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Worrying about my more immediate future in this period of budget cuts, accentuated slow growth of the world economy, and generalized uncertainty about what is going on has been therapeutically postposed thanks to writing this dissertation. No more excuses, though. However, before planning my next step towards pursuing my career, and also before becoming an ex-smoker, it is a pleasure to mention and acknowledge those that have contributed to making me feel fortunate during the last three years.

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Abstract

This dissertation explores Harmonic Serialism in the realm of syllabification. Harmonic Serialism is a derivational version of Optimality Theory (OT). In this model, GEN is restrained by a gradualness condition on candidate generation by which candidates only introduce one single modification with respect to the (latest) input, until convergence on the fully faithful candidate is achieved (*i.e.*, no further harmonic improvement is possible). An inescapable consequence of gradualness is the need for a GEN → EVAL → GEN... loop, given that output forms are often the result of applying more than one phonological operation. In Harmonic Serialism, EVAL imposes the same constraint hierarchy at every step of the derivation. The perdurability of the constraint hierarchy in Harmonic Serialism contrasts with Stratal Optimality Theory, in which the three standardly recognized levels of phonological evaluation (stem, word and phrase) show a different ranking of the constraint set. Harmonic Serialism is also different from another derivational version of OT called Optimality Theory with Candidate Chains, in which whole derivations are evaluated in parallel. The architecture of Harmonic Serialism, when compared with that of both Stratal Optimality Theory and Optimality Theory with Candidate Chains, is just more simple. This is why it is of interest to explore the explanatory power of Harmonic Serialism where standard parallel OT is challenged. The most interesting research question behind the Harmonic Serialism enterprise is defining gradualness, that is, exploring what it means to introduce one phonological operation at a time. This dissertation pursues this goal by looking at opaque interactions between syllabification, prosodification at higher levels of constituency, and morphology. I argue in favor of an operation-based definition of grad-

ualness by which all prosody-building operations, including syllabification, apply in a step-wise manner. In doing so, this dissertation presents a novel theory of serial syllabification in Harmonic Serialism that has consequences for the phonology-morphology interface, as well as for the appropriate formulation of faithfulness constraints on moraicity. I defend the idea that syllable formation operations cannot yield a binary syllable in which one of the segments in a pair of segments, but not the other segment, is contained in a prosodic constituent higher than the syllable at some intermediate level of representation, and there is no other higher prosodic category dominating both segments. This means that prosodic categories higher than the syllable create opaque domains for syllable formation operations. This situation permits the transparent application of phonological operations at intermediate stages of prosodification that will not coincide with the prosodification of the final output, thus giving rise to opacity.

Chapter 1 introduces the basics of Harmonic Serialism and reviews the literature. Chapter 2 develops a theory of syllabification in Harmonic Serialism. The hypotheses presented in chapter 2 are then tested against different kinds of data. Chapters 3 gives an account of opaque /s/ aspiration in different dialects of Spanish in which word and phrasal resyllabification counterbleed /s/ aspiration. Chapter 4 accounts for directional syllabification and opaque vowel epenthesis placement in Mongolian, where the location of epenthetic vowels depends on the morphological make-up of the word. Chapters 5 and 6 explore opaque weight by position in Harmonic Serialism. Chapter 5 deals with gemination processes in Catalan, West Germanic, and dialects of Ancient Greek. Chapter 6 explains synchronic compensatory lengthening in Komi and opaque vowel lengthening in Friulian and Alsatian French. Finally, chapter 7 concludes this dissertation and points towards potential future lines of research.

Resum

Aquesta tesi doctoral explora la teoria del Serialisme Harmònic en el domini de la sil·labificació. El Serialisme Harmònic és una versió derivacional de la Teoria de l'Optimitat (TO). En aquest model, Gen està constret per una condició de gradualitat segons la qual els candidats generats només introdueixen un sol canvi en relació a l'últim input, fins que la derivació convergeix en el candidat plenament fidel, és a dir, quan cap millora harmònica és possible. Una conseqüència inevitable de la gradualitat és l'existència d'un bucle Gen $\rightarrow$ Aval $\rightarrow$ Gen, ja que les formes superficials normalment són el resultat de l'aplicació de més d'una operació fonològica. En Serialisme Harmònic, Aval imposa la mateixa jerarquia de restriccions a cada pas de la derivació. La perdurabilitat de la jerarquia de restriccions en Serialisme Harmònic contrasta amb la Teoria de l'Optimitat Estratal, en què els tres nivells morfològics de l'avaluació fonològica (l'arrel, el mot i la frase) mostren una ordenació específica del conjunt de restriccions. El Serialisme Harmònic també és diferent d'una altra versió derivacional de la TO anomenada Teoria de l'Optimitat amb Candidats-Cadena, en què s'avaluen en paral·lel derivacions completes. L'arquitectura del Serialisme Harmònic, quan es compara amb la de la Teoria de l'Optimitat Estratal i la de la Teoria de l'Optimitat amb Candidats-Cadena, és més simple. És per això que resulta interessant d'explorar el poder explicatiu del Serialisme Harmònic allà on la TO paral·lela és incapaç de donar compte de certs fenòmens. La pregunta més interessant que guia la recerca en Serialisme Harmònic és definir la gradualitat, això és, explorar què significa introduir un sol canvi a cada pas de la derivació. Aquesta tesi té com a objectiu això mateix, i investiga la gradualitat a partir de fenòmens d'interacció opaca entre la sil·labificació, la prosodificació a

nivells més alts de constituència i la morfologia. En aquesta tesi, defenso que la gradualitat s'ha de definir a partir del concepte d'operació i que totes les operacions que creen estructura, incloses les operacions de sil·labificació, s'apliquen de manera gradual. Per tal d'explorar aquesta hipòtesi, desenvolupo una teoria serial sobre la sil·labificació en Serialisme Harmònic que té conseqüències per a la interfície fonologia-morfologia, així com també per a una formulació més ajustada de les restriccions de fidelitat a l'estructura moraica. Més concretament, proposo que les operacions de sil·labificació no poden produir una síl·laba de tipus binari si només un dels segments en un parell de segments, però no l'altre segment, està contingut en un constituent prosòdic més alt que la síl·laba en algun nivell de representació intermedi, i no hi ha cap altra categoria prosòdica que domini tots dos segments. Això significa que les categories prosòdiques superiors a la síl·laba creen dominis opacs per a les operacions de sil·labificació. Aquesta situació permet que algunes operacions fonològiques s'apliquin de manera transparent en estadis intermedis de prosodificació que no coincidiran amb la prosodificació de l'output final, donant lloc a fenòmens opacs.

El capítol 1 introdueix al lector els supòsits bàsics del Serialisme Harmònic i en revisa la literatura més rellevant. El capítol 2 desenvolupa la teoria serial de la sil·labificació en Serialisme Harmònic. El capítol 3 presenta una anàlisi de l'aspiració opaca de /s/ en dialectes de l'espanyol en què la resil·labificació a nivell del mot i a nivell de la frase contrasagna l'aspiració de /s/. El capítol 4 dóna compte de la sil·labificació direccional i la localització opaca de vocals epentètiques en mongol, on la posició d'aquestes vocals depèn de l'estructura morfològica del mot. Els capítols 5 i 6 exploren l'aplicació opaca de l'assignació de pes per posició. El capítol 5 tracta sobre processos de geminació en català, germànic occidental i dialectes del grec antic. El capítol 6 explora l'allargament compensatori en komi i l'allargament vocàlic opac en friülà i francès alsacià. Finalment, el capítol 7 presenta les conclusions generals i apunta possibles línies d'investigació futures.

Contents

Chapter 1

Introduction

1.1 Overview

In Optimality Theory (Prince and Smolensky 1993/2004), henceforth OT, surface representations are the most harmonic forms among a set of potential candidates according to a language-particular ranking of universal but violable constraints. OT is a theory of neither grammatical operations nor linguistic representations. It is just a theory of how constraints interact in grammar. In the foundational paper of the theory, Prince and Smolensky [1993/2004] argued in favor of a parallel architecture of OT, which I will refer to as parallel OT, henceforth POT. In POT, the only levels of linguistic representation are the input and the output, and intermediate representations are consequently excluded. It follows from parallelism that the Gen component of Universal Grammar acts as a blind brute force that generates an infinite set of output candidates, which can show the application of more than one phonological operation at a time, and a pervasive application of the same operation at once. One of the aims of POT is to establish the set of universal but violable constraints in order to explain attested phonological patterns. Possible grammars are thus the result of factorial typology (*i.e.*, the typological differences arising from different constraint permutations). Unattested phonological patterns are thus not expected to emerge from factorial typology. In order to explain why only a subset of the imaginable properties of particular grammars are in fact attested in natural languages, POT focuses on universal well-formedness output conditions, formalized as output markedness constraints, and their interaction with input preservation conditions, formalized as input-output faithfulness constraints.[1] The exact nature of Gen in POT becomes irrelevant from an internal theoretical perspective. If there are no indirect mappings to get to a surface representation from an underlying representation, then Gen operations can simply be ignored. All in all, Gen has no explanatory power in POT.

By contrast, in Harmonic Serialism (Prince and Smolensky 1993/2004, Elfner 2009, to appear, Jesney to appear, Kimper 2011, McCarthy 2000, 2007a,b,c, 2008b,c, 2009, McCarthy et al. 2010, McCarthy 2010, 2011, 2012, to appeara, McCarthy and Pater to appear, McCarthy and Pruitt to appear, Moore-Cantwell 2010, Pruitt 2010, 2011), henceforth HS, Gen plays a paramount role in the theory. Gen in HS is restrained by a gradualness condition on candidate generation by which candidates can introduce only one single modification with respect to the latest input. Defining gradualness, that is to say, exploring what it means to introduce a single modification at a time with respect to the latest input, is one of the main research interests in HS. Moreover, in the last half decade, studies on HS have already been proved to be appropriate to both the study of language typology and specific cases of phonological opacity.

The motivation for this dissertation is to further pursue some of the main research questions that HS has put forward in current debates in the field of theoretical phonology regarding the need to introduce some kind of derivational device in the architecture of an OT grammar.

Along the lines of previous research on HS, this dissertation is devoted to the study of certain properties of Gen. More concretely, the main goals of this dissertation are twofold: (a) to study how syllables enter prosodic structure, and (b) to explore under what assumptions about Gen and Con specific cases of phonological opacity in which prosodification (and morphology) is involved can be accounted for.

[1] Faithfulness has also been extended to transderivational output-output correspondence relations (Benua 1997).

This dissertation is organized as follows. In the next section of this chapter, the architectural properties of HS are explained. Then I give a review of the literature on HS, focusing on those works that show the typological advantages of HS over POT, and also those studies that deal with certain types of phonological opacity in which prosodification is involved. After that, the concept of phonological opacity is briefly discussed in relation with HS.

Chapter 2 presents a novel theory of serial syllabification in HS that have consequences for the phonology-morphology interface. The following specific topics will be discussed:

- Syllable formation operations and syllable structure
- Directionality
- Faithfulness to underlying moraicity
- Domain of syllabification
- Bottom-up and top-down prosodification

The theory presented in chapter 2 is used to explain specific cases of phonological opacity in which prosodification is involved. The subsequent chapters include four different case studies.

Chapter 3 argues that prosodification in HS, including syllabification, is built in harmonically improving single steps and proposes that prosodic constituents higher than the syllable create opaque domains for syllable-building operations. Those assumptions prevent syllable formation operations from obtaining a binary syllable if one of the segments in a pair of adjacent segments, but not the other segment, is contained in a prosodic constituent higher than the syllable at some intermediate level of representation, and there is no other higher prosodic category dominating both of them. The case of opacity by overapplication of /s/ aspiration in Spanish due to word- and phrasal-level resyllabification finds a straightforward explanation in those terms. The relative transparency of the aspiration process found in different dialects of Spanish is derived by the relative position that the markedness constraint CODA-CONDITION occupies with respect to two families of prosody-enforcing constraints: PARSE-SEGMENT

≫ PARSE-PROSODICWORD, and two morphology-prosody alignment constraints, ALIGN/Left (stem, Prosodic Word) ≫ ALIGN/Left (Morphological Word, Prosodic Word).

Chapter 4 investigates the nature of directional syllabification and vowel epenthesis placement in standard Ulaanbaatar Mongolian, or Khalkha Mongolian (Svantesson 1995, 2009, Svantesson et al. 2005) in HS. I focus on specific cases of cyclic syllabification in which the optimal directional syllabification algorithm is obscured by the morphological structure in morphologically complex words.

Chapter 5 provides a HS analysis of stop gemination in Catalan. Labial and velar voiced stops followed by an alveolar lateral surface as geminates in root-final position. Otherwise, they undergo spirantization and the cluster is parsed as a complex onset. Gemination stands in a counterbleeding relation with vowel epenthesis and morphological affixation in the sense that the presence of an epenthetic schwa or vowel-initial suffix does not block gemination as would be expected, since this is what happens when the cluster is followed by a vowel belonging to the root. In order to explain the facts, I propose that binary syllable formation operations can create complex minor syllables and cannot operate with two adjacent segments if one of these segments, but not the other, is integrated into a prosodic category higher than the syllable. This means that prosodic categories create opaque domains for syllabification. This assumption together with serial prosodification guarantees that vowels outside the root, either epenthetic or inflectional, are not available for syllabification purposes when the root is first prosodified. This analysis then is extended to explain West Germanic gemination.

Chapter 6 demonstrates that a set of phonological processes that involves opaque mora preservation, in which weight by position overapplies, finds a straightforward and more unified explanation in terms of HS if certain assumptions about the gradual nature of GEN are assumed together: (a) syllabification is subject to the gradualness requirement on GEN; (b) deletion is a two-step process that begins with debuccalisation; and (c) resyllabification is a two-step process of association-plus-delinking of autosegmental association lines, meaning that gemination is always a necessary step before resyllabification. The empirical coverage includes synchronic compensatory lengthening in Komi; non-local compensatory lengthening (double flop) and gemination in dialects of Ancient Greek; and opaque vowel lengthening in Friulian and Alsatian French.

Chapter 7 concludes the dissertation and proposes some topics for further research.

1.2 The architecture of HS

In Prince and Smolensky [1993/2004], HS was briefly considered, but then abandoned in favor of POT. HS was described as follows:

> Universal grammar must provide a function GEN that admits the candidates to be evaluated. [...] we have entertained two different conceptions of GEN. The first, closer to standard generative phonology, is based on serial or derivational processing: some general procedure (Do-α) is allowed to make a certain single modification to the input, producing the candidate set of all possible outcomes of such modification. This is then evaluated; and the grammar continues with the output so determined. In this serial version of grammar, the theory of rules is narrowly circumscribed, but it is inaccurate to think of it as trivial. There are constraints inherent in the limitation to a single operation and in the requirement that each individual operation in the sequence improve Harmony. (Prince and Smolensky 1993/2004:94-95)

In McCarthy [2000, 2002], HS was again reconsidered and argued not to be an adequate theory of phonological opacity, although it was recognized that a more restrictive language typology directly followed from HS, as opposed to POT, which predicts in some cases typological gaps.

A serial version of OT similar to HS was later on developed in McCarthy [2007a], called OT with Candidate-Chains, henceforth OT-CC. In OT-CC, candidates are evaluated in parallel, but derivations are implemented within candidates by means of intermediate representations that link the first member of the chain, which is always the fully faithful parse of the input, with the terminal of the chain, which corresponds to the output. OT-CC is a general theory of phonological opacity. Opacity in OT-CC emerges as an optimal solution to satisfy a metaconstraint called PRECEDENCE (A, B), where A and B correspond to faithfulness constraints, and which forces a particular ordering between these two faithfulness violations in consecutive members of a candidate chain. PRECEDENCE (A, B) constraints have thus the effect of simulating rule ordering. Although PRECEDENCE (A, B) constraints successfully handle opacity, in the sense that a particular ordering in the application of phonological operations is imposed on candidate chains, HS has received more attention in the last half decade because of its architectural simplicity.

POT is a non-serial, parallel version of OT. In POT, input-output mappings are accomplished at once, intermediate representations being excluded. In POT, EVAL imposes a language-particular ranking of universal but violable constraints to select the most harmonic member among an infinite candidate set provided by GEN. In (1), the basic architecture of POT is illustrated.

(1) POT architecture

$$\begin{array}{c} \textit{input} = \text{Underlying Representation} \\ \downarrow \\ \textsc{Gen} \\ \downarrow \\ \text{infinite set of candidates} \\ \downarrow \\ \textsc{Eval} \\ \downarrow \\ \textit{output} \end{array}$$

Actual output forms in natural languages are often the result of the application of more than one phonological operation. Even in these cases, input-output mappings are accomplished at once in POT. This is possible in POT because GEN is able to introduce at once an infinite number of phonological modifications with respect to the input. This property of GEN is called *freedom of analysis*. Consider the following example of classic Arabic. In classic Arabic, underlying /ktub/ surfaces as [ʔuktub] "write!" (McCarthy 2009). The surface representation [ʔuktub] contains two segments that have no correspondent segments in the underlying representation /ktub/. This means that the anti-epenthesis faithfulness constraint DEP is violated twice in [ʔuktub]. These DEP violations guarantee the satisfaction of two top-ranked markedness constraints, namely *COMPLEX-ONSET (*COMPL-ONS), which militates against binary branching onsets, and ONSET (ONS), which prohibits onsetless syllables. These two top-ranked markedness constraints are undominated with respect to each other because they never conflict, as shown in tableau (1) by the absence of Ls in their respective columns.[2] At

[2]Throughout this dissertation tableaux are presented in comparative format (Prince 2002), and also include integers instead of the more traditional violation marks "*". This format, which focuses on favoring relations, is referred to as "combination tableaux" in McCarthy [2008a]. A capital W is entered into the cell of a particular loser row if the winner is favored over that loser by the constraint in that column. A capital L is inserted in the opposite situation, that is, if that loser is favored over the winner. Nothing is inserted if neither the winner nor a particular loser are favored by a specific constraint. Every L must be dominated by at least one W in comparative tableaux, meaning that a loser-favoring constraint is dominated by a winner-favoring constraint. This type of

the same time, these two markedness constraints dominate the faithfulness constraint DEP, which is violated twice by the winning candidate, as noted above. Other potential candidates such as [tub] are not included in tableau (1) for the sake of simplicity. A losing candidate like [tub] is ruled out in Classical Arabic because the anti-deletion faithfulness constraint MAX is top-ranked and also dominates DEP. Dots mark syllable boundaries.

Tableau 1: POT analysis: /ktub/ → ʔuktub

	/ktub/	*COMPL-ONS	ONS	DEP
a. ☞	ʔuk.tub			2
b.	uk.tub		1 W	1 L
c.	ktub	1 W		L

However, in HS, GEN is restrained by a gradualness condition on candidate generation by which candidates only introduce one single modification with respect to the (latest) input, until convergence on the fully faithful candidate is achieved, meaning that no further harmonic improvement is possible. An inescapable consequence of gradualness is the need for a GEN → EVAL → GEN... loop, given that output forms are often the result of applying more than one phonological operation. In HS, EVAL imposes the same constraint hierarchy at every step of the derivation. The perdurability of the constraint hierarchy in HS contrasts with Stratal OT (Kiparsky 2000, Bermúdez-Otero to appear), in which the three standardly recognized levels of phonological evaluation (stem, word and phrase) may apply a different ranking of the constraint set. In other words, HS is just a version of OT that combines optimization (*i.e.*, constraint interaction) with derivations.

Going back to the classic Arabic example, in HS, the input /ktub/ cannot be mapped into [ʔuktub] in a single pass through EVAL. This is due to the gradualness requirement on GEN, by which candidates can only differ minimally with respect to the input. The exact nature of what it means to make one single modification at a time is an empirical ongoing research question. For now, let us assume that one phonological operation correlates with one violation of a basic faithfulness constraint (McCarthy 2007a). Given

tableau is especially useful in constructing and presenting ranking arguments.

that every epenthesized segment is correlated with one violation of the basic faithfulness constraint DEP, it is reasonable to think that GEN is restrained to introduce no more than one epenthetic segment at a time. The surface form [ʔuktub] thus necessitates a two-step derivation in HS because GEN can only produce a subset of the candidates that are available in POT. In tableau (2), the fully faithful candidate (b) is ruled out because it fatally violates the top-ranked markedness constraint *COMPLEX-ONSET. The most harmonic candidate is thus candidate (a), which violates both ONSET and DEP. By epenthesizing [u], an onsetless syllable is created. One interesting aspect of HS that differentiates it from POT is that a superset of the ranking arguments that are known in POT is sometimes required in HS. In POT, the ranking between *COMPLEX-ONSET and ONSET was unknown, but in HS *COMPLEX-ONSET must dominate ONSET in order to select the intermediate form *uk.tub*[3] as the most harmonic candidate at the first step of the derivation. *COMPLEX-ONSET also dominates DEP.

Tableau 2: Step 1: /ktub/ → uk.tub

	/ktub/	*COMPL-ONS	ONS	DEP
a. ☞	uk.tub		1	1
b.	ktub	1 W	L	L

The winning candidate at the first step of the derivation is then fed back to GEN as a new input for another round of evaluation, in which constraint permutation is not allowed. At the second step, candidate (a), in which a glottal stop is epenthesized in order to satisfy ONSET, which is violated by candidate (b), is the most harmonic candidate. The next tableau demonstrates that ONSET also dominates DEP.

Tableau 3: Step 2: /uk.tub/ → ʔuk.tub

	/uk.tub/	*COMPL-ONS	ONS	DEP
a. ☞	ʔuk.tub			1
b.	uk.tub		1 W	L

[3]Throughout this dissertation intermediate forms are represented in italics.

The winning candidate at step 3 is again fed back to GEN. The result of the third evaluation is illustrated in tableau (4). The winning candidate (a) is the fully faithful parse of the input. It harmonically bounds all the other candidates, meaning that no harmonic improvement is possible at this point. When the most harmonic candidate is the fully faithful parse of the input, the HS derivation converges and the actual output, the surface representation, is achieved.

Tableau 4: Step 3: convergence on ʔuk.tub

	/ʔuk.tub/	*COMPL-ONS	ONS	DEP
a. ☞	ʔuk.tub			
b.	ʔu.ku.tub			1 W
c.	uk.tub		1 W	

The basic architecture of HS is represented as a flowchart in (2).

(2) HS architecture

input = Underlying Representation
↓
restrained Gen
↓
finite set of candidates
↓
Eval
↓
convergence?
↙ ↘
no — yes
↓ ↓
new input — *final output*
↓
restrained Gen
↓
...
↓
convergence?
↙ ↘
no — yes
↓ ↓
new input — *final output*
↓
...

As can be easily deduced from the preceding analysis, each winning candidate at every step of the derivation must be either more harmonic than the latest input or as harmonic as the latest input. In the former case, the derivation continues. In the latter case, the derivation converges because the winning candidate is the fully faithful parse of the latest input, and no further harmonic improvement is achievable. This property of HS is called harmonic improvement, and naturally follows from its architecture, in which reranking of constraints at different evaluation steps is not allowed. In order to illustrate how intermediate representations improve harmony according to the same language-particular constraint hierarchy, a harmonic improvement tableau is usually used. Harmonic improvement tableaux only include the winning candidates at each derivational step. The harmonic improvement tableau of the /ktub/ → [ʔuktub] mapping is shown in tableau (5).

Tableau 5: harmonic improvement tableau: /ktub/ → ʔuk.tub

/ktub/	*Compl-Ons	Ons	Dep
Step 1. ktub *is less harmonic than*	1		
Step 2. uk.tub *is less harmonic than*		1	1
Step 3. ʔuk.tub			1

To sum up, the relevant formal properties of HS are the finiteness of the candidate set and the finiteness of derivations. On the one hand, the finiteness of the candidate set is a natural consequence of the gradualness requirement on Gen. Even though Gen includes structure-building operations such as the insertion of epenthetic segments, they cannot apply in an iterative or recursive way because that would imply more than one violation of a basic faithfulness constraint at a time. On the other hand, the finiteness of derivations is a consequence of the fact that the same hierarchy of constraints is pervasive through the whole derivation, meaning that there is a point in the derivation in which no further harmonic improvement is possible. If the hierarchy was allowed to randomly permute constraints at every time a winning candidate is fed back to Gen, convergence would be unattainable (but see Kimper 2011 for a multiple-ranking constraint theory within HS to deal with phonological variation). The durability of constraint rankings explains why Duke-of-York derivations of the type /A/ → B → [A] are impossible in HS. Saying that /A/ is less harmonic than [B] means that /A/ performs worse than [B] with respect to the highest constraint that differentiates between /A/ and [B]. Once [B] has been selected as the most harmonic candidate at the first pass through Eval, this candidate is fed back to Gen as a new input. If the constraint ranking could change in a way that the constraint that favored [B] over the fully faithful candidate A could be ranked below the constraint favoring A, the selected candidate at step 2 would be [A]. This situation could be repeated *ad infinitum*, blocking convergence. The null hypotheses for HS must be that the same grammar (*i.e.*, the same constraint hierarchy) applies through the whole derivation.

1.3 Gen operations and language typology in HS

McCarthy [2009] is concerned with the study of what it means to make one single modification at a time with respect to the input in HS. In order to explore the gradual properties of Gen, two different techiques are presented and exemplified in McCarthy [2009]. These techniques can be empirically grounded on both attested and unattested phonological mappings. Understanding Gen actually means finding out how much information must be available to the grammar at each step of the derivation in order to account for attested mappings and discard unattested mappings.

One of the most interesting aspects that emerge when POT and HS are compared is that these two versions of OT usually predict different typological patterns given the same assumptions about Con. This situation is usually found in the following situation. Imagine that in HS an intermediate form B is needed in order for underlying /A/ to surface as [C]. As in POT, the derivation /A/ $\rightarrow B \rightarrow$ [C] is harmonically improving in HS if [C] is more harmonic than both /A/ and B, but, as opposed to POT, that derivation is harmonically improving if and only if:

1. There is a markedness constraint M that favors B over /A/.

2. The markedness constraint M that favors B over /A/ is ranked higher than any other constraint favoring /A/ over B.

A harmonically improving derivation /A/ $\rightarrow B \rightarrow$ [C] in HS must respect the two abovementioned situations, that is, [C] must be more harmonic than /A/, and B must also be more harmonic than /A/ but less harmonic than [C]. Otherwise, if B is less harmonic than /A/, even if [C] is more harmonic than /A/, the derivation gets stuck at the point in which B is selected as the most harmonic candidate, meaning that there is no harmonically improving path to get to the final output [C]. However, in POT, the relative markedness between /A/ and B is not a necessary condition in order for underlying /A/ to surface as [C]. It is enough in POT if [C] is less marked than /A/ and the markedness constraint that favors [C] over /A/ is ranked higher than any other constraint favoring /A/. The predictions of POT and HS can thus be substantially different.

Attested mappings (McCarthy 2009)

With respect to attested phonological mappings, consider a hypothetical language with the mapping /A/ $\rightarrow$ [C]. Two different theories about GEN are conceivable in this situation according to McCarthy [2009]: one in which an additional intermediate step B is required to get to [C] from /A/, and another in which no intermediate step is required and [C] is already available at the first step of the derivation. Suppose that B is never more harmonic than /A/ under any permutation of CON because there is no plausible universal constraint favoring B over /A/, or there is one, but the necessary ranking to get B from /A/ contradicts known constraint rankings in this hypothetical language. This situation means that GEN must necessarily be defined in a way that permits the /A/ $\rightarrow$ [C] mapping to be accomplished at once. In McCarthy [2009], this situation is exemplified with an example from Cairene Arabic.

In Cairene Arabic, short high vowels in a non-final CV syllable undergo deletion, as can be seen in the first two examples in (1).

(1)

/wiħiʃ-a/	[ˈwiħ.ʃa]	“bad.FEM.SG”
/xulusˤ-it/	[ˈxul.sˤit]	“she finished”
/ħagar kibiːr/	[ˈħa.gar.ki.ˈbiːr]	“my parcel is big”

The examples in (1) raise the question as to whether syncope and resyllabification occur at different derivational steps. The fact that syncope does not apply when /i/ is preceded by a consonantal cluster ([ˈħa.gar.ki.ˈbiːr]) is crucial in deciding how Gen performs the operations of syncope and resyllabification. If syncope and resyllabification constituted different Gen operations, then an intermediate representation in which the vowel has deleted and the consonant becomes either syllabic or belongs to a minor syllable could be harmonically improving. The derivation for /wiħiʃ-a/ should then be something like <... → (ˈwi)(ħi)(ʃa) → (ˈwi)(ħ̩)(ʃa) → (ˈwiħ)(ʃa) >, where parentheses mark syllable boundaries. Whether this derivation is harmonically improving or not depends on the ranking of the markedness constraint favoring syncope, which must dominate the markedness constraint against syllabic consonants, *Nucleus/Consonant. Otherwise, the intermediate representation (ˈwi)(ħ̩)(ʃa) would not be harmonically improving. But the opposite ranking, that is, *Nucleus/Consonant dominating the syncope-favoring markedness constraint, is actually needed for /hagar kibiːr/, where syncope is blocked, [ˈha.gar.ki.ˈbiːr]. If syncope and resyllabification are thought to be independent processes subject to the gradualness condition on Gen, a ranking paradox is thus obtained.

Only with the ranking in which the syncope-favoring markedness constraint dominates *Nucleus/Consonant and syncope and resyllabification are collapsed into a single Gen operation are the actual outputs obtained. This is so because the amount of available information at the derivational step in which syncope has the chance to apply is big enough to look ahead to the consequences of resyllabification, which include candidates that fatally violate the top-ranked markedness constraints *Complex-Onset and *Complex-Coda in Cairene Arabic. Gen must supply the candidates showing both syncope and resyllabification: (ˈwiħ)(ʃa), on the one hand,

and (ˈħa)(gark)(ˈbiːr), (ˈħa)(gar)(ˈkbiːr), on the other hand. These forms are included in the candidate set when the grammar decides whether the syncopated candidate is the winner. Both syncopated candidates (ˈħa)(gark)(ˈbiːr) and (ˈħa)(gar)(ˈkbiːr) lose because they violate top-ranked *COMPLEX-ONSET or *COMPLEX-CODA. These two well-formedness constraints on syllable structure must consequently dominate the syncope-favoring markedness constraint. In the case of (ˈwiħ)(ʃa) , however, the optimal candidate is the syncopated one because it shows a well-formed syllable configuration and satisfies the markedness constraint prohibiting /i/ in non-final open syllables without violating any constraint on syllabic well-formedness. Splitting syncope and resyllabification into two separate GEN operations would imply a look-ahead problem. McCarthy [2009] invokes this example as the basis to conclude that syncope and resyllabification must be performed at once in HS.

