Greek

(a) **odwos* → [**o**:dos]	(b) **wiswos* → [**i**:sos]
‘threshold’	‘equal’

Note. Adapted from Steriade (1982, pp. 117-118).

Significantly, this process did not involve metathesis; no intermediate forms of these words featuring metathesis are attested, and words with [w] in coda position (such as [awlaks] ‘furrow’) undergo neither deletion nor lengthening (Hayes, 1989, p. 265). A representation of this process, proposed by Steriade and translated into moraic phonology by Hayes, is reproduced in Figure 15 (p. 62).

Figure 15. Schematization of segment deletion, resyllabification, and mora reassociation in Ancient Greek **odwos* → [oːdos]



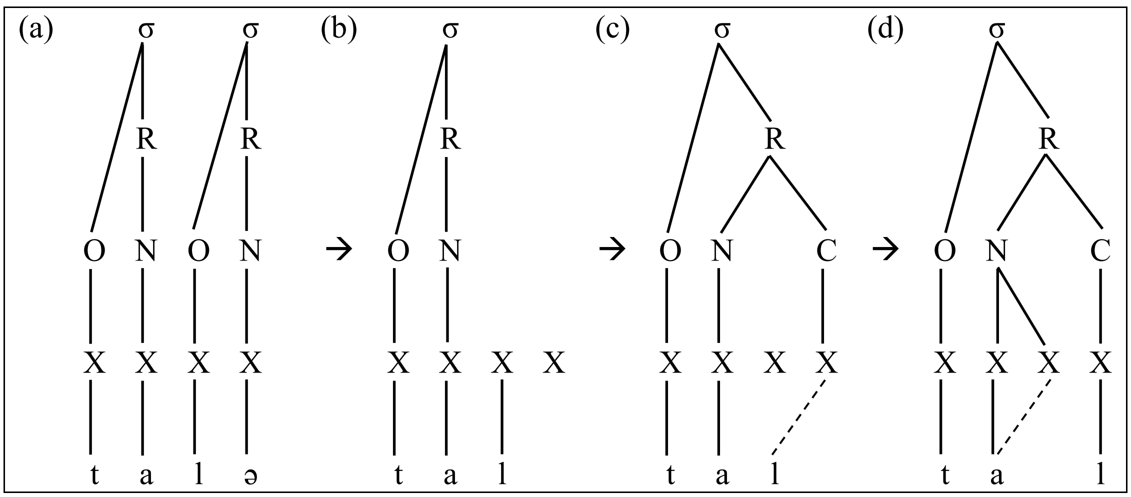
Note. Adapted from Hayes (1989, p. 266); Steriade (1982, pp. 125-126).

Hayes refers to this as a “double flop mechanism” (Hayes, 1989, p. 265).[32] Following the deletion of the /w/, two “flops” – shifts in the mappings of the segmental tier to the prosodic tier – take place in Figure 15(c-d) (p. 62), represented by dotted lines. First, to prevent the form *|od.os| in Figure 15(b) (p. 62), which maintains the number of moras but has an illicit syllable structure, /d/ is remapped to the onset of the following syllable in Figure 15(c) (p. 62). Following this resyllabification, the initial /o/ spreads to the vacated mora in Figure 15(d) (p. 62). The result is geminate /oː/, yielding the correct surface form, [oːdos].

[32] Some authors (see for example Beltzung (2008, p. 3), Kavitskaya (2001, p. 27) among others) restrict their definition of “double flop” to the exact type of process shown in Figure 15 (p. 62), with a consonant onset trigger and a vowel target. Hayes’ definition (1989, pp. 265, 267) refers more broadly to any phonological process that involves two separate remappings between the prosodic and segmental tiers. I adopt the latter definition in this work.

Finally, to conclude the discussion raised in §4.2.2, the double flop mechanism also exposes the limits of the X theory of prosodic structure and provides additional justification for moraic theory. Due to the syllabic restructuring required for double flop, X theory would need to be expanded to allow segments to disregard the syllabic roles assigned to their timing slots (Hayes, 1989, p. 268). Consider the compensatory lengthening process triggered by schwa deletion in Middle English /talə/ → [taːl] 'tale' represented with X theory in Figure 16 (p. 63).

Figure 16. Schematization of double flop in Middle English /talə/ → [taːl] using X theory



Note. Adapted from Hayes (1989, p. 267).

The crucial point here is that, in Figure 16(c) (p. 63), /l/ associates to a timing slot that was formerly designated as a nucleus, while /a/ spreads to a former onset in Figure 16(d) (p. 63). Permitting these transformations entails essentially allowing "any segment [to] lengthen to compensate for the deletion of any other," an undesirably powerful result that is typologically unjustifiable (Hayes, 1989, pp. 254, 278-279). Moraic theory, on the other hand, more closely mirrors the attested range of processes of this type.

4.4.3. Compensatory lengthening in Optimality Theory

Compensatory lengthening is an opaque process; in order for the process to take place, the trigger must be assigned the appropriate weight specification, and then the trigger must be deleted, in that specific order (Topintzi, 2012, p. 2). Without recourse to intermediate representations, this type of process presents difficulties for classic OT as described in §4.1. Additionally, given that Richness of the Base prohibits limitations on potential inputs, both moraic and non-moraic inputs must be considered. As inputs are not syllabified, any compensatory lengthening process whose trigger is a moraic coda is unable to be properly captured; any *requirement* for moras to be specified in the input is a violation of Richness of the Base (Samko, 2011, p. 7; Topintzi, 2006a, p. 187).

This section serves as a brief overview of some of the methods that have been devised to handle the opacity of compensatory lengthening in OT. While this section is limited to analyses of the phenomenon in classic OT and HS, other variants of OT have also been used to model compensatory lengthening processes, such as Optimality Theory with Candidate Chains (OT-CC) in Shaw (2007) and Stratal OT in Kiparsky (2011).

4.4.3.1. Compensatory lengthening in classic Optimality Theory

One approach within the bounds of classic OT is to question the approach to compensatory lengthening as a phenomenon exclusively based on mora preservation. Topintzi, for example, conceives of the problem as one of *position* preservation, or position correspondence, where an input segment can correspond with either a segment or a mora in the output. By removing the input mora's central role in the process, this approach avoids the violation of Richness of the Base raised in §4.4.3 (Topintzi, 2006b, p. 6). Position correspondence is expressed in OT through the constraint POSCORR, defined in Figure 17 (p. 65).

Figure 17. Definition of the constraint POSCORR

POSCORR (adapted from Topintzi, 2006a, p. 189) An input segment must have an output correspondent either segmentally or prosodically.

In order to correctly predict cases where compensatory lengthening is expected to occur as well as those where it is not, POSCORR is paired with the constraint P(OSITIONAL)-DEP-μ, a variation on the dependence constraint family ("no epenthesis") militating against adding moras which lead to lengthening (Topintzi, 2006b, p. 12). This is in contrast to DEP-μ, which simply requires that the number of moras appearing in the output does not exceed the number of moras in the input. The two constraints are compared in Figure 18 (p. 65).

Figure 18. Definitions of the constraints DEP-μ and P-DEP-μ

(a)	**DEP-μ** Every mora in the output corresponds to a mora in the input.
(b)	**P-DEP-μ** (adapted from Topintzi, 2006b, p. 12) A mora in the output which is *not* the only prosodic unit dominating a segment α has a correspondent in the input.

Crucial to the definition of P-DEP-μ is the concept that vowels and geminate consonants are underlyingly moraic, while long vowels are underlyingly bimoraic; any moras of these types that appear in the input have no specific relation to the associated segment's position within a syllable. P-DEP-μ militates against the transfer of a mora from one segment in the input to another in the output, one of the key components of compensatory lengthening.

In order to result in compensatory lengthening, these constraints must be combined with a markedness constraint which is satisfied by deletion of the trigger. In the case of a compensatory lengthening process with the shape /CVC/ → [CVː], a constraint prohibiting codas (NoCoda) is sufficient (Topintzi, 2006b, pp. 6, 9). Additionally, to prevent segments from coalescing without lengthening, Topintzi positions the constraint Uniformity, defined in Figure 19 (p. 66), high in the ranking.

Figure 19. Definition of the constraint Uniformity

Uniformity (adapted from McCarthy & Prince, 1995, p. 123)
No correspondent of the input has multiple correspondents in the output. ("No coalescence")

With the constraints introduced thus far, an input /$ka_{\mu}n_{\mu}$/ with a moraic coda in Table 45 (p. 66) and an input /$ka_{\mu}n$/ with a non-moraic coda in Table 46 (p. 67) arrive at the same result: [kaː] (adapted from Topintzi, 2006b, pp. 9, 13).[33] In candidate (b) in Tables 45 (p. 66) and 46 (p. 67), we see that adding a mora to the coda has no effect on P-Dep-μ, as this operation does not result in lengthening.[34]

Table 45. OT tableau demonstrating compensatory lengthening with PosCorr (input with moraic coda)

	/$k_1a_{2\mu}n_{3\mu}$/	Uniformity	NoCoda	PosCorr	P-Dep-μ
a.	$k_1a_{2\mu}n_3$		*!		
b.	$k_1a_{2\mu}n_{3\mu}$		*!		
c.	$k_1a_{2\mu}$			*!	
d. ☞	$k_1a_{2\mu\mu3}$				*
e.	$k_1a_{2,3\mu}$	*!			