Unattested mappings

In relation to unattested mappings, HS offers a new explanation of them. In POT, typological gaps can only be explained by resorting to harmonic bounding, meaning that a form never emerges as optimal under any permutation of CON. If an unattested form is never harmonically bounded, meaning that it is generated by constraint permutation, there is a conundrum. This situation is called the *too many repairs problem*, which refers to the fact that certain ill-formed targets are only repaired by a subset of the logically possible repairing strategies.

In HS, on the other hand, typological gaps can also be explained resorting to the notion of harmonic improvement. If the mapping /A/ → [C] is unattested, it could be because that mapping requires an intermediate step B that is always less harmonic than /A/. Although [C] could be the best global option for further harmonic improvement, GEN restrains the amount of information available at the derivational step in which the finite set of candidates derived from /A/ are evalutated. The final form [C] is not generated from the input /A/, because it requires more than one step to be obtained, so

GEN cannot look ahead to that candidate in order to see whether it is more harmonic overall than /A/. In this situation, the derivation gets stuck at the first derivational step. This is the difference between the local minimum for further harmonic improvement that defines HS, as opposed to the global minimum for potential harmonic improvement that is intrinsic to POT.

In McCarthy [2007b, 2009], a situation like that is exemplified with an unattested apocope pattern. POT is able to derive instances of unattested cases of non-local patterns of apocope with a constraint hierarchy in which the markedness constraint FINAL-C, which requires words to end in a consonant, and the markedness constraint CODA/sonorant (CODA/son), which requires coda consonants to be sonorant, dominate the anti-deletion faithfulness constraint MAX. From an input like /sanata/, the output [san] is selected in POT, as can be seen in tableau (6). Dots mark syllable boundaries.

Tableau 6: POT analysis: /sanata/ → san

	/sanata/	FINAL-C	CODA/son	MAX
a. ☞	san			3
b.	sa.nat		1 W	1 L
c.	sa.na.ta	1 W		L
d.	sa.na	1 W		2 L

The constraint ranking in tableau (6) describes a language in which a multisegmental string is deleted whenever a word contains a sonorant consonant. HS, on the other hand, cannot derive such a pattern of non-local apocope. In HS, only one segment is deleted in vowel-final words if FINAL-C dominates CODA/sonorant, as illustrated in tableaux (7) and (8).

Tableau 7: Step 1: /sanata/ → sa.nat

	/sanata/	FINAL-C	CODA/son	MAX
a. ☞	sa.nat		1	1
b.	sa.na.ta	1 W	L	L

Tableau 8: Step 2: convergence on sa.nat

	/sanat/	FINAL-C	CODA/son	MAX
a. ☞	sa.nat		1	
b.	sa.na	1 W	L	1 W

The opposite ranking in which CODA/sonorant dominates FINAL-C describes a language in which deletion is always blocked, as can be seen in tableau (9).

Tableau 9: Step 1: convergence on sa.na.ta

	/sanata/	CODA/son	FINAL-C	MAX
a. ☞	sa.na.ta		1	
b.	sa.nat	1 W	L	1 W

In order to define GEN, a well-defined theory of the amount of phonological information available to the grammar at each derivational step based on empirical argumentations must be pursued. In the example of Cairene Arabic, GEN must be defined in such a way that syncope and resyllabification are performed at once by GEN. In the case of the highly non-local unattested apocope pattern, GEN must be defined in a way whereby only one segment can be deleted at a time, blocking deletion of a multisegmental string in the presence of a sonorant consonant in the word.

The typological advantages of HS over POT have also been discussed recently in different works. It is not the purpose of this chapter to discuss in depth all of these studies, but merely to briefly point out some of their findings as a background to HS.

Cluster simplification (McCarthy 2008b)

In McCarthy [2008b], a HS theory of consonantal cluster simplification is developed based on pre-OT autosegmental developments. Processes of deletion and place assimilation are split into two serially ordered single-step processes. In deletion, the first step is always debuccalisation (*i.e.*, deletion of oral place features), which introduces a MAX(place) (MAX(pl)) violation, followed by deletion of the root node, which correlates with a MAX-C violation. In place assimilation, the first step is also debuccalisation, and the second one, insertion of a new association line between the placeless root node and the place feature autosegment associated with the onset consonant, which constitutes a violation of NO-LINK(place). The markedness constraint that triggers debuccalisation is CODA-CONDITION (CODA-COND), which prohibits place features to be associated with segments that are parsed in syllable coda position. In a NO-LINK(place)-violating representation, CODA-CONDITION is satisfied because the place feature associated with the coda consonant, being also associated with an onset, becomes licensed.

The main argument in favor of splitting deletion and place assimilation into two separate autosegmental processes comes from the coda/onset asymmetry. The coda/onset asymmetry refers to the fact that codas, but not onsets, are generally affected by deletion and place assimilation processes. A HS derivation of the mapping /patka/ → [pa.ka] is thus as follows: /patka/ → *paH.ka* → [pa.ka], where capital *H* represents a debuccalised, placeless stop consonant. This derivation is gradual and harmonically improving when evaluated by a constraint hierarchy in which CODA-CONDITION dominates HAVE-PLACE (HAVE-PL), a markedness constraint against placeless segments, and MAX(place); and HAVE-PLACE dominates sMAX-C. This is shown in the harmonic improvement tableau (10).

Tableau 10: harmonic improvement tableau

/patka/	CODA-COND	HAVE-PL	MAX(pl)	MAX-C
Step 1. pat.ka *is less harmonic than*	1			
Step 2. paH.ka *is less harmonic than*		1	1	
Step 3. pa.ka				1

However, a derivation which results in onset deletion like **/patka/ → *pat.Ha* → [pa.ta] (where ** marks a non-harmonically improving derivation) is harmonically bounded at the first step of the derivation, where it gets stuck. Debuccalisation of the second consonant in *pat.Ha* is not a harmonically improving step under any permutation of the constraint set presented so far because *pat.Ha* incurs a superset of the violations incurred by the fully faithful parse of the input, *pat.ka*. Both *pat.Ha* and *pat.ka* violate CODA-CONDITION, because there is a coda consonant associated with its own place feature, but *pat.Ha* gratuitously adds violations of HAVE-PLACE and MAX(place). This is illustrated in the non-harmonic improvement tableau (11).

Tableau 11: non-harmonic improvement tableau

/patka/	CODA-COND	HAVE-PL	MAX(pl)	MAX-C
a. pat.ka	1			
is more harmonic than				
b. pat.Ha	1	1	1	

POT, by contrast, cannot predict the coda/onset asymmetry because both [pa.ka] and [pa.ta] tie under the same assumptions of CON.

Tableau 12: POT analysis: /patka/ $\rightarrow$ pa.ta $\sim$ pa.ka

	/patka/	CODA-COND	HAVE-PL	MAX(pl)	MAX-C
a.	pat.ka	1 W		L	L
b.	paH.ka		1 W	1	L
c.	pat.Ha	1 W	1 W	1	L
d. ☞	pa.ta			1	1
e. ☞	pa.ka			1	1

In sum, McCarthy [2008b] demonstrates that HS yields a more restrictive typology of consonantal cluster simplification than POT under the same assumptions of CON based on the observation that deletion and place assimilation are best treated as the result of a two-step process.

Metrically conditioned syncope (McCarthy 2008c)

A specific case of process interaction in which HS yields a more restrictive typology than POT does comes from stress-syncope interactions as analyzed in McCarthy [2008c]. In many languages, unstressed vowels undergo deletion. In POT, the effects of stress assignment and unstressed vowel deletion must be evaluated in parallel. The problem in POT resides in the fact that unstressed vowels are not known until stress is assigned. The gradualness requirement on GEN presents a solution: the effects of stress assignment and deletion of unstressed vowels must be evaluated serially. In McCarthy [2008c], two crucial ideas about the nature of GEN and CON are discussed in order to derive the necessary intrinsic ordering between stress assignment and syncope. Gradualness merely establishes that stress assignment and syncope cannot occur simultaneously, but it does not say anything about their relative ordering. This fact must follow from CON. The intrinsic ordering of these two processes needs to be syncope following stress assignment, because at the derivational step in which syncope occurs the grammar must know which vowels occupy the weak syllable in metrical feet. McCarthy [2008c] argues that intrinsic ordering between stress assignment and syncope can only be accounted for if certain previously proposed universal constraints are excluded from CON. The first constraint that should be eliminated from CON is PARSE-SYLLABLE (PRS-SYLL) under the following formulation.

(2) PARSE-SYLLABLE (after McCarthy and Prince 1993)

Assign one violation mark for every syllable that is not dominated by some foot.

The problem with this constraint is that it improves harmony in forms that lack foot structure when a vowel deletes, meaning that syncope could be a harmonically improving step before stress assignment. This is shown in the harmonic improvement tableau (13). Building metrical feet correlates with an IDENT(stress) (ID(stress)) faithfulness violation. Dots mark syllable boundaries, parentheses mark foot boundaries, and square brackets mark prosodic word boundaries.

Tableau 13: harmonic improvement tableau

/pataka/	PRS-SYLL	ID(stress)	MAX-V
Step 1. pa.ta.ka *is less harmonic than*	3		
Step 2. pat.ka *is less harmonic than*	2		1
Step 3. [(ˈpat)ka]	1	1	

The problem with Parse-Syllable is that it is violated under two different situations. It is violated when a syllable is not integrated into any higher-level of prosodic constituency, and is also violated by a syllable that is not associated with a foot but is dominated by a prosodic word node, as candidate (c) in tableau (13) shows. On the other hand, a constraint like Exhaustivity(X^n) (Exh(X^n)), as defined in (3), is vacuously satisfied by those candidates in which syncope has applied when there is no prosodic structure, meaning that the candidate with syncope before stress assignment is never harmonically improving because it only adds a violation of Max-V.

(3) Exhaustivity(X^n) (Itô and Mester 1992/2003, Selkirk 1995)

Assign one violation mark for every constituent of type X^m that is immediately dominated by a constituent of type X^n, if $m < n - 1$.

Tableau (14) shows that syncope preceding stress assignment is not a harmonically improving step if Parse-Syllable is replaced by Exhaustivity(X^n).

Tableau 14: non-harmonic improvement tableau

/pataka/	Exh(X^n)	Id(stress)	Max-V
a. pa.ta.ka *is more harmonic than*			
b. pat.ka			1

A constraint that disfavors unstressed vowels in general as defined in (4), *V-Place$_{\text{unstressed}}$ (*V-Pl$_{\text{uns}}$) also presents a problem in establishing an intrinsic ordering between stress assignment and unstressed vowel deletion in HS.

(4) *V-Place$_{\text{unstressed}}$

Assign one violation mark for every place-bearing vowel that is not in the head syllable of some metrical foot.

Ranking *V-Place$_{\text{unstressed}}$ over Ident(stress) and Max-V would result in a harmonically improving derivation in which deletion could take place before stress assignment, as shown in tableau (15).

Tableau 15: harmonic improvement tableau

/pataka/	*V-$\textsc{Pl}_{uns}$	$\textsc{Id}$(stress)	$\textsc{Max}$-V
Step 1. pa.ta.ka *is less harmonic than*	3		
Step 2. pat.ka *is less harmonic than*	2		1
Step 3. [(ˈpat)ka]	1	1	

If this was the case, then syncope could not be intrinsically ordered after stress assignment. If *V-$\textsc{Place}_{unstressed}$ is replaced by a constraint like *V-$\textsc{Place}_{weak}$, (*V-$\textsc{Pl}_{weak}$), where only vowels occupying weak prosodic positions such as the non-head syllable of a foot or a syllable that is immediately dominated by a prosodic word node, then candidates (a) and (b) in tableau (15), which lack metrical foot structure, would not violate *V-$\textsc{Place}_{weak}$, meaning that applying syncope before stress assignment would not be harmonically improving, as tableau (16) illustrates. This is so because the markedness constraint *V-$\textsc{Place}_{weak}$ is vacuously satisfied until prosodic word and foot structure are projected.

Tableau 16: non-harmonic improvement tableau

/pataka/	*V-$\textsc{Pl}_{weak}$	$\textsc{Id}$(stress)	$\textsc{Max}$-V
a. pa.ta.ka *is more harmonic than*			
b. pat.ka			1

The solution given in McCarthy [2008c] is that metrical foot building is enforced by the satisfaction of the grammar-prosody interface constraint $\textsc{Lx}\approx\textsc{Pr}$ (Prince and Smolensky 1993/2004), or WordCondition (Selkirk 1995). $\textsc{Lx}\approx\textsc{Pr}$ requires lexical words to be integrated into prosodic words. Given that projecting a prosodic word node never adds a violation of a basic faithfulness constraint, projecting a prosodic word node can co-occur with foot building. This is consistent with the faithfulness-based definition of gradualness, because only one basic faithfulness constraint, namely Ident(stress), is violated when a prosodic word node is projected together with the head foot of the prosodic word. The constraint ranking WordCondition $\gg$

IDENT(stress), EXHAUSTIVITY(X^n) forces stress assignment to apply before syncope.

Tableau 17: harmonic improvement tableau

/pataka/	LX≈PR	ID(stress)	EXH(X^n)
Step 1. pa.ta.ka *is less harmonic than*	1		
Step 2. [(ˈpa.ta)ka]		1	1

By way of illustration, consider syncope in Aguaruna, an iambic stress language, as analyzed in McCarthy [2008c]. I simplify McCarthy [2008c]'s analysis for expository reasons here. At the first step of the derivation, the grammar selects the footed candidate as the most harmonic one, as tableau (18) shows. EXHAUSTIVITY(X^n) must also dominate IDENT(stress) in order to rule out candidate (c), with just one metrical foot. The markedness constraint FOOTFORM = IAMBIC (FT=I) must dominate FOOTFORM = TROCHEE (FT=T) in order to select the candidate with iambic foot parsing.

Tableau 18: Step 1: /itʃinakaŋumina/ → [(i.ˈtʃi)(na.ˈka)(ŋu.ˈmi)na] "your pot.ACC"

	/itʃinakaŋumina/	LX≈PR	EXH(X^n)	ID(stress)	FT=I	FT=T
a. ☞	[(i.ˈtʃi)(na.ˈka)(ŋu.ˈmi)na]		1	3		3
b.	[(ˈi.tʃi)(ˈna.ka)(ˈŋu.mi)na]		1	3	3 W	L
c.	[(iˈtʃi)na.ka.ŋu.mi.na]		5 W	1 L		1 L
d.	i.tʃi.na.ka.ŋu.mi.na	1 W	L	L		

At the second step of the derivation, the footed candidate is fed back to GEN as a new input. Ranking the syncope-favoring constraint *V-PLACE$_{\text{weak}}$ above MAX-V makes the candidate with syncope the most harmonic one.

Tableau 19: Step 2: /[(i.ˈtʃi)(na.ˈka)(ŋu.ˈmi)na]/ → [(i.ˈtʃin)(ˈkaŋ)(ˈmin)]

	/[(i.ˈtʃi)(na.ˈka)(ŋu.ˈmi)na]/	*V-PL$_{\text{weak}}$	MAX-V
a. ☞	[(i.ˈtʃin)(ˈkaŋ)(ˈmin)]		3
b.	[(i.ˈtʃi)(na.ˈka)(ŋu.ˈmi)na]	4 W	L

Harmony (McCarthy to appearb)

In McCarthy [to appearb], HS is demonstrated to resolve the pathological predictions observed by Wilson [2003, 2004, 2006] with respect to autosegmental spreading in POT.

McCarthy [to appearb] takes nasal harmony as the empirical domain to argue in favor of Serial Harmony (SH), a theory of harmony in HS. In autosegmental phonology, nasal harmony was the result of applying in an interative fashion a directionally-specified rule that spreads the feature [nasal] onto a neighboring segment. In POT, two main approaches on nasal harmony exist depending on the constraint that favors nasal spreading: the local markedness constraint AGREE-Right/Left ([nasal]) and the alignment long-distance constraint ALIGN-Right/Left ([nasal], word) (AL-R/L ([nas], word)).

The local spreading-favoring markedness constraint AGREE-Right ([nasal]) (AGREE-R([nas])) disfavors those candidates that contain a sequence of adjacent segments *xy* when *x* is associated with [nasal] but *y* is not. Nasal harmony is usually blocked in the presence of certain intervening segments. The fact that less sonorous segments act universally as blockers of nasal harmony is formalized as a fixed universal constraint hierarchy in Walker [1998] as follows: *NASALPLOSIVE ≫ *NASALFRICATIVE ≫ *NASALLIQUID ≫ *NASALGLIDE ≫ *NASALVOWEL. The problem with AGREE-Right ([nasal]) in POT is that it shows a *sour-grapes* problem: the local constraint AGREE-Right ([nasal]) inhibits nasal harmony in the absence of a blocking segment, but completely blocks nasal harmony in the presence of a blocking segment. This is shown in tableau (20) with a hypothetical language in which liquid segments are blockers.

Tableau 20: POT analysis with AGREE-Right ([nasal])

	/mawara/	*NASLIQ	AGREE-R([nas])	ID([nas])
a. ☞	mawara		1	
b.	mãwara		1	1 W
c.	mãw̃ara		1	2 W
d. ☹	mãw̃ãra		1	3 W
e.	mãw̃ãr̃a	1 W	1	4 W
f.	mãw̃ãr̃ã	1 W	L	5 W

Candidate (d), in which nasal harmony spreads as far as the blocking segment allows, is harmonically bounded by candidate (a), with no nasal harmony at all. Languages like this, with sour-grapes spreading, are unattested.

Candidate (d) in tableau (20) is selected as the most harmonic one if AGREE-Right ([nasal], word) is replaced by the alignment long-distance constraint ALIGN-Right ([nasal], word), which gradiently assigns as many violation marks as the number of segments that intervene between the right edge of the feature [nasal] and the right edge of the word. This is so because candidate (d) minimally violates ALIGN-Right ([nasal], word), as opposed to the first three candidates, which violate ALIGN-Right ([nasal], word) more than twice. This result is shown in tableau (21).

Tableau 21: POT analysis with ALIGN-Right ([nasal], word)

	/mawara/	*NASLIQ	AL-R([nas], word)	ID([nas])
a.	mawara		5 W	L
b.	mãwara		4 W	1 L
c.	mãw̃ara		3 W	2 L
d. ☞	mãw̃ãra		2	3
e.	mãw̃ãr̃a	1 W	1 L	4 W
f.	mãw̃ãr̃ã	1 W	L	5 W

Nevertheless, constraint permutation in POT predicts unattested ways of minimizing the number of segments that intervene between the right edge of the feature [nasal] and the right edge of the word, namely segmental deletion, metathesis, epenthesis, affix repositioning, and allomorph selection.

In SH, a new harmony-favoring markedness constraint is proposed, SHARE ([nasal]). This constraint assigns one violation mark for every pair of adjacent segments that are not linked to the same token of the feature [nasal]. This constraint is violated by different structures, listed below.

1. A pair of adjacent segments in which one of them is linked to a feature [nasal] but the other is not.

2. A pair of adjancent segments linked to their own feature [nasal].

3. A pair of adjacent segments in which none of them are linked to a feature [nasal].

The theory of GEN operations in SH is restricted to insert or delete either a feature and a single association line that links that feature to some already existing structure, or just a single association line linking those two already existing structures.

On the one hand, when SH is compared with the effects of AGREE-Right ([nasal]) in POT, it is shown that SHARE ([nasal]) in SH has no sour-grapes property, because actually candidate (a) in tableau (20) has more violations of SHARE ([nasal]) than intended winning candidate (d). In SH, segments are predicted to nasalize sequentially until the blocking segment is encountered.

On the other hand, when SH is compared with the effects of ALIGN-Right ([nasal], word), it is also shown that SHARE ([nasal]) in SH solves the pathological results predicted by ranking permutation in POT first observed by Wilson [2003, 2004, 2006].

With respect to segmental deletion, if ALIGN-Right ([nasal], word) dominates the anti-deletion faithfulness constraint MAX, and ONSET is low ranked, POT predicts that deletion only occurs in the presence of a harmony-blocking segment. This pattern is unattested. In SH, if deletion is understood as a two-step process of first debuccalisation and then root deletion (McCarthy 2008b), then the first step in deleting a segment does not improve performance on SHARE([nasal]). Regarding metathesis, ranking ALIGN-Right ([nasal], word) over the anti-metathesis faithfulness constraint LINEARITY also makes the implausible prediction that metathesis only occurs in order to minimize violations of ALIGN-Right ([nasal], word). In SH, however, metathesis and autosegmental spreading are separate phonological operations, so they cannot co-occur in the same GEN's finite candidate set. This means that in SH a candidate like [mãw̃ããr] is not among the candidates at the derivational step in which [mãw̃ãra] is selected as the most harmonic candidate. In fact, [mãw̃ãra] is as marked as the candidate undergoing metathesis [mãw̃ãar], but more faithful, because it incurs no violations of LINEARITY. Epenthesis also represents a way to minimize violations of ALIGN-Right ([nasal], word) in POT, if the markedness constraint NO-CODA, which must dominate DEP-

V, is dominated by ALIGN-Right ([nasal], word). With this ranking, POT predicts a language that only undergoes epenthesis in words with no blocking segments. By contrast, in the presence of a blocking segment, offgoing epenthesis improves performance on ALIGN-Right ([nasal], word) because there is one less segment intervening between the right edge of the feature [nasal] and the right edge of the word. In SH, epenthesis and autosegmental spreading constitute separate operations, so the consequences of epenthesis cannot be evaluated taking into account how that can affect autosegmental spreading. HS cannot look ahead for the global minimum for potential harmonic improvement. In SH, ranking SHARE ([nasal]) over NO-CODA simply blocks epenthesis elsewhere, and this is not a pathological prediction. The advantages of SHARE ([nasal]) in SH compared with ALIGN-Right ([nasal], word) in POT are also shown to exist with respect to affix placement and allomorph selection (see McCarthy to appearb for more details). All these pathologies do not represent a problem for SH because the consequences of undergoing deletion, metathesis, or epenthesis, although representing global minima for further potential harmonic improvement, do not improve harmony at the derivational step in which they are available because they cannot co-occur with autosegmental spreading given the gradualness requirement on GEN.

Stress-epenthesis interactions (Elfner to appear)

Some studies have recently demonstrated that HS is able to resolve specific cases of opacity in which segmental processes interact with prosody-building operations like stress assignment. In Elfner [to appear], specific cases of opacity in which vowel epenthesis counterbleeds the language-specific stress assignment pattern is easily accounted for in HS. Elfner [to appear] argues in favor of a faithfulness-based definition of gradualness, in which one phonological operation ties with one violation of a faithfulness constraint. In this respect, syllabification, which is not contrastive in any language, can co-occur simultaneously with other phonological operations such as vowel epenthesis. Syllabification is thus not subject to the gradualness requirement on

GEN (see Elfner 2009 for a different approach). As opposed to syllabification, stress assignment can be contrastive, meaning that it is the result of an unfaithful mapping. Stress assignment in Elfner [to appear] violates DEP-PROMINENCE (DEP-PROM), but satisfies a markedness constraint that militates against stressless words, PROSODICWORDHEAD (PWDHD). Stress assignment, as a consequence of foot building, thus counts as a single operation, and is always accomplished at a point in which vowel epenthesis is not an available phonological operation. The relative ordering between stress assignment and vowel epenthesis, derived by constraint ranking, explains why stress-epenthesis interactions can be transparent or opaque.

Swahili is a language in which stress-epenthesis interactions are transparent, meaning that vowel epenthesis is visible for stress assignment. In Swahili, vowel epenthesis is triggered by the satisfaction of NO-CODA. This syllable structure markedness constraint also dominates PROSODICWORDHEAD. This ranking ensures that when stress assignment has the chance to apply, vowel epenthesis is already present at the step of the derivation in which PROSODICWORDHEAD must be satisfied. At the first step of the derivation, the ranking NO-CODA ≫ PROSODICWORDHEAD favors the candidate in which vowel epenthesis has applied, as shown in tableau (22). This language shows a regular penultimate stress pattern that is also transparently observed in epenthesized loanwords such as /ratli/ → [ra('ti.li)] "pound".

Tableau 22: Step 1: /ratli/ → ra.ti.li

	/ratli/	NO-CODA	PWDHD	DEP-PROM	DEP-V
a. ☞	ra.ti.li		1		1
b.	('rat.li)	1 W	L	1 W	L
c.	rat.li	1 W	1		L

At the second step of the derivation, the epenthetic vowel is present in the input, and stress assignment is the most harmonic operation because PROSODICWORDHEAD is satisfied at the expense of violating DEP-PROMINENCE.

Tableau 23: Step 2: /ra.ti.li/ → ra(ˈti.li)

	/ra.ti.li/	NO-CODA	PWDHD	DEP-PROM	DEP-V
a. ☞	ra(ˈti.li)			1	
b.	ra.ti.li		1 W	L	

The derivation converges at the third step of the derivation. I am omitting the constraints responsible for selecting the foot type and the alignment of the head foot with respect to the right or left edge of the prosodic word for simplification purposes.

An opaque stress-epenthesis interaction is found in Dakota, for instance. In Dakota, epenthetic vowels are invisible for stress assignment, meaning that the regular stress pattern, which falls on the second syllable of the word, is not surface-true in epenthesized words such as /tʃap/ → [(ˈtʃa.pa)] "beaver". This opaque pattern is easily derived by constraint permutation. In languages with this opaque pattern, the ranking PROSODICWORDHEAD≫ NO-CODA is observed. With this ranking, stress takes priority over vowel epenthesis. Stress is then assigned independently of the need for an epenthetic vowel to satisfy NO-CODA. This is so because the gradualness requirement on GEN do not supply candidates with both stress assignment and epenthesis.

Tableau 24: Step 1: /tʃap/ → (ˈtʃap)

	/tʃap/	PWDHD	NO-CODA	DEP-PROM	DEP-V
a. ☞	(ˈtʃap)		1	1	
b.	tʃa.pa	1 W	L	L	1 W
c.	tʃap	1 W	1	L	

Once the head foot is built, epenthesis applies at the second step of the derivation, making the stress pattern opaque because stress does not fall on the second syllable of the word. This way, the markedness constraint FOOT = IAMB, requiring the head syllable of the foot to be final, must also be dominated by NO-CODA.

Tableau 25: Step 2: /(ˈtʃap)/ → (ˈtʃa.pa)

	/(ˈtʃap)/	PWDHD	NO-CODA	Ft=I	DEP-V
a. ☞	(ˈtʃa.pa)			1	1
b.	(ˈtʃap)		1 W	L	L

The derivation converges at the next step. At that stage of the derivation, a candidate with stress shift to the second syllable of the foot would satisfy FOOT = IAMB. But stress shift, under the assumption that foot building is an unfaithful mapping, must be a faithfulness-violating operation that requires two different steps: one in which the foot is removed and the other one in which it is reassigned. This means that at the third step of the derivation, a transparent candidate like (tʃa.ˈpa) is not available for evaluation and the derivation gets stuck at the point in which (ˈtʃa.pa) is fed back to GEN as a new input. The candidate in which the foot has been removed, which represents the necessary step before being able to select transparent *(tʃa.ˈpa), fatally violates the high-ranked constraint PROSODICWORDHEAD, and also FAITHFULNESSSTRESS (FAITHSTRESS).

Tableau 26: Step 3: convergence on (ˈtʃa.pa)

/(ˈtʃa.pa)/	PWDHD	NO-CODA	FT=I	FAITHSTRESS	DEP-V
a. ☞ (ˈtʃa.pa)			1		
b. tʃa.pa	1 W		L	1 W	

HS is also argued to account for mixed languages in which stress-epenthesis interactions are opaque in some specific environments, but not always, such as Mohawk or Levantine Arabic. In Mohawk, *e*-epenthesis has different triggering environments. Among these triggering environments, *e*-epenthesis breaks underlying CCC clusters, on the one hand, and sequences of an oral stop plus a sonorant consonant. Given that these two types of epenthesis are fixing strategies to satisfy different markedness constraints, namely *COMPLEX, in the case of underlying CCC clusters, and SYLLABLE-CONTACT, in the case of an oral stop plus a sonorant consonant, the constraint ranking *COMPLEX ≫ PROSODICWORDHEAD ≫ SYLLABLECONTACT derives the fact that *e*-epenthesis, when it breaks underlying CCC sequences, interacts transparently with stress assignment, whereas *e*-epenthesis breaking clusters of an oral stop plus a sonorant consonant interacts opaquely with stress assignment. In

Elfner [to appear], other types of *e*-epenthesis in Mohawk are considered and given a satisfactory HS account. A parallel analysis is also given for Levantine Arabic, in which only *i*-epenthesis interacts transparently with stress assignment when it breaks underlying CCC clusters, but opaquely when it breaks underlying CCCC clusters. The asymmetry observed among the different types of epenthesis is derived by assuming that syllabification can leave some segments unparsed in order to satisfy the top-ranked markedness constraint *COMPLEX (*COMPL). By ranking PARSE-CC (PRS-CC), which assigns one violation mark when two or more segments are left unparsed, over PROSODICWORDHEAD, which in turn dominates the more stringent constraint PARSE-SEGMENT, the actual outputs are selected. The following tableaux exemplify the HS derivations with two different inputs, one containing an underlying CCC cluster, and the other one containing an underlying CCCC cluster in Levantine Arabic.

In inputs containing an underlying CCC cluster, at the first step of the derivation both the top-ranked markedness constraints against complex onsets or codas, *COMPLEX, and PROSODICWORDHEAD, can be satisfied at once by leaving one segment unparsed.

Tableau 27: Step 1: /katab-l-ha/ → ka('tab)<l>ha "he wrote to her"

	/katab-l-ha/	*COMPL	PWDHD	PRS-SEG
a. ☞	ka('tab)<l>ha			1
b.	ka.ta.bil.ha		1 W	L
c.	ka('tabl)ha	1 W		L
d.	ka('tab)lha	1 W		L
e.	ka.tab<l>ha		1 W	1

At the second step of the derivation, epenthesis occurs in order to satisfy PARSE-SEGMENT. Stress assignment does not follow the regular pattern, in which stress falls on the penultimate syllable if it is heavy or in the preantepenultimate if the penultimate syllable is light, because stress is assigned before *i*-epenthesis. Notice that resyllabification of /b/ is accomplished simultaneously when the epenthetic vowel is inserted because resyllabification is considered a cost-free operation that is not correlated with any violation of a basic faithfulness constraint (see also McCarthy 2009 for arguments in favor of considering resyllabification an operation that co-occurs with other phonological operations). Parse-Segment also dominates Foot-Binarityμ (Ft-Binμ), a markedness constraint requiring metrical feet to dominate exactly two moras. Violations of Dep-V are omitted.

Tableau 28: Step 2: /ka('tab)<l>ha/ → ka('ta)bil.ha

	/ka('tab)<l>ha/	*Compl	PWdHd	Prs-Seg	Ft-Binμ
a. ☞	ka('ta)bil.ha				1
b.	ka('tab)<l>ha			1 W	L

Convergence is reached at the next step of the derivation, omitted here.

When an input contains an underlying CCCC cluster, however, leaving two of the consonants unparsed is not a harmonically improving step because Parse-CC (Prs-CC) dominates ProsodicWordHead. This ranking ensures that epenthesis is first applied and stress will be assigned transparently at the second step of the derivation.

Tableau 29: Step 1: /katab-t-l-ha/ → ka.tab.til.ha "I wrote to her"

	/katab-t-l-ha/	*Compl	Prs-CC	PWdHd	Prs-Seg
a. ☞	ka.tab.til.ha			1	
b.	ka('tab)<tl>ha		1 W	L	2 W
c.	ka.tab<tl>ha		1 W	1	2 W

Tableau 30: Step 2: /ka.tab.til.ha/ → ka.tab('til)ha

	/ka.tab.til.ha/	*Comp	Prs-CC	PWdHd	Prs-Seg
a. ☞	ka.tab('til)ha				
b.	ka.tab.til.ha			1 W	

Elfner [to appear] thus demonstrates that stress-epenthesis interactions find a straightforward explanation in HS if standard OT constraints are just considered.

Positional faithfulness (Jesney to appear)

Jesney [to appear] argues in favor of HS in the light of pathological unattested patterns in which positional faithfulness constraints are involved (Beckman

1997). There is a constraint ranking in POT responsible for an unattested positional-faithfulness effect. This constraint ranking is illustrated in (5).

(5) IDENT(voice)/ONSET ≫ *VOICEDOBSTRUENT ≫ IDENT(voice), ONSET

The tableaux in (31) illustrate that, under the constraint hierarchy in (5), an underlying voicing contrast opaquely surfaces as a contrast on syllabification. An underlying voiceless consonant surfaces as such in onset position, whereas an underlying voiced consonant is also devoiced because it can surface in coda position. This is due to the low-ranked position of ONSET.

Tableau 31: POT analysis

	/pata/	ID(vc)/ONS	*VCDOBST	ID(vc)	ONS
a. ☞	pa.ta				
b.	pat.a				1 W

	/pada/	ID(vc)/ONS	*VCDOBST	ID(vc)	ONS
a. ☞	pat.a			1	1
b.	pad.a		1 W	L	1
c.	pa.ta	1 W		1	L
d.	pa.da		1 W	L	L

The tableaux above illustrate a pathology. There is no known language with such a contrast. Jesney [to appear] argues that this unexpected result is underivable in HS, where the underlying voicing specification of consonants cannot affect syllabification. This is so because privileged prosodic positions can be defined at the first step of the derivation, and in later derivational stages positional faithfulness is computed according to a syllabified intermediate input. In this approach, it is assumed that syllabification cannot co-exist simultaneously with another single operation such as devoicing. Resyllabification, however, is tacitly assumed to co-occur with other phonological operations, as candidate (d) in tableau (33) shows. The next tableaux (32) and (33) illustrate that a voiced obstruent cannot be devoiced at the expense of parsing it in syllable coda position after syllabification is accomplished at the first step of the derivation because the positionally faithfulness constraint

IDENT(voice)/ONSET is computed with respect to the already syllabified new input.

Tableau 32: Step 1: /pada/ → pa.da

	/pada/	ID(vc)/ONS	*VCDOBST	ID(vc)	ONS
a. ☞	pa.da		1		
b.	pad.a		1		1 W

Tableau 33: convergence on pa.da

	/pa.da/	ID(vc)/ONS	*VCDOBST	ID(vc)	ONS
a. ☞	pa.da		1		
b.	pad.a		1		1 W
c.	pa.ta	1 W	L	1 W	
d.	pat.a	1 W	L	1 W	1 W

Her proposal in HS consists of ordering prosodification before any other feature-changing operation. This way privileged prosodic positions are established in the first step of the derivation and thus positional faithfulness constraints can be sensitive to the prosodic information present in intermediate inputs.

Variation (Kimper 2011)

Kimper [2011] argues in favor of HS in the light of phonological variation, and proposes Serial Variation, henceforth SV, to model it. SV is a theory that combines HS with a partially ordered constraints model that allows constraint permutation at each pass through GEN and EVAL.

As opposed to POT, SV predicts both local and global variation. Local variation occurs in those forms where multiple loci subject to variation are independent from each other, whereas in global variation the choice at multiple loci with respect to variation must be consistent. POT cannot predict local variation because only one total order of the constraint set can be selected at EVAL. This is so because harmony is evaluated for the entire domain in parallel. HS, on the other hand, allows the selection of different total orders of the constraint set throughout the derivation, thus predicting local variation. The choice of the variant at each locus is independent from the other loci and crucially depends on imposing a different total order of constraints at different passes through GEN and EVAL.

In SV, a grammar is a set of constraints in a partial ranking. From this partial order, different total orders are possible. Each time EVAL applies, a different total order is selected, giving rise to variation. How to model frequency effects is ignored in Kimper [2011].

To illustrate this point, Kimper [2011] uses the following hypothetical data. Imagine a grammar with an input /dada/ and a constraint set with a markedness constraints *VOICE (*VC) against voiced consonants, and a faithfulness constraint IDENT(voice) (ID(vc)), against voicing disparities between input and output. These two constraints are partially ranked, so a different ranking between them can be selected at EVAL. In POT, only global variation is predicted. If *VOICE outranks IDENT(voice), the surface form [tata] is selected. By contrast, if IDENT(voice) dominates *VOICE, the faithful candidate emerges as optimal, [dada]. Tableaux (34) and (35) show these results.

Tableau 34: POT analysis: /dada/ → tata

/dada/		*VC	ID(vc)
a. ☞	tata		2
b.	data	1 W	1 L
c.	tada	1 W	1 L
d.	dada	2 W	L

Tableau 35: POT analysis: /dada/ → dada

/dada/		ID(vc)	*VC
a. ☞	dada		2
b.	data	1 W	1 L
c.	tada	1 W	1 L
d.	tata	2 W	L

SV, on the other hand, predicts the existence of the local variants [data] or [tada], precisely because only one change at a time can be performed at each step of the derivation, and because the order of the constraint set is permutable at each pass through EVAL. The next tableaux illustrate a SV derivation. At the first step, ranking *VOICE above IDENT(voice) favors those candidates in which one of the voiced stops has devoiced. The global candidate [tata] is not among the candidates generated at the first step of the derivation because of gradualness.

Tableau 36: Step 1: /dada/ → tada

	/dada/	*VC	ID(vc)
a. ☞	tada	1	1
b. ☞	data	1	1
c.	dada	2 W	L

At the second step of the derivation the opposite total order of the constraint set, IDENT(voice) dominating *VOICE, forces convergence on the local variant [tada] or [data]. Ties like the one in tableau (36) are common in HS. If [tada] is taken as the optimal output, this form converges at the next step of the derivation.

Tableau 37: Step 2: convergence on tada

	/tada/	IDENT(voice)	*VOICE
a. ☞	tada		1
b.	dada	1 W	2 W
c.	tata	1 W	L

In Kimper [2011], two case studies of local variation are analyzed, namely variation in phrasing in Bengali, and schwa deletion in French. With respect to global variation, labial (de)voicing in Warao is considered. Two strong predictions follow from SV. The first one is that local variation is predicted to exist in SV only when a process is monotonic, meaning that it cannot be altered after being created. Bengali minor phrase creation and schwa deletion in French are cases of local variation because both involve monotonic metrical foot building (see Pruitt 2010 for arguments in favor of monotonicity in foot structure building). Monotonicity can be modeled by a universal inviolable principle on GEN or by the activity of a top-ranked faithfulness constraint. Second, global variation is also predicted in SV, but only when opposing markedness constraints are in a partial ranking but both dominate a faithfulness constraint. In these cases, convergence on locally variable forms is thus not possible. This is the case of labial (de)voicing in Warao, which shows global variation in which two markedness constraints, *VOICE and *p, which militates against voiceless labial stops, are partially ranked and both dominate IDENT(voice) (see Kimper 2011 for more details).

Foot parsing (Pruitt 2010)

Pruitt [2010] argues that HS yields a more restrictive typology of stress patterns than POT does. It is claimed that GEN is only able to build one headed foot at a time. This view of GEN causes the global optimization of stress patterns to be blocked during the course of the derivation, thus excluding unattested patterns in which metrification is globally harmonized. One example of this sort comes from left-to-right trochee languages, which allow monosyllabic feet with heavy syllables only at the right edge of the parse, but not in other positions, as can be seen in 6, where H stands for a heavy syllable, and σ stands for either a light or heavy syllable.

(6)

σσσσH	(ˈσσ)(ˈσσ)(ˈH)
σσσσL	(ˈσσ)(ˈσσ)L
σσσσ	(ˈσσ)(ˈσσ)

The system represented in (6) is derived from the following constraint ranking: TROCHEE, FOOT-BINARITYμ ≫ PARSE-SYLLABLE ≫ ALLFEETLEFT ≫ ALLFEETRIGHT, FOOT-BINARITYσ. In Pruitt [2010], FOOT-BINARITYμ is violated by every foot containing less than two moras. That constrait ranking can be applied to derive the stress pattern of a three-syllable word HLL in a language like Wergaia. At the first step of the derivation, candidate (a) in tableau (38) is more harmonic than candidate (b) because the former minimally violates PARSE-SYLLABLE. Candidate (c) is ruled out because ALLFEETLEFT (ALLFTL) dominates ALLFEETRIGHT (ALLFTR), then triggering left-to-right parsing. The result is a local minimum of harmonic improvement where the first two syllables HL are parsed together.

Tableau 38: Step 1: /delguna/ → (ˈdel.gu)na “to cure”

/delguna/ “to cure”		Ft-Binμ	Prs-Syll	AllFtL	AllFtR	Ft-Binσ
a. ☞	(ˈdel.gu)na		1		1	
b.	(ˈdel)gu.na		2 W		2 W	1 W
c.	del(ˈgu.na)		1	1 W	L	

Candidate (b) at the second step of the derivation in tableau (39), with a word-final monosyllabic feet (ˈL), is not selected as the winning candidate because Foot-Binarityμ dominates Parse-Syllable. The final output is (ˈHL)L, in which the last syllable is left unparsed, predicting the right local pattern.

Tableau 39: convergence on (ˈdel.gu)na

/(ˈdel.gu)na/		Ft-Binμ	Prs-Syll	AllFtL	AllFtR	Ft-Binσ
a. ☞	(ˈdel.gu)na		1		1	
b.	(ˈdel.gu)(ˈna)	1 W	L	2 W	1	1 W

However, POT predicts an input like /HLL/ to be mapped as (ˈH)(ˈLL), in which metrification is globally harmonized in order to completely satisfy Parse-Syllable, as shown in tableau (40).

Tableau 40: POT analysis: /delguna/ → *(ˈdel)(ˈgu.na)

/delguna/		Ft-Binμ	Prs-Syll	AllFtL	AllFtR	Ft-Binσ
a. ☹	(ˈdel.gu)na		1		1	
b. ☞	(ˈdel)(ˈgu.na)		L	1 W	2 W	1 W
c.	(ˈdel.gu)(ˈna)	1 W	L	2 W	1	1 W
d.	del(ˈgu.na)		1	1 W	L	

Other phenomena such as iambic reversal and trochaic shortening are also analyzed in Pruitt [2010], in which it is also demonstrated that only HS predicts local patterns of metrification and excludes unattested patterns in which metrification is globally harmonized (see Pruitt 2010, 2011 for more details on metrical foot parsing in HS.)

1.4 Phonological opacity in HS

Phonological opacity challenges POT. In rule-based generative phonology in the tradition of Chomsky and Halle [1968], on the contrary, opacity is easily accommodated because phonological rules can be extrinsically ordered.

The concept of phonological opacity was first introduced by Kiparsky [1973] in the context of rule-based phonology. The quotation below states when a phonological rule is opaque.

> A phonological rule P of the form A → B / C _ D is opaque if there are surface forms with any of the following characteristics:
>
> 1. Instances of A in the environment C _ D.
> 2. Instances of B derived by P that occur in environments other than C _ D. (Kiparsky 1973:79)

The first clause refers to those cases in which a phonological rule underapplies (*i.e.*, it is non-surface-true). In underapplication, a phonological rule does not apply even though the structural description that makes that phonological rule applicable is met in the surface representation. This type of opacity is the result of a counterfeeding ordering relation, in which rule A, which feeds rule B, is extrinsically ordered after B. The following rule-based derivation exemplifies this situation with an example from Bedouin Arabic (McCarthy 2000).

(1) /badw/ → ba.du

/badw/	Underlying Representation
no change	raising (/a/ → i / _ CV) - rule B
badu	glide vocalization (/w/ → u / _ #) - rule A
[ba.du]	Surface Representation

In fact, the rule of glide vocalization changing /w/ to [u] introduces the structural description, _ CV, that would make the rule of *a*-raising applicable. But it is too late for *a*-raising to apply when the structural description is met because the rules present a counterfeeding ordering relation.

The second clause refers to those cases in which a phonological rule overapplies (*i.e.*, it is non-surface apparent). In overapplication, a phonological rule applies even though the structural description that makes that rule applicable is not met in the surface representation. This type of opacity is the result of a counterbleeding order, in which rule A, which bleeds rule B, is extrinsically ordered after B. The following example is from Hebrew (McCarthy 2000).

(2) /deʃʔ/ → deʃe

/deʃʔ/	Underlying Representation
deʃeʔ	*e*-epenthesis (Ø → e / ʃ _ ʔ) - rule B
deʃe	*ʔ*-deletion (ʔ → Ø / _ #) - rule A
[deʃe]	Surface Representation

The effect of the *ʔ*-deletion rule would make the rule of *e*-epenthesis unapplicable, but deletion applies too late in the derivation. The rule of *e*-epenthesis has already had the chance to apply before *ʔ*-deletion wipes out the structural description that made *e*-epenthesis applicable.

One of the first works trying to accommodate phonological opacity in terms of HS is that of McCarthy [2000]. He argues that HS is not an adequate theory of phonological opacity despite its similarities with rule-based derivational phonology. The two types of opacity exemplified with the Bedouin Arabic and Hebrew examples are proved to be underivable in HS, which selects as the most harmonic candidates the transparent ones. Tableaux (41), (42), and (43) illustrate the whole HS derivation of the input /badw/, which exemplifies the case of counterfeeding opacity. The constraints used have been simplified for the sake of clarity. There are two markedness constraints, one against word-final [w], *w#, and the other one against [a] in open syllables followed by a CV syllable, *a.CV. The two faithfulness constraints militate against changing /w/ to [u], *w → u, and /a/ to [i], *a → i. To get glide vocalization, the markedness constraint *w# must dominate the faithfulness constraint *w → u, and to get raising, the markedness constraint *a.CV must dominate the faithfulness constraint *a → i. At the first step of the derivation, only three candidates are generated. The candidate *bi.du* cannot be generated at the first step of the derivation because it is the result of applying more than one operation, namely glide vocalization and raising. The markedness constraint *w# must also dominate the other markedness constraint *a.CV to select *ba.du* as the most harmonic candidate at the first step. The rest of the candidates fatally violate top-ranked *w#. At the second step of the derivation, the winning candidate at step 1 is fed back to Gen as a new input for evaluation. Harmony can be improved by selecting *bi.du* as the most harmonic candidate, because the markedness constraint *a.CV dominates the faithfulness constraint *a → i. At step 3, the derivation converges on the fully faithful candidate *bi.du, which harmonically bounds the rest of competitors. In any case, this is the undesired transparent form.

Tableau 41: Step 1: /badw/ → ba.du

	/badw/	*w#	*w → u	*a.CV	*a → i
a. ☞	ba.du		1	1	
b.	bi.dw	1 W	L	L	1 W
c.	badw	1 W	L	L	

Tableau 42: /ba.du/ → bi.du

	/ba.du/	*w#	*w → u	*a.CV	*a → i
a. ☞	bi.du				1
b.	ba.du			1 W	L
c.	badw	1 W			L

Tableau 43: convergence on bi.du

	/bi.du/	*w#	*w → u	*a.CV	*a → i
a. ☞	bi.du				
b. ☹	ba.du			1 W	
c.	bidw	1 W			

In McCarthy [2007a], it is argued that some cases of counterfeeding opacity can be implemeted in POT by resorting to faithfulness constraints that prohibit certain unfaithful mappings. However, in order to deal with the whole range of counterfeeding opacity a typologically unsupported new theory of faithfulness constraints would be needed. McCarthy [2009] presents a specific case of counterfeeding opacity in Bedouin Arabic as an example of that. In Bedouin Arabic, there is a rule of *a*-raising when this vowel is the nucleus of a light syllable. This rule feeds another rule of *i*-deletion when this vowel is also in a light syllable. But if [i] is derived from /a/, then *i*-deletion is blocked, meaning that *i*-deletion counterfeeds *a*-raising. The unfaithful mapping /i/ → Ø can be protected by a specific Max-a constraint. The activity of this constraint is to block *i*-deletion only in those cases where [i] is derived from /a/, but it is vacuously satisfied elsewhere. This can be seen in tableau (44).

Tableau 44: Step 1: /dafaʕ/ → di.faʕ

	/dafaʕ/	Max-a	*a.CV	*i.CV	Id(low)	Max-V
a. ☞	di.faʕ			1	1	
b.	dfaʕ	1 W		L	L	1 W
c.	da.faʕ		1 W	L	L	

According to McCarthy [2000], HS also fails in deriving cases of counterbleeding opacity. The next tableaux show the whole HS derivation of the input /deʃʔ/, which exemplifies a case of counterbleeding opacity. The constraints used in the tableaux below are the following: the markedness constraint *ʃʔ dominates the faithfulness constraint Dep-e to account for *e*-epenthesis between ʃʔ sequences; and the markedness constraint *ʔ# dominates the faithfulness constraint Max-ʔ to get word-final *ʔ*-deletion. At the first step of the derivation, the most harmonic candidate is the one with *ʔ*-deletion. The desired winner [de.ʃe] is not among the generated candidates at step 1 because it is the result of applying more than one operation, namely *e*-epenthesis and *ʔ*-deletion. This candidate is only present at step 2 of the derivation, when it is too late for it to be optimal.

Tableau 45: Step 1: /deʃʔ/ → deʃ

	/deʃʔ/	*ʃʔ	*ʔ#	Dep-e	Max-ʔ
a. ☞	deʃ				1
b.	de.ʃeʔ		1 W	1 W	L
c.	deʃʔ	1 W	1 W		L

Tableau 46: Step 2: convergence on deʃ

	/deʃ/	*ʃʔ	*ʔ#	Dep-e	Max-ʔ
a. ☞	deʃ			L	
b. ☹	de.ʃe			1	
c.	deʃʔ	1 W	1 W	L	

As McCarthy [2000] points out, satisfaction of *ʃʔ will not trigger the Ø → e mapping because by only applying ʔ-deletion both of the two top-ranked markedness constraints are satisfied. The crucial point here is that the interaction between markedness and faithfulness constraints are not equivalent to rewrite rules of the type Ø → e / ʃ _ ʔ.

In sum, HS is not able to derive phonological opacity because of two consequences of its architecture: (a) the durability of the constraint hierarchy, which makes the derivation to converge when all the phonological processes have had the opportunity to apply in the case of counterfeeding opacity, or when an unfaithful mapping is only achievable at a further stage of the derivation in which is not harmonically improving in the case of counterbleeding opacity; and (b) the interaction between markedness and faithfulness constraints in OT evaluation, which do not mirror the effects of rewrite language-particular phonological rules.

Nevertheless, McCarthy [2000] states that some cases of counterbleeding opacity can be accounted for in HS if Gen is assumed to show the same restrictions that were proposed in autosegmental phonology. In autosegmental phonology, some phonological processes were reduced to a basic set of operations like insertion, deletion, and spreading of autosegmental features and association lines. In HS, this line of research has proved to be very successful in a vast array of phonological phenomena that have been discussed before in this chapter. If Gen operations are able to be decomposable into more primitive operations, counterbleeding opacity can be derived in HS because satisfying both of the top-ranked markedness constraints involved in counterbleeding interactions cannot be done at once, allowing the unfaithful mapping which is parallel to the bled phonological rule to apply first, as happens in rule-based derivations. Trying to simulate rule ordering relations with constraint ranking by looking closely at the nature of GEN is the right strategy to follow if one desires to accommodate counterbleeding opacity in HS. Counterfeeding opacity, by contrast, seems harder to make implementable in HS.

In chapter 2, I present a novel theory of serial syllabification in HS that aims to explain specific cases of phonological opacity emerging from the interaction between prosodification and morphology, and specific cases of opaque mora preservation.

Chapter 2

A theory of serial syllabification in HS

Abstract

This chapter develops a theory of serial syllabification in HS. It presents a set of syllable formation operations that apply one at a time and directionally. This set of syllable-building operations allows for the creation of both unary and binary syllabic configurations that can be either moraic or not, giving rise to minor, moraless syllables. The possibility of inserting a mora or not, but also the possibility of inserting a label C(oda) or not, generates fully specified syllabic configurations that will be proved to account for asymmetries in vowel epenthesis placement (illustrated by Iraqi and Cairene Arabic). Then a reformulation of the faithfulness constraint DEP-μ in the light of HS will be also demonstrated to solve some pathologies regarding unattested contrastive moraicity in coda consonants and unattested tautomorphemic contrastive syllabification. At the end, a theory that derives the domain of syllabification depending on how a string of input segments is prosodified during the derivation will be presented, which is based on the idea that two adjacent segments cannot be parsed together by some syllable formation operation if one of them, but not the other, is contained in a prosodic constituent higher than the syllable, and there is no other higher prosodic

constituent dominating both segments, meaning that prosodic boundaries define domains for syllabification that can be altered during the course of a HS derivation. This idea makes sense if both bottom-up and top-down prosodification are allowed in HS when motivated by a language-particular ranking of prosody-enforcing markedness constraints of the Parse type and prosody-morphology alignment constraints. The ideas developed in this chapter will be used in chapters 3, 4, 5, and 6, which deal with specific cases of opacity in which prosodification is involved.

2.1 How syllables enter prosodic structure in HS

2.1.1 Prosodic tier assumptions

Background

Different theories of the prosodic tier have been discussed in theoretical phonology at length: CV-theory (McCarthy 1979 and others), X-theory (Levin 1985, Lowenstamm and Kaye 1986), and Moraic Theory (Hyman 1985, McCarthy and Prince 1986, Hayes 1989). Both CV-theory and X-theory are characterized as *segmental* prosodic theories by Hayes [1989] because the number of prosodic elements, either skeletal C and V units or X units, directly correspond to the number of segments. Moraic Theory, on the other hand, does not represent prosodic units depending on the number of segments, but instead these prosodic units, moras, differentiate between light syllables, containing just one mora, and heavy syllables, containing two moras. Another crucial difference between X-theory and both CV-theory and Moraic Theory is that only the former incorporates a rich hierarchical syllable structure. In X-theory, every X unit is labeled as being an Onset (O), a Nucleus (N), or a Coda (C). N and C create a constituent Rhyme (R), and O and R create a constituent σ.

A light syllable, heavy syllable, and closed syllable are represented in CV-theory as in (1).

(1) (a)

CV-tier	C	V	
segmental tier	t	a	

(b)

CV-tier	C	V	V
segmental tier	t	aː	

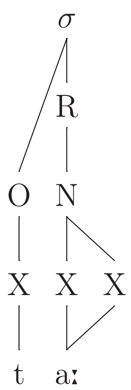
(c)

CV-tier	C	V	C
segmental tier	t	a	t

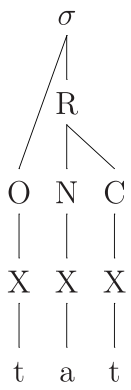
The same syllabic configurations are represented in X-theory as in (2).

(2) (a)

(b)

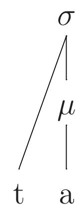


(c)

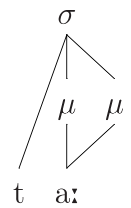


In (3), the same syllabic configurations are represented under Moraic Theory. In moraic representations, as noted above, the number of segments does not correspond to the number of prosodic units, in this case moras. I follow Hayes [1989] in regarding coda consonants that are not weight-contributing as directly dominated by the head mora dominating the syllabic nucleus.

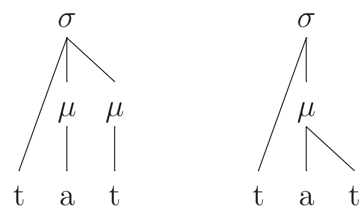
(3) (a)



(b)



(c)



To sum up, syllables linked to one mora are universally light, and open syllables linked to two moras (with a long vowel as its nucleus) are universally heavy. Syllables closed by a coda consonant are subject to parametrization:

some languages, such as Latin, treat them as heavy, whereas other languages, like Lardil, treat them as light (see Hayes 1989). It follows from this assumption that rhymal segments (nuclei and coda consonants) are always immediately dominated by moras, whereas onset consonants are always dominated by the syllable node, and therefore they are universally weightless. In some cases, I will make use of the following notational system: parentheses mark syllable boundaries, subscript <$_\mu$> stands for a mora linked to the preceding segment, regular <μ> between two segments stands for a shared mora, and superscript <$^\mu$> stands for a floating mora, meaning that it is not linked to any segment. These representations are shown in (4).

(4) Notational conventions

light (monomoraic) σ	(CV$_\mu$)
open heavy (bimoraic) σ	(CV$_{\mu\mu}$)
closed heavy (bimoraic) σ	(CV$_\mu$C$_\mu$)
closed light (monomoraic) σ	(CVμC)
light (with a floating μ) σ	(CV$^\mu$)

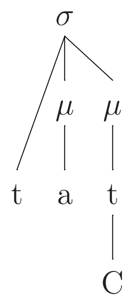
An enriched version of moraic representations

In this dissertation, I propose a slight modification of moraic representations based on those in Hayes [1989]. This representational modification of Moraic Theory finds justification in the light of HS, as will be argued in the next subsections of this chapter. As already noted, in Hayes [1989] both weight-contributing coda consonants and weightless coda consonants are directly dominated by a mora, but never by a syllable. The difference between weighted coda consonants and weightless ones lies in the status of the mora which directly dominates them. Only in the case of weight-contributing coda consonants is the mora not branching. Weightless coda consonants thus share the mora that is projected by the syllabic nucleus.

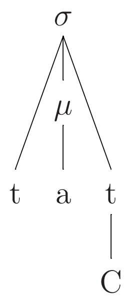
I propose to introduce the label Coda (C) below the root node in a separate tier, and consequently to represent weightless coda consonants as segments immediately dominated by the syllable node.

Coda consonants under this view result in the moraic representations in (5).

(5) (a) Weight-contributing coda consonant:



(b) Weightless coda consonant:



I will argue that in a model of HS in which degenerate, minor syllables (*i.e.*, nucleusless syllables) are allowed, ascribing a specific subsyllabic structural interpretation to minor syllables is necessary. During a HS derivation, Con must be able to evaluate minor syllables as corresponding to a nucleusless onset, or a nucleusless coda. Only by introducing the label C does this become possible. I will demonstrate that it is necessary to enrich moraic syllabic representations with only the label C because Con itself cannot predict the location of epenthetic vowels as a strategy to satisfy markedness constraints against minor syllables.

2.1.2 Syllable formation operations

Gradualness

Two different views with respect to syllabification are plausible in HS. In one of them, rooted in a faithfulness-based definition of gradualness, syllable-building operations are not subject to the gradualness requirement on Gen because one single modification is defined in terms of one single violation of a basic faithfulness constraint (McCarthy 2007a). This means that gradual operations must be unfaithful mappings. This definition of gradualness is given in (6).

(6) **Faithfulness-based definition of gradualness**

Candidates differ from their input only by the application of one unfaithful mapping.

Given that syllabification is never contrastive in tautomorphemic sequences in a given language, faithfulness constraints protecting syllabification must be excluded from CON (Blevins 1995, Clements 1986, Hayes 1989, McCarthy 2003). It follows from this that syllabification must be evaluated in parallel and accomplished simultaneously with another single operation without disrespecting gradualness (McCarthy 2009, Elfner to appear, Pruitt 2010). In contrast to syllabification, metrification does count as a single modification under the faithfulness-based definition of gradualness because it can be contrastive. Metrical foot building is thus an unfaithful mapping that violates a constraint like IDENT(stress), as in McCarthy [2008c], or DEP-PROMINENCE, as in Elfner [to appear].

The other approach to syllabification derives from an operation-based definition of gradualness, in which all prosody-building operations, including syllabification, count as an autonomous operation (Elfner 2009, Pater 2012, Jesney to appear). This definition of gradualness is given in 7.

(7) **Operation-based definition of gradualness**

Candidates differ from their input only by the application of one phonological operation.

Under this view, syllabification cannot co-exist with other phonological operations within the same candidate set. I will not discuss here whether syllables are built one at a time (Elfner 2009, Pater 2012), or whether whole syllabification of the entire input string is achieved in a single step (Jesney to appear).

Here I argue that Gen performs syllable-building operations in a step-wise manner, that is, one syllable at a time. These syllable-building operations are autonomous operations that cannot co-occur with other prosody-building or feature-changing phonological operations.

Gen's operations (Elfner 2009)

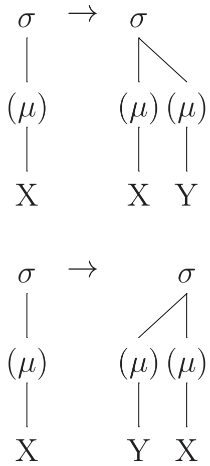
My starting point is the theory of serial syllabification in HS proposed in Elfner [2009] and I then develop a novel theory based on it. Elfner [2009] proposes a set of three basic syllable formation operations, listed in (8).

(8) Elfner [2009]'s syllable formation operations in HS

- *Project syllable*: from a segment *X*, create a syllable (X), where *X* can be either moraic, (X_μ), or not (X).

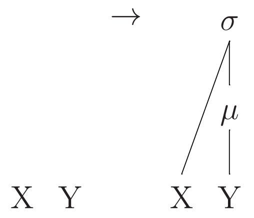
$$\mathrm{X} \quad \rightarrow \quad \begin{array}{c}\sigma\\ |\\ (\mu)\\ |\\ \mathrm{X}\end{array}$$

- *Adjunction*: given a syllable (X_μ) or (X), adjoin a segment Y, where Y can be moraic or not, to the right (coda adjunction) or to the left (onset adjunction).[1]



[1] The operation of adjunction allows for moraic onsets. Typologically, moraic onsets do not seem to exist (but see Topintzi 2006). The fact that moraic onsets can be generated given the existence of an operation of adjunction of a moraic consonant to the left of an already syllabified moraic nucleus does not necessarily mean that a HS grammar predicts moraic onsets if there are universal constraints against them. The operation of adjunction is thus not precisely an instance of a duplication problem, whereby the same generalization is stated twice in the grammar (in both GEN and CON). CON should suffice to discard moraic onsets. Moreover, the possibility of adjoining a moraic consonant to the left of an already existing onsetless moraic syllable is always harmonically bounded at previous derivational steps by those candidates undergoing core syllabification.