[33] The indices in the tableaux represent an input-output correspondence; moras in the output candidates are only presented with an index when they have taken the place of a coindexed input segment.
[34] Instead, this constitutes a violation of Dep-μ, which is ranked lower than all other constraints pictured. Nevertheless, candidates with a coda are prevented by NoCoda.

Table 46. OT tableau demonstrating compensatory lengthening with POSCORR (input with non-moraic coda)

	/$k_1a_{2\mu}n_3$/	UNIFORMITY	NOCODA	POSCORR	P-DEP-μ
a.	$k_1a_{2\mu}n_3$		*!		
b.	$k_1a_{2\mu}n_{3\mu}$		*!		
c.	$k_1a_{2\mu}$			*!	
d. ☞	$k_1a_{2\mu\mu3}$				*
e.	$k_1a_{2,3\mu}$	*!			

Note once again that it is crucial to this analysis to assume that all vowels are underlyingly moraic; Tables 45 (p. 66) and 46 (p. 67) merely indicate that this constraint ranking produces compensatory lengthening of the vowel without needing to involve moras related to a segment's position within a syllable (i.e. codas that are moraic due to weight-by-position).

One criticism of this solution is that despite its orientation toward prosodic elements, it still affords considerable importance to segment count, resulting in an overgeneration of compensatory lengthening types that is not typologically justified (Kiparsky, 2011, p. 59). Furthermore, this approach cannot easily account for certain types of compensatory lengthening. For example, compensatory lengthening as a result of resyllabification in Luganda /m**un**tu/ → |(m$\mathbf{u_{\mu}n_{\mu}}$)(tu$_{\mu}$)| → [(m**u**:$_{\mu\mu}$)(**n**tu$_{\mu}$)] 'person' cannot be explained by position correspondence as no deletion takes place (Clements, 1986, p. 52; Kiparsky, 2011, pp. 34, 59). Additionally, the formulation of POSCORR allows only for segmental or prosodic correspondence, but not both; this cannot account for a process such as nasalization accompanying compensatory lengthening in Choctaw /łaba**n**ka/ → [łab**ã**:ka] 'to snore' (Beltzung, 2008, pp. 297-298; Lombardi & McCarthy, 1991, p. 40).

4.4.3.2. Compensatory lengthening in Harmonic Serialism

In the analysis of compensatory lengthening using HS in Torres-Tamarit (2012, 2016), several important statements are made about the functioning of GEN: (1) the formation of each syllable represents a "step" insofar as the gradualness requirement is concerned; (2) following McCarthy (2008b), coda deletion and assimilation are both preceded by debuccalization[35] of the affected segment; and (3) resyllabification – in the case of double flop, for example – is a stepwise process that incurs faithfulness violations (Torres-Tamarit, 2012, pp. 4-5). Regarding the first statement, given that an initial input is necessarily non-syllabified, each instance of syllabification represents harmonic improvement with regard to the constraint PARSE-SEGMENT, defined in Figure 20 (p. 68).[36]

Figure 20. Definition of the constraint PARSE-SEGMENT

PARSE-SEGMENT (PRS-SEG) (Elfner, 2009, p. 7; Torres-Tamarit, 2012, p. 62) Assign one violation mark for every segment that is not associated with a syllable.

A process of vowel lengthening following post-consonantal /j/ deletion in Ancient Greek is used to illustrate the functioning of this system as applied to non-local compensatory lengthening, specifically with the example /kr**in**+**j**ɔː/ → [kr**i**ːnɔː] 'judge-INF.IND.PRES.' (Ingria, 1980, p. 478; Torres-Tamarit, 2012, p. 209).[37] In addition to PRS-SEG, four other constraints, presented in Figure 21 (p. 69) (adapted from Torres-Tamarit, 2012, pp. 210-215), are active in the first evaluation.

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[35] *Debuccalization* is defined as the "deletion of oral place features," represented as either /h/ or /ʔ/ (McCarthy, 2008b, p. 287).
[36] The proposed syllabification process is described at length in Elfner (2009, pp. 6-7) and Torres-Tamarit (2012, pp. 54-60).
[37] These sources indicate that this change occurred in dialects outside of Lesbos and Thessaloniki.

Figure 21. Definitions of the constraints WEIGHT-BY-POSITION, $*_{\sigma}$[CG, *j, and SYLLABLE-CONTACT

(a)	**WEIGHT-BY-POSITION (WBP)** All coda consonants must be dominated by a mora.
(b)	**$*_{\sigma}$[CG** No complex onsets consisting of a consonant and a glide.
(c)	***j** No [j].
(d)	**SYLLABLE-CONTACT (SYLL-CONT)** No rising sonority profile across syllable boundaries.

PRS-SEG, WBP, and $*_{\sigma}$[CG all prohibit forms – unparsed syllables, non-moraic coda consonants, and consonant-glide onsets, respectively – that were categorically absent in surface Ancient Greek, so these constraints must be non-crucially ranked on the top tier of constraints. *j and SYLL-CONT represent lower-ranked markedness constraints, the latter of which is used to build individual syllables, collapsed here into a single step (Torres-Tamarit, 2012, p. 210). The evaluation nevertheless begins with the unparsed input /krinjɔ$_{\mu\mu}$/, as shown in Table 47 (p. 69).[38]

Table 47. Step 1 in HS derivation: /kri$_{\mu}$n+jɔ$_{\mu\mu}$/ → (kri$_{\mu}$n$_{\mu}$)(jɔ$_{\mu\mu}$)

	/kri$_{\mu}$n+jɔ$_{\mu\mu}$/	PRS-SEG	WBP	$*_{\sigma}$[CG	*j	SYLL-CONT
a. ☞	(kri$_{\mu}$n$_{\mu}$)(jɔ$_{\mu\mu}$)				*	*
b.	(kri$_{\mu}$)(njɔ$_{\mu\mu}$)			*!	*	
c.	(kri$_{\mu}$n)(jɔ$_{\mu\mu}$)		*!		*	*
d.	kri$_{\mu}$nɔ$_{\mu\mu}$	5!				
e.	kri$_{\mu}$njɔ$_{\mu\mu}$	6!			*	

Note. Adapted from Torres-Tamarit (2012, p. 211).

[38] Any number of constraint violations equal to or greater than five are depicted in numerals rather than asterisks to render presentation less cumbersome.

To counterbalance the constraint *j, the constraints in Figure 22 (p. 70) are introduced, penalizing undue consonant deletion and enforcing a particular syllable shape.

Figure 22. Definitions of the constraints MAX-C and ONSET.

(a)	**MAX-C** Every consonant in the input corresponds to a consonant in the output.
(b)	**ONSET** Syllables must have onsets.

The second evaluation in Table 48 (p. 70) sees the deletion of [j] from an otherwise faithful candidate, violating MAX-C and ONSET at a lower cost.[39] All candidates retaining [j] at the outset of the second evaluation are eliminated.

Table 48. Step 2 of HS derivation: /(kri$_{\mu}$n$_{\mu}$)(jɔ$_{\mu\mu}$)/ → (kri$_{\mu}$n$_{\mu}$)(ɔ$_{\mu\mu}$)

/(kri$_{\mu}$n$_{\mu}$)(jɔ$_{\mu\mu}$)/	*j	SYLL-CONT	MAX-C	ONSET
a. ☞ (kri$_{\mu}$n$_{\mu}$)(ɔ$_{\mu\mu}$)		*	*	*
b. (kri$_{\mu}$)(njɔ$_{\mu\mu}$)	*!	*		
c. (kri$_{\mu}$n$_{\mu}$)(njɔ$_{\mu\mu}$)	*!			

Note. Adapted from Torres-Tamarit (2012, p. 212).

The stage is now set for a double flop process, taking place as described in §4.4.2. To achieve this, a constraint prohibiting insertion of syllable-segment associations comes into play, as well as a general constraint militating against geminate segments, both defined in Figure 23 (p. 71).

[39] In the analysis presented in Torres-Tamarit (2012), it is assumed that debuccalization only occurs during the process of *coda* deletion or assimilation (p. 226). In McCarthy (2008b), on the other hand, it is stated that debuccalization of an onset segment (with the implication that it could theoretically occur) simply would never represent harmonic improvement as it would not resolve CODA-COND (p. 278).

Figure 23. Definitions of the constraints DEPLINK-σ and *GEM.

(a)	**DEPLINK-σ** (adapted from Morén, 1999, p. 40) Syllable-segment links in the output correspond to syllable-segment links in the input.
(b)	***GEM** No geminate segments.

In the winning candidate of the third evaluation, shown in Table 49 (p. 71), [n] is doubly linked to its own mora as well as the following syllable node (represented here as *...n*$_{\mu}$*)(n...)*), resulting in a geminate. This necessitates a crucial ranking between ONSET and the two constraints introduced in Figure 23 (p. 71), as it is on these grounds that the faithful onsetless candidate is eliminated. Note that this represents a step that is not considered in the analysis of double flop in Hayes (1989) as depicted in Figure 15 (p. 62).

Table 49. Step 3 of HS derivation: /(kri$_{\mu}$n$_{\mu}$)(ɔ$_{\mu\mu}$)/ → (kri$_{\mu}$n$_{\mu}$)(nɔ$_{\mu\mu}$)

	/(kri$_{\mu}$n$_{\mu}$)(ɔ$_{\mu\mu}$)/	ONSET	DEPLINK-σ	*GEM
a. ☞	(kri$_{\mu}$n$_{\mu}$)(nɔ$_{\mu\mu}$)		*	**
b.	(kri$_{\mu}$n$_{\mu}$)(ɔ$_{\mu\mu}$)	*!		*

Note. Adapted from Torres-Tamarit (2012, p. 212).

The main constraint forcing the deletion of the association line between [n] and its mora (and thereby reducing it to a singleton onset) is MAXLINK-μ, defined in Figure 24(a) (p. 72). *FLOAT(ING)-μ, presented in Figure 24(b) (p. 72), penalizes the presence of floating moras in output candidates (represented in the tableaux as $^{\mu}$).[40]

[40] Floating, unattached, or "defective" moras in OT literature serve as triggers for a specific change, usually related to what Trommer & Zimmermann term "quantity-manipulating morphology," processes of lengthening or deletion that occur due to morphological considerations (2014, p. 463). Floating moras used in OT accounts therefore act as links to the language's morphology that require some repair to prevent them from surfacing, at the expense of faithfulness (Saba Kirchner, 2007, p. 54).

Figure 24. Definitions of the constraints MAXLINK-μ and *FLOAT-μ.

(a)	**MAXLINK-μ** (Morén, 1999, p. 39) Mora-segment links in the input correspond to mora-segment links in the output.
(b)	***FLOAT-μ** No moras without links to segments.

In Table 50 (p. 72), we see that it is ultimately the geminate [n] that disqualifies the faithful candidate in the fourth evaluation. The disassociation of [n] from its moraic node and the presence of the consequent floating mora in the winning candidate are judged less severe by the constraint ranking.[41]

Table 50. Step 4 of HS derivation: /(kri$_\mu$n$_\mu$)(nɔ$_{\mu\mu}$)/ → (kri$_\mu$$^\mu$)(nɔ$_{\mu\mu}$)

	/(kri$_\mu$n$_\mu$)(nɔ$_{\mu\mu}$)/	*GEM	MAXLINK-μ	*FLOAT-μ
a. ☞	(kri$_\mu$$^\mu$)(nɔ$_{\mu\mu}$)	*	*	*
b.	(kri$_\mu$n$_\mu$)(nɔ$_{\mu\mu}$)	**!		

Note. Adapted from Torres-Tamarit (2012, p. 214).

Finally, the three constraints presented in Figure 25 (p. 72) penalize the deletion of moras, the addition of new mora-segment association lines, and the presence of long vowels.

Figure 25. Definitions of the constraints MAX-μ, DEPLINK-μ, and *LONG-V

(a)	**MAX-μ** Every mora in the input has a correspondent in the output.
(b)	**DEPLINK-μ** Mora-segment links in the output correspond to mora-segment links in the input.
(c)	***LONG-V** No long vowels.

[41] Evidence from various languages suggests that floating moras behave in much the same way as other floating autosegments and can unproblematically be represented not only in input structures, but also in output structures (see for example Saba Kirchner, 2007, pp. 41-43 on Kwak'wala; Wolf, 2006, p. 18 on various languages).

In order to force the association of the stray mora to the preceding [i] in the fifth evaluation, appearing in Table 51 (p. 73), DEPLINK-μ must be dominated by the constraints that would prefer an output candidate that either maintains a floating mora or deletes it altogether to a candidate that adds a new mora-segment association line. The constraint *LONG-V is included as a general markedness constraint, dominated by all other constraints in the present hierarchy as its violation is not considered severe.[42]

Table 51. Step 5 of HS derivation: /$(\text{kri}_{\mu\mu})(\text{nɔ}_{\mu\mu})$/ → $(\text{kri}_{\mu\mu})(\text{nɔ}_{\mu\mu})$

	/$(\text{kri}_{\mu}{}^{\mu})(\text{nɔ}_{\mu\mu})$/	*FLOAT-μ	MAX-μ	DEPLINK-μ	*LONG-V
a. ☞	$(\text{kri}_{\mu\mu})(\text{nɔ}_{\mu\mu})$			*	**
b.	$(\text{kri}_{\mu}{}^{\mu})(\text{nɔ}_{\mu\mu})$	*!			*
c.	$(\text{kri}_{\mu})(\text{nɔ}_{\mu\mu})$		*!		*

Note. Adapted from Torres-Tamarit (2012, p. 214).

One potential weakness of this approach is that compensatory lengthening processes whose triggers are laryngeal consonants are unable to be explained, especially troubling due to the cross-linguistic frequency of such processes (Samko, 2011, p. 24; Topintzi, 2012, p. 5). On the other hand, if a distinction is made between consonants specified for place and consonants which are truly placeless, this difficulty is easily resolved. McCarthy writes that "we expect to find no difference in behaviour between the output of debuccalisation and underlying /ʔ/ and /h/ in languages where /ʔ/ and /h/ are truly Placeless, whereas we do expect to find differences when /ʔ/ and /h/ have [pharyngeal] Place" (2008b, p. 289).

[42] The sixth and final evaluation, not presented here, simply yields the convergence of the input and the output, where the form [kriːnɔː] is chosen as the optimal output.

4.5. Conclusion

In this chapter, I have introduced various theoretical components that shape the remainder of this thesis. First, the necessary background to describe HS and the moraic theory of prosodic structure has been presented in §4.1 and §4.2. Additionally, theoretical descriptions of geminate consonants and gemination processes that drive the analysis have been described in §4.3 and §4.4, along with examples of how they have been represented in OT-based systems. The analysis that follows in Chapter 5 proposes a model in HS of assimilatory consonant gemination in West Greenlandic that incorporates the methods and conclusions of the works described in this chapter.

5. Analysis

This section begins with a summary of the information to be handled by the analysis in §5.1. The major components of the analysis are described and justified in §5.2, followed by a demonstration of their application presented in §5.3, concluding with the final constraint ranking in §5.3.5. A discussion of the analysis presented here and conclusion of the thesis follows in Chapter 6.

5.1. Summary

5.1.1. Categorization of words

In West Greenlandic, words may be classified into one of three categories: verbs, nouns, and "particles" (Bjørnum, 2012, p. 33). Adjective- and adverb-like functions are carried out by words of these three categories, where *particle* simply refers to any root that cannot be inflected and does not belong to the other two categories (Fortescue, 1984, p. 204). Leaving aside particles for the purposes of my analysis, the present discussion centers around a sketch of nouns and verbs in morphophonological terms.

Verbs and nouns can host inflectional and derivational affixes as well as clitics. A subset of derivational affixes ("nominalizers" and "verbalizers") allow conversion between the two categories (Sadock, 2003, pp. 3, 8). The remaining derivational affixes permit semantic change within the same category.

Verbs are distinct from nouns in that an uninflected verb stem cannot stand alone (Fortescue, 1980, p. 261). For reasons discussed in the following subsection, the exact underlying form of a final consonant in a verb root is obscured; the possibilities are reduced to either uvular or non-uvular, based on whether the preceding vowel has been uvularized (Bjørnum, 2012, p. 35).

Another key respect in which nouns and verbs differ is that noun inflection poses a special problem: a significant number of nouns undergo stem-internal gemination when inflected. In contrast, stem-internal gemination never occurs in inflected verb stems (Fortescue, 1984, p. 345; Sadock, 2003, p. 15). The matter of stem-internal gemination is raised in §6.2.

5.1.2. Stem-final consonant processes

Stem-final consonants at a stem-affix juncture are invariably affected in one of two ways: they undergo deletion ($C_1+C_2 \rightarrow \text{Ø}+C_2$) or assimilation to an affix-initial consonant ($C_1+C_2 \rightarrow C_2+C_2$).[43] The behavior of a stem-final consonant is conditioned by the following affix. Affixes are regularly referred to in the literature as either *truncating* or *additive* in reference to how they affect a preceding stem-final consonant (Fortescue, 1984, pp. 344-345; Rischel, 1974, p. 197). While this behavior is sometimes described as affix-conditioned allomorphy,[44] I propose an explanation that is purely phonological in the following sections.

5.1.3. Geminates

5.1.3.1. Derived geminates

The most basic formula to describe geminate consonant formation via assimilation is $C_1+C_2 \rightarrow C_2+C_2$, meaning that the first consonant's features are entirely replaced by those of the second consonant. While this description roughly captures the process, restrictions on geminate surface forms result in a certain number of alternations. Consonants that undergo

[43] The idiosyncratic behavior of clitics in this regard is briefly addressed in §6.2. Otherwise, clitics, which are quite few in number, are set aside in this analysis.
[44] For example, "stem selection" in Sadock (2003, p. 12).

alternations in this context are presented in Table 52 (p. 77), where **C** represents any underlying consonant (reproduced from Tables 7 and 8, p. 24).

Table 52. Consonant alternations in geminate forms

(a) **/C + ɣ/ → [kk]**	(b) **/C + ʃ/ → [tt]**	(c) **/C + v/ → [pp]**	(d) **/C + l/ → [ɬɬ]**
/uppi**t**+**ɣ**ama/	/sini**k**+**ʃ**uq/	/sini**k**+**v**uq/	/malə**k**+**l**i/
[uppi**k**+**k**ama]	[sini**t**+**t**oq]	[sini**p**+**p**oq]	[mali**ɬ**+**ɬ**i]
{fall+CAUS.1SG.}	{sleep+PART.3SG.}	{sleep+IND.3SG.}	{wave+but}
'because I fell'	'the one who sleeps'	's/he sleeps'	'but a wave'

From this picture, it is clear that voiced obstruent geminates are disfavored, as well as fricative geminates with the notable exceptions of [ɬɬ] (devoicing but remaining a continuant) and [ss] (undergoing no alternation). These are addressed in §5.3.3 and §5.3.4 respectively.