- *Core syllabification*: from adjacent segments X and Y, create a binary syllable (XY_{μ}), where X is the dependent and Y the moraic head.[2]



Gen's operations after Elfner [2009]

In the theory of serial syllabification in HS presented here, Gen, when performing syllable-building operations, allows for choosing (a) the number of segments to operate with (up to two segments), (b) the insertion or not of a mora, and (c) the insertion or not of the label C, which depends on directionality (only right-to-left syllabification forces Gen to insert the label C).

Moreover, Gen specifies an inherent unviolable principle that constrains binary syllable formation operations, which I call the *structural adjacency principle of binary syllable formation operations*, defined in (9).

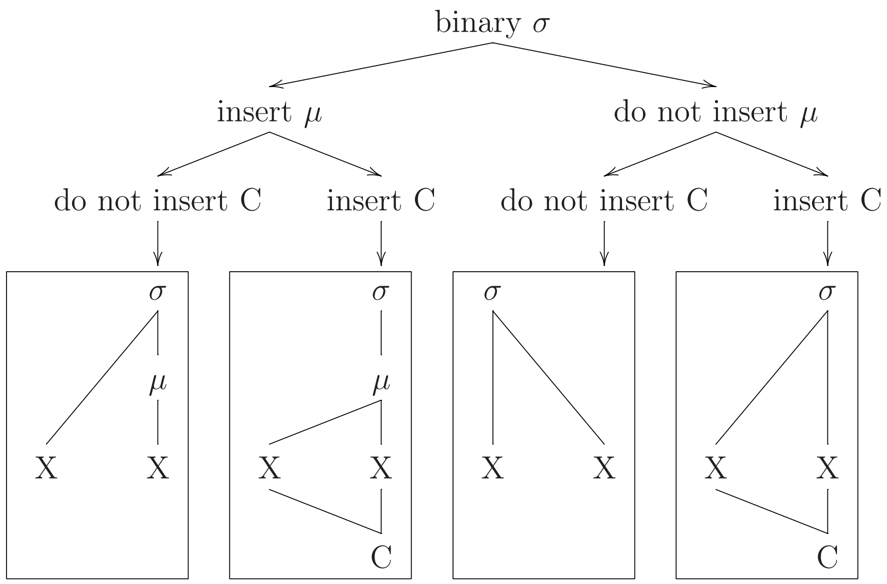
(9) *Structural adjacency principle of binary syllable formation operations*

Gen cannot create syllables in which segments do not belong to the same subsyllabic constituents (*i.e.*, if two segments are parsed simultaneously, one of them cannot be an onset and the other one a coda, for instance.)

[2] Elfner [2009] argues that core syllabification is necessary in order to discard unattested stress assignment patterns. Her argument is as follows. Consider a ranking in which Parse-Segment dominates Onset and Onset dominates No-Coda. Without core syllabification, an input like /pata/ would be mapped as (pat)(a). Although it is true that a later derivational step would be able to resyllabify the coda as the onset of the following syllable, HS would be able to predict a language where the placement of stress is sensitive to the presence of onset consonants if stress assignment precedes resyllabification. For instance, in a hypothetical language with final stress except in the presence of a heavy syllable, and with the ranking Parse-Segment $\gg$ Onset $\gg$ No-Coda, /pata/ might be stressed as (pá)(ta) because stress would be assigned to the intermediate form (pát)(a), and /paa/ might be stressed as (pa)(á). Elfner [2009] points out that a stress system like this does not seem to occur.

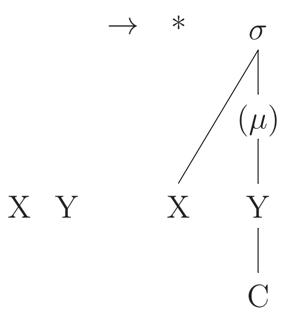
According to this restrained GEN, different syllabic configurations can be generated from unparsed segments depending on the number of segments with which GEN operates, the possibility of inserting a mora or not, and also the insertion of the label C or not. If a binary syllable is built, the syllabic configurations in (10) are generated by GEN.

(10) Binary syllable formation operations



According to the *structural adjacency principle* stated in (9), it is not possible to obtain a binary syllable (xy) if x is dominated by the syllable node and y is parsed as a coda. This way, GEN cannot build a syllable like the one in (11).

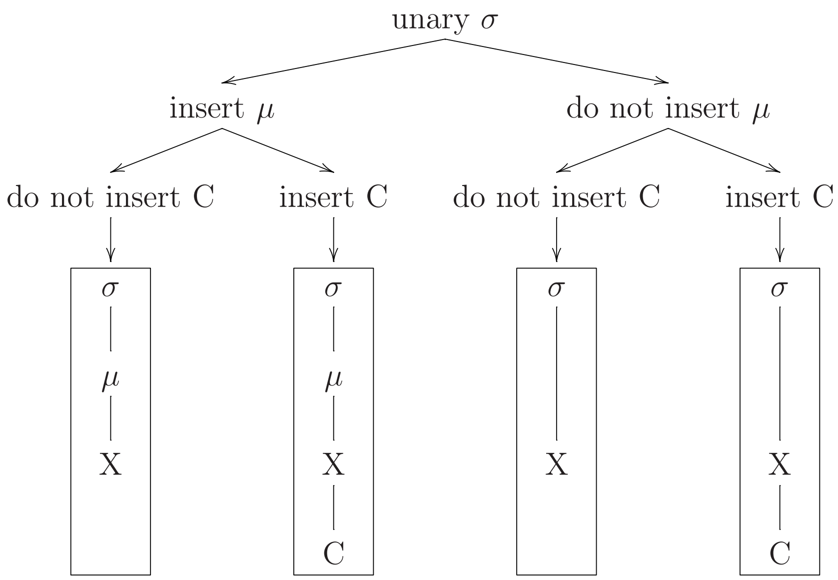
(11) Structural adjancency principle-violating syllabic configuration



This type of configuration can only be generated as the result of a two-step process of first unary syllable formation operation and then adjunction to the left (as in Elfner 2009).

With regard to unary syllable-building operations, the syllabic configurations in (12) are generated.

(12) Unary syllable formation operations



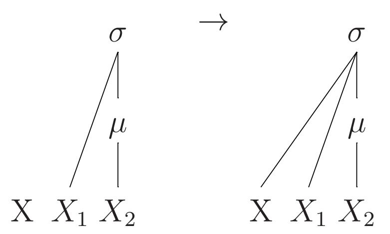
As can be seen in (10), if GEN operates with two segments and inserts a mora, a core syllable is built. This operation is also present in Elfner [2009]'s theory of serial syllabification. However, in two different situations, that is, in the absence of a mora, and in the presence of the label C regardless of the presence or not of a mora, a degenerate, minor syllable is obtained. I will refer to these syllabic configurations as binary and unary minor syllables. The introduction of the label C is necessary to ensure that minor syllables are unambiguous. CON does not suffice to disambiguate minor syllables when they are fixed. One could think that a final ascription of minor syllables as nucleusless onsets or nucleusless codas depends on the language-particular constraint hierarchy and the way these minor syllables are fixed during the derivation. But, as will be argued, CON must be able to evaluate these binary minor syllables either as complex onsets or complex codas on a language-particular basis prior to fixing them.

Adjunction, as defined in Elfner [2009], is maintained in this proposal. The effect of this operation is to adjoin an unparsed segment to an already existing syllable to the left or the right edge of that syllable, with or without mora. In fact, a moraic or a non-moraic segment can be adjoined to any of the eight syllabic configurations shown in (10) and (12). As a matter of illustration, I give in (13) some possible outcomes if adjunction applies to binary syllables. The adjoined segment appears without subscript in the representations in (13) for the sake of clarity.

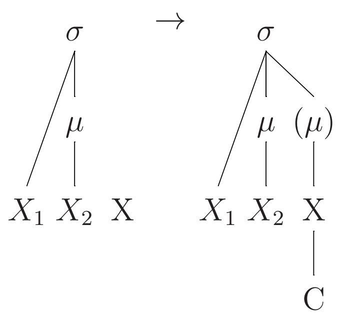
As illustrated in (13), adjunction to the left of an already existing core syllable results in a syllable containing a complex onset. The adjunction of a coda is thus only possible if the segment is adjoined to the right of the nucleus. In this case, given that the segment is adjoined at the right of a syllabic nucleus, the insertion of the label C is mandatory.[3]

(13) Outcomes of adjunction after applying binary syllable formation operations

Binary syllable with mora + adjunction to the left



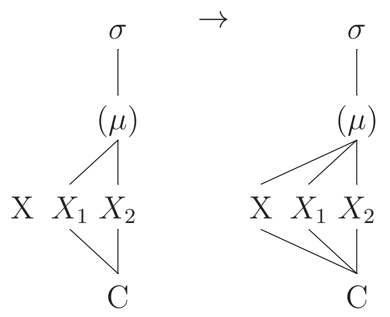
Binary syllable with mora + adjunction to the right (with or without mora)



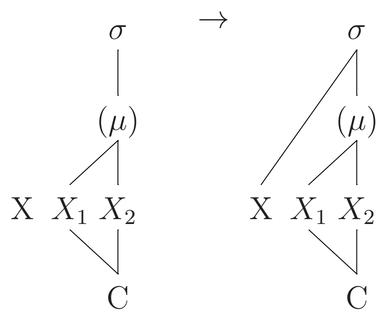
[3]In this case, the label C is clearly redundant. But, as will be argued later on for other cases, the label C is necessary to ascribe a structural interpretation to both binary and unary minor syllables in the course of a HS derivation.

Adjunction to a binary minor syllable of a segment labeled as C can result in a three-consonant complex coda, as illustrated in (14). Adjunction can also link the segment to the syllable node, but not to C, thus creating a three-segment minor syllable with a single onset and a complex two-segment coda.

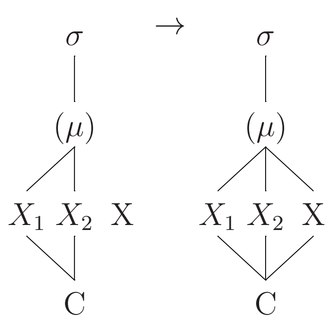
(14) *Binary minor syllable (with or without mora and labeled as C)* + adjunction to the left and to C



Binary minor syllable (with or without mora and labeled as C) + adjunction to the left but not to C

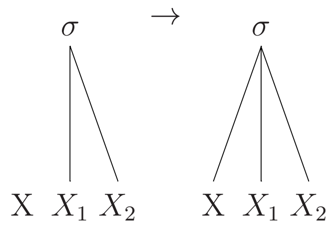


Binary minor syllable (with or without mora and labeled as C) + adjunction to the right

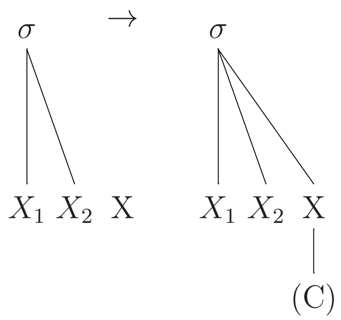


Adjunction to the left of a binary minor syllable not labeled as C results in a three-consonant complex onset, as illustrated in (15). However, if adjunction applies to the right, there is the possibility of inserting the label C. If this is the case, the configuration obtained is a three-segment minor syllable containing a complex onset and a coda. This type of syllabic configuration and the second one in (13) do not violate the inherent property of Gen which I have called *structural adjancency principle* because this principle only refers to binary syllable-building operations. It is not a principle applying to configurations derived by an adjunction operation.

(15) *Binary minor syllable not labeled as C* + adjunction to the left



Binary minor syllable not labeled as C + adjunction to the right (with or without the label C)



In the next subsection, I will present the set of constraints responsible for evaluating syllable structure in this model of serial syllabification in HS. After that, some of the proposed Gen operations will be justified in the light of vowel epenthesis placement in Cairene and Iraqi Arabic. Other issues will be justified in the last four chapters.

2.1.3 Con

What drives syllabification in HS could be a markedness constraint like Parse-Segment (Prs-Seg) (Prince and Smolensky 1993/2004, Elfner 2009), requiring every segment to be associated with some syllable, or it could be an inherent feature of Gen. Throughout this dissertation, I will assume that syllabification is enforced by the satisfaction of the markedness constraint Parse-Segment. Some problems regarding ranking permutation of this constraint will be addressed later. The way an unparsed string of input segments is syllabified depends on the following standard markedness constraints on syllable well-formedness.

(16) Standard markedness constraints on syllable well-formedness

Onset (Ons): assign one violation mark for every onsetless syllable.

No-Coda: assign one violation mark for every syllable containing a coda.

*Complex-Onset (*Compl-Ons): assign one violation mark for every syllable containing a complex onset.

*Complex-Coda(*Compl-Coda): assign one violation mark for every syllable containing a complex coda.

Syllable-Contact (Syll-Cont): assign one violation mark for every flat or rising intersyllabic contact. (Gouskova 2004)

Sonority-Sequencing (Son-Seq): assign one violation mark for every offending intrasyllabic sonority profile. (Clements 1990)

All Gen-generated syllabic configurations but those with a moraic syllabic nucleus violate the markedness constraint Syllable-Head, which assigns as many violation marks as nucleusless syllables. This constraint is defined below.

(17) Syllable-Head

Assign one violation mark for every minor (*i.e.*, nucleusless) syllable. (Elfner 2009)

Apart from this constraint, binary minor syllables also violate *COMPLEX and are thus susceptible to violating SONORITY-SEQUENCING. In chapter 5, I will argue in favor of different split versions of SONORITY-SEQUENCING relativized to refer exclusively to binary minor syllables.

Following Elfner [2009], I will adopt the idea that SYLLABLE-HEAD is satisfied by means of epenthesis. Inserting an epenthetic nuclear segment, which correlates with a DEP-V faithfulness violation, is preceded in such cases by a minor syllable-building operation.

Now I will briefly illustrate different syllable-building derivations from an input /CVC/. I focus on the relevant constraints presented so far. The label C is not used in these cases for the sake of clarity.

At the first step of a HS derivation, no matter the constraint hierarchy, a core syllable is always created, $(CV_{\mu})C$. This is the most harmonic candidate under any permutation of the constraint set, because the candidate $(CV_{\mu})C$ harmonically bounds all the other potential candidates, as can be seen in tableau (47).

Tableau 47: Step 1: /CVC/ → (CV$_{\mu}$)C

/CVC/	Syll-Head	Prs-Seg	Max-C	Dep-V	No-Coda
a. ☞ σ μ C V C		1			
b. σ μ C V C		2 W			
c. C V		2 W	1 W		
d. C V C		3 W			
e. σ C V C	1 W	2 W			

A language that exhaustively parses /CVC/ as (CVμC) ranks Parse-Segment, Max-C and Dep-V above No-Coda. At step 2, coda adjunction is the most harmonic candidate under that constraint hierarchy, as seen in tableau (48).

Tableau 48: Step 2: /(CV$_{\mu}$)C/ $\rightarrow$ (CVμC)

σ μ C V C	Syll-Head	Prs-Seg	Max-C	Dep-V	No-Coda
a. ☞ σ μ C V C					1
b. σ μ C V			1 W		L
c. σ μ C V C		1 W			L
d. σ σ μ C V C	1 W				L

The derivation converges at the next step of the derivation, as illustrated in tableau (49).

Tableau 49: Step 3: convergence

	SYLL-HEAD	PRS-SEG	MAX-C	DEP-V	NO-CODA
a. ☞ 					1
b. 			1 W		L
c. 		1 W			L

Languages in which codas are prohibited and this is enforced by deletion are derived by ranking NO-CODA over MAX-C, the rest of the ranking being equal. This is illustrated in tableau (50), which illustrates the second step of the derivation after the application of core syllabification.

Tableau 50: Step 2: /(CV$_\mu$)C/ → (CV$_\mu$)

σ μ C V C	Syll-Head	Prs-Seg	Dep-V	No-Coda	Max-C
a. ☞ σ μ C V					1
b. σ μ C V C				1 W	L
c. σ μ C V C		1 W			L
d. σ σ μ C V C	1 W				L

Finally, languages in which codas are prohibited and this is enforced by vowel epenthesis are derived by parsing Parse-Segment, No-Coda and Max-C above Syllable-Head, and Syllable-Head above Dep-V. Tableax (51) and (52) illustrate a derivation in which first a minor syllable is created, and next the minor syllables are fixed by means of vowel epenthesis, represented as [i] in tableau (52).

Tableau 51: Step 2: /(CV$_{\mu}$)C/ → (CV)(C)

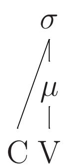
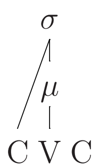
	Prs-Seg	Max-C	No-Coda	Syll-Head	Dep-V
a. ☞ 				1	
b. 			1 W	L	
c. 		1 W		L	
d. 	1 W			L	

Tableau 52: Step 3: /(CV$_\mu$)(C)/ → (CV$_\mu$)(Ci)

σ σ μ C V C	Prs-Seg	Max-C	No-Coda	Syll-Head	Dep-V
a. ☞ σ σ μ μ C V C i					1
b. σ σ μ C V C				1 W	L
c. σ μ C V		1 W			L
d. σ μ C V C	1 W				L

2.2 Directional syllabification and vowel epenthesis placement: the case of Iraqi and Cairene Arabic

The effects of directional syllabification in POT have been attributed to the effect of alignment constraints requiring the left or right edges of every syllable to coincide with the left or right edges of some prosodic word.

In Mester and Padgett [1994], the asymmetry observed between Iraqi and Cairene Arabic with respect to vowel epenthesis placement is interpreted as the result of satisfying either ALIGN-Left (σ, Prosodic Word) or ALIGN-Right (σ, Prosodic Word). Vowel epenthesis placement is thus the result of directional structure-building algorithms that apply in a step-wise fashion scanning the string of segments from one end of the word to the opposite end (Itô 1986). Under the theory of syllabification in HS presented here, the same kind of structure-building algorithm is needed, given that syllables are built one at a time. Before explaining how to obtain such results, I will first summarize the proposal made in Mester and Padgett [1994] within POT.

In Mester and Padgett [1994], both alignment constraints ALIGN-Left (σ, Prosodic Word) and ALIGN-Right (σ, Prosodic Word) are evaluated gradiently. Their violation marks can be computed by counting either the number of moras or the number of segments that stand between some edge of every syllable and some designated prosodic word edge. I will count segments in the analyses below. In these varieties of Arabic, underlying CCC clusters are prohibited and they are broken up by means of vowel epenthesis. Vowel epenthesis placement is attributed to the ranking ALIGN-Left (σ, Prosodic Word) $\gg$ ALIGN-Right (σ, Prosodic Word) in Iraqi Arabic to get epenthesis between the first and the second consonant of the cluster, [CiCC], or to the opposite ranking ALIGN-Right (σ, Prosodic Word) $\gg$ ALIGN-Left (σ, Prosodic Word) in Cairene Arabic to get epenthesis between the second and the third consonant of the cluster, [CCiC]. This asymmetry is exemplified in (1).

(1) Iraqi Arabic (Mester and Padgett 1994)

/gil-t-la/ $\rightarrow$ [gi.lit.la] "I said to him"

Cairene Arabic (Mester and Padgett 1994)

/ʔul-t-lu/ $\rightarrow$ [ʔul.ti.lu] "I said to him"

In tableau (53), candidate (a) violates seven times the alignment constraint ALIGN-Left (σ, Prosodic Word). The first syllable is perfectly aligned with the left edge of the prosodic word, the second syllable introduces two violation marks because two segments stand between the left edge of the second syllable and the left edge of the prosodic word, and the third syllable adds five more violation marks because five segments stand between the left edge of the third syllable and the left edge of the prosodic word. Candidate (b), however, fatally violates ALIGN-Left (σ, Prosodic Word) because the first syllable contains one more segment. The reverse ranking in tableau (54) produces the opposite result.

Tableau 53: Iraqi Arabic

/CVCCCV/		AL-L(σ,PWd)	AL-R(σ,PWd)
a. ☞	σ σ σ μ μ μ μ C V C i C C V	7	7
b.	σ σ σ μ μ μ μ C V C C i C V	8 W	6 L

Tableau 54: Cairene Arabic

/CVCCCV/		AL-R(σ,PWd)	AL-L(σ,PWd)
a. ☞	σ σ σ μ μ μ μ C V C C i C V	6	8
b.	σ σ σ μ μ μ μ C V C i C C V	7 W	7 L

If ALIGN-Left (σ, Prosodic Word) dominates ALIGN-Right (σ, Prosodic Word), syllable boundaries stand as close to the left edge of the prosodic word as possible, and if ALIGN-Right (σ, Prosodic Word) dominates ALIGN-Left (σ, Prosodic Word), syllable boundaries stand as close to the right edge of the prosodic word as possible.

In the version of HS defended in this dissertation, however, syllables are built one at a time, and left-to-right or right-to-left parsing is not the result of global optimization, but must proceed derivationally as a directional algorithm. It is plausible to attribute directionality effect in HS to the satisfaction of one of the alignment constraints proposed in Mester and Padgett [1994]. But in HS, the traditional formulation of these alignment constraints has undesirable consequences if the alignment constraint dominates the syllable enforcing constraint PARSE-SEGMENT. The following two-step derivation shows an unattested typological pattern in which syllabification is blocked only when building a new syllable adds violations of the alignment constraint requiring every syllable to be aligned as much as possible to some designated edge of some prosodic word. I assume that the candidates in the tableaux below are parsed into prosodic words.

Tableau 55: Step 1: /CVCVCV/ → $(CV_{\mu})CVCV$

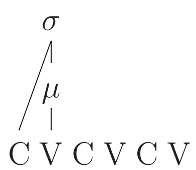
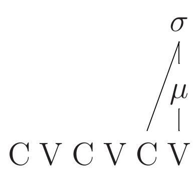
/CVCVCV/	AL-L(σ,PWd)	PRS-SEG	AL-R(σ,PWd)
a. ☞ 		4	4
b. 	4 W	4	L
c. C V C V C V		6 W	L

Tableau 56: Step 2: convergence on $(CV_{\mu})CVCV$

σ μ C V C V C V	AL-L(σ,PWd)	PRS-SEG	AL-R(σ,PWd)
a. ☞ σ μ C V C V C V		4	4
b. ☹ σ σ μ μ C V C V C V	2 W	2 L	6 W
c. σ σ μ μ C V C V C V	4 W	2 L	4
d. C V C V C V		6 W	L

At step 2, candidate (b) is ruled out because building a new syllable not perfectly aligned to the left edge of some prosodic word is always correlated with an alignment violation. If PARSE-SEGMENT is not top-ranked, then a language in which syllabification is blocked in order to satisfy an alignment constraint is predicted to exist. As far as I know, this pattern does not seem to exist. But given that prosodification is serially built in this verion of HS in which gradualness is operationally-based, it is legitimate to propose a reformulation of these alignment constraints by referring to unparsed segments instead of segments. This new definition is shown below.

(2) Align-Left/Right (σ, Prosodic Word) reformulated

Assign one violation mark for every unparsed segment that stands between the left/right edge of every syllable and the left/right edge of some prosodic word.

This definition makes sense in HS because intermediate inputs contain prosodic structure inherited from previous derivational steps. This way, candidate (b) in tableau (56) does not violate Align-Left (σ, Prosodic Word) because there is no unparsed segment standing between the left edge of the second syllable and the left edge of the prosodic word. However, candidate (c) is also ruled out under this new definition of Align-Left (σ, Prosodic Word) because there are two unparsed segments between the left edge of the second syllable and the left edge of the prosodic word. The problem is thus solved.

Taking as a starting point this new definition for this type of alignment constraint, some of the proposed Gen operations presented in (2.1.2) as well as the need for directional syllabification will be justified with the data from Iraqi and Cairene Arabic.

In Iraqi and Cairene Arabic, a markedness constraint *CCC must be top-ranked and dominate Dep-V in order to trigger vowel epenthesis as a response to break up a CCC consonantal cluster. First of all, I am going to show that Elfner [2009]'s constraints without alignment constraints are not enough the derive the asymmetry regarding vowel epenthesis placement between Iraqi and Cairene Arabic.

I will make use of the following constraints in the subsequent analysis.

(3) *Complex (*Compl):

Assign one violation mark for every syllable containing a complex onset or complex coda.

Parse-Segment (Prs-Seg):

Assign one violation mark for every segment that is not associated with any syllable.

Syllable-Head (Syll-Head):

Assign one violation mark for every minor (*i.e.*, nucleusless) syllable. (Elfner 2009)

No-Coda:

Assign one violation mark for every syllable containing a coda.

Dep-V:

Assign one violation mark for every vowel in the output that has no correspondent in the input.

From an input /CVCCCV/, at the first two steps of the derivation, two core syllables are built, yielding the intermediate form (CV)CC(CV), both in Iraqi and Cairene Arabic. This is so because building core syllables always harmonically bounds all the other potential candidates because PARSE-SEGMENT is maximally satisfied and no other markedness constraint is violated. In order to derive the Cairene pattern, in which the epenthetic vowel appears between the second and the third consonant, SYLLABLE-HEAD must dominate NO-CODA. This is illustrated in tableau (57).

Tableau 57: Step 3: /(CV$_\mu$)CC(CV$_\mu$)/ → (CV$_\mu$C$_\mu$)C(CV$_\mu$) Cair.

	/(CV$_\mu$)CC(CV$_\mu$)/	*COMPL	PRS-SEG	SYLL-HEAD	NO-CODA
a. ☞	(CV$_\mu$C$_\mu$)C(CV$_\mu$)		1		1
b.	(CV$_\mu$)(C)C(CV$_\mu$)		1	1 W	L
c.	(CV$_\mu$)CC(CV$_\mu$)		2 W		L
d.	(CV$_\mu$)C(CCV$_\mu$)	1 W	1		L

At the fourth step of the derivation, the unparsed segment is syllabified as a minor syllable because this is the only way to satisfy both *COMPLEX and PARSE-SEGMENT.

Tableau 58: Step 4: /(CV$_\mu$C$_\mu$)C(CV$_\mu$)/ → (CV$_\mu$C$_\mu$)(C)(CV$_\mu$) Cair.

	/(CV$_\mu$C$_\mu$)C(CV$_\mu$)/	*COMPL	PRS-SEG	SYLL-HEAD	NO-CODA
a. ☞	(CV$_\mu$C$_\mu$)(C)(CV$_\mu$)			1	1
b.	(CV$_\mu$C$_\mu$)C(CV$_\mu$)		1 W	L	1
c.	(CV$_\mu$C$_\mu$)(CCV$_\mu$)	1 W		L	1

At the next step of the derivation, the minor syllable is fixed by means of vowel epenthesis, meaning that SYLLABLE-HEAD must dominate DEP-V.

Tableau 59: Step 5: $/(CV_\mu C_\mu)(C)(CV_\mu)/ \rightarrow (CV_\mu C_\mu)(Ci_\mu)(CV_\mu)$ Cair.

	$/(CV_\mu C_\mu)(C)(CV)/$	*Compl	Prs-Seg	Syll-Head	No-Coda	Dep-V
a. ☞	$(CV_\mu C_\mu)(Ci)(CV_\mu)$				1	1
b.	$(CV_\mu C_\mu)(C)(CV_\mu)$			1 W	1	L

This is the right result. However, in order to derive the Iraqi pattern, in which the epenthetic vowel surfaces between the first and the second consonant of the CCC cluster, No-Coda should dominate Syllable-Head in order to block coda adjunction to the first core syllable at step 3 of the derivation. This result is illustrated in tableau (60).

Tableau 60: Step 3: $/(CV_\mu)CC(CV_\mu)/ \rightarrow (CV_\mu)(C)C(CV_\mu)$ Ir.

	$/(CV_\mu)CC(CV_\mu)/$	*Compl	Prs-Seg	No-Coda	Syll-Head
a. ☞	$(CV_\mu)(C)C(CV_\mu)$		1		1
b.	$(CV_\mu C_\mu)C(CV_\mu)$		1	1 W	L

The problem arises at step 4 of the derivation. At this point, the high ranking of Parse-Segment forces the syllabification of the unparsed consonant. A complex minor syllable with an onset and final appendix resulting from adjunction to a unary minor syllable can be generated, but this candidate is ruled out because No-Coda dominates Syllable-Head, as was illustrated in the previous tableau. The most harmonic candidate is thus the candidate in which another minor syllable is built.

Tableau 61: Step 4: /$(CV_\mu)(C)C(CV_\mu)$/ → $(CV_\mu)(C)(C)(CV_\mu)$ Ir.

	/$(CV_\mu)(C)C(CV_\mu)$/	*Compl	Prs-Seg	No-Coda	Syll-Head	Dep-V
a. ☞	$(CV_\mu)(C)(C)(CV_\mu)$				2	
b.	$(CV_\mu)(CC)(CV_\mu)$			1 W	1 L	
c.	$(CV_\mu)(C)C(CV_\mu)$		1 W		1 L	
d.	$(CV_\mu)(Ci_\mu)C(CV_\mu)$		1 W		L	1 W
e.	$(CV_\mu)(C)(CCV_\mu)$	1 W			1 L	

At the next step of the derivation, two candidates tie: $(CV_\mu)(Ci_\mu)(C)(CV_\mu)$ and $(CV_\mu)(C)(Ci_\mu)(CV_\mu)$.

Tableau 62: Step 5: tie Ir.

	/$(CV_\mu)(C)(C)(CV_\mu)$/	No-Coda	Syll-Head	Dep-V
a. ☞	$(CV_\mu)(Ci_\mu)(C)(CV_\mu)$		1	1
b. ☞	$(CV_\mu)(C)(Ci_\mu)(CV_\mu)$		1	1
c.	$(CV_\mu)(C)(C)(CV_\mu)$		2 W	L
d.	$(CV_\mu C_\mu)(C)(CV_\mu)$	1 W	1	L

At the sixth step of the derivation, either taking as the new input candidate (a) or candidate (b) in tableau (62), the actual output form cannot be chosen as the most harmonic one because of the ranking No-Coda ≫ Syllable-Head.

Tableau 63: Step 6: wrong output $(CV_\mu)(Ci_\mu)(Ci_\mu)(CV_\mu)$ Ir.