5.1.3.2. Underlying geminates

Underlying geminate consonants, in contrast to derived geminates, always retain their [continuant] feature values. Additionally, the underlying palatal geminate (which does not occur in derived form) never surfaces as such, but instead as [tt^{s}]. The restriction on voicing holds, as illustrated in the table of underlying geminate consonant alternations in Table 53 (p. 77) (reproduced from Table 21, p. 30).

Table 53. Consonant alternations in underlying geminates

(a) **/vv/ → [ff]**	(b) **/ɣɣ/ → [xx]**	(c) **/ll/ → [ɬɬ]**	(d) **/ʁʁ/ → [χχ]**	(e) **/cc/ → [tt^{s}]**
/ti**vv**asiq/	/ki**ɣɣ**aq/	/i**ll**u/	/ta**ʁʁ**aq/	/illu+**cc**iaq/
[ti**ff**asɐq]	[ki**xx**ɑq]	[i**ɬɬ**u]	[tɑ**χχ**ɑq]	[iɬɬu**tt^{s}**iɑq]
'drum dance'	'mountain pass'	'house'	'shadow'	'fair-sized house'

5.2. Key points of analysis

This section presents an overview and description of the major components of the analysis. These components are presented in the form of constraints and further elaborated upon with sample derivations in §5.3.

5.2.1. Prosody building

Following Torres-Tamarit (2012), the analysis begins with the stepwise building of prosodic words and syllables. I accept the assertion in Schiering, Bickel, and Hildebrandt (2010) that the prosodic word "has no privileged or universal status in phonology, but only emerges through frequent reference of sound patterns to a given construction type in a given language" (p. 657); furthermore, I accept that the exact definition of the prosodic word is language-specific and simply refers to a domain in which phonological processes take place. With this in mind, I propose the morpheme as the basis for the prosodic word in West Greenlandic, as deletion and assimilation always target morpheme-final segments.[45]

Syllabification crucially follows the construction of prosodic words.[46] As codas alone may be targeted for deletion or assimilation, syllables must not be built across prosodic word boundaries, following the proposal in Torres-Tamarit (2012) that initial syllabification is constrained by GEN:

[45] This decision is not without precedent; an earlier proposal establishing a correspondence between the morpheme and the prosodic word in Italian and Kíhehe is found in van Oostendorp (1999).
[46] Whether HS's gradualness requirement permits prosodic structure and syllables to be built in a single step or if they must be built over the course of several steps does not affect the outcome of the analysis and is therefore unimportant to the discussion. For ease of exposition, the building of prosodic words is collapsed here into a single step and the building of syllables is collapsed into the following step.

Gen restrained syllable formation operations (Torres-Tamarit, 2012, p. 103)

Let (x, y) stand for a pair of segments such that x immediately precedes y, and $PCat_1$ and $PCat_2$ stand for prosodic categories higher than the syllable, where $PCat_2 > PCat_1$. Syllable formation operations cannot simultaneously build or derivationally produce a binary syllable (xy) if there is a $PCat_1$ such that $PCat_1$ dominates x but not y, or y but not x, and there is no $PCat_2$ such that $PCat_2$ dominates both x and y.

Informally, this principle restricts syllable building to *within* a structure of a given prosodic category, in this case a prosodic word, unless there is a prosodic structure that dominates all of the material to be syllabified. Consider the word *siniataarpoq* 's/he sleeps intensely', composed of the three morphemes /sinik/, /ataaʁ/, and /vuq/. Note that, in the complete word, the /k/ in /sinik/ has been deleted, and therefore it is imperative that this /k/ be parsed as a coda. If we do not assume this principle as an intrinsic feature of Gen, there is no mechanism to prevent the syllabification *[(si)(ni)**(k]$_\omega$[a)**(taaʁ)]$_\omega$[(vuq)]$_\omega$, where /k/ forms the onset of a syllable with a nucleus in another prosodic word.

Instead, if syllable formation is only allowed within a prosodic grouping that is equally dominated by the same higher prosodic structure, only the syllabification [(si)(ni**k)]$_\omega$[(a**)(taaʁ)]$_\omega$[(vuq)]$_\omega$ can obtain, since the two prosodic words in question are undominated at this stage of the derivation. This syllabification correctly allows /k/ to be parsed as a coda.

Following initial syllabification, resyllabification is possible in subsequent derivations, driven by markedness constraints that determine syllable shape. Resyllabification is made possible by the stipulation that syllable-building operations are no longer restricted by prosodic word boundaries after initial syllabification has been established (Torres-Tamarit, 2012, p. 122). Regarding the formulation of the constraints responsible for building prosodic structures (to be introduced in §5.3.1), I follow Torres-Tamarit in assuming that "these prosody-morphology interface alignment constraints can state in their definition that the coincidence between edges is only required in the absence of input syllables" (2012, p. 178).

5.2.2. Floating moras

A second major feature of the analysis is the inclusion of floating moras, which I propose to be the main impetus behind consonant assimilation. Any affix triggering gemination in a stem-final consonant is considered to be fronted by an underlying floating mora responsible for attaching to and lengthening a preceding consonant. In line with Richness of the Base, the inclusion of floating moras in an underlying form is unrestricted, but the constraint ranking serves to either eliminate them in positions where consonant gemination is not possible or attach them to consonants before convergence is reached. Conversely, any affix without a leading floating mora triggers deletion of a preceding consonant. This is therefore considered to be the "default" behavior of affixes, mirroring the assertion in Sadock (2003, p. 13) that it is assimilation that must be "lexically specified" rather than deletion.

5.2.3. Debuccalization

Debuccalization, as described in McCarthy (2008b), is the mechanism responsible for deletion and assimilation of coda consonants. As shown in the derivations in §4.4.3.2, debuccalization is a two-step process, introduced with gradualness in mind, that precedes deletion of a coda with the removal of its place features. It also addresses coda-onset asymmetry in the sense that it is impossible for debuccalization of an onset to represent harmonic improvement (McCarthy, 2008b, pp. 278, 287). In the present analysis, debuccalization allows either deletion or assimilation to take place, where deletion is resisted by moraic codas (see §5.3.2).

5.2.4. Governing of geminates

In order to correctly predict geminate surface forms, markedness constraints targeting geminates (see §4.3.1) feature prominently in the proposed constraint hierarchy. Given that geminate fission – see Table 38(b) (p. 55) – is impossible in West Greenlandic but not universally, the concept of geminate integrity is encoded as a violable constraint that disfavors unequal application of a process to both halves of a geminate. Finally, I assume that geminates are treated as a single unit in terms of faithfulness violations. For example, this means that /vː/ → [fː] represents a single violation of a constraint penalizing unfaithfulness to manner of articulation (i.e. ID[voi]).[47]

For this reason as well as theoretical reasons related to prosody building (which may or may not incur faithfulness violations), I assume a model of HS using an operation-based definition of gradualness as stated in §4.1.2, where each step permits maximally one operation affecting faithfulness (McCarthy, 2010, p. 1002; Torres-Tamarit, 2012, p. 53). This is in contrast to a faithfulness-based definition of gradualness, where only one violation of a faithfulness constraint may be incurred per step (McCarthy, 2007, p. 61). Under a faithfulness-based definition of gradualness, [fː] would be an impossible output candidate for /vː/, as in addition to

[47] The representations of geminate segments as [*x*ː] and [*xx*] are to be considered equivalent in this text. The latter notation is preferred where it is relevant to emphasize that geminate segments occupy two syllable positions.

ID[voi], onset faithfulness is also violated. This problem is avoided if a phonological operation, such as devoicing, is considered a gradual step.

5.3. Derivations and constraint hierarchy

All derivations are bound by the same constraint ranking which is presented in its entirety in §5.3.5. Constraints may be omitted from tableaux for the purposes of space and clarity when they are not immediately relevant, but all constraints are active even if they do not appear in a given tableau.

5.3.1. Consonant deletion

To demonstrate consonant deletion following affixation, I model the word *nulialik* ‘husband’, composed of the root /nuliaq/ ‘wife’ and the affix /lik/ ‘provided with, owner’. To begin, the constraints defined in Figure 26 (p. 82) are undominated to ensure that morphemes are parsed into prosodic words.

Figure 26. Definitions of the constraints LX≈PR(Morpheme) and ALIGN(ω, Morpheme)

(a)	**LX≈PR(Morpheme)** (adapted from Prince & Smolensky, 1993/2004, p. 51) A member of the morphological category *morpheme* corresponds to a prosodic word.
(b)	**ALIGN(ω, Morpheme)** (adapted from Torres-Tamarit, 2012, p. 119) Both edges of every prosodic word must coincide with both edges of some morpheme in the absence of input syllables.

LX≈PR(Morpheme) in Figure 26(a) (p. 82) requires that all morphemes must be prosodic words and vice versa. The ALIGN constraint in Figure 26(b) (p. 82), a contraction of ALIGN-L(EFT) and ALIGN-R(IGHT), ensures that every edge of a prosodic word corresponds to the same edge of a morpheme; in other words, it verifies that no morphemes are only partially parsed. The wording of the latter constraint’s definition, specifically that it shall only apply “in the absence of input syllables," is crucial: once initial syllabification has been carried out, this constraint is no longer be violated if the exact boundaries of the prosodic structures shift as a result of repairs imposed by the constraint ranking (Torres-Tamarit, 2012, p. 122).

Step 1 of the derivation is presented in Table 54 (p. 83). Candidates (a), (c), and (d) violate LX≈PR(Morpheme) because at least one morpheme is left unparsed. Candidate (e) violates ALIGN(ω, Morpheme) twice because the right edge of the prosodic word does not align with the right edge of /nuliα**q**/, while the left edge of prosodic word does not align with the left edge of /**l**ik/. Candidate (b) is the winner of this evaluation because it is the only candidate where every morpheme is parsed as a separate prosodic word.

Table 54. Step 1 in HS derivation: /nuliaq+lik/ → [nuliaq]$_{\omega}$[lik]$_{\omega}$

/nuliaq+lik/	LX≈PR(Morpheme)	ALIGN(ω, Morpheme)
a. nuliaqlik	*!*	
b. ☞ [nuliaq]$_{\omega}$[lik]$_{\omega}$		
c. [nuliaq]$_{\omega}$lik	*!	
d. nuliaq[lik]$_{\omega}$	*!	
e. [nuliaqlik]$_{\omega}$		*!*

Step 2 of the derivation, syllabification, is enforced by the constraint PARSE-SEGMENT as defined in Figure 19 (p. 66). At the point in the derivation shown in Table 55 (p. 84), assuming that syllabification of the entire output string is considered a single operation that is accomplished in one step, only two candidates are provided by GEN: the faithful candidate, (a), where no syllables have been formed at all, and the unfaithful candidate, (b), where the entire string has been syllabified.

Table 55. Step 2 in HS derivation: /[nuliaq]$_ω$[lik]$_ω$/ → [(nu)(li)(aq)]$_ω$[(lik)]$_ω$

/[nuliaq]$_ω$[lik]$_ω$/	LX≈PR(Morpheme)	ALIGN(ω, Morpheme)	PRS-SEG
a. [nuliaq]$_ω$[lik]$_ω$			8!
b. ☞ [(nu)(li)(aq)]$_ω$[(lik)]$_ω$			

Following syllabification, the constraint CODA-COND,[48] introduced in Figure 10 (p. 56), is responsible for triggering (or not triggering) debuccalization. The process of debuccalization itself automatically violates two additional place constraints, defined in Figure 27 (p. 84).

Figure 27. Definitions of the constraints MAX[place] and HAVEPLACE

(a) **MAX[place]**
Let *input Place tier* = $p_1p_2p_3...p_m$ and *output Place tier* = $P_1P_2P_3...P_n$. Assign one violation mark for every p_x that has no correspondent P_y.

(b) **HAVEPLACE**
Assign one violation mark for every segment that has no place specification.

Note. Reproduced from McCarthy (2008b, pp. 277, 279).

MAX[place] is only violated when a debuccalized segment is first produced; in any subsequent evaluation, an input-output pairing of debuccalized segments satisfies this constraint as there is no place mismatch. However, HAVEPLACE remains violated as long as any debuccalized segment appears in an output candidate.

In Table 56 (p. 85), step 3 of the derivation sees the |q| of |nuliaq| debuccalized; this is a preferable outcome to preserving a coda with place features that do not correspond with those of the following onset. The debuccalized segment is represented in the output as |H|, following McCarthy (2008b, p. 277).

[48] Following Goldsmith (1990), word-final consonant place features are licensed independently and are not considered to be in violation of CODA-COND.

Table 56. Step 3 in HS derivation: /[(nu)(li)(aq)]$_\omega$[(lik)]$_\omega$/ → [(nu)(li)(aH)]$_\omega$[(lik)]$_\omega$

	/[(nu)(li)(aq)]$_\omega$[(lik)]$_\omega$/	CODA-COND	MAX[place]	HAVEPLACE
a.	[(nu)(li)(aq)]$_\omega$[(lik)]$_\omega$	*!		
b. ☞	[(nu)(li)(aH)]$_\omega$[(lik)]$_\omega$		*	*

At this point, a decision must be made about what to do with the debuccalized segment: should the result be deletion or assimilation? Two constraints are active in making this decision. The first is MAX-C, defined in Figure 21 (p. 69), which is tasked with preventing consonant deletion. The second, defined in Figure 28 (p. 85), disfavors non-moraic geminates.

Figure 28. Definition of the constraint G=M

G(EMINATE)=M(ORAIC) (Hume, Muller, & van Engelenhoven, 1997, p. 394)
A geminate is moraic.

For reasons that are elaborated upon in §5.3.4 but are not relevant to the current discussion, G=M dominates MAX[place] in the constraint ranking. MAX-C, on the other hand, must be less severe than HAVEPLACE, the violation of which is the cost of maintaining the debuccalized segment.

Table 57. Step 4 in HS derivation: /[(nu)(li)(aH)]$_\omega$[(lik)]$_\omega$/ → [(nu)(li)(a)]$_\omega$[(lik)]$_\omega$

	/[(nu)(li)(aH)]$_\omega$[(lik)]$_\omega$/	G=M	MAX[place]	HAVEPLACE	MAX-C
a.	[(nu)(li)(aH)]$_\omega$[(lik)]$_\omega$			*!	
b. ☞	[(nu)(li)(a)]$_\omega$[(lik)]$_\omega$				*
c.	[(nu)(li)(al)]$_\omega$[(lik)]$_\omega$	*!			

The three options in Table 57 (p. 85) are maintaining the debuccalized segment in candidate (a), deleting it in candidate (b), and assimilating it to the following onset in candidate (c). The debuccalized segment always loses at this stage of the evaluation to either deletion or assimilation. Here, the assimilating candidate (c) creates a non-moraic geminate which proves fatal. Deletion is therefore the best move in terms of harmonic improvement, as inserting a consonant as well as a mora would require two steps, while deleting a debuccalized segment requires only one. Following this step, the derivation converges on the output form [(nu)(li)(a)]$_{\omega}$[(lik)]$_{\omega}$.

5.3.2. Consonant assimilation

In this subsection, a derivation featuring consonant assimilation is modeled by the word *sinippoq* 's/he sleeps', composed of the morphemes /sinik/ 'sleep (v.)' and /$^{\mu}$vuq/ 'IND.3SG.'.

There are five main constraints that serve to produce or restrict consonant assimilation. Their tasks are to direct affix-initial floating moras to attach to a preceding stem-final consonant and to prevent floating moras elsewhere from exerting any influence. Two of these constraints, *FLOAT-μ and MAX-μ, have been defined already in Figures 24 and 25 (p. 72) respectively. The remaining two constraints that govern floating moras are presented in Figure 29 (p. 86).

Figure 29. Definitions of the constraints DEPLINK-μ[Seg] and *μ/ONS

(a)	**DEPLINK-μ[Seg(ment)]** (Morén, 1999, p. 39) If Seg_2 is associated with a mora, then Seg_1 is associated with a mora. ('Do not insert mora association lines.')
(b)	***μ/ONS(ET)** (Topintzi, 2006a, pp. 35-36) No moraic onsets.

Two versions of DEPLINK-μ[Seg] are included in the constraint hierarchy: DEPLINK-μ[V(owel)] and DEPLINK-μ[C(onsonant)]. As vowel lengthening is not a process that generally occurs in West Greenlandic,[49] DEPLINK-μ[V] is ranked higher than DEPLINK-μ[C]. The

[49] While some northern dialects have a vowel lengthening process exclusive to yes/no questions (Fortescue, 1984, pp. 341-342; Rischel, 1974, p. 103), I leave the processes of non-Central dialects aside for future research.

remaining constraint, *μ/ONS, is tasked with restricting what it is possible to do with a floating mora by discouraging moraic onsets.[50]

The first two steps are passed over as the prosody-building mechanisms do not differ by derivation. At step three, the issue at hand is the floating mora in the affix. Step 3 in shown in Table 58 (p. 87).

Table 58. Step 3 in HS derivation: /[(si)(nik)]$_\omega$ $^\mu$[(vuq)]$_\omega$/ → [(si)(nik$_\mu$)]$_\omega$[(vuq)]$_\omega$

	/[(si)(nik)]$_\omega$ $^\mu$[(vuq)]$_\omega$/	*FLOAT-μ	*μ/ONS	CODA-COND	MAX-μ
a.	[(si)(nik)]$_\omega$ $^\mu$[(vuq)]$_\omega$	*!		*	
b. ☞	[(si)(nik$_\mu$)]$_\omega$[(vuq)]$_\omega$			*	
c.	[(si)(nik)]$_\omega$[(vuq)]$_\omega$			*	*!
d.	[(si)(nik)]$_\omega$[(v$_\mu$uq)]$_\omega$		*!	*	

As the issue of floating moras must be handled before deletion or assimilation, *FLOAT-μ dominates CODA-COND. As forming a moraic onset is a similarly severe violation, *μ/ONS is ranked alongside *FLOAT-μ, serving to exclude candidate (d). The constraint ranking is organized to favor assigning the floating mora to the preceding coda, and the candidate (b) duly wins the evaluation.

Debuccalization, shown in Step 4 in Table 59 (p. 88), proceeds much the same way as in Table 56 (p. 85). The only difference here is that a third candidate, (c), demonstrates the outcome of simply deleting the floating mora: while a violation of MAX-μ is less costly than debuccalization, a violation of higher-ranked CODA-COND remains unresolved, and therefore candidate (c) loses to candidate (b).