	/$(CV_\mu)(Ci_\mu)(C)(CV_\mu)$/	No-Coda	Syll-Head	Dep-V
a. ☞	$(CV_\mu)(Ci_\mu)(Ci_\mu)(CV_\mu)$			1
b.	$(CV_\mu)(Ci_\mu)(C)(CV_\mu)$		1 W	L
c. ☹	$(CV_\mu)(Ci_\mu C_\mu)(CV_\mu)$	1 W		L

Elfner [2009]'s theory of serial syllabification without directional alignment constraints is not enough to account for vowel epenthesis placement in these two Arabic dialects given the standard set of constraints proposed so far. But introducing directional alignment constraints does not resolve the problem either for Iraqi Arabic. In Iraqi Arabic, Align-Right (σ, Prosodic

Word) must dominate PARSE-SEGMENT and PARSE-SEGMENT must dominate ALIGN-Left (σ, Prosodic Word). At the first step of the derivation, a core syllable aligned to the right of the prosodic word is selected as the most harmonic candidate given the ranking already mentioned.

Tableau 64: Step 1: /CVCCCV/ → CVCC(CV_μ) Ir.

	/CVCCCV/	AL-R(σ,PWd)	PRS-SEG	AL-L(σ,PWd)
a. ☞	CVCC(CV_μ)		4	4
b.	CVCCCV		6 W	L
c.	(CV_μ)CCCV	4 W	4	L

At step 2, a minor syllable adjacent to the syllable at the right edge of the prosodic word is built. Strictly right-to-left directional syllabification is the only way to satisfy ALIGN-Right (σ, Prosodic Word).

Tableau 65: Step 2: /CVCC(CV_μ)/ → CVC(C)(CV_μ) Ir.

	/CVCC(CV_μ)/	*COMPL	AL-R(σ,PWd)	PRS-SEG	AL-L(σ,PWd)	SYLL-HEAD	NO-CODA
a. ☞	CVC(C)(CV_μ)			3	6	1	
b.	CVCC(CV_μ)			4 W	4 L	L	
c.	(CV_μ)CC(CV_μ)		2 W	2 L	2 L	L	
d.	CVC(CCV_μ)	1 W		3	3 L	L	

At step 3, the most harmonic candidate is the one in which a second minor syllable is created. Adjoining another consonant to the already built minor syllable would not be possible in Elfner [2009]'s theory of serial syllabification because the consonant in the already built minor syllable is not in an appendix position. To adjoin a consonant as an appendix a minor syllable should only take a consonant located at the right of the minor syllable. But there is no available unparsed consonant at the right of the minor syllable. This problem has to do with the structural underspecification of minor syllables in Elfner [2009]'s model. In fact, from the input /$CVC_1(C_2)(CV)$/, a candidate in which C_1 is adjoined to (C_2) as in (C_1C_2) means that adjunction to the left should restructure the internal position of segments in a minor syllable because C_2 ends up occupying an appendix position. In Elfner [2009], it is not clear whether (C_1C_2) should be treated as a complex minor syllable containing a complex onset or a complex minor syllable containing an onset and a coda. One might think that minor syllables have no internal structure, but I will show in chapter 4 that before CON is able to predict the exact location of epenthetic vowels, GEN must be powerful enough to specify the internal structure of minor syllables.

Tableau 66: Step 3: /CVC(C)(CV$_\mu$)/ → CV(C)(C)(CV$_\mu$) Ir.

	/CVC(C)(CV$_\mu$)/	AL-R(σ,PWd)	PRS-SEG	AL-L(σ,PWd)	SYLL-HEAD	NO-CODA	DEP-V
a. ☞	CV(C)(C)(CV$_\mu$)		2	6	2		
b.	CVC(C)(CV$_\mu$)		3 W	6	1 L		
c.	CVC(Ci$_\mu$)(CV$_\mu$)		3 W	6	L		1 W
d.	(CV$_\mu$)C(C)(CV$_\mu$)	1 W	1 L	2 L	1 L		

At the next step of the derivation, the whole string is syllabified.

Tableau 67: Step 4: /CV(C)(C)(CV$_\mu$)/ → (CV$_\mu$)(C)(C)(CV$_\mu$) Ir.

	/CV(C)(C)(CV$_\mu$)/	PRS-SEG	AL-L(σ,PWd)	SYLL-HEAD	NO-CODA	DEP-V
a. ☞	(CV$_\mu$)(C)(C)(CV$_\mu$)			2		
b.	CV(Ci$_\mu$)(C)(CV$_\mu$)		6 W	1 L		1 W
c.	CV(C)(C)(CV$_\mu$)	2 W	6 W	2		

At step 5, the same tie observed before is obtained. Candidates with an epenthetic vowel in one of the minor syllables are equally harmonic. Candidate (c) in (68) must be ruled out, because it would yield the Cairene pattern. This is obtained by ranking NO-CODA above DEP-V.

Tableau 68: Step 5: tie Ir.

	$/(CV_\mu)(C)(C)(CV_\mu)/$	SYLL-HEAD	NO-CODA	DEP-V
a. ☞	$(CV_\mu)(Ci_\mu)(C)(CV_\mu)$	1		1
b. ☞	$(CV_\mu)(C)(Ci_\mu)(CV_\mu)$	1		1
c.	$(CV_\mu C_\mu)(C)(CV_\mu)$	1	1 W	L

If candidate (a) is taken as the new input for a subsequent evaluation, the wrong output is selected because NO-CODA must dominate DEP-V, as shown in the previous tableau, in order to discard the Cairene pattern. The same happens if candidate (b) is taken as the new input. This is exemplified below if candidate (a) is submitted to EVAL.

Tableau 69: Step 6: $/(CV_\mu)(Ci_\mu)(C)(CV_\mu)/ \rightarrow (CV_\mu)(Ci_\mu C_\mu)(CV_\mu)$ Ir.

	$/(CV_\mu)(Ci_\mu)(C)(CV_\mu)/$	SYLL-HEAD	NO-CODA	DEP-V
a. ☞	$(CV_\mu)(Ci_\mu)(Ci_\mu)(CV_\mu)$			2
b.	$(CV_\mu)(Ci_\mu C_\mu)(CV_\mu)$		1 W	L
c.	$(CV_\mu)(Ci_\mu)(C)(CV_\mu)$	1 W		L

In the theory of serial syllabification proposed in this dissertation, when a minor syllable is created, a label C is inserted only if syllabification proceeds leftwards. No label is inserted if syllabification proceeds rightwards.

For Iraqi Arabic, syllabification proceeds from right to left. At the second step of the derivation, the candidate with a minor syllable with the label C is selected as the most harmonic candidate, once a core syllable aligned with the right edge of the prosodic word has been built at the first step of the derivation. A subscript C represents that the consonant occupies the appendix/coda position of the minor syllable. This way, these minor syllables also violate NO-CODA.

Tableau 70: Step 2: CVCC(CV$_\mu$) $\rightarrow$ CVC(C$_{\mu/C}$)(CV$_\mu$) Ir.

	/CVCC(CV$_\mu$)/	*Compl	Al-R(σ,PWd)	Prs-Seg	Al-L(σ,PWd)	Syll-Head	No-Coda
a. ☞	CVC(C$_{\mu/C}$)(CV$_\mu$)			3	6	1	1
b.	CVCC(CV$_\mu$)			4 W	4 L	L	L
c.	(CV$_\mu$)CC(CV$_\mu$)		2 W	2 L	2 L	L	L
d.	CVC(CCV$_\mu$)	1 W		3	3 L	L	L

At step 3, onset adjunction applies and a complex minor syllable is obtained, as candidate (a) shows below. I represent this complex minor syllable containing an onset and a coda as (C_C), the use of lower case meaning that these two consonants occupy different subsyllabic positions. Candidate (e) also shows the result of applying adjunction, but in this case a binary minor syllable containing a complex coda is obtained, which is ruled out by *Complex. Candidate (b) adds another minor syllable, and for this reason is less harmonic than candidate (a).

Tableau 71: Step 3: /CVC(C$_{\mu/C}$)(CV$_\mu$)/ $\rightarrow$ CV(C_C$_{\mu/C}$)(CV$_\mu$) Ir.

	/CVC(C$_{\mu/C}$)(CV$_\mu$)/	*Compl	Al-R(σ,PWd)	Prs-Seg	Al-L(σ,PWd)	Syll-Head	No-Coda
a. ☞	CV(C_C$_{\mu/C}$)(CV$_\mu$)			2	4	1	1
b.	CV(C$_{\mu/C}$)(C$_{\mu/C}$)(CV$_\mu$)			2	6 W	2 W	2 W
c.	CVC(iC$_{\mu/C}$)(CV$_\mu$)			3 W	6 W	L	1
d.	(CV)C(C$_{\mu/C}$)(CV$_\mu$)		1 W	1 L	2 L	1	1
e.	CV(CC$_{\mu/C}$)(CV$_\mu$)	1 W		2	4	1	1

At the next step, a core syllable is built and the whole input string is syllabified. Then the minor syllable is fixed by means of vowel epenthesis, meaning that Syllable-Head dominates Dep-V.

For Cairene Arabic, ranking Align-Left (σ, Prosodic Word) above Parse-Segment is enough to derive the actual pattern. At the second step of the derivation, coda adjunction is more harmonic than building a minor syllable, thus ensuring that the epenthetic vowel will appear between the second and third consonant of the CCC cluster.

Tableau 72: Step 2: /(CV$_\mu$)CCCV/ → (CV$_\mu$C$_{\mu/C}$)CCV Cair.

	/(CV$_\mu$)CCCV/	Al-L(σ,PWd)	Prs-Seg	Al-R(σ,PWd)	Syll-Head	No-Coda
a. ☞	(CV$_\mu$C$_{\mu/C}$)CCV		3	3		1
b.	(CV$_\mu$)(C)CCV		3	6 W	1 W	L
c.	(CV$_\mu$)CCCV		4 W	4 W		1
d.	(CV$_\mu$)CC(CV$_\mu$)	2 W	2 L	2 L		1

At the next steps of the derivation, a minor syllable is created, then a core syllable, and finally an epenthetic vowel is inserted in order to fix the minor syllable which corresponds to the second consonant of the CCC cluster.

2.3 Faithfulness to moraicity

In this section I discuss how to model faithfulness to moraicity in HS. First, I go through a standard analysis to derive light and heavy syllables in POT, and present some pathological predictions that arise from Dep-µ. Then I present a new definition of Dep-µ within the light of HS that solves those pathological predictions.

2.3.1 Deriving the asymmetry between light and heavy syllables in POT

A lexical contrast between short and long vowels in POT must be specified in underlying representations as a function of the number of moras linked to input vowels (*i.e.*, ta$_\mu$ *versus* ta$_{\mu\mu}$). Moraic faithfulness constraints in terms of Correspondence Theory (McCarthy and Prince 1995) are defined below.

(1) Max-μ

Assign one violation mark for every mora in the input that has no correspondent in the output.

(Do not insert moras.)

Dep-μ

Assign one violation mark for every mora in the output that has no correspondent in the input.

(Do not delete moras.)

By ranking both Max-μ and Dep-μ over the markedness constraints prohibiting long vowels, $*V_{\mu\mu}$, a language with a lexical constrast between short and long vowels, is derived.

Tableau 73: $/V_{\mu}/ \rightarrow (V_{\mu})$ in POT

$/V_{\mu}/$	Max-μ	Dep-μ	$*V_{\mu\mu}$
a. ☞ σ | μ | V			
b. σ μ μ V		1 W	1 W

Tableau 74: $/V_{\mu\mu}/ \rightarrow (V_{\mu\mu})$ in POT

$/V_{\mu\mu}/$	Max-μ	Dep-μ	$*V_{\mu\mu}$
a. ☞ σ μ μ V			1
b. σ | μ | V	1 W		L

In a language with no lexical constrat between short and long vowels, a ranking in which $*V_{\mu\mu}$ dominates MAX-μ is needed.

Tableau 75: $/V_{\mu\mu}/ \rightarrow (V_{\mu})$ in POT

<table>
<tr><th>$/V_{\mu\mu}/$</th><th>$*V_{\mu\mu}$</th><th>DEP-μ</th><th>MAX-μ</th></tr>
<tr><td>a. ☞ σ
|
μ
|
V</td><td></td><td></td><td>1</td></tr>
<tr><td>b. σ
$\mu\ \mu$
V</td><td>1 W</td><td></td><td>L</td></tr>
</table>

The asymmetry between weight-contributing and weightless coda consonants

The asymmetry between weight-contributing and weightless coda consonants is a function of the relative order between the following two constraints:

(2) WEIGHT-BY-POSITION (Hayes 1989)

Assign one violation mark for every coda consonant that does not project a mora.

*μ/C (Broselow et al. 1997)

Assign one violation mark for every mora headed by a consonant.

The following tableaux, consistent with the Richness of the Base hypothesis, illustrate the results obtained by permuting WEIGHT-BY-POSITION and *μ/C.

Tableau 76: /CV$_\mu$C/ → (CV$_\mu$C$_\mu$)

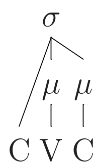
/CV$_\mu$C/	WBP	*μ/C
a. ☞ 		1
b. 	1 W	L

Tableau 77: /CV$_\mu$C$_\mu$/ → (CV$_\mu$C$_\mu$)

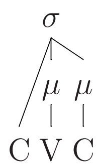
/CV$_\mu$C$_\mu$/	WBP	*μ/C
a. ☞ 		1
b. 	1 W	L

Tableau 78: /CV$_\mu$C/ → (CVμC)

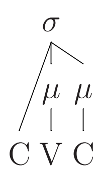
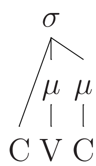
/CV$_\mu$C/	*μ/C	WBP
a. ☞ 		1
b. 	1 W	L

Tableau 79: /CV$_\mu$C$_\mu$/ → (CVμC)

/CV$_\mu$C$_\mu$/		*μ/C	WBP
a. ☞			1
b.		1 W	L

2.3.2 Pathologies involving Dep-μ

Unattested contrastive moraicity in coda consonants

When Dep-μ as defined in (1) is taken into consideration, an unattested *scenario* is predicted to exist if Dep-μ dominates WbP, that is, a language in which consonant moraicity is contrastive depending on the underlying moraic specification of consonants, as argued in Campos-Astorkiza [2004]. This situation is shown below.

Tableau 80: weightless coda from /CV$_\mu$C/

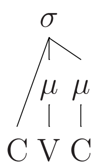
/CV$_\mu$C/		Dep-μ	WbP	*μ/C
a. ☞			1	
b.		1 W	L	1 W

Tableau 81: weight-contributing coda from /CV$_{\mu}$C$_{\mu}$/

/CV$_{\mu}$C$_{\mu}$/	DEP-μ	WBP	*μ/C
a. ☞ σ μ μ C V C			1
b. σ μ C V C		1 W	L

As tableau (81) illustrates, DEP-μ is vacuously satisfied by those candidates with weight-contributing coda consonants if coda consonants are underlyingly moraic. The faithfulness constraint DEP-μ only blocks weight-by-position when coda consonants are underlyingly non-moraic. Under the ranking DEP-μ ≫ WBP ≫ *μ/C, unattested systems in which coda consonants contrast in moraicity at the surface depending on their underlying moraic status is predicted to exist in POT.

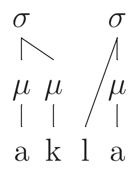
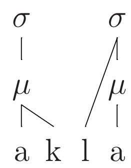
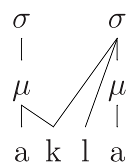
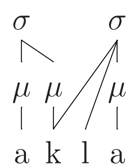
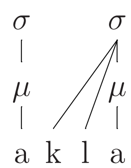
Unattested tautomorphemic contrastive syllabification

The moraic faithfulness constraint DEP-μ, formulated in terms of Correspondence Theory, also leads to unattested tautomorphemic contrastive syllabification (Bermúdez-Otero 2001) under the following ranking.

(3) DEP-μ, WEIGHT-BY-POSITION ≫ *COMPLEX-ONSET ≫ SYLLABLE-CONTACT, *μ/C

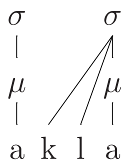
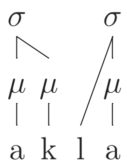
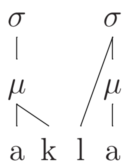
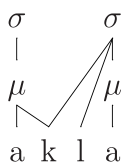
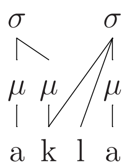
The following tableaux illustrate that an underlying moraic consonant as the first member of an intervocalic consonantal cluster surfaces as a weight-contributing coda, whereas an underlying nonmoraic consonant in the same context surfaces as the first member of a complex onset.

Tableau 82: /$a_\mu k_\mu la_\mu$/ → ($a_\mu k_\mu$)(la_μ)

/$a_\mu k_\mu la_\mu$/	DEP-μ	WBP	*COMPL-ONS	SYLL-CONT	*μ/C
a. ☞ 				1	1
b. 		1 W		1	L
c. 		1 W	1 W	L	L
d. 			1 W	L	1
e. 			1 W	L	L

As shown in tableau (82), if an underlying consonant is the first member of an intervocalic consonantal cluster, this consonant surfaces as a weight-contributing coda consonant because top-ranked DEP-μ is not violated, and consequently top-ranked WEIGHT-BY-POSITION can be succesfully satisfied. However, if the very same consonant is underlyingly non-moraic, satisfaction of WEIGHT-BY-POSITION is blocked by a DEP-μ violation, as candidate (b) in tableau (83) illustrates. This type of constrastive syllabification depending on the underlying moraic status of consonants is unattested.

Tableau 83: /$a_{\mu}kla_{\mu}$/ → (a_{μ})(kla_{μ})

/$a_{\mu}kla_{\mu}$/	DEP-μ	WBP	*COMPL-ONS	SYLL-CONT	*μ/C
a. ☞ 			1		
b. 	1 W		L	1 W	1 W
c. 		1 W	L	1 W	
d. 		1 W	1		
e. 	1 W		1		1 W

Candidates (c) and (d) in tableau (82) and (d) and (e) in tableau (83) include geminate consonants, interpreted as one root-node doubly linked to two prosodic units, a mora and a following syllable node.

Solution in POT

Both Bermúdez-Otero [2001] and Campos-Astorkiza [2004] propose a new definition of DEP-μ based on prosodic licensing in order for this constraint to be satisfied when a mora-bearing consonant is syllabified in coda position. Under their new definition of DEP-μ, this constraint is only violated in processes involving lengthening, and is vacuously satisfied in basic syllabification.

(4) Bermúdez-Otero [2001]'s reformulation of DEP-μ:

Let μ be a mora in the output.

Either

(i) μ has a correspondent in the input,

or

(ii) μ is a positional μ-licenser.

Positional μ-licensing:

A nonsyllabic segment α is positionally μ-licensed by a mora μ if and only if

(i) α does not have an input correspondent linked to a mora, and

(ii) α is immediately dominated only by μ.

(5) Campos-Astorkiza [2004]'s reformulation of DEP-μ:

A non-positional μ-licenser mora in S_2 has a correspondent in S_1.

Positional μ-licenser:

Let μ be a mora and α be a segment, μ is a positional μ-licenser of α, if and only if μ is the only prosodic unit immediately dominating α.

Non-positional μ-licenser:

Let μ be a mora and α be a segment, μ is a non-positional μ-licenser of α, if and only if μ is not the only prosodic unit immediately dominating α.

Lengthened segments are not immediately dominated by just one mora, but rather by two moras in the case of lengthened vowels, and they are also dominated by a syllable node in the case of geminates. Only in these cases is DEP-μ violated.

If Dep-µ is not violated when a mora is inserted when weight-contributing codas are syllabified, then the pathologies disappear. This way, candidate (b) in tableau (83) would satisfy Dep-µ and would then be selected by the grammar.

2.3.3 A new approach to moraic faithfulness in HS

A pathology involving Dep-µ and Parse-Segment

If syllabification is defined as a phonological operation subject to the gradualness requirement on Gen, it must be enforced by Parse-Segment. But parsing segments into syllables violates Dep-µ. If Dep-µ dominates Parse-Segment, a pathological system is predicted to exist, namely a language in which all segments are left unsyllabified.[4]

Tableau 84: Step 1: convergence on CV

/CV/	Dep-µ	Prs-Seg
a. ☞ C V		1
b. σ μ C V	1 W	L

New formulation of Dep-µ in the light of Harmonic Serialism

I propose the following new formulation of Dep-µ in the context of HS. Remember that in HS inputs are lexical inputs but also later step inputs that include prosodic structure.

(6) Dep-µ in HS

If σ_1 in S_1 dominates n moras and σ_2 in S_2 dominates m moras, where $m > n$, assign $m - n$ violation marks.

[4] It is usually claimed that syllables exist in all languages. Languages like Gokana (Hyman 1985) or the Barra dialect of Gaelic (Clements 1986) could be argued to lack positive evidence for syllables, but no direct evidence against the existence of syllables has been offered.

Both the intrinsic serialism of HS and the operation-based definition of gradualness allow for the new definition of Dep-μ: given that syllables are built gradually, syllables can be present in intermediate input representations, so they can serve as correspondence elements between inputs and outputs.

The pathology in tableau (84) is solved under the new definition of Dep-μ. In tableau (85), Dep-μ is vacuously satisfied by all the candidates. This is so because projecting a syllable always introduces a new syllable which has no correspondent in the input. The choice among the candidates is made by Parse-Segment alone.

Tableau 85: Step 1: /CV/ → (CV$_{\mu}$)

/CV/	Dep-μ	Prs-Seg
a. ☞ σ μ C V		
b. σ μ C V		1 W
c. C V		2 W

Factorial typology of coda consonants

Given the set of constraints Parse-Segment, Weight - by - Position, Dep-μ (under the new definition provided in 6), and *μ/C, twenty-four potential rankings are derived by factorial typology ($4 \times 3 \times 2 \times 1 = 24$). From these twenty-four rankings, seven possible grammars are derived that lead to three attested possible grammars: languages with weight-contributing codas, languages with weightless codas, and languages that leave codas unparsed. The ranking of each possible grammar is illustrated below.

(7) Factorial typology of coda consonants

Weight-contributing codas:

- PARSE-SEGMENT, WEIGHT-BY-POSITION ≫ DEP-μ, *μ/C

Weightless codas:

- PARSE-SEGMENT, DEP-μ ≫ WEIGHT-BY-POSITION, *μ/C
- PARSE-SEGMENT, DEP-μ, *μ/C ≫ WEIGHT-BY-POSITION
- PARSE-SEGMENT, *μ/C ≫ WEIGHT-BY-POSITION, DEP-μ

Unparsed codas

- DEP-μ, WEIGHT-BY-POSITION, *μ/C ≫ PARSE-SEGMENT
- DEP-μ, WEIGHT-BY-POSITION ≫ PARSE-SEGMENT, *μ/C
- WEIGHT-BY-POSITION, *μ/C ≫ PARSE-SEGMENT, DEP-μ

Unattested contrastive moraicity in coda consonants

A language in which consonant moraicity is contrastive depending on the underlying moraic specificication of consonants, as argued in Campos-Astorkiza [2004], disappears under the new definition of DEP-μ provided in (6).

A weightless coda is obtained from /$CV_{\mu}C$/ under a constraint hierarchy in which DEP-μ dominates WEIGHT-BY-POSITION. The constraint *μ/C appears at the bottom of the hierarchy preceded by a double line, meaning that it is irrelevant for selecting or discarding candidates.

Tableau 86: Step 1: $/CV_{\mu}C/ \rightarrow (CV_{\mu})C$

$/CV_{\mu}C/$	DEP-μ	PRS-SEG	WBP	*μ/C
a. ☞ σ μ C V C		1		
b. σ μ C V C		2 W		
c. μ C V C		3 W		

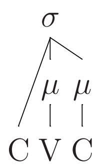
At the second step of the derivation, projecting a weight-contributing coda consonant to the already existing input syllable violates DEP-μ, as candidate (b) shows in tableau (87).

Tableau 87: Step 2: $/(CV_{\mu})C/ \rightarrow (CV\mu C)$

σ μ C V C	DEP-μ	PRS-SEG	WBP	*μ/C
a. ☞ σ μ C V C			1	
b. σ μ μ C V C	1 W		L	1 W
c. σ μ C V C		1 W	L	

Convergence is then met at step 3, in which a language with weightless coda consonants is derived.

Tableau 88: Step 3: convergence on (CVμC)

	DEP-μ	PRS-SEG	WBP	*μ/C
a. ☞ 			1	
b. 	1 W		L	1 W
c. 		1 W	L	

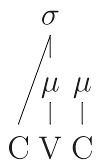
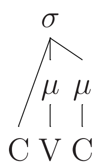
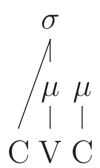
A weightless coda consonant is also obtained when starting from $/CV_{\mu}C_{\mu}/$. MAX-μ is not included, but it is dominated by DEP-μ and PARSE-SEGMENT.

Tableau 89: Step 1: $/CV_{\mu}C_{\mu}/ \rightarrow (CV_{\mu})C_{\mu}$

$/CV_{\mu}C_{\mu}/$	DEP-μ	PRS-SEG	WBP	*μ/C
a. ☞ σ μ μ C V C		1		1
b. σ μ μ C V C		2 W		1
c. μ μ C V C		3 W		1

At step 2 of the derivation, although there is a mora in the input associated with the second consonant, adjoining it to the already built syllable also violates DEP-μ under the new formulation in (6), thus solving the pathology pointed out in Campos-Astorkiza [2004].

Tableau 90: Step 2: $/(CV_{\mu})C_{\mu}/ \rightarrow (CV\mu C)$

	DEP-μ	PRS-SEG	WBP	*μ/C
a. ☞ 			1	
b. 	1 W		L	1 W
c. 		1 W	L	1 W

The derivation converges at the next step of the derivation.

Tableau 91: Step 3: convergence on (CVμC)

	DEP-μ	PRS-SEG	WBP	*μ/C
σ μ C V C				
a. ☞ σ μ C V C			1	
b. σ μ μ C V C	1 W		L	1 W
c. σ μ μ C V C		1 W	L	1 W

Unattested tautomorphemic contrastive syllabification

A language in which syllabification is contrastive depending on the underlying moraic specificication of the first consonant in an intervocalic consonantal cluster, as argued in Bermúdez-Otero [2001], also disappears under the new definition of DEP-μ provided in (6). Consider the input /$a_μk_μla_μ$/, which in tableau (82) surfaced as [($a_μk_μ$)($la_μ$)]. In HS, however, it surfaces as [($a_μ$)($kla_μ$)] because DEP-μ is violated regardless of its presence or not in the input. The whole HS derivation of the input /$a_μk_μla_μ$/ appears below.

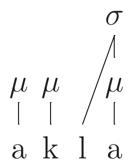
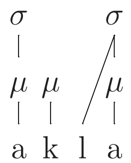
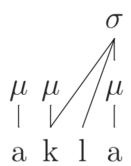
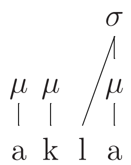
At the first step of the derivation, building a core syllable, a binary moraic syllable is the most harmonically improving step because PARSE-SEGMENT is maximally satisfied.

Tableau 92: Step 1: /$a_\mu k_\mu la_\mu$/ → $a_\mu k_\mu (la_\mu)$

/$a_\mu k_\mu la_\mu$/	Dep-μ	Prs-Seg	WbP	*Compl-Ons	Syll-Cont	*μ/C
a. ☞ σ $\mu\ \mu\ \ \ \mu$ a k l a		2				1
b. σ $\mu\ \mu\ \ \ \mu$ a k l a		3 W				1
c. $\mu\ \mu\ \ \ \mu$ a k l a		4 W				1

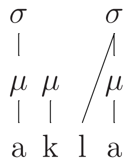
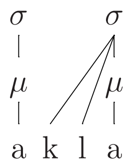
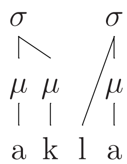
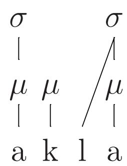
At step 2, a unary moraic syllable is built. Adjoining the first consonant of the intervocalic consonantal cluster is harmonically bounded by candidate (a) because it adds a violation of *Complex-Onset, as shown by candidate (b) in tableau (93).

Tableau 93: Step 2: /$a_\mu k_\mu (la_\mu)$/ → $(a_\mu)k_\mu(la_\mu)$

	DEP-μ	PRS-SEG	WBP	*COMPL-ONS	SYLL-CONT	*μ/C
a. ☞ 		1				1
b. 		1		1 W		1
c. 		2 W				1

At step 3, the unparsed moraic consonant in the input cannot surface as a moraic consonant due to the top-ranked position of DEP-μ.

Tableau 94: Step 3: $/(a_{\mu})k_{\mu}(la_{\mu})/ \rightarrow (a_{\mu})(kla_{\mu})$

	DEP-μ	PRS-SEG	WBP	*COMPL-ONS	SYLL-CONT	*μ/C
a. ☞ 				1		
b. 	1 W			L	1 W	1 W
c. 		1 W		L		1 W

From a nonmoraic consonant in the initial input form, the same result is obtained. This is shown in the tableau (95).

Tableau 95: Step 3: /(a_{μ})k(la_{μ})/ → (a_{μ})(kla_{μ})

σ σ μ μ a k l a	DEP-μ	PRS-SEG	WBP	*COMPL-ONS	SYLL-CONT	*μ/C
a. ☞ σ σ μ μ a k l a				1		
b. σ σ μ μ μ a k l a	1 W			L	1 W	1 W
c. σ σ μ μ a k l a			1 W	L		

All in all, if DEP-μ is top-ranked, weight-contributing codas are not allowed. This result is independent of the underlying moraic status of coda consonants. However, a language in which /$a_{\mu}k_{\mu}la_{\mu}$/ or /$a_{\mu}kla_{\mu}$/ maps into ($a_{\mu}k_{\mu}$)(la_{μ}) requires DEP-μ to be low-ranked.

So far so good: the effects of DEP-μ and *μ/C are the same. Nevertheless, in chapter 6 it will be argued that only *μ/C has a specific triggering effect, namely vowel lengthening before voiced obstruent coda consonants, it being a markedness constraint that, in contrast to the faithfulness constraint DEP-μ, is able to be violated pervasively during the derivation.

2.4 The domain of syllabification

I assume the standard idea that the input of phonology as an interpretative component of a generative grammar is a set of morphs that stand in a hierarchical morphosyntactic representation, from which linear precedence relations directly follow. Phonological linear immediate precedence relations, or adjacency, come from two different sources. On the one hand, the linear immediate precedence relation between two segments x and y can be established in the lexicon if (a) both x and y are a substring of the same morph; (b) x precedes y in the underlying representation of that morph; and (c) there is no z such that x precedes z and z precedes y. On the other hand, the linear immediate precedence relation between two segments x and y can be inherited from morphosyntax if (a) x is the last segment in the underlying representation of a morph M_1; (b) y is the first segment in the underlying representation of another morph M_2; and (c) M_1 precedes M_2 after morphosyntax. In order for binary syllable formation operations to apply, the segments x and y must stand in a linear immediate precedence relation. This is implicit in Elfner [2009]'s formulation of core syllabification. However, I also propose to further constrain the applicability of syllable formation operations through another universal condition, formalized in (1), which must be understood as an inherent property or feature of Gen.