[50] Whether the floating mora appears inside or outside the prosodic word and syllable boundaries is immaterial; as initial syllabification has been achieved, it is not constrained by these barriers in any case.

Table 59. Step 4 in HS derivation: /[(si)(nik$_\mu$)]$_\omega$[(vuq)]$_\omega$/ → [(si)(niH$_\mu$)]$_\omega$[(vuq)]$_\omega$

/[(si)(nik$_\mu$)]$_\omega$[(vuq)]$_\omega$/	CODA-COND	MAX[place]	HAVEPLACE	MAX-μ
a. [(si)(nik$_\mu$)]$_\omega$[(vuq)]$_\omega$	*!			
b. ☞ [(si)(niH$_\mu$)]$_\omega$[(vuq)]$_\omega$		*	*	
c. [(si)(nik)]$_\omega$[(vuq)]$_\omega$	*!			*

In Table 60 (p. 88), we see how the newly moraic segment blocks all possibilities besides assimilation to the following onset, shown in candidate (d). Note in particular the consequences of deleting the debuccalized segment in candidate (b): the result is that its mora becomes detached, violating *FLOAT-μ and clearly not representing a harmonic improvement.

Table 60. Step 5 in HS derivation: /[(si)(niH$_\mu$)]$_\omega$[(vuq)]$_\omega$/ → [(si)(niv$_\mu$)]$_\omega$[(vuq)]$_\omega$

/[(si)(niH$_\mu$)]$_\omega$[(vuq)]$_\omega$/	*FLOAT-μ	MAX[place]	HAVEPLACE	MAX-μ	MAX-C	ID[place]
a. [(si)(niH$_\mu$)]$_\omega$[(vuq)]$_\omega$			*!			
b. [(si)(ni$^\mu$)]$_\omega$[(vuq)]$_\omega$	*!				*	
c. [(si)(niH)]$_\omega$[(vuq)]$_\omega$			*!	*		
d. ☞ [(si)(niv$_\mu$)]$_\omega$[(vuq)]$_\omega$						*

As all obstruent geminates are voiceless in West Greenlandic, the next step sees |vː| devoice. As fricative geminates are disfavored in general, this also must be reflected in the constraint ranking, partially through the constraint *VOIOBSGEM, defined in Figure 13(a) (p. 58). Finally, as mentioned in §5.2.4, geminate integrity and onset faithfulness become active at this step. Three other constraints for these purposes are defined in Figure 30 (p. 89).

Figure 30. Definitions of the constraints *GEMFRIC, GEMINT, and ID[ons]

(a)	***GEMFRIC** No fricative geminates.
(b)	**GEMINT** (Schein & Steriade, 1986; Shin, 2011, p. 121) Processes apply equally to both halves of a geminate structure.
(c)	**ID[ons]** Every onset in the input corresponds to an onset with the same features in the output.

I propose that the transition from |vː| to |pː| is two separate operations: devoicing followed by fortition into a stop. The first operation (step 6 of the overall derivation) is shown in Table 61 (p. 89).

Table 61. Step 6 in HS derivation: /[(si)(niv$_\mu$)]$_\omega$[(vuq)]$_\omega$/ → [(si)(nif$_\mu$)]$_\omega$[(fuq)]$_\omega$

	/[(si)(niv$_\mu$)]$_\omega$[(vuq)]$_\omega$/	GEMINT	*VOIOBSGEM	*GEMFRIC	ID[ons]
a.	[(si)(niv$_\mu$)]$_\omega$[(vuq)]$_\omega$		*!		
b. ☞	[(si)(nif$_\mu$)]$_\omega$[(fuq)]$_\omega$			*	*
c.	[(si)(nif$_\mu$)]$_\omega$[(vuq)]$_\omega$	*!			

This step illustrates the importance of treating geminates as single units as far as phonological operations are concerned; GEMINT prevents candidate (c) from devoicing the geminate as two separate segments. Candidate (b) wins this evaluation by devoicing the entire geminate in single step.

Finally, step 7 of the derivation sees the completed transformation of |vː| into |pː|, shown in Table 62 (p. 89). The derivation then converges on the output form [(si)(nip$_\mu$)]$_\omega$[(puq)]$_\omega$.

Table 62. Step 7 in HS derivation: /[(si)(nif$_\mu$)]$_\omega$[(fuq)]$_\omega$/ → [(si)(nip$_\mu$)]$_\omega$[(puq)]$_\omega$

	/[(si)(nif$_\mu$)]$_\omega$[(fuq)]$_\omega$/	GEMINT	*GEMFRIC	ID[ons]
a.	[(si)(nif$_\mu$)]$_\omega$[(fuq)]$_\omega$		*!	
b. ☞	[(si)(nip$_\mu$)]$_\omega$[(puq)]$_\omega$			*
c.	[(si)(nip$_\mu$)]$_\omega$[(fuq)]$_\omega$	*!		

5.3.3. Maintenance of geminate /s/

The abridged derivation presented in this subsection is intended to illustrate the mechanism in place to allow [sː] across morpheme boundaries while generally excluding fricatives in this position. The word *makissimaarpoq* ‘s/he stands upright’ is used as an example. This word composed of three morphemes: /makit/ ‘get up’, /$^{\mu}$simaaʁ/ ‘continuing, intense state’, and the familiar /$^{\mu}$vuq/ ‘IND.3SG.’. As the behavior of /$^{\mu}$vuq/ has already been discussed, this demonstration focuses on the interaction between /makit/ and /$^{\mu}$simmaʁ/. Step 5, following the building of prosodic structures and adjunction of both floating moras to their respective preceding codas, is presented in Table 63 (p. 90).

Table 63. Step 5 in HS derivation: /[(ma)(kit$_{\mu}$)]$_{\omega}$[(si)(maaʁ$_{\mu}$)]$_{\omega}$[(vuq)]$_{\omega}$/ → [(ma)(kiH$_{\mu}$)]$_{\omega}$[(si)(maaʁ$_{\mu}$)]$_{\omega}$[(vuq)]$_{\omega}$

	/[(ma)(kit$_{\mu}$)]$_{\omega}$[(si)(maaʁ$_{\mu}$)]$_{\omega}$[(vuq)]$_{\omega}$/	CODA-COND	MAX[place]	HAVEPLACE
a.	[(ma)(kit$_{\mu}$)]$_{\omega}$[(si)(maaʁ$_{\mu}$)]$_{\omega}$[(vuq)]$_{\omega}$	**!		
b. ☞	[(ma)(kiH$_{\mu}$)]$_{\omega}$[(si)(maaʁ$_{\mu}$)]$_{\omega}$[(vuq)]$_{\omega}$	*	*	*

Following debuccalization of |t|, assimilation follows as expected, shown in Table 64 (p. 91). All candidates under consideration are level on CODA-COND, each still having one non-word-final coda with place features, but those candidates maintaining a debuccalized segment violate HAVEPLACE, while the candidate where the debuccalized segment assimilates to the following onset, (b), wins the evaluation.

Table 64. Step 6 in HS derivation: /[(ma)(kiH$_\mu$)]$_\omega$[(si)(maaʁ$_\mu$)]$_\omega$[(vuq)]$_\omega$/ → [(ma)(kis$_\mu$)]$_\omega$[(si)(maaʁ$_\mu$)]$_\omega$[(vuq)]$_\omega$

	/[(ma)(kiH$_\mu$)]$_\omega$[(si)(maaʁ$_\mu$)]$_\omega$[(vuq)]$_\omega$/	*FLOAT-μ	CODA-COND	MAX[place]	HAVEPLACE	MAX-μ
a.	[(ma)(kiH$_\mu$)]$_\omega$[(si)(maaʁ$_\mu$)]$_\omega$[(vuq)]$_\omega$		*		*!	
b. ☞	[(ma)(kis$_\mu$)]$_\omega$[(si)(maaʁ$_\mu$)]$_\omega$[(vuq)]$_\omega$		*			
c.	[(ma)(kiH)]$_\omega$[(si)(maaʁ$_\mu$)]$_\omega$[(vuq)]$_\omega$		*		*!	*
d.	[(ma)(ki$^\mu$)]$_\omega$[(si)(maaʁ$_\mu$)]$_\omega$[(vuq)]$_\omega$	*!	*			

Afterwards, debuccalization takes place between the other two prosodic word boundaries in steps 7 and 8 (not shown), ultimately arriving at the form [(ma)(kis$_\mu$)]$_\omega$[(si)(maav$_\mu$)]$_\omega$[vuq]$_\omega$. The most notable part of this derivation begins in step 9: the markedness of the two geminates is evaluated. Four additional constraints take part in this evaluation: two are basic identity constraints for the features [continuant] and [voice], formalized as ID[cont] and ID[voi] respectively, while the remaining two are defined in Figure 31 (p. 91).

Figure 31. Definitions of the constraints *MAX[sibilant] and *CONT]$_\omega$

(a) **MAX[sibilant]**
Every sibilant in the input has a correspondent in the output.

(b) ***CONT]$_\omega$**[51]
No continuants at the right edge of a prosodic word.

The constraint MAX[sibilant] is the driving force behind maintaining a geminate /sː/ even when it appears in a position that is otherwise illegal for a fricative to occupy; therefore, it must

[51] This constraint – using "ω" as an abbreviation for "prosodic word" – is proposed by analogy with other constraints placing restrictions on specific phonological domains. Other examples of constraints using the prosodic word as a domain can be found in McCarthy (1993, p. 176) and Itô and Mester (2009, p. 243).

dominate the constraint *CONT]$_\omega$. Step 9 in Table 65 (p. 92) crucially determines that |s:| undergoing fortition to |t:| does not represent harmonic improvement, and instead moves to devoice the |v:| appearing later in the word.