(1) Gen-restrained syllable formation operations

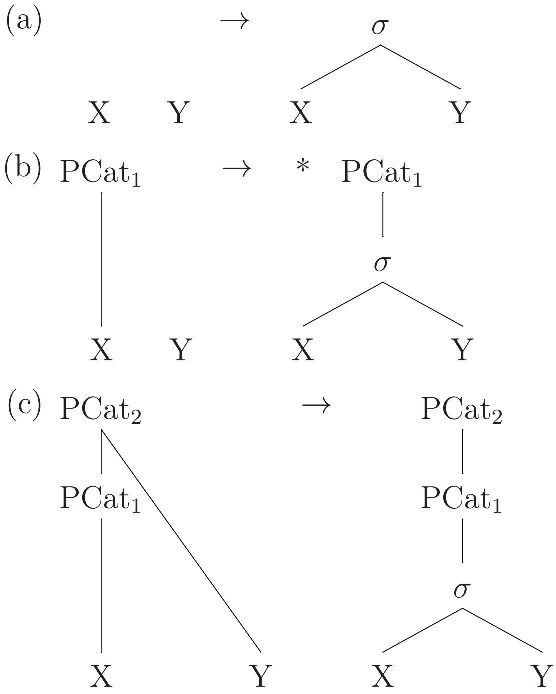
Let (x, y) stand for a pair of segments *s.t.* x immediately precedes y, and PCat_1 and PCat_2 stand for prosodic categories higher than the syllable, where $\mathrm{PCat}_2 > \mathrm{PCat}_1$.

Syllable formation operations cannot simultaneously build or derivationally produce a binary syllable (xy) if there is a PCat_1 *s.t.* PCat_1 dominates x but not y, or y but not x, and there is no PCat_2 *s.t.* PCat_2 dominates both x and y.

As stated in (1), binary syllable formation operations, or unary operations that yield a binary syllable, are blocked when only one of the two segments that stand in a phonological linear immediate precedence relation, but not the other, is dominated by a prosodic category higher than the syllable, and there is no other higher prosodic category that dominates both of them. This means that the presence of a prosodic category higher than the syllable creates an opaque domain for syllabification.

As a matter of illustration, consider an input /xy/. The following input-output mappings schematically illustrate under which circumstances Gen-restrained syllable formation operations are able to apply or not. These examples apply core syllabification.

(2)



The operation in (2b) is not a possible Gen operation given the principle in (1). In (2c), in which y, when syllabified together with x, is immediately contained in PCat_1 by transitivity, in the sense that y was already contained in PCat_2 and PCat_2 dominates PCat_1, I adopt the idea that there is concomitant readjustment of the boundary of PCat_1.

2.5 Bottom-up and top-down prosodification

Moore-Cantwell [2010] points out that the two possible orderings between the markedness constraints Parse-Segment and Parse - Syllable predict unattested patterns. If PARSE-SYLLABLE dominates PARSE-SEGMENT, the winning candidate is the one with no syllabification at all, because the creation of a syllable introduces a fatal violation of PARSE-SYLLABLE because there is a syllable which is not associated with any metrical foot,[5] and the derivation gets stuck at that point. This is certainly an unattested pattern because all languages have syllables. This is shown in tableau (96).

Tableau 96: Failure to syllabify at Step 1: convergence on pata

/pata/	PRS-SYLL	PRS-SEG
a. ☞ pata		4
b. (pa)ta	1 W	2 L

This undesired outcome is easily discarded if the constraint LX ≈ PR (Prince and Smolensky 1993/2004), which militates against every lexical word that is not a prosodic word, is included in CON as a grammar-prosody interface constraint that, together with the PARSE family of constraints, enforces prosodification. In order to discard a derivation like the one illustrated in tableau (96), GEN must be defined in a way that allows the projection of prosodic words that do not dominate lower prosodic constituents. The typological gap corresponding to the winning candidate in tableau (96) does not emerge under any permutation of the constraint set, as illustrated below.

Tableau 97: PRS-SEG ≫ PRS-SYLL, LX≈PR

/pat-ka/	PRS-SEG	PRS-SYLL	LX≈PR
a. ☞ (pat)(ka)		2	1
b. [patka]	5 W	L	L
c. pat-ka	5 W	L	1

Tableau 98: PRS-SEG ≫ LX≈PR, PRS-SYLL

/pat-ka/	PRS-SEG	LX≈PR	PRS-SYLL
a. ☞ (pat)(ka)		1	2
b. [patka]	5 W	L	L
c. pat-ka	5 W	1	L

[5] I will use a non-standard definition of PARSE-SYLLABLE which demands that syllables be parsed into prosodic words. But even with this definition of PARSE-SYLLABLE, Moore-Cantwell [2010]'s diagnosis is not invalidated.

Tableau 99: Prs-Syll ≫ Prs-Seg, Lx≈Pr,

	/pat-ka/	Prs-Syll	Prs-Seg	Lx≈Pr
a. ☞	[patka]		5	
b.	pat-ka		5	1 W
c.	(pat)(ka)	2 W	L	1 W

Tableau 100: Prs-Syll, Lx≈Pr ≫ Prs-Seg

	/pat-ka/	Prs-Syll	Lx≈Pr	Prs-Seg
a. ☞	[patka]			5
b.	pat-ka		1 W	5
c.	(pat)(ka)	2 W		L

Tableau 101: Lx≈Pr ≫ Prs-Seg, Prs-Syll

	/pat-ka/	Lx≈Pr	Prs-Seg	Prs-Syll
a. ☞	[patka]		5	
b.	pat-ka	1 W	5	
c.	(pat)(ka)	1 W	L	2 W

Tableau 102: Lx≈Pr, Prs-Syll ≫ Prs-Seg

	/pat-ka/	Lx≈Pr	Prs-Syll	Prs-Seg
a. ☞	[patka]			5
b.	pat-ka	1 W		5
c.	(pat)(ka)	1 W	2 W	L

However, if the constraint Exhaustivity (X^n) (Itô and Mester 1992/2003, Selkirk 1995) is included in the constraint set, and is top-ranked together with Parse-Syllable, the candidate with no syllabification emerges as the most harmonic candidate, as shown below. Recall that Exhaustivity(X^n) is violated when prosodic categories are skipped.

Tableau 103: Failure to syllabify at Step 1: Convergence

	/pat-ka/	Exh(X^n)	Prs-Syll	Lx≈Pr	Prs-Seg
a. ☞	pat-ka			1	5
b.	(pat)(ka)		2 W	1	L
c.	[patka]	1 W		L	5

In order to exclude such a derivation, two different alternatives are at hand. The first one, following McCarthy [2008c], consists of defining Gen in a way that allows both the projection of a prosodic word node and a lower prosodic category (a metrical foot in McCarthy 2008c) at once. This way, the candidate (c) in tableau (103) is not a possible generated candidate. The second alternative is to exclude Exhaustivity(X^n) from Con. I propose to exclude Exhaustivity(X^n) from Con because prosodification has to be able to build structure both bottom-up and up-down in order to account for interlinguistic variation regarding the domain of syllabification, which can be morph-, word- or phrase-bounded following the Gen-restrained syllable formation operations principle stated in (1).

2.6 Conclusion

This chapter has presented a theory of serial syllabification in HS. I have proposed a set of syllable formation operations that apply one at a time and directionally. This set of syllable-building operations allows for the creation of both unary and binary syllabic configurations that can be either moraic or not, giving rise to minor, moraless syllables. The possibility of inserting a mora or not, and also the possibility of inserting a label C(oda) or not generates fully specified syllabic configurations that will be proved to account for asymmetries in vowel epenthesis placement in chapter 4. These asymmetries have been firstly illustrated with data from Iraqi and Cairene Arabic. A reformulation of the faithfulness constraint Dep-μ in the light of HS has also been shown to solve some pathologies regarding unattested contrastive moraicity in coda consonants and unattested tautomorphemic contrastive syllabification. At the end, a theory that derives the domain of syllabification depending on how a string of input segments is prosodified during the derivation has been presented, which is based on the hypothesis that prosodic constituents higher than the syllable define opaque domains for syllable formation operations. In order for syllable formation operations to apply, a pair of segments x and y must stand in a linear immediate precedence relation. This is implicit in Elfner [2009]'s formulation of core syllabification. However, I also propose to further constrain the applicability of syllable formation operations through another universal condition, formalized again in (1), which must be understood as an inherent property or feature of GEN.

(1) GEN-restrained syllable formation operations

Let (x, y) stand for a pair of segments *s.t.* x immediately precedes y, and PCat_1 and PCat_2 stand for prosodic categories higher than the syllable, where $\text{PCat}_2 > \text{PCat}_1$.

Syllable formation operations cannot simultaneously build or derivationally produce a binary syllable (xy) if there is a PCat_1 *s.t.* PCat_1 dominates x but not y, or y but not x, and there is no PCat_2 *s.t.* PCat_2 dominates both x and y.

As stated in (1), binary syllable formation operations, or unary operations that yield a binary syllable, are blocked when only one of the two segments that stand in a phonological linear immediate precedence relation, but not the other, is dominated by a prosodic category higher than the syllable, and there is no other higher prosodic category that dominates both of them. This means that the presence of a prosodic category higher than the syllable creates an opaque domain for binary syllable formation operations.

The principle in (1) allows the transparent application of phonological operations at intermediate stages of prosodification that will not coincide with the prosodification of the final output, thus giving rise to non-surface-apparent opacity, as will be explained in chapters 3, 4 and 5.

Chapter 3

Phonology-morphology opacity in Spanish: the case of /s/ aspiration

Abstract

In this chapter, I defend the idea that prosodification in HS is built in harmonically improving single steps and propose that prosodic constituents higher than the syllable create opaque domains for syllable-building operations. These assumptions prevent core syllabification from operating with adjacent segments belonging to different morphs if one of the segments, but not the other, is contained in a prosodic constituent higher than the syllable at some intermediate level of representation. The case of opacity by overapplication of /s/ aspiration in Spanish due to word- and phrasal-level resyllabification finds a straightforward explanation in these terms. The degree of transparency of the aspiration process found in different dialects of Spanish is derived by the relative position that the markedness constraint CODA-CONDITION occupies with respect to two families of constraints enforcing prosodification: PARSE-SEGMENT $\gg$ PARSE-PROSODICWORD, and two morphology-prosody alignment constraints, ALIGN/Left(stem, Prosodic Word) $\gg$ ALIGN/Left(Morphological Word, Prosodic Word).

3.1 Introduction

It is a well-known characteristic of Spanish phonology that many dialects aspirate /s/ in syllable coda position.[1] Among the aspirating dialects of Spanish, however, cases of opacity by overapplication are found in which the process of /s/ aspiration is counterbled by word- and phrasal-level resyllabification. In order to account for the relative transparency of the /s/ aspiration process in different dialects of Spanish, I present a HS analysis that predicts only the attested patterns of opacity and discards the unattested ones. In the light of these data, I defend an operation-based definition of gradualness in HS in which all prosody-building operations are serially built in harmonically improving single steps, as previously argued for in Elfner [2009] and Pater [2012] for syllabification, and propose that prosodic constituents higher than the syllable create opaque domains for syllable formation operations. These assumptions prevent core syllabification from operating with adjacent segments belonging to different morphs if one of the segments, but not the other, is contained in a prosodic constituent higher than the syllable at some intermediate level of representation, allowing /s/ aspiration to take priority over word and phrasal resyllabification. I argue that the interdialectal variation with respect to the interaction between aspiration and resyllabification is the consequence of the relative position that the markedness constraint CODA-CONDITION occupies with respect to two families of markedness constraints enforcing prosodification: PARSE-SEGMENT $\gg$ PARSE-PROSODICWORD, on the one hand, and two morphology-prosody alignment constraints, ALIGN/Left(stem, Prosodic Word) $\gg$ ALIGN/Left(Morphological Word, Prosodic Word), on the other hand.

[1] It is not the goal of this chapter to review in depth the abundant literature on Spanish /s/ aspiration. The following selected references cover the most salient theory-oriented studies on the subject: Bakovic [1999], Colina [1995, 1997, 2002], Guitart [1976], Harris [1983, 1993], Harris and Kaisse [1999], Hualde [1989, 1990, 1991a,b], Kaisse [1996, 1999], Kenstowicz [1995], Morris [2000], Roca [2005], Wiltshire [2002, 2006].

3.2 Transparent /s/ aspiration

In many dialects of Spanish the underlying voiceless alveolar fricative /s/ surfaces as a voiceless glottal fricative [h] in syllable coda position.[2] Some examples appear in (1).

(1) Transparent /s/ aspiration (Kaisse 1996)

Pa[h]cual	"Pascual (proper name)"
gu[h]to	"pleasure"
cono[h]co	"I know"
mae[h]tro	"teacher"
e[h]quí	"ski"
e[h]nob	"snob"
de[h]graciadamente	"unfortunately"
di[h]gustar	"displease"
ha[h]lo	"do it!"
ve[h] dos	"you see two"

The examples in (1) constitute cases in which an underlying /s/ is unquestionably syllabified in syllable coda position because it is followed by another consonant.[3] The first six examples contain a morpheme-internal /s/ preceding a consonant. The /s/ is prefix-final and preceding a consonant-initial base in *de*[h]*graciadamente* and *di*[h]*gustar*, stem-final preceding a consonant-initial pronominal enclitic in *ha*[h]*lo*, and word-final preceding a consonant-initial word in *ve*[h] *dos*. The process of /s/ aspiration applies in all aspirating dialects of Spanish as in (1) if /s/ precedes a consonant, regardless of the morphological or syntactic environment. These instances of

[2] Apart from the more general pattern of aspiration, some Andalusian dialects avoid syllable coda /s/ by means of total assimilation (ob[ip.p]o "bishop"), which in some varieties is preaspirated (ob[i^{h}p.p]o "bishop") (Morris 2000). These examples could be explained as cases of compensatory lengthening. For preaspirated geminates, however, a more sophisticated analysis would be needed in order to explain the occurrence of aspiration, which seems to contradict an analysis exclusively based on the preservation of weight or timing units.

[3] As standardly assumed, /s/ in Spanish cannot be tautosyllabic with a following nonglide consonant (Harris 1983).

/s/ aspiration are thus transparent, because the structural requirement for aspiration is always met.[4]

I interpret /s/ aspiration as a debuccalisation process following Kaisse [1996] by which voiceless coronal fricatives lose their place features in syllable coda position. In OT, debuccalisation applies as a response to satisfy a coda condition constraint. This markedness constraint is formulated in (2).

(2) Coda-Condition (Coda-Cond)

Assign one violation mark for every token of [cor] that is associated with a [–son, +cont] segment in the syllable coda. (based on McCarthy 2008b)

The markedness constraint Coda-Condition must outrank a faithfulness constraint against deleting place features. This faithfulness constraint is defined in (3).

(3) Max[place] (Max[pl])

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}. (McCarthy 2008b)

Debuccalised segments violate another markedness constraint that disfavors placeless segments. This constraint is formulated in (4).

(4) Have-Place (Have-Pl)

Assign one violation mark for every debuccalised, placeless segment. (McCarthy 2008b)

[4] Kaisse [1996] reports for Argentinian Spanish that /s/ aspiration also applies after a complex nucleus consisting of a vowel and a glide, as in *c*[awh.t]*ico* "caustic" and *s*[ejh.s]*ientos* "six hundred". Nevertheless, in sonorant plus /s/ complex codas, Kaisse [1996] recognizes /s/ maintenance for Buenos Aires Argentinian Spanish, as in *s*[ols.t]*icio* "solstice", *c*[ons.t]*ante* "constant" and *p*[ers.p]*ectiva* "perspective". However, in Kaisse [1999] aspiration in those contexts is reported for Río Negro Argentinian Spanish, as in [inh.p]ector "inspector". An interim interpretation of the facts for Buenos Aires Argentinian Spanish could be that /s/ aspiration is only blocked in a place-sharing configuration within the coda, thus explaining *c*[ons.t]*ante*, but not *c*[awh.t]*ico*, the latter constituting a single coda given that glides form a complex nucleus with a preceding vowel in Spanish (Harris 1983).

As already stated, underlying /s/ aspirates whenever it is parsed in syllable coda position.[5] In roots ending in /s/ followed by a vowel-initial derivational or inflectional affix, the /s/ is syllabified in onset position and surfaces faithfully as [s]. If a root-final /s/ is followed by a consonant-initial derivational affix, however, /s/ is syllabified in syllable coda position and thus undergoes debuccalisation. This result is obtained by ranking the markedness constraint Coda-Condition over the faithfulness constraint Max[place]. The same result obtains with a preconsonantal morpheme-internal /s/. The next tableaux illustrate all these cases. Dots mark syllable boundaries.

In tableau (104), candidates (c) and (d) are ruled out because they maximally violate the markedness constraint Onset, which penalizes onsetless syllables. Both candidates (a) and (b) equally violate Onset, but candidate (b) is less faithful than candidate (a) because it fatally violates Max[place] without performing better on Coda-Condition, which is satisfied by candidates (a) and (b). The winning candidate is thus candidate (a), in which underlying /s/ faithfully surfaces as [s].

Tableau 104: root-final /s/ followed by a vowel-initial derivational affix

	/aros+al/ “rice field”	Ons	Coda-Cond	Max[pl]
a. ☞	a.ro.sal	1		
b.	a.ro.hal	1		1 W
c.	a.ros.al	2 W	1 W	
d.	a.roh.al	2 W		

In tableaux (105) and (106) the most harmonic candidates are the ones in which /s/ undergoes debuccalisation because the fully faithful parse of the input, which corresponds to candidates (b), fatally violates Coda-Condition.

[5] In those Andalusian dialects that lack /s/ in their phonemic inventory, aspiration targets /θ/ instead in syllable coda position, as in Granada Spanish (Hualde 2005:165). In dialects with a distinction between /s/ and /θ/, aspiration targets both segments. In some tableaux, examples are representative of Spanish dialects that lack /θ/ in their phonemic inventory, a shibboleth of some Andalusian dialects and American Spanish. Apart from this, [h] as the result of debuccalisation must not be confused with the phoneme /h/ in those dialects lacking the voiceless uvular fricative /χ/ or /x/ in their phonemic inventory.

Tableau 105: root-final /s/ followed by a consonant-initial derivational affix

	/dies+m+a/ "(s)he decimates"	Ons	Coda-Cond	Max[pl]	Have-Pl
a. ☞	djeh.ma			1	1
b.	djes.ma		1 W	L	L

Tableau 106: preconsonantal morpheme-internal /s/

	/kasp+a/ "dandruff"	Ons	Coda-Cond	Max[pl]	Have-Pl
a. ☞	kah.pa			1	1
b.	kas.pa		1 W	L	L

This analysis implies that place features are separate entities instead of attributes of segments. In HS, where input-output mappings often require several steps, the winning candidate (a) of tableau (106) is fed back to Gen for a new evaluation. A faithfulness constraint such as Dep-Link must dominate the markedness constraint Have-Place in order to discard a potential candidate such as [kaɸ.pa], in which the debuccalised, placeless fricative /h/ from the latest input undergoes place assimilation by inserting an association line linking the root node with the place feature [lab] associated with the consonant parsed in syllable onset position.[6]

The necessary ranking is shown in tableau (107). The derivation converges at that point of the derivation because no more harmonic improvement is possible. This is why the winning candidate is the fully faithful parse of the latest input.

Tableau 107: Step 2: convergence on kah.pa

	/kah.pa/	Dep-Link	Have-Pl
a. ☞	kah.pa		1
b.	kaɸ.pa	1 W	L

[6]Kaisse [1996] only reports velar regressive place assimilation for Argentinian Spanish: *Pa*[x.k]*ual*, but **de*[f.p]*acio* or **de*[ɸ.p]*acio* "slowly".

A debuccalised segment could also be a target for deletion. The faithfulness constraint MAX-C, which militates against consonantal root node deletion, must also dominate HAVE-PLACE.

In prepausal contexts, /s/ aspiration fails to apply in some aspirating dialects like Buenos Aires Argentinian Spanish. This fact could be interpreted as the activity of a positional faithfulness constraint MAX[place] relativized according to the right edge of the highest prosodic category of the prosodic hierarchy, namely the utterance, which would dominate CODA-CONDITION. However, this possibility would run into problems in HS if prosody were serially built because the utterance could be absent from intermediate representations until late derivational stages. Instead, making use of contextual markedness instead of positional faithfulness, and proposing that MAX[place] is dominated by a contextual markedness constraint CODA-CONDITION/_C, which in turn dominates the less stringent CODA-CONDITION, would be preferable. The tableau in (108) illustrates /s/ maintenance in prepausal contexts, meaning that the right edge of /s/ is not adjacent to any consonant. Tableau (109) shows that /s/ aspiration applies in preconsonantal contexts because CODA-CONDITION/_C dominates MAX[place].

Tableau 108: /s/ maintenance in prepausal context in Buenos Aires Argentinian Spanish

	/bes/ "you see"	CODA-COND/_C	MAX[pl]	CODA-COND
a. ☞	bes			1
b.	beh		1 W	L

Tableau 109: /s/ aspiration in preconsonantal context in Buenos Aires Argentinian Spanish

	/kah.pa/	CODA-COND/_C	MAX[pl]	CODA-COND
a. ☞	kah.pa		1	
b.	kas.pa	1 W	L	1 W

3.3 Opacity by overapplication of /s/ aspiration

The process of /s/ aspiration overapplies in some varieties of Spanish. Opacity by overapplication was formulated as in (1) from a rule-based perspective in Kiparsky [1973]. See section 1.4 for more details on opacity.

(1) Opacity by overapplication (Kiparsky 1973)

A phonological rule P of the form A → B / C _ D is opaque if there are surface forms that contain B derived by P that occur in environments other than C _ D.

The situation described in (1) refers to those cases in which a phonological rule applies even though the structural condition that makes the rule applicable is invisible at the surface. In rule-based generative phonology, this type of opacity is the result of a counterbleeding order in which rule A, which bleeds rule B, is extrinsically ordered after B. In other words, in a counterbleeding interaction rule B has already had the chance to apply before rule A wipes out the structural condition that made rule B applicable, rendering a non-surface-apparent linguistic generalization.

Opacity by overapplication of /s/ aspiration in Spanish is found in prefixes ending in /s/ followed by a vowel-initial base or in two-word phrases in which the first word ends in /s/ and precedes a vowel-initial word.[7] The non-surface-apparent environment for /s/ aspiration is due to the opaque interaction between debuccalisation and word- and phrasal-level resyllabification, in which resyllabification counterbleeds debuccalisation. In other

[7]As far as I know, compounds of the type *dios-héroe* "god-hero" do not behave differently from two-word phrases. I will thus ignore them in this analysis. Apart from compounds, whether preclitic forms such as *lo*[h] *otros* "the others" are opaque, for instance, in Río Negro Argentinian Spanish, in which only phrasal resyllabification counterbleeds /s/ aspiration (*ve*[h] *uno* "you see one"), but not word-level resyllabification (*de*[s]*armar* "to disarm"), deserves further research. However, one could hypothesize that preclitic forms such as *los otros* behave exactly the same as phrases containing two content words in the light of data from Ecuadorian Spanish, in which word-final prevocalic /s/ is voiced also in forms such as *ha*[z] *ido* "you have gone" vs. *ha* [s]*ido* "it has been" (Bermúdez-Otero 2011).

words, aspiration takes place even though it ends up targeting an /s/ syllabified in onset position.[8]

The works of Kaisse [1996, 1999] and Harris and Kaisse [1999] give a broad perspective of the interdialectal variation with respect to /s/ aspiration. I therefore use their dialectal classification based on the relative transparency of the process. The data in (2) illustrate three major dialects ranging from more transparent to less transparent ones with respect to /s/ aspiration in different morphosyntactic environments.[9]

(2) Distribution of opacity by overapplication of /s/ aspiration (Harris and Kaisse 1999)[10]

Aspirating dialects	prefixed forms	two-word phrases
Group A	de[h]armar "to disarm"	ve[h] uno "you see one"
Group B	de[s]armar	ve[h] uno
Group C	de[s]armar	ve[s] uno

Group A dialects correspond to those varieties in which both word- and phrasal-level resyllabification counterbleed /s/ aspiration. A mixed opaque

[8]Hualde [1989] reports the existence of some stigmatized sociolects in which /s/ aspiration applies regardless of its syllabic affiliation, thus targeting /s/ also when syllabified in onset position, as in ba[h]ura "garbage".

[9]Determining which specific dialects correspond to each group of aspirating dialects is beyond the purposes of this chapter. I will therefore use a conventional notation based on the distribution found in Kaisse (1999). The references in footnote 1 should satiate the more curious reader. To give just a few details, group A corresponds to what Kaisse 1999 dubs as Caribbean Spanish I, which includes Honduras and Granada Spanish; group B to Río Negro Argentinian Spanish (and also the city of Córdoba in Argentina and a portion of Neuquén province) and Chinato Spanish (Hualde 1991a); and group C to Buenos Aires Argentinian Spanish.

[10]The fact that maximal syllabification of stop plus sonorant clusters in Spanish is avoided in prefixed forms such as sub.lu.nar "sublunar", where in some varieties /b/ undergoes obstruent syllable-final devoicing (*su*[ɸ.]*lunar*) vs. su.bli.mar "to sublimate", a non-prefixed form, where /b/ spirantizes in all Spanish dialects (*su*[.β]*limar*), supports the idea that prefixes in Spanish, as opposed to suffixes, are phonologically non-coherent with respect to the bases to which they attach (Hualde 1991b, Harris 1983). Fábregas [2010] develops a syntactic approach to morphological constituency of Spanish diminutives and prefixed forms. His analysis predicts that only locatum *en–* prefix is sensitive to being debuccalised before vowel-initial bases in velarizing dialects (*e*[ŋ]*hebrar* "to put the thread in the needle"). I think that this interesting strong prediction should be tested with more data in order to discover if a form like *e*[ŋ]*hebrar* co-exists with *e*[n]*amorar* in the same velarizing dialect, with a change-of-state *en–* prefix. It seems that this could be the case in Ecuadorian Spanish (Martín Kohlberger p.c.).

pattern is found in group B dialects, in which only phrasal-level resyllabification, but not word-level resyllabification, counterbleeds /s/ aspiration. Finally, in group C dialects /s/ aspiration only applies transparently.

3.4 HS Analysis

3.4.1 Morphological constituency of affixed forms and prosody-enforcing constraints

I assume the existence of a morphological component prior to phonology that arranges roots and affixes into a hierarchical structure. Both inflectional suffixes and prefixes attach to stems, in contrast to derivational affixes, which attach to roots. In the presence of more than one suffix, recursive stems are built successively. Once the morphological operations terminate, the root node is labeled as a MORPHOLOGICAL WORD, which is defined as the linguistic unit of analysis whose integrating parts are unable to be manipulated by syntax. Phonology will treat STEM and MORPHOLOGICAL WORD in a different way. This labeled hierarchical structure serves as the input to the phonological component of grammar.

The morphological constituency of complex words derived by suffixation and prefixation is shown in (1).

(1) Morphological constituency of complex words

base + der. affix	$[\,[\,[\,\textit{arroz}_{\text{Root}}\,]\,\text{–}\textit{al}\,]_{\text{Stem}}\,\text{–}\emptyset]_{\text{MWd}}$	"rice field"
base + infl. affix	$[\,[\,\textit{mes}_{\text{Root}}\,]\,]_{\text{Stem}}\,\text{–}\textit{a}]_{\text{MWd}}$	"to disable"
prefix + base	$[\,\textit{des}\text{–}\,[\,[\,[\,\textit{arm}_{\text{Root}}\,]\,]_{\text{Stem}}\,\text{–}\textit{ar}\,]_{\text{Stem}}\,]_{\text{MWd}}$	"to disarm"

The mapping from morphosyntax to prosodic structure is driven by the satisfaction of two independent families of prosody-enforcing markedness constraints. The first family of constraints is of the Parse type, which demands that segments be parsed into syllables and prosodic words be parsed into phonological phrases respectively, as stated in (2) and (3).

(2) Parse-Segment (Prs-Seg)

Assign one violation mark for every segment that is not associated with a syllable. (Elfner 2009)

(3) Parse-ProsodicWord (Prs-PWd)

Assign one violation mark for every prosodic word that is not associated with a phonological phrase.

Apart from those constraints, two alignment constraints demand coincidence between the edges of morphological categories and prosodic categories, as defined in (4) and (5).

(4) Align-Left (stem, Prosodic Word) (Al-L(St, PWd))

The left edge of every stem must coincide with the left edge of some prosodic word. (McCarthy and Prince 1993)

(5) Align-Left (Morphological Word, Prosodic Word) (Al-L(MWd, PWd))

The left edge of every morphological word must coincide with the left edge of some prosodic word. (Selkirk 1995)

3.4.2 Group A dialects

In this chapter, syllabification of the entire input string is accomplished at a single derivational step for the sake of clarity. Whether syllables are construed one at a time or if whole syllabification is accomplished at a single step is irrelevant to the discussion.

Group A dialects show opacity by overapplication of /s/ aspiration in prefixed forms and two-word phrases, meaning that both word- and phrasal-level resyllabification counterbleed debuccalisation.

Prefixed forms

The following tableaux illustrate the HS derivation for the prefixed form /des+aɾm+aɾ/. At step 1 of the derivation, the high ranking of the alignment constraint Align-Left (stem, Prosodic Word) favors candidate (a) in tableau (110), in which the left edge of the stem, which excludes the prefix, is parsed into a prosodic word. This constraint dominates the remaining prosody-enforcing constraints. Hereafter, square brackets mark prosodic word boundaries, parentheses mark syllable boundaries, and curly brackets indicate phonological phrase boundaries.

Tableau 110: Step 1 /des+aɾm+aɾ/ → des[aɾmaɾ]

	/des+aɾm+aɾ/	Al-L(st, PWd)	Prs-Seg	Al-L(MWd, PWd)	Prs-PWd
a. ☞	des[aɾmaɾ]		8	1	1
b.	(de)(saɾ)(maɾ)	1 W	L	1	L
c.	desaɾmaɾ	1 W	8	1	L
d.	[desaɾmaɾ]	1 W	8	L	1
e.	{desaɾmaɾ}	1 W	8	1	L

At step 2 of the derivation, syllable formation operations apply because Parse-Segment is ranked higher than all other prosody-enforcing constraints. Parse-Segment also dominates Coda-Condition and Onset. When syllabification is able to apply at this step of the derivation, the /s/ of the prefix cannot be syllabified as the onset of the initial vowel of the stem because the presence of the prosodic word boundary blocks core syllabification to operate with the adjacent segments /s/ and /a/, as was stated in section 2.4.