Table 65. Step 9 in HS derivation: /[(ma)(kis$_\mu$)]$_\omega$[(si)(maav$_\mu$)]$_\omega$[(vuq)]$_\omega$/ → [(ma)(kis$_\mu$)]$_\omega$[(si)(maaf$_\mu$)]$_\omega$[(fuq)]$_\omega$

	/[(ma)(kis$_\mu$)]$_\omega$[(si)(maav$_\mu$)]$_\omega$[(vuq)]$_\omega$/	MAX[sibilant]	*VOIOBSGEM	*CONT]$_\omega$	*GEMFRIC	ID[ons]	ID[cont]	ID[voi]
a.	[(ma)(kis$_\mu$)]$_\omega$[(si)(maav$_\mu$)]$_\omega$[(vuq)]$_\omega$		*!	**	**			
b. ☞	[(ma)(kis$_\mu$)]$_\omega$[(si)(maaf$_\mu$)]$_\omega$[(fuq)]$_\omega$			**	**	*	*	*
c.	[(ma)(kit$_\mu$)]$_\omega$[(ti)(maav$_\mu$)]$_\omega$[(vuq)]$_\omega$	*!	*	*	*	*	*	

In step 10 (not shown), the derivation completes the fortition of |f:| into |p:| as in Table 62 (p. 89), then converging on the output form [(ma)(kis$_\mu$)]$_\omega$[(si)(maap$_\mu$)]$_\omega$[(puq)]$_\omega$.[52]

While not directly related to this derivation, one important challenge regarding the rendering of /s/ is the existence of the phoneme /ʃ/, which also surfaces as [s] in the modern language. The trouble stems from the geminate forms: while /s:/ becomes [s:], /ʃ:/ becomes [t:]. In order to properly capture this distinction, I appeal to the only feature that separates these two segments: [distributed] (Rischel, 1974, p. 372).[53] This feature, incidentally, is also active in the distinction between the palatals /c/ and /j/, the former of which does not surface in West Greenlandic. As /s/ and /j/ have the value [-distributed] while /ʃ/ and /c/ have the value

[52] The residual issue of vowel uvularization in these representations is discussed in §6.2.
[53] The feature [distributed] is defined as follows in Chomsky and Halle (1968): "Distributed sounds are produced with a constriction that extends for a considerable distance along the direction of the air flow; nondistributed sounds are produced with a constriction that extends only for a short distance in this direction" (p. 312).

[+distributed], I propose a constraint acting against all segments with the value [+distributed], which targets both /ʃ/ and /c/ without affecting /s/ and /j/. This constraint is defined in Figure 32 (p. 93).[54]

Figure 32. Definition of the constraint *DISTRIBUTED

***DISTRIBUTED** No [+distributed] segments in the output.

This constraint is dominated by MAX[place] and HAVEPLACE while it dominates MAX[sibilant]. With this ranking established, any instance of /ʃ/ is able to undergo gemination, but to avoid violating *DISTRIBUTED, the least costly repair is to satisfy *GEMFRIC, producing the surface form [tː].

5.3.4. Affix-initial and underlying geminates

In the word *illutsiaq* 'fair-sized house', there are two morphemes: /illu/ 'house' and /cciaq/ 'fair-sized'. This derivation is included to demonstrate the capability of the analysis to handle affix-initial and underlying (i.e. not derived) geminates. To begin, we introduce a constraint which acts immediately to prevent the occurrence of complex syllable positions, defined in Figure 33.

Figure 33. Definition of the constraint *COMPLEX

***COMPLEX** (Prince & Smolensky, 1993/2004, p. 108) No more than one C or V may associate to any syllable position node.

[54] A similar constraint, ID[-dist], appears in Elzinga (1999, p. 157).

Beginning with a fully parsed [(il)(lu)]$_{\omega}$[(cci)(aq)]$_{\omega}$ in step 3, resyllabification of the complex onset in |(cci)(aq)| into the preceding syllable's coda position is free to occur, as initial syllabification has already been established. This is shown in Table 66 (p. 94).

Table 66. Step 3 in HS derivation: /[(il)(lu)]$_{\omega}$[(cci)(aq)]$_{\omega}$/ → [(il)(luc)]$_{\omega}$[(ci)(aq)]$_{\omega}$

	/[(il)(lu)]$_{\omega}$[(cci)(aq)]$_{\omega}$/	*COMPLEX	G=M	GEMINT	DEP-μ	MAX-C	DEPLINK-μ[C]	ID[ons]
a.	[(il)(lu)]$_{\omega}$[(cci)(aq)]$_{\omega}$	*!	**					
b. ☞	[(il)(luc)]$_{\omega}$[(ci)(aq)]$_{\omega}$		**					*
c.	[(il$_{\mu}$)(lu)]$_{\omega}$[(cci)(aq)]$_{\omega}$	*!	*		*		*	
d.	[(il)(lu)]$_{\omega}$[(ci)(aq)]$_{\omega}$		*	*		*!		*

Candidate (c) demonstrates that the complex onset of the syllable |(cci)| must be addressed before the moraicity of either geminate consonant due to the high ranking of the constraint *COMPLEX. Meanwhile, candidate (d) serves to illustrate that simplifying this complex onset by deleting one of the segments is not a repair that is tolerated. While tying with the winning candidate (b) on G=M and GEMINT, candidate (d) incurs a fatal violation of MAX-C.

From here, the constraint DEP-μ, defined in Figure 18(a) (p. 65), must become active to regulate the insertion of moras. G=M ensures that moras are attached to the geminates at the cost of violating DEP-μ and DEPLINK-μ[C]. G=M and GEMINT must dominate MAX[place] to ensure that debuccalization is not used as a strategy to avoid violation of G=M. Meanwhile, it must be ensured that inserting a mora is a less costly repair. This is illustrated in Table 67 (p. 95).

Table 67. Step 4 in HS derivation: /[(il)(luc)]$_\omega$[(ci)(aq)]$_\omega$/ → [(il$_\mu$)(luc)]$_\omega$[(ci)(aq)]$_\omega$

	/[(il)(luc)]$_\omega$[(ci)(aq)]$_\omega$/	G=M	GEMINT	MAX[place]	DEP-μ	DEPLINK-μ[C]
a.	[(il)(luc)]$_\omega$[(ci)(aq)]$_\omega$	**!				
b. ☞	[(il$_\mu$)(luc)]$_\omega$[(ci)(aq)]$_\omega$	*			*	*
c.	[(iH)(luc)]$_\omega$[(ci)(aq)]$_\omega$	*	*!	*		

As the process does not differ significantly in step 5, where |cː| becomes moraic, this step is not shown here.

A feature of this particular derivation is that it involves two geminates whose surface forms differ from their underlying forms, as discussed in §5.1.3. For these alternations, two additional constraints, defined in Figure 34 (p. 95), come into effect.

Figure 34. Definitions of the constraints *LL (revised) and MAX[lateral]

(a) ***LL** (revised from Figure 13(c), p. 58)
No *sonorant* geminate laterals.

(b) **MAX[lateral]**
Correspondent segments are identical in the feature [lateral].

In terms of ranking, these two constraints along with *DISTRIBUTED must be dominated by MAX[place] and HAVEPLACE in order for derived geminates to first be able to surface and to subsequently undergo alternation. MAX[lateral] is ranked alongside MAX[sibilant], and in turn, both dominate *CONT]$_\omega$, since these are the two continuant geminates that surface regardless of whether they occur at a prosodic word boundary; ensuring that they retain their lateral and sibilant features blocks any potential fortition. In Table 68 (p. 96), |lː| resists alternation with |tː| in candidate (c) by requiring faithfulness to its lateral feature; candidate (b) wins the evaluation by substituting a non-sonorant lateral at the expense of a violation of ID[place] (defined in Figure 11, p. 56).

Table 68. Step 6 in HS derivation: /[(il$_{\mu}$)(luc$_{\mu}$)]$_{\omega}$[(ci)(aq)]$_{\omega}$/ → [(ił$_{\mu}$)(łuc$_{\mu}$)]$_{\omega}$[(ci)(aq)]$_{\omega}$

	/[(il$_{\mu}$)(luc$_{\mu}$)]$_{\omega}$[(ci)(aq)]$_{\omega}$/	*DISTRIBUTED	*LL	MAX[lateral]	*μ/ONS	*GEMFRIC	ID[voi]	ID[place]
a.	[(il$_{\mu}$)(luc$_{\mu}$)]$_{\omega}$[(ci)(aq)]$_{\omega}$	*	*!		*			
b. ☞	[(ił$_{\mu}$)(łuc$_{\mu}$)]$_{\omega}$[(ci)(aq)]$_{\omega}$	*			*	*	*	*
c.	[(it$_{\mu}$)(tuc$_{\mu}$)]$_{\omega}$[(ci)(aq)]$_{\omega}$	*		*!	*		*	*

Step 7 proceeds in a similar fashion, where |cː| alternates with the less-marked alveolar stop to satisfy the constraint *DISTRIBUTED, violating ID[place] in the process. This is shown in Table 69 (p. 96). This is the final step before convergence, which produces [(ił$_{\mu}$)(łut$_{\mu}$)]$_{\omega}$[(ti)(aq)]$_{\omega}$ as the final output form.