Tableau 111: Step 2: /des[aɾmaɾ]/ → (des)[(aɾ)(maɾ)]

/des[aɾmaɾ]/		Prs-Seg	Ons	Coda-Cond	Al-L(MWd, PWd)	Prs-PWd
a. ☞	(des)[(aɾ)(maɾ)]		1	1	1	1
b.	des[aɾmaɾ]	8 W	L	L	1	1
c.	[des[aɾmaɾ]]	8 W	L	L	L	2 W
d.	{des[aɾmaɾ]}	8 W	L	L	1	L

At step 3 of the derivation, /s/ aspiration applies because Coda-Condition dominates Align-Left (Morphological Word, Prosodic Word).

Tableau 112: Step 3: /(des)[(aɾ)(maɾ)]/ → (deh)[(aɾ)(maɾ)]

/(des)[(aɾ)(maɾ)]/		Coda-Cond	Al-L(MWd, PWd)	Prs-PWd	Max[pl]
a. ☞	(deh)[(aɾ)(maɾ)]		1	1	1
b.	[(des)[(aɾ)(maɾ)]]	1 W	L	2 W	L
c.	(des)[(aɾ)(maɾ)]	1 W	1	1	L
d.	{(des)[(aɾ)(maɾ)]}	1 W	1	L	L

At step 4 of the derivation, Align-Left (Morphological Word, Prosodic Word), which dominates Parse-ProsodicWord, is satisfied.

Tableau 113: Step 4: /(deh)[(aɾ)(maɾ)]/ → [(deh)[(aɾ)(maɾ)]]

/(deh)[(aɾ)(maɾ)]/		Al-L(MWd, PWd)	Prs-PWd
a. ☞	[(deh)[(aɾ)(maɾ)]]		2
b.	(deh)[(aɾ)(maɾ)]	1 W	1 L
c.	{(deh)[(aɾ)(maɾ)]}	1 W	L

Once the outer prosodic word has been projected, syllable formation operations are able to operate with adjacent segments belonging to different morphs because there is a prosodic category higher than the syllable that dominates them. This way, resyllabification takes place at the next step of the derivation. Resyllabification satisfies ONSET, which dominates PARSE-PROSODICWORD.

Tableau 114: Step 5: /[(deh)[(aɾ)(maɾ)]]/ → [(de)[(haɾ)(maɾ)]]

	/[(deh)[(aɾ)(maɾ)]]/	ONS	PRS-PWD
a. ☞	[(de)[(haɾ)(maɾ)]]		2
b.	[(deh)[(aɾ)(maɾ)]]	1 W	2
c.	{[(deh)[(aɾ)(maɾ)]]}	1 W	L

The winning candidate in tableau (114) shows resyllabification and readjustment of the inner prosodic word left boundary (Peperkamp 1997). When resyllabification applies, the top-ranked constraint ALIGN-Left (stem, Prosodic Word) should be violated given the formulation in (4). Since HS permits the existence of derived prosodic structure in intermediate inputs, a reformulation of the constraint as in (6) is legitimate and would be satisfied by candidate (a) in tableau (114).

(6) Reformulation of ALIGN-Left (stem, Prosodic Word)

The left edge of every stem must coincide with the left edge of some prosodic word in the absence of input syllables.

In the next chapters, other alignment constraints will be given the very same formulation with respect to the fact that coincidence between edges is only required in the absence of input syllables.

Finally, at step 6 of the derivation, a phonological phrase is projected. Then the remaining higher prosodic categories, the intonational phrase and the utterance, are built gradually until convergence. I omit these steps because they are irrelevant to the discussion.

Two-word phrases

Group A dialects also show opacity by overapplication of /s/ aspiration in two-word phrases, meaning that phrasal-level resyllabification counterbleeds debuccalisation.

At the first steps of the derivation, both stems are parsed into their own prosodic words, making core syllabification not applicable between the last segment of the first word and the first segment of the second word. The derivation proceeds like this because of the ranking ALIGN-Left (stem, Prosodic Word) ≫ PARSE-SEGMENT.

At step 4, when the whole string is syllabified, debuccalisation applies because CODA-CONDITION dominates PARSE-PROSODICWORD, as tableau (115) illustrates with the input /bes#uno/ "you see one".

Tableau 115: Step 4: /[(bes)][(u)(no)]/ → [(beh)][(u)(no)]

	/[(bes)][(u)(no)]/	CODA-COND	PRS-PWD	MAX[pl]
a. ☞	[(beh)][(u)(no)]		2	1
b.	[(bes)][(u)(no)]	1 W	2	L
c.	{[(bes)][(u)(no)]}	1 W	L	L

Then the two prosodic words are parsed together into a phonological phrase, allowing resyllabification at the next step to apply across word boundaries. This gives rise to the opaque surface form *ve*[h] *uno*.

3.4.3 Group B dialects

In group B dialects, only phrasal-level resyllabification, but not word-level resyllabification, counterbleeds debuccalisation. This result obtains if ALIGN-Left (Morphological Word, Prosodic Word) dominates CODA-CONDITION and CODA-CONDITION dominates PARSE-PROSODICWORD.

In prefixed forms, when the stem is parsed into its own prosodic word and the whole string is syllabified, the projection of an outer prosodic word including the prefix takes precedence over debuccalisation at step 3 of the derivation, as tableau (116) shows.

Tableau 116: Step 3: /(des)[(aɾ)(maɾ)]/ → [(des)[(aɾ)(maɾ)]]

	/(des)[(aɾ)(maɾ)]/	AL-L(MWd, PWd)	CODA-COND	PRS-PWD
a. ☞	[(des)[(aɾ)(maɾ)]]		1	2
b.	(deh)[(aɾ)(maɾ)]	1 W	L	1 L
c.	(des)[(aɾ)(maɾ)]	1 W	1	1 L
d.	{(des)[(aɾ)(maɾ)]}	1 W	1	L

Once the prefix and the stem have been parsed into an outer recursive prosodic word, resyllabification applies at the next step of the derivation because the resyllabified candidate harmonically bounds the candidate undergoing debuccalisation.

Tableau 117: Step 4: /[(des)[(aɾ)(maɾ)]]/ → [(de)[(saɾ)(maɾ)]]

	/[(des)[(aɾ)(maɾ)]]/	ONS	CODA-COND	MAX[pl]
a. ☞	[(de)[(saɾ)(maɾ)]]			
b.	[(deh)[(aɾ)(maɾ)]]	1 W		1 W

Unlike prefixed forms, overapplication in two-word phrases is found in group B dialects because CODA-CONDITION dominates PARSE-PROSODICWORD. The tableau in (115) for group A dialects serves as an example.

3.4.4 Group C dialects

In group C dialects, /s/ aspiration only applies transparently, that is to say, when /s/ is in preconsonantal syllable coda position, meaning that no morphologically-induced opacity is at play. This result obtains by ranking CODA-CONDITION below all the prosody-enforcing markedness constraints.

In the next tableaux, I show the two crucial steps in which debuccalisation is bled by resyllabification in prefixed forms (tableaux 118 and 119) and two-word phrases (tableaux 120 and 121).

Tableau 118: Step 3 (prefixed form)

/(des)[(aɾ)(maɾ)]/	AL-L(MWd, PWd)	PRS-PWD	CODA-COND
a. ☞ [(des)[(aɾ)(maɾ)]]		2	1
b. (deh)[(aɾ)(maɾ)]	1 W	1 L	L
c. (des)[(aɾ)(maɾ)]	1 W	1 L	1
d. {(des)[(aɾ)(maɾ)]}	1 W	L	1

Tableau 119: Step 4 (prefixed form)

/[(des)[(aɾ)(maɾ)]]/	ONS	CODA-COND	MAX[pl]
a. ☞ [(de)[(saɾ)(maɾ)]]			
b. [(deh)[(aɾ)(maɾ)]]	1 W		1 W

Tableau 120: Step 4 (two-word phrase)

/[(bes)][(u)(no)]/	PRS-PWD	CODA-COND	MAX[pl]
a. ☞ {[(bes)][(u)(no)]}		1	
b. [(bes)][(u)(no)]	2 W	1	
c. [(beh)][(u)(no)]	2 W	L	1 W

Tableau 121: Step 5 (two-word phrase)

/{[(bes)][(u)(no)]}/	ONS	CODA-COND	MAX[pl]
a. ☞ {[(be)][(su)(no)]}			
b. {[(beh)][(u)(no)]}	1 W		1 W

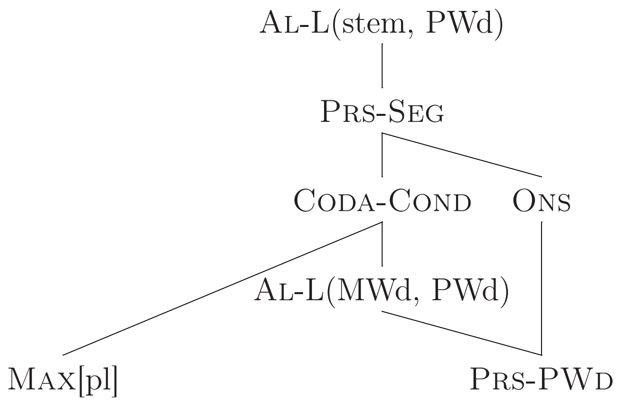
3.5 Summary: constraint rankings

Given that prosodification is serially built in HS under an operation-based definition of gradualness, the presence of certain prosodic boundaries between two adjacent segments belonging to different morphs at some intermediate levels of representation blocks the application of core syllabification, thus forcing a universally marked C.V syllable configuration to be perdurable until a higher prosodic category that dominates both segments is built. This situation leads to the possibility of satisfying Coda-Condition before a coda consonant is able to be syllabified as the onset of a following onsetless syllable, thus giving rise to the opacity by overapplication pattern of /s/ aspiration.

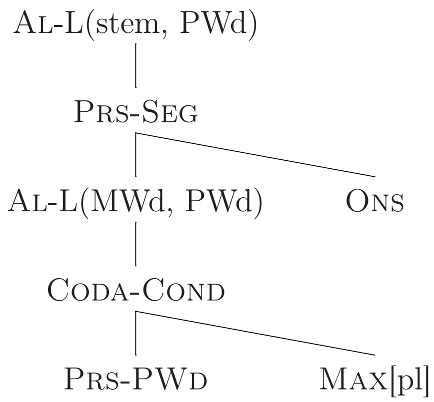
The phonological asymmetries observed in prefixed forms and two-word phrases in Spanish with respect to /s/ aspiration have been shown to depend on the interaction between the markedness constraint responsible for the [s]-[h] allophonic alternation, Coda-Condition, and a set of prosody-enforcing markedness constraints which are ranked in the same way in all varieties.

The Hasse diagrams below summarize the constraint rankings for each group of dialects.

(1) Group A dialects



(2) Group B dialects



(3) Group C dialects

Al-L(stem, PWd)
|
Prs-Seg
|
Al-L(MWd, PWd)   Ons
|
Prs-PWd
|
Coda-Cond
|
Max[pl]

3.6 Conclusion

In this chapter, I have defended the position that prosodification in HS is built in harmonically improving single steps and have proposed that prosodic constituents higher than the syllable create opaque domains for syllable-building operations. These assumptions prevent core syllabification from operating with adjacent segments belonging to different morphs if one of the segments, but not the other, is contained in a prosodic constituent higher than the syllable. The relative transparency of the /s/ aspiration process found in different dialects of Spanish is derived by the relative position that the markedness constraint Coda-Condition occupies with respect to two families of constraints enforcing prosodification: Parse-Segment $\gg$ Parse-ProsodicWord, on the one hand, and two morphology-prosody alignment constraints, Align/Left(stem, Prosodic Word) $\gg$ Align/Left(Morphological Word, Prosodic Word), on the other hand.

Chapter 4

Opaque syllabification in Mongolian

Abstract

This chapter investigates the nature of directional syllabification and vowel epenthesis placement in standard Ulaanbaatar Mongolian, or Khalkha Mongolian (Svantesson 1995, 2009, Svantesson et al. 2005) in HS. I focus on specific cases of cyclic syllabification in which the optimal directional syllabification algorithm is obscured by the morphological structure in morphologically complex words. In order to examine these facts, I make use of the theory of serial syllabification presented in chapter 2, and give support to the idea that prosodic categories higher than the syllable create opaque domains for syllabification.

4.1 Introduction

It is not the goal of this chapter to give a complete account of the syllable structure in Mongolian. For more detailed studies, see Svantesson [1995, 2009], Svantesson et al. [2005]. All the data and descriptive generalizations come from these sources.

Surface syllables in Mongolian have the structure (C)V(V)(C)(C)(C), and demand a strictly falling-sonority profile in syllable codas; this is enforced by word-internal vowel epenthesis, which can be either [ə] or [ɪ], depending on the phonological context. The examples in (1) illustrate possible two-consonant codas, cases with an epenthetic vowel, in which the first consonant is less sonorous than the second consonant, and underlying CC sequences with the same degree of sonority that are also fixed by means of vowel epenthesis. Dots mark syllable boundaries.

(1) C_1 more sonorous than C_2

/ʤims/	[ʤims]	"fruit"
/limb/	[limb]	"flute"
/tsɔŋx/	[tsɔŋx]	"window"
/ʊls/	[ʊls]	"state"
/ard/	[ard]	"people"
/ar^{j}x^j/	[ar^{j}x^j]	"liquor"
/sʊwd/	[sʊwd]	"pearl"
/sawx/	[sawx]	"chopsticks"

C_1 less sonorous than C_2 (epenthesis)

/dɔtn/	[dɔ.tən]	"inside"
/tʊtm/	[tʊ.təm]	"each"
/ɔx^{j}n/	[ɔ.x^{j}ən]	"daughter"
/aʣl/	[a.ʣɪl]	"work"
/baːtr/	[baː.tər]	"hero"
/ɢazr/	[ɢa.zər]	"place"
/sidw/	[si.dəw]	"theme"
/tʊsw/	[tʊ.səw]	"plan"

C_1 as sonorous as C_2 (epenthesis)

/x^{j}atd/	[x^{j}a.təd]	"China"
/unŋ/	[u.nəŋ]	"truth"
/ɢʊr^{j}l/	[ɢʊ.r^{j}ɪl]	"flour"
/aw-w/	[a.wəw]	"take.PAST"

In order to account for these facts, Svantesson [1995] proposes the sonority scale for Mongolian in (2), and a subsequent coda constraint in (3).

(2) Sonority scale for Mongolian (Svantesson 1995:758)

Stops/Affricates < Fricatives < Sonorants (< Vowels)

(3) Coda constraint (Svantesson 1995: 758)

A string of (zero or more) consonants is a possible coda if and only if it has strictly decreasing sonority.

Three-consonant codas are equally subject to the coda constraint. Underlying CCC sequences with a non-decreasing sonority profile appear to have an epenthetic vowel in the surface. Compare the examples in (4) with those in (5).

(4) CCC underlying sequences with a permissible sonority profile

/ils-t-te/	[ilst.te]	"sandy.COM"
/ʊːr-s-tl-a/	[ʊːrst.la]	"steam.VERB.TERM.REFL"
/ai-ms-tl-a/	[aimst.la]	"fear.VERB.TERM.REFL"

(5) CCC underlying sequences with non-permissible sonority profiles

/ɢʊtmʧ/	[ɢʊ.təmʧ]	"street"
/ɢʊrnʦ/	[ɢʊ.rənʦ]	"emery"
/ʃitms/	[ʃi.təms]	"fillet"
/itsʰstʰ/	[i.tsʰəstʰ]	"as a result of"
/gurwʫ/	[gur.wəʫ]	"lizard"
/xitmŋ/	[xit.məŋ]	"pear"
/pompg/	[pom.pəg]	"ball"
/xʊwtʃʰs/	[xʊw.tʃʰəs]	"clothes"

In underlying CCC sequences, the location of the epenthetic vowel differs, as can be compared from the the first four examples and the last four examples in (5). If the last two consonants can form a complex coda with decreasing sonority, the epenthetic vowel follows the first consonant of the CCC sequence. Otherwise, the epenthetic vowel follows the second consonant. In underlying CCC sequences, the location of an epenthetic vowel has been interpreted as a function of right-to-left directional maximal syllabification (Svantesson 1995, Svantesson et al. 2005). Right-to-left directional maximal syllabification is clear in cases with an underlying CCCC sequence like /jort^{h}nts^{h}/ → [jor.t^{h}ənts^{h}] "world", which cannot surface as *[jort^{h}.nəts^{h}], which is otherwise a form that respects well-formedness syllable constraints in the language. The syllabification algorithm as explained in Svantesson et al. [2005] starts by applying at the right edge of the word and builds a maximal coda if possible. If not, an epenthetic vowel is inserted between the last and the penultimate consonants. In underlying CCC sequences, if a two-consonant coda has been built, and if there is an available preceding vowel, it becomes part of the syllable. If a consonant precedes the consonant cluster, then an epenthetic vowel is inserted between the second and third consonant from the right. A remaining consonant before a vowel always becomes an onset. This procedure is repeated until the underlying string is completely syllabified. The derivation in (6) shows the effects of the right-to-left maximal syllabification algorithm. The derivation in (7) produces the wrong result because the underlying segmental string is scanned from left-to-right.

(6) Right-to-left maximal syllabification algorithm (Svantesson et al. 2005)

/jort^{h}nts^{h}/	Underlying Representation
jort^{h}(nts^{h})	maximal coda building
jort^{h}(ə(nts^{h}))	epenthesis (rhyme building)
jor(t^{h}(ə(nts^{h})))	onset adjunction
j(or)(t^{h}(ə(nts^{h})))	rhyme building
(j(or))(t^{h}(ə(nts^{h})))	onset adjunction

(7) Simplified left-to-right maximal syllabification algorithm (Svantesson et al. 2005)

/jort^{h}nts^{h}/	Underlying Representation
(jort^{h})nts^{h}	maximal coda building (+ rhyme building)
*(jort^{h})(nəts^{h})	epenthesis

In the next section, I give an analysis of non-cyclic syllabification applying POT.

4.2 A POT analysis of non-cyclic syllabification

In Mongolian, word-initial syllables can be onsetless. Tableau (122) shows the evaluation of an input containing a vowel-initial word. C represents an epenthesized consonant.

Tableau 122: /atʊ/ → a.tʊ "horse"

	/atʊ/	MAX-V	DEP-C	ONSET
a. ☞	a.tʊ			1
b.	at.ʊ			2 W
c.	Cat.ʊ		1 W	1
d.	Ca.tʊ		1 W	L
e.	tʊ	1 W		L

Inputs containing an onsetless word-initial vowel are mapped faithfully. This fact demands that the faithfulness constraint MAX-V, which prohibits vowel deletion, and DEP-C, which prohibits consonant insertion, must be ranked above the markedness constraint ONSET, which penalizes onsetless syllables, as loser candidates (e) and (d) illustrate. Candidate (c) is harmonically bounded by candidate (a) because it shows a superset of the number of violations incurred by the winning candidate. Although ONSET occupies a low position in the constraint hierarchy, it is active when selecting candidate (a) as the winner compared with candidate (b), because candidate (a) violates ONSET minimally. This is a classic case of emergence of the unmarked.

Word-internal syllables, however, are always required to have an onset in Mongolian; this is enforced by consonant epenthesis, which can be either [ɢ] or [g], depending on the phonological context. The markedness constraint that disfavors onsetless word-internal syllables, NO-HIATUS, must be ranked above DEP-C. Tableau (123) illustrates this.

Tableau 123: /sana-a/ → sa.na.ɢa "thought.REFL"

	/sana-a/	MAX-V	NO-HIATUS	DEP-C	ONSET
a. ☞	sa.na.ɢa			1	
b.	sa.na.a		1 W	L	1 W
c.	sa.na	1 W		L	

Tableau (123) demonstrates that MAX-V and NO-HIATUS must be ranked above DEP-C. This constraint hierarchy ensures that vowel-initial words are mapped faithfully as onsetless word-initial syllables, whereas onsetless word-internal syllables are avoided by means of consonant epenthesis.

Syllables in Mongolian allow complex codas of at most three consonants. However, complex onsets are prohibited. Tableau (124) evaluates an input with an underlying CCCC sequence that surfaces with no epenthetic vowel.

Tableau 124: /nɔir-s-tl-ɔ/ → nɔirst.lɔ "sleep.VERB.TERM.REFL"

	/nɔir-s-tl-ɔ/	*COMPL-ONS	MAX-C	DEP-V	*COMPL-CODA
a. ☞	nɔirst.lɔ				1
b.	nɔirs.lɔ		1 W		1
c.	nɔir.lɔ		2 W		1
d.	nɔi.lɔ		3 W		L
e.	nɔi.rə.sə.tə.lɔ			3 W	L
f.	nɔirs.tlɔ	1 W			1

Tableau (124) demonstrates that the faithfulness constraint MAX-C, which prohibits consonant deletion, and DEP-V, which disfavors vowel insertion, must be ranked above the markedness constraint against complex codas, *COMPLEX-CODA. Hence an input containing an underlying CCCC sequence is mapped as CCC.C, forming a complex coda with a single onset if the sonority constraint on codas is respected. It is known that the word-internal sequence (rst) is in the rhyme position because it can also appear word-finally.

The markedness constraint against complex onset, *COMPLEX-ONSET, dominates the markedness constraint against syllables with complex codas, *COMPLEX-CODA. This can be seen in tableau (125), with an input containing a CCC underlying sequence. The relative ranking between *COMPLEX-CODA and NO-CODA cannot be established given that these two constraints stand in a stringency relation and thus never conflict.

Tableau 125: /xandɢai/ → xand.ɢai "elk"

	/xandɢai/	*Compl-Ons	*Compl-Coda
a. ☞	xand.ɢai		1
b.	xan.dɢai	1 W	L

Given that complex codas are allowed in Mongolian, the constraint No-Coda must also be dominated by the faithfulness constraints Max-C and Dep-V, as tableau (126) shows. V represents an epenthetic vowel.

Tableau 126: /tɔtʲ/ → tɔtʲ "parrot"

	/tɔtʲ/	Max-C	Dep-V	No-Coda
a. ☞	tɔtʲ			1
b.	tɔ.tʲV		1 W	L
c.	tɔ	1 W		L

Epenthetic vowels in Mongolian are never found word-finally. I attribute this fact to the activity of an alignment constraint that requires the left edge of every syllable to coincide with the left edge of some prosodic word, Align-Left (σ, Prosodic Word) (Mester and Padgett 1994). The number of violation marks computed by this alignment constraint is counted here by the number of segments that stand between the left edge of every syllable and the left edge of some prosodic word. The minimal satisfaction of that alignment constraint triggers the location of the epenthetic vowel, which is always located as much to the left of the prosodic word as possible. A constraint that disfavors sequences of consonants syllabified in coda position with a rising or flat sonority profile, abbreviated here as Coda-Constraint, using the term used by Svantesson [1995], is also introduced in the following tableau. The tableaux below illustrate inputs with an underlying CCCC sequence in which the epenthetic vowel appears at different loci.

Tableau 127: /xʊwʧs/ → xʊw.ʧəs "clothes"

/xʊwʧs/	Coda-Const	*Compl-Ons	Al-L(σ, PWd)	Dep-V	*Compl-Coda	No-Coda
a. ☞ xʊw.ʧəs			3	1		1
b. xʊwʧ.sə			4 W	1	1 W	1
c. xʊ.wə.ʧəs			6 W	2 W		1
d. xʊw.ʧsə		1 W	3	1		L
e. xʊ.wəʧs	1 W		2 L	1	1 W	1
f. xʊwʧs	1 W		L	L	1 W	1

Tableau 128: /sar^{j}ms/ → sa.r^{j}ɪms "garlic"

/sar^{j}ms/	Coda-Const	*Complex-Ons	Al-L(σ, PWd)	Dep-V	*Complex-Coda	No-Coda
a. ☞ sa.r^{j}ɪms			2	1	1	1
b. sar^j.mɪs			3 W	1	L	2 W
c. sa.r^{j}ɪ.mɪs			6 W	2 W	L	1
d. sar^j.msɪ		1 W	3 W	1	L	1
e. sar^{j}ms	1 W		L	L	1	1

The last candidates in tableaux (140) and (128) are ruled out because they violate Coda-Constraint, given that they have a complex coda that does not show a strictly decreasing sonority profile. Candidates (d) fatally violate *Complex-Onset. Although the first three candidates tie with the winning candidates with respect to the top-ranked constraints, they introduce too many violations of Align-Left (σ, Prosodic Word). These competitors introduce more epenthetic vowels than required. Having too many epenthetic vowels adds extra syllables that are computed by the alignment constraint. The interesting pairs are those between candidates (a) and (b). In tableau

(140), candidate (a), with an epenthetic vowel between the second and third final consonant sequence, is the winner because only three segments, namely (xʊw), intervene between the left edge of the second syllable and the left edge of the prosodic word. Candidate (b), however, with a word-final epenthetic vowel, introduce four violations of the alignment constraint because the first syllable is larger, (xʊwʧ). In tableau (128), the same can be said if candidates (a) and (b) are compared. The descriptive generalization that emerges from the interaction of these constraints is that the epenthetic vowel surfaces as much to the left as possible, provided that the syllable structure is optimal. In an underlying CCCC sequence, the epenthetic vowel appears between the second and third consonants if the last three consonants cannot form an optimal complex coda. Otherwise, the epenthetic vowel appears between the first and second consonants, and this is triggered by the minimal satisfaction of the alignment constraint. The activity of ALIGN-Left (σ, Prosodic Word) is clear if an input with an underlying CCCC sequence like /jort^{h}nts^{h}/ is considered.

Tableau 129: /jort^{h}nts^{h}/ → jor.t^{h}ənts^{h} "world"

	/jort^{h}nts^{h}/	AL-L(σ, PWd)	DEP-V	*COMPL-CODA	NO-CODA
a. ☞	jor.t^{h}ənts^{h}	3	1	1	2
b.	jort^{h}.nəts^{h}	4 W	1	1	2
c.	jo.rət^{h}.nəts^{h}	7 W	2 W	L	2
d.	jor.t^{h}ə.nəts^{h}	8 W	2 W	L	2

Candidates (b) and (a) in the previous tableau introduce the same number of violations with respect to DEP-V, *COMPLEX-CODA and NO-CODA. They only differ with respect to the location of the epenthetic vowel. The constraint responsible for selecting the actual output form is then ALIGN-Left(σ, PWd), which disfavors candidate (b) because four segments, (jort^{h}), intervene between the left edge of the second syllable and the left edge of the prosodic word, as opposed to candidate (a), in which only three segments, namely (jor), stand between the two edges.

The same effect can be seen with larger underlying consonant sequences, which trigger the appearance of multiple epenthetic vowels, as tableau (130) illustrates. The winning candidate in the tableau below also harmonically bounds candidates (b) and (c).

Tableau 130: /naimlzrɢn/ → nai.məl.zər.ɢən "louse"

	/naimlzrɢn/	AL-L(σ, PWd)	DEP-V	NO-CODA
a. ☞	nai.məl.zər.ɢən	18	3	3
b.	naim.ləz.rə.ɢən	20 W	3	3
c.	naim.ləz.rəɢ.nə	21 W	3	3

4.3 Cyclic syllabification in non-monomorphemic words

Before presenting the analysis of cyclic syllabification in non-monomorphemic words in Mongolian, I will justify the necessity of postulating the structural adjacency principle on syllable formation operations formulated in (9) in 2.1.2, stated again in (1), as well as the necessity of allowing GEN to build complex minor syllables in which subsyllabic affiliation is computed by the grammar.

(1) *Structural adjacency principle on syllable formation operations*

GEN cannot create syllables in which segments do not belong to the same subsyllabic constituents (*i.e.*, if two segments are parsed simultaneously, one of them cannot be an onset and the other one a coda, for instance.)

In the version of HS defended here, syllables are built one at a time and directionally. Consider the input /jort^{h}nts^{h}/. If only one segment is allowed to be parsed into a minor syllable, then the intermediate form jort^{h}n(ts$^{h}{}_{C}$) would be selected. This candidate is selected if ALIGN-Right/σ (AL-R/σ) dominates PARSE-SEGMENT, as shown in tableau (131). The minor syllable is labeled as a coda (C) because of right-to-left syllabification.

Tableau 131: unary minor syllable building

	/jort^{h}nts^h/	AL-R/σ	PRS-SEG
a. ☞	jort^{h}n(ts^h$_C$)		5
b.	(jo)rt^{h}nts^h	4 W	4 L

At the next step, the closest segment to the already built syllable can undergo adjunction. Two different options are available: adjoining it to the minor syllable as part of the coda, or adjoining it to the syllable node but not linking it to the label C, meaning that the consonant occupies the onset position. The problem is that the latter option will always be more harmonic than the former option because, even in languages in which complex codas are allowed, a configuration with an onset and a single coda harmonically bounds a configuration without onset and a complex coda. This is shown in tableau (132). The lower case illustrates the different affiliation of the adjoined sonorant with respect to the last segment of the string.

Tableau 132: adjunction

	/jort^{h}n(ts^h$_C$)/	AL-R/σ	PRS-SEG	*COMPL-CODA	ONS
a. ☞	jort^h(n_ts^h$_C$)		4	L	L
b. ☹	jort^h(_nts^h$_C$)		4	1	1

The selected candidate (a) predicts ungrammatical *jort.^{h}nəts^h. The myopic nature of HS can only select candidate (a). Thus, I propose that GEN must be defined in a way that allows building a complex minor syllable at a single step. The structural adjacency principle on syllable formation operations blocks the possibility of parsing the last two segments as in candidate (a) in tableau (132) because the segments do not belong to the same subsyllabic constituents.

GEN must be able not only to build complex minor syllables but also to assign to every segment in a minor syllable a subsyllabic affiliation (see section 2.1.2 in chatper 2 for more details). Subsyllabic ascription is sometimes derived by the representation itself: if a segment is non-moraic, and is immediately dominated by the syllable node, then this segment occupies the onset position of a minor syllable. Recall that for codas, both moraic and non-moraic, it is necessary to enrich the representation by introducing the label C in a separate tier. This idea can also be justified with the input /jort^{h}nts^{h}/. In a theory in which minor syllables have no subsyllabic affiliation, at the first step of the derivation, a complex minor syllable can be built, jort^{h}(nts^{h}). However, at the next step of the derivation, a representation like jor(t^{h}nts^{h}) can only be selected if the grammar "knows" that (nts^{h}) is a possible complex coda in the language, and that t^{h} can be an onset of that minor syllable. If no subsyllabic constituency is postulated, HS becomes too myopic, and (t^{h}nts^{h}) could not be evaluated as more harmonic than, for instance, (t^{h})(nts^{h}). Once (nts^{h}) is built, the grammar must know that this complex minor syllable is a possible coda in the language, and, as a consequence, allow the adjunction of (t^{h}) to the already existing minor complex syllable. However, if the complex minor syllable contains a pair of segments that show a rising sonority profile, such as (ʧs) in /xʊwʧs/, the grammar must "know" that w cannot be adjoined to that syllable but must form its own minor syllable, thus giving rise to the insertion of an epenthetic schwa between the two segments at later derivational steps, (ʧəs). Enriching moraic representations with the label C in HS solves this look-ahead problem.[1]

In Mongolian, there are some derived and inflected words in which syllabification interacts cyclically with the morphological structure of the word.[2] This can be seen from minimal pairs containing the same underlying segmental string but differing in the location of morpheme boundaries. Some examples are given in (2), taken from Svantesson [1995]. The last pair is an

[1]In words containing multiple epenthetic vowels, applying epenthesis in an intermediate step before adjunction could also solve the look-ahead problem, thus meaning that no subsyllabic information is needed. But this is not possible in HS because of the top-ranked constraint Parse-Segment, which demands that the whole input string be syllabified before epenthesis is able to aply.