Table 69. Step 7 in HS derivation: /[(ił$_{\mu}$)(łuc$_{\mu}$)]$_{\omega}$[(ci)(aq)]$_{\omega}$/ → [(ił$_{\mu}$)(łut$_{\mu}$)]$_{\omega}$[(ti)(aq)]$_{\omega}$

	/[(ił$_{\mu}$)(łuc$_{\mu}$)]$_{\omega}$[(ci)(aq)]$_{\omega}$/	*DISTRIBUTED	*LL	*GEMFRIC	ID[ons]	ID[place]
a.	[(ił$_{\mu}$)(łuc$_{\mu}$)]$_{\omega}$[(ci)(aq)]$_{\omega}$	*!		*		
b. ☞	[(ił$_{\mu}$)(łut$_{\mu}$)]$_{\omega}$[(ti)(aq)]$_{\omega}$			*	*	*

5.3.5. Final constraint hierarchy

The final constraint hierarchy that I propose for this analysis is presented in Figure 35 (p. 97), separated by crucial ranking.

Figure 35. Final constraint hierarchy

(1)	LX≈PR(Morpheme), ALIGN(ω, Morpheme) >>
(2)	PARSE-SEGMENT >>
(3)	*FLOAT-μ, DEPLINK-μ[V], *μ/ONS >>
(4)	*COMPLEX >>
(5)	CODA-COND >>
(6)	G=M, GEMINT >>
(7)	MAX[place], HAVEPLACE >>
(8)	*DISTRIBUTED, *LL >>
(9)	MAX[sibilant], MAX[lateral] >>
(10)	MAX-μ >>
(11)	*VOIOBSGEM, *CONT]$_{\omega}$ >>
(12)	DEP-μ >>
(13)	MAX-C >>
(14)	DEPLINK-μ[C] >>
(15)	*GEMFRIC >>
(16)	ID[ons], ID[cont], ID[voi], ID[place]

6. Discussion and conclusion

The analysis presented in Chapter 5 models assimilatory gemination and consonant behavior at morpheme boundaries in West Greenlandic as a stepwise process involving a host of different operations. This chapter is separated into a discussion of the analysis in §6.1, a discussion of residual issues in §6.2, and concluding remarks in §6.3.

6.1. Discussion

The main advantage of using Harmonic Serialism over classic OT for this analysis is the ability to gradually build prosodic structures over the course of several steps. Given that syllabification cannot be guaranteed in classic OT inputs, this already represents a great advantage, as fully syllabified inputs are perfectly natural in intermediate stages of derivation using HS. Being able to single out segments for phonological operations based on syllable position, one of the core components of this analysis, runs up against serious theoretical challenges in classic OT.

Furthermore, it is impossible in a parallel framework to capture the fact that the two components of prosody building in this analysis must be enacted in a specific order to make the correct predictions about where assimilation or deletion operations should occur. Being able to establish prosodic domains which restrict where phonological processes can take place is a critical precondition for syllabification. Since in this case, the processes we are interested in controlling occur at morpheme boundaries, morphemes are the natural choice to be the basis for these prosodic domains. By forcing initial syllabification to take place within morphemes, morpheme-final consonants are always treated as codas and are therefore be accessible to the deletion and assimilation processes, even if their position in the larger input string would cause them to syllabify as onsets without this restriction.

The two-step process of debuccalization responsible for deletion and assimilation, while partially a concession to HS's requirement of gradual harmonic improvement, also sets important limitations on what options are available for eliminating consonant clusters. By using CODA-COND violations as a trigger and only accepting the deletion or reduction of a coda as a repair that brings about harmonic improvement, it accurately reflects the cross-linguistic coda-onset asymmetry whereby the deletion of an onset is never an option for reducing a consonant cluster, something which is borne out in West Greenlandic. Debuccalization therefore prevents overgeneration in this respect.

Floating moras are proposed as a phonological means for affixes to force the assimilation process on their hosts. This is achieved by attaching the floating mora to a stem-final consonant. As moraic segments cannot be deleted without leaving an unattached mora behind, this essentially blocks the stem-final consonant from deletion, as only assimilation with the following onset represents harmonic improvement. The largely arbitrary distribution of affixes that favor assimilation or deletion as a repair strategy for consonant cluster reduction makes the inclusion of floating moras a practical solution for differentiating the two groups.

The issue of how geminates are represented and processed also bears elaboration. With the incorporation of the principle of geminate integrity into this analysis as a high-ranking constraint, GEMINT, geminates are protected from undue separation by geminate fission, as in the case of /vː/ → *[fv], or by simplification, as in /vː/ → *[v]. Additionally, as geminate consonants are compelled to be moraic by another high-ranking constraint, G=M, they are further protected from deletion.

Certain steps needed to be taken to meet the HS requirement of gradualness in regard to processes affecting geminates. First of all, an operation-based definition of gradualness, whereby an *operation* constitutes a gradual change rather than a single constraint violation, is assumed. This allows geminates to undergo changes that involve multiple faithfulness constraint violations, provided these all constitute a single operation; for example, /vː/ → [fː] is considered a single operation, although it violates both ID[voi] and ID[ons]. Furthermore, geminates are considered to be single units, permitting a change undergone by both halves of the geminate to only register as a single faithfulness violation.

Through the interpretation of devoicing and fortition as separate steps, it is possible to capture the fact that geminate surface forms vary depending on their position within a morpheme (see §5.2.4). This allows morpheme-internal fricatives to devoice but to be blocked from proceeding to fortition, thus maintaining their [continuant] feature values. Additionally, while fricatives are generally disallowed across morpheme boundaries, [sː] and [ɬː] are permitted through the activation of constraints specifically geared toward their feature specifications (see §5.3.3 and §5.3.4, respectively).

Finally, the creation of the constraint *DISTRIBUTED in particular allows for important underlying distinctions to be masked on the surface. As no segments with the feature value [+distributed] surface in the modern language, this constraint is able to target both /c/ and /ʃ/ for neutralization into an unmarked alveolar stop. This allows for a clear phonological explanation of the divergence between /sː/ and /ʃː/ with their distinct surface alternation patterns while establishing a division between /c/ and /j/ which a constraint such as *PALATAL would overlook.

This analysis demonstrates the formal relationship between the operations that are responsible for driving these processes. In addition, it allows for the explanation of certain phenomena, such as the distribution of assimilation and deletion processes and the distinction between underlying sibilants undergoing gemination, in phonological terms where previously these had been cast as exceptional or purely lexically determined.

6.2. Residual issues

I am aware of certain omissions from the analysis that are worth discussing, and these will be taken up in this section. Firstly, the analysis does not differentiate between allophonic vowels in the environment of surface or underlying uvular consonants. Given that lowered vowels in this environment are cross-linguistically well attested, it would be plausible to propose a constraint to derive them (Ladefoged & Maddieson, 1996, p. 36). However, since the vowels are not all affected in a single manner that can be succinctly expressed, it may not be possible to define a single constraint to capture their exact values (see §3.1.1) without resorting to rather *ad hoc* descriptions.

On a related note, the analysis does not render secondary articulation in either uvularized vowels ($V^ʁ$) or the segment [tt^s]. As assimilation counterbleeds vowel uvularization, this proves quite difficult to formalize without considerably complicating the discussion for the purposes of exact phonetic accuracy. Similarly, regarding the segment [tt^s], deriving the secondary articulation entails additions to the machinery that did not end up being sufficiently illuminating to warrant their inclusion.

As mentioned in Footnote 43 (p. 76) at the beginning of this chapter, clitics were left aside for the purposes of this analysis. While their phonological behavior can be relatively easily described – assimilation in the case of consonant-initial clitics and nasalization of a preceding consonant in the case of vowel-initial clitics (Sadock, 2003, pp. 61-62) – the main difficulty involves differentiating them from other types of affixes in a natural way. A more morphologically-oriented variant of HS may be able to capture these facts straightforwardly, or perhaps a floating [nasal] feature could be proposed as an addition to the present analysis. I leave the question open.

This analysis does not address the relationship between noun roots and certain inflectional affixes, notably the allomorphic absolutive plural and relative singular affixes used for fricative-final noun roots as discussed in §3.4.2. Furthermore, the proposed diachronic intervocalic fricative deletion that formed the allomorphic affixes in these cases is left aside.

Finally, one particularly interesting direction for future research would be to incorporate an explanation for stem-internal gemination into this discussion. Due to its incredibly specific and limited distribution, this could require substantial changes and additions to the machinery presented here, specifically to orient the theoretical framework in a more morphological direction. Furthermore, the uncertainty about its productivity in the modern language (see Footnote 11, p. 26) might favor a less uniquely synchronic description.

6.3. Concluding remarks

This thesis is intended as a contribution to modern West Greenlandic phonological theory. By modeling the behavior of consonants at morpheme boundaries, the mutually exclusive regressive assimilation and deletion processes, and the surface restrictions on geminate consonants in Harmonic Serialism, it is my hope that this thesis serves as an argument for the capacity of this framework to be used in producing formally unified analyses of West Greenlandic phonological phenomena. Regarding the place of this thesis in the broader body of literature on Harmonic Serialism, I have attempted to elaborate on the ramifications of adapting the principle of geminate integrity into a constraint within a Harmonic Serialist analysis as well as develop a working distinction between the behavior of derived and non-derived geminates entirely through the ranking of constraints.

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