[2]In Mongolian, not every morphologically complex word shows cyclic syllabification, but it is not the case that certain morphemes trigger cyclic syllabification. Cyclic syllabification is triggered rather by the combination of different sonority values in the segment string formed when the suffixes are added (Svantesson 2009:74), that is, the process of morphological concatenation itself. The only exception is the verb suffix -*x*, which sometimes requires a schwa (Svantesson 2009:75) (Svantesson p.c.).

instance of a near minimal pair, in which consonants differ except in their sonority value.

(2) (Near-)minimal pairs in the location of the epenthetic vowel

/xʊts-t-la/	[xʊ.tsət.la]	"ram.VERB.PAST"
/xʊts-tl-a/	[xʊts.tə.la]	"bark.TERM.REFL"
/ʥɵwl-lɵ/	[ʥɵ.wəl.lɵ]	"advise.PAST"
/ʥɵwl-l-ɵ/	[ʥɵw.lə.lɵ]	"advise.NOUN.REFL"
/alt-d-ml/	[al.təd.məl]	"gold.VERB.ADJ"
/ard-ʧl-l/	[art.ʧɪ.ləl]	"people.VERB.NOUN"

The analyses presented in Svantesson [1995], Svantesson et al. [2005] are based on the notion of the cycle, in which syllabification applies cyclically after every morphological operation of affixation. That analysis correctly derives the actual surface forms, as illustrated in (3).

(3) Cyclic derivation (Svantesson 1995)

Root	/xʊts/	[xʊts]	"ram"
VERB	-t	[xʊ.tsət]	"to mount (like a ram)"
PAST	-la	[xʊ.tsət.la]	"mounted"
Root	/xʊts/	[xʊts]	"to bark (of dog)"
TERMINAL	-tl	[xʊts.təl]	"until (it) barks"
REFLEXIVE	-a	[xʊts.tə.la]	"until its barking"

In a POT analysis, the actual output forms [xʊts.tə.la], [ʥɵw.lə.lɵ], and [art.ʧɪ.ləl] would be ruled out because of the activity of ALIGN-Left(σ, Prosodic Word). This is shown in tableau (144).

Tableau 133: /xʊts-tl-a/ → *xʊ.tsət.la

/xʊts-tl-a/	AL-L(σ, PWd)	NO-CODA
a. ☞ xʊ.tsət.la	7 L	1
b. ☹ xʊts.tə.la	8	1

One could think that other constraints regulating the location of the epenthetic vowel with respect to morpheme boundaries could do the job in selecting the actual outputs. But even if we posit one constraint prohibiting morpheme-internal epenthetic vowels, OUTPUT-CONTIGUITY (O-CONT), and another one prohibiting epenthetic vowels between morphemes, like ALIGN-Left/Right (morphemes) (AL-Left/Right(morph)), they also fail in selecting the right candidates because they require contradictory rankings with respect to ALIGN-Left (σ, Prosodic Word). This can be checked in the following tableaux.

Tableau 134: ALIGN-Left/Right (morphemes) $\gg$ ALIGN-Left (σ, Prosodic Word)

	/xʊʦ-tl-a/	AL-L/R(morph)	AL-L(σ, PWd)
a. ☞	xʊʦ.tə.la		8
b.	xʊ.tsət.la	1 W	7 L

Tableau 135: ALIGN-Left (σ, Prosodic Word) $\gg$ ALIGN-Left/Right (morphemes)

	/xʊts-t/	AL-L(σ, PWd)	AL-L/R(morph)
a. ☞	xʊ.tsət	2	1
b.	xʊts.tə	3 W	L

Tableau 136: OUTPUT-CONTIGUITY $\gg$ ALIGN-Left (σ, Prosodic Word)

	/ʥɵwl-l-ɵ/	O-CONT	AL-L(σ, PWd)
a. ☞	ʥɵw.lə.lɵ		8
b.	ʥɵ.wəl.lɵ	1 W	7 L

Tableau 137: ALIGN-Left (σ, Prosodic Word) $\gg$ OUTPUT-CONTIGUITY

	/ʥɵwl/	AL-L(σ, PWd)	O-CONT
a. ☞	ʥɵ.wəl	2	1
b.	ʥɵw.lə	3 W	L

There is no way in standard POT to select the right output forms. Some kind of cyclic, derivational precedure is needed.

4.4 HS analysis

This section presents a formal interpretation of cyclic syllabification in Mongolian couched within the formalism of HS using the ideas developed in chapter 2. The analysis will focus on one minimal pair. This minimal pair is repeated below.

(1) Minimal pair

/xʊʦ-t-la/	[xʊ.ʦət.la]	"mounted"
/xʊʦ-tl-a/	[xʊʦ.tə.la]	"until its barking"

First, consider the input /xʊʦ-t-la/. At step 1 of the derivation the winning candidate is that one that parses the root and the first suffix into the same prosodic word, satisfying Lx≈Pr (Prince and Smolensky 1993/2004). Notice that the dash between the root and the first suffix is deleted in candidate (a) in tableau (138), meaning that once both morphs are dominated by the same prosodic constituent, syllable formation operations are able to operate with adjacent segments belonging to different morphs. I propose that only the first two morphs can be integrated into the same prosodic word at a single step because of a maximal binary Gen restriction on prosody-building operations stating that prosody-building operations are constrained to operate with at most two phonological or morphological units present in the input. Brackets mark prosodic word boundaries and parentheses syllable boundaries in the tableaux below. As noted, at step 1, the root and first affix are parsed together in a prosodic word in order to satisfy the constraint Lx≈Pr.[3]

Tableau 138: Step 1: /xʊʦ-t-la/ → [xʊtst]-la

/xʊʦ-t-la/		Lx≈Pr	Al-R/σ	Prs-Seg	Prs-Syll
a. ☞	[xʊtst]-la			6	
b.	xʊʦ-t-la	1 W		6	
c.	xʊʦ-t-(la)	1 W		4 L	1 W
d.	(xʊ)ʦ-t-la	1 W	4 W	4 L	1 W

[3]As argued for in Morén [1999], consonants in Mongolian are never moraic. I therefore do not represent moras.

At step 2 of the derivation, the most harmonic candidate, candidate (a), is the one that parses the second suffix as a core syllable. Candidate (e) in tableau (139), however, which also incurs four violations of PARSE-SEGMENT, fatally violates ALIGN-Right/σ because there are two segments intervening between the right edge of the syllable and the right edge of the prosodic word. ALIGN-Right/σ forces right-to-left syllabification in this analysis. Candidate (d) integrates the last two segments of the previously created prosodic word as a minor complex coda, violating CODA-CONSTRAINT. This candidate has been generated by a binary syllable formation without mora (given that Khalkha Mongolian is a weight-insensitive language), and in which the label C has been inserted as a function of the directionality of the parser provided by GEN. The rest of the candidates violate PARSE-SEGMENT more than candidate (a). For instance, candidate (b), with a minor syllable located at the left edge of the morpheme boundary, is ruled out because it is less harmonic than creating a core syllable that is outside the prosodic word, as candidate (a) shows.

Tableau 139: Step 2: /[xʊt͡st]-la/ → [xʊt͡st]-(la)

	/[xʊt͡st]-la/	AL-R/σ	CODA-CONST	PRS-SEG	PRS-SYLL	SYLL-HEAD	NO-CODA	ONS
a. ☞	[xʊt͡st]-(la)			4	1			
b.	[xʊt͡s(t$_C$)]-la			5 W	L	1 W	1 W	1 W
c.	[xʊt͡st]-la			6 W	L			
d.	[xʊ(t͡st$_C$)]-la		1 W	4	L	1 W	1 W	1 W
e.	[(xʊ)t͡st]-la	2 W		4	L			

At step 3, the segments incorporated into the prosodic word must be parsed into some syllable. Syllabification must proceed from right to left, and for this reason candidate (d) in tableau (140) is ruled out, because it violates ALIGN-Right/σ. Candidates (c) and (a) are the result of projecting a minor syllable with an empty nucleus. In candidate (c), two segments are incorporated into a binary minor syllable, thus violating CODA-CONSTRAINT.

Candidate (b), the fully faithful one, receives one more violation than candidate (a) with respect to PARSE-SEGMENT. The winning candidate is candidate (a), in which the last segment of the prosodic word is parsed as the coda of a minor syllable.

Tableau 140: Step 3: /[xʊt͡st]-(la)/ → [xʊt͡s(t$_C$)]-(la)

/[xʊt͡st]-(la)/	AL-R/σ	CODA-CONST	PRS-SEG	PRS-SYLL	SYLL-HEAD	NO-CODA	ONS
a. ☞ [xʊt͡s(t$_C$)]-(la)			3	1	1	1	1
b. [xʊt͡st]-(la)			4 W	L	L	L	L
c. [xʊ(t͡st$_C$)]-(la)		1 W	2 L	1	1	1	1
d. [(xʊ)t͡st]-(la)	2 W		2 L	1	L	L	L

At step 4, candidate (f) is discarded because it fatally violates ALIGN-Right/σ, although it is the only candidate that shows a better performance on PARSE-SEGMENT. The only difference between candidates (e) and (d) revolves around the adjunction or not of the last syllable of the string into the pre-existing prosodic word. Both candidates fatally violate PARSE-SEGMENT, as does candidate (c), the only one that completely satisfies SYLLABLE-HEAD by inserting an epenthetic vowel. Candidate (b) is harmonically - bounded by candidate (a), the winner at this evaluation step, because it violates a superset of the violation marks assigned to candidate (a). Candidate (b) creates an additional minor syllable and thus receives more violations of NO-CODA and ONSET than candidate (a). The winning candidate is the one in which onset adjunction takes place, which harmonically bounds candidate (b) because no extra minor syllable is projected. A low dash in a minor syllable indicates that the consonant at the left edge of the syllable is dominated by the syllable node and is not labeled as C, meaning that this consonant is the onset of a minor syllable.

Tableau 141: Step 4: /[xʊts(t$_C$)]-(la)/ → [xʊ(ts_t$_C$)]-(la)

/[xʊts(t$_C$)]-(la)/	Al-R/σ	Prs-Seg	Prs-Syll	Syll-Head	Dep-V	No-Coda	Ons
a. ☞ [xʊ(ts_t$_C$)]-(la)		2	1	1		1	
b. [xʊ(ts$_C$)(t$_C$)]-(la)		2	1	2 W		2 W	2 W
c. [xʊts(ət)]-(la)		3 W	1	L	1 W	1	1 W
d. [xʊts(t$_C$)-(la)]		3 W	L	1		1	1 W
e. [xʊts(t$_C$)]-(la)		3 W	1	1		1	1 W
f. [(xʊ)ts(t$_C$)]-(la)	1 W	1 L	1	1		1	1 W

The most harmonic candidate at step 5 is candidate (a), the one in which all segments have been parsed into some syllable. All the other available Gen operations perform worse in terms of Parse-Segment.

Tableau 142: Step 5: /[xʊ(ts_t$_C$)]-(la)/ → [(xʊ)(ts_t$_C$)]-(la)

/[xʊ(ts_t$_C$)]-(la)/	Al-R/σ	Prs-Seg	Prs-Syll	Syll-Head	Dep-V	No-Coda	Ons
a. ☞ [(xʊ)(ts_t$_C$)]-(la)			1	1		1	
b. [xʊ(ts_t$_C$)]-(la)		2 W	1	1		1	
c. [xʊ(ts_t$_C$)-(la)]		2 W	L	1		1	
d. [x(ʊ)(ts_t$_C$)]-(la)		1 W	1	1		1	1 W
e. [xʊ(tsət)]-(la)		2 W	1	L	1 W	1	

The winning candidate at step 6 is the candidate in which the syllable (la) is adjoined into the pre-existing prosodic word in order to satisfy Parse-Syllable.

Tableau 143: Step 6: /[(xʊ)(ts_t$_C$)]-(la)/ → [(xʊ)(ts_t$_C$)(la)]

	/[(xʊ)(ts_t$_C$)]-(la)/	Prs-Syll	Syll-Head	Dep-V	No-Coda
a. ☞	[(xʊ)(ts_t$_C$)(la)]		1		1
b.	[(xʊ)(tsət)]-(la)	1 W	L	1 W	1
c.	[(xʊ)(ts_t$_C$)]-(la)	1 W	1		1

At the next step of the derivation, the most harmonic candidate is the one in which vowel epenthesis applies in order to fix the minor syllable, meaning that Syllable-Head dominates Dep-V, as seen in tableau (144).

Tableau 144: Step 7: /[(xʊ)(ts_t$_C$)(la)]/ → [(xʊ)(tsət)(la)]

	/[(xʊ)(ts_t)(la)]/	Syll-Head	Dep-V	No-Coda
a. ☞	[(xʊ)(tsət)(la)]		1	1
b.	[(xʊ)(ts_t$_C$)(la)]	1 W	L	1

The derivation converges at step 8 because the winning candidate is the fully faithful one, meaning that no more harmonic improvement is achievable.

Tableau 145: convergence on [(xʊ)(tsət)(la)]

	/[(xʊ)(tsət)(la)]/	Syll-Head	Dep-V	No-Coda
a. ☞	[(xʊ)(tsət)(la)]		1	1
b.	[(xʊ)(ts_t)(la)]	1 W	L	1

All the successive harmonically improving candidates in the derivation appear in the next harmonic improvement tableau.

Tableau 146: harmonic improvement tableau for /xʊʦ-t-la/

/xʊʦ-t-la/	PRS-SEG	PRS-SYLL	SYLL-HEAD	DEP-V	NO-CODA	ONS
Step 1. [xʊʦt]-la *is less harmonic than*	6					
Step 2. [xʊʦt]-(la) *is less harmonic than*	4	1				
Step 3. [xʊʦ(t_C)]-(la) *is less harmonic than*	3	1	1		1	1
Step 4. [xʊ(ʦ_t_C)]-(la) *is less harmonic than*	2	1	1		1	
Step 5. [(xʊ)(ʦ_t_C)]-(la) *is less harmonic than*		1	1		1	
Step 6. [(xʊ)(ʦ_t_C)(la)] *is less harmonic than*			1		1	
Step 7. [(xʊ)(ʦət)(la)] *is as harmonic as*				1	1	
Step 8. [(xʊ)(ʦət)(la)]					1	

In this derivation, the epenthetic vowel surfaces between the first and second consonant of the underlying CCC sequence. This is so because syllable formation operations first scan the root and first suffix, which are defined as an opaque domain for syllabification given their association with a prosodic word that excludes the last suffix of the lexical word. The last suffix is syllabified independently of the root and first suffix, and adjoined later into the already existing prosodic word.

Now I will present the HS analysis for the input /xʊʦ-tl-a/, which surfaces as [(xʊʦ)(tə)(la)], instead of [(xʊ)(ʦət)(la)]. In this case, the epenthetic vowel appears between the second and third consonant of the underlying CCC sequence. The difference in the location of the epenthetic vowel follows directly from the fact that the last consonant of the underlying CCC sequence, the lateral, is parsed at step 1 of the derivation into a prosodic word, together with the root, because this consonant belongs to the first affix, as opposed to /xʊʦ-t-la/, in which the last consonant of the CCC cluster belongs to the second affix. The ranking Lx≈Pr ≫ Parse-Segment ensures that outcome.

Tableau 147: Step 1: /xʊts-tl-a/ → [xʊtstl]-a

	/xʊts-tl-a/	Lx≈Pr	Al-R/σ	Prs-Seg	Prs-Syll
a. ☞	[xʊtstl]-a			6	
b.	xʊts-tl-a	1 W		6	
c,.	xʊts-tl-(a)	1 W		5 L	1 W
d.	(xʊ)ts-tl-a	1 W	4 W	4 L	1 W

At step 2 of the derivation, projecting a minor syllable inside the prosodic word is more harmonic than building a syllable that is not incorporated into the prosodic word, as can be seen by comparing candidates (a) and (b) in tableau (148), because Parse-Syllable dominates Syllable-Head and No-Coda.

Tableau 148: Step 2: /[xʊtstl]-a/ → [xʊtst(l_C)] -a

	/[xʊtstl]-a/	Al-R/σ	Coda-Const	Prs-Seg	Prs-Syll	Syll-Head	No-Coda	Ons
a. ☞	[xʊtst(l_C)]-a			5		1	1	1
b.	[xʊtstl]-(a)			5	1 W	L	L	1
c.	[xʊtstl]-a			6 W		L	L	L
d.	[xʊts(tl_C)]-a		1 W	4 L		1	1	1
e.	[(xʊ)tstl]-a	3 W		4 L		L	L	L

At step 3, parallel to step 4 in tableau (141), onset adjunction is the most harmonic operation.

Tableau 149: Step 3: /[xʊtst(l$_C$)]-a/ → [xʊts(t_l$_C$)]-a

/[xʊtst(l$_C$)]-a/		Al-R/σ	Coda-Const	Prs-Seg	Syll-Head	Dep-V	No-Coda	Ons
a. ☞	[xʊts(t_l$_C$)]-a			4	1		1	
b.	[xʊts(t$_C$)(l$_C$)]-a			4	2 W		2 W	2 W
c.	[xʊtst(l$_C$)]-a			5 W	1		1	1 W
d.	[xʊtst(əl)]-a			5 W	L	1 W	1	1 W
e.	[xʊ(tst$_C$)(l$_C$)]-a		1 W	3 L	2 W		2 W	2 W
f.	[(xʊ)tst(l$_C$)]-a	2 W		3 L	1		1	1 W

At the next step of the derivation, right-to-left syllabification is maintained. It is better to perform the projection of a unary minor syllable, as candidate (a) shows in tableau (150), than to syllabify the last morph of the word, as candidate (b) illustrates, because it adds a violation of Parse-Syllable. Candidate (c) is the fully faithful candidate and is eliminated because it fatally violates Parse-Segment. Although it causes a better performance on Syllable-Head, inserting an epenthetic vowel implies a worse performance in terms of Parse-Segment, as candidate (d) illustrates. The last candidate (e) creates a core syllable at the left edge of the prosodic word, thus fatally violating Align-Right/σ once, given that there is an unparsed segment that stands between the right edge of the first syllable and the right edge of the prosodic word. This step is shown in tableau (150).

Tableau 150: Step 4: /[xʊts(t_l$_C$)]-a/ → [xʊ(ts)$_C$(t_l$_C$)]-a

/[xʊts(t_l$_C$)]-a/		Al-R/σ	Prs-Seg	Prs-Syll	Syll-Head	Dep-V	No-Coda	Ons
a. ☞	[xʊ(ts$_C$)(t_l$_C$)]-a		3		2		2	1
b.	[xʊts(t_l$_C$)]-(a)		3	1 W	1 L		1 L	1
c.	[xʊts(t_l$_C$)]-a		4 W		1 L		1 L	L
d.	[xʊts(təl)]-a		4 W		L	1 W	1 L	L
e.	[(xʊ)ts(t_l$_C$)]-a	1 W	2 L		1 L		1 L	L

The next winning candidate at step 5 is the one in which all the segments associated with the prosodic word are parsed into some syllable. This is due to the high ranking of PARSE-SEGMENT.

Tableau 151: Step 5: /[xʊ(ʦ$_C$)(t_l$_C$)]-a/ → [(xʊ)(ʦ$_C$)(t_l$_C$)]-a

	/[xʊ(ʦ$_C$)(t_l$_C$)]-a/	PRS-SEG	PRS-SYLL	SYLL-HEAD	DEP-V	NO-CODA	ONS
a. ☞	[(xʊ)(ʦ$_C$)(t_l$_C$)]-a	1		2		2	1
b.	[xʊ(ʦ$_C$)(t_l$_C$)]-a	3 W		2		2	1
c.	[xʊ(ʦ$_C$)(təl)]-a	3 W		1 L	1 W	2	1
d.	[x(ʊ)(ʦ$_C$)(t_l$_C$)]-a	2 W		2		2	2 W
e.	[xʊ(ʦ$_C$)(t_l$_C$)]-(a)	2 W	1 W	2		2	2 W

At step 6, the remaining unparsed segment, which corresponds to the second affix, is parsed into a syllable.

Tableau 152: Step 6: /[(xʊ)(ʦ$_C$)(t_l$_C$)]-a/ → [(xʊ)(ʦ$_C$)(t_l$_C$)]-(a)

	/[(xʊ)(ʦ$_C$)(t_l$_C$)]-a/	PRS-SEG	PRS-SYLL	SYLL-HEAD	DEP-V	NO-CODA	ONS
a. ☞	[(xʊ)(ʦ$_C$)(t_l$_C$)]-(a)		1	2		2	2
b.	[(xʊ)(ʦ$_C$)(təl)]-a	1 W	L	1 L	1 W	2	1 L
c.	[(xʊ)(ʦ$_C$)(t_l$_C$)]-a	1 W	L	2		2	1 L

At step 7, the unparsed syllable is integrated into the previously existing prosodic word in order to satisfy PARSE-SYLLABLE.

Tableau 153: Step 7: /[(xʊ)(ʦ$_C$)(t_l$_C$)]-(a)/ → [(xʊ)(ʦ$_C$)(t_l$_C$)(a)]

	/[(xʊ)(_ʦ$_C$)(t_l$_C$)]-(a)/	Prs-Syll	Syll-Head	Dep-V	No-Coda	Ons
a. ☞	[(xʊ)(ʦ$_C$)(t_l$_C$)(a)]		2		2	2
b.	[(xʊ)(ʦ$_C$)(təl)]-(a)	1 W	1 L	1 W	2	2
c.	[(xʊ)(ʦ$_C$)(t_l$_C$)]-(a)	1 W	2		2	2

At this point of the derivation, all morphs have become dominated by the same prosodic category, namely the prosodic word. This situation licenses syllabification to operate with adjacent segments belonging to different morphs. In the next steps of the derivation, minor syllables are fixed by means of different operations, whose order of application is determined by the constraint ranking. As can be seen in the tableaux below, the first operation is resyllabification (step 8). The application of this operation fixes the first minor syllable without violating Dep-V, meaning that, if possible, resyllabification always takes precedence over vowel insertion. Then a vowel is inserted in order to fix the last minor syllable (step 9). Finally, coda resyllabification applies in order to remove a violation of Onset (step 10).

Tableau 154: Step 8: /[(xʊ)(ʦ$_C$)(t_l$_C$)(a)]/ → [(xʊts)(t_l$_C$)(a)]

	/[(xʊ)(ʦ$_C$)(t_l$_C$)(a)]/	Syll-Head	Dep-V	No-Coda	Ons
a. ☞	[(xʊts)(t_l$_C$)(a)]	1		2	1
b.	[(xʊ)(ʦ$_C$)(təl)(a)]	1	1 W	2	2 W
c.	[(xʊ)(ʦ$_C$)(t_l$_C$)(a)]	2 W		2	2 W

Tableau 155: Step 9: /[(xʊts)(t_l$_C$)(a)]/ → [(xʊts)(təl)(a)]

	/[(xʊts)(t_l$_C$)(a)]/	Syll-Head	Dep-V	No-Coda	Ons
a. ☞	[(xʊts)(təl)(a)]		1	2	1
b.	[(xʊts)(t)(la)]	1 W	L	1 L	L
c.	[(xʊts)(t_l$_C$)(a)]	1 W	L	2	1

Tableau 156: Step 10: /[(xʊt͡s)(təl)(a)]/ → [(xʊt͡s)(tə)(la)]

	/[(xʊt͡s)(təl)(a)]/	NO-CODA	ONS
a. ☞	[(xʊt͡s)(tə)(la)]	1	
b.	[(xʊt͡s)(təl)(a)]	2 W	1 W

The derivation converges at the next step, omitted here. A harmonic improvement tableau summarizes the whole derivation of /xʊt͡s-tl-a/ in tableau (157).

Tableau 157: harmonic improvement tableau for /xʊt͡s-tl-a/

/xʊt͡s-tl-a/	PRS-SEG	PARSE-σ	SYLL-HEAD	DEP-V	NO-CODA	ONS
Step 1. [xʊt͡stl]-a *is less harmonic than*	6					
Step 2. [xʊt͡st(l$_C$)]-a *is less harmonic than*	5		1		1	1
Step 3. [xʊt͡s(t‿l$_C$)]-a *is less harmonic than*	4		1		1	
Step 4. [xʊ(t͡s$_C$)(t‿l$_C$)]-a *is less harmonic than*	3		2		2	1
Step 5. [(xʊ)(t͡s$_C$)(t‿l$_C$)]-a *is less harmonic than*	1		2		2	1
Step 6. [(xʊ)(t͡s$_C$)(t‿l$_C$)]-(a) *is less harmonic than*		1	2		2	2
Step 7. [(xʊ)(t͡s$_C$)(t‿l$_C$)(a)] *is less harmonic than*			2		2	2
Step 8. [(xʊt͡s)(t‿l$_C$)(a)] *is less harmonic than*			1		2	1
Step 9. [(xʊt͡s)(təl)(a)] *is less harmonic than*				1	2	1
Step 10. [(xʊt͡s)(tə)(la)] *is as harmonic as*					1	
Step 11. [(xʊt͡s)(tə)(la)]					1	

The derivations of the two inputs analyzed in this section are repeated below. The operations at each derivational step are specified for comparison.

(2) derivation of /xʊts-t-la/

original input A:	/xʊts-t-la/
project PWd	[xʊtst]-la
core syllabification	[xʊtst]-(la)
project minor syllable	[xʊts(t_C)]-(la)
onset adjunction	[xʊ(ts_t_C)]-(la)
core syllabification	[(xʊ)(ts_t_C)]-(la)
syllable adjunction	[(xʊ)(ts_t_C)(la)]
vowel epenthesis	[(xʊ)(tsət)(la)]

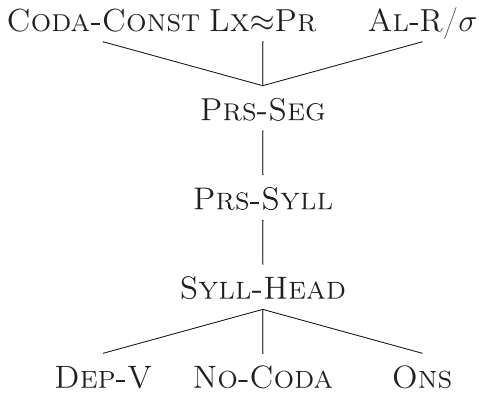
(3) derivation of /xʊts-tl-a/

original input B:	/xʊts-tl-a/
project PWd	[xʊtstl]-a
project minor syllable	[xʊtst(l_C)]-a
onset adjunction	[xʊts(t_ l_C)] -a
project minor syllable	[xʊ(ts_C)(t_ l_C)] -a
core syllabification	[(xʊ)(ts_C)(t_l_C)]-a
project syllable	[(xʊ)(ts_C)(t_l_C)]-(a)
syllable adjunction	[(xʊ)(ts_C)(t_l_C)(a)]
resyllabification	[(xʊts)(t_l_C)(a)]
vowel epenthesis	[(xʊts)(təl)(a)]
resyllabification	[(xʊts)(tə)(la)]

As the derivations in (2) and (3) make clear, the first harmonically improving step is to project a prosodic word that dominates the root and first affix. Taking more than two morphs in order to parse them into a prosodic word is not allowed, since I propose that Gen is restricted to a binary condition that restrains it to select no more than two morphological elements and parse them into a particular prosodic category. At step 2, from the input A a core syllable is built outside the existing prosodic word. Although this operation introduces a violation of Parse-Syllable, it maximally satisfies Parse-Segment, which dominates the former constraint. From input B, however, syllabification starts out by parsing the last segment dominated by the prosodic word because the last affix of the string, which is not parsed into the prosodic word, corresponds to a single vowel. Parsing this vowel into a syllable would violate Parse-Syllable without improving on Parse-Segment. In the next steps, the segments dominated by the already existing prosodic word are parsed into syllables from right-to-left because of the high ranking of Align-Right/σ. These syllables are minor, moraless. The choices that the operation of minor syllable projection is able to choose (*i.e.*, incorporation of a single consonant or a sequence of two consonants into a minor syllable) depend on the relative ranking of the constraints on syllable well-formedness: Coda-Constraint, Syllable-Head, and No-Coda. Once all segments are parsed into some syllable, the syllable that remains outside the prosodic word is integrated into the existing prosodic word through an operation of syllable adjunction triggered by the satisfaction of Parse-Syllable. At this derivational point, the three morphs are dominated by the same prosodic category, which allows syllable formation operations to operate with adjacent segments belonging to different morphs, as stated in chapter 2. In the last steps of the derivation, minor syllables are fixed by means of different operations, resyllabification and vowel epenthesis.

All the ranking arguments justified so far appear as a Hasse Diagram in (4).

(4) Hasse diagram for Mongolian in HS



4.5 Conclusion

This chapter has shown how directional syllabification and vowel epenthesis placement in standard Ulaanbaatar Mongolian can be implemented in HS. It has mainly focused on a specific case of cyclic syllabification in which the optimal directional syllabification pattern becomes opaque due to the morphological structure of multimorphemic words. The hypothesis that syllable building operations, in the presence of prosodic categories higher than the syllable, are licensed to operate with a pair of adjacent segments if and only if a higher prosodic constituent than the syllable dominates both segments, and the hypothesis that prosody-building operations are constrained to operate with at most two phonological or morphological units, have been demonstrated to account for a specific case of opacity located at the phonology-morphology interface.

Chapter 5

Opaque weight by position I: gemination

Abstract

This chapter provides a HS analysis of stop gemination in Catalan and pre-jod gemination in West Germanic. In Catalan, labial and velar voiced stops followed by an alveolar lateral surface as geminates in root-final position. Otherwise, they undergo spirantization and the cluster is parsed as a complex onset. Gemination stands in a counterbleeding relation with vowel epenthesis and morphological affixation in the sense that the presence of an epenthetic schwa or a vowel-initial suffix does not block gemination. In order to explain these facts, I suggest that the binary operation core syllabification can create complex minor syllables and cannot operate with two adjacent segments if one of these segments, but not the other, is integrated into a prosodic category higher than the syllable. This means that prosodic categories create opaque domains for syllabification. This assumption, together with serial prosodification, guarantees that vowels outside the root, either epenthetic or inflectional, are not available for syllabification purposes when the root is first parsed into its own prosodic word in order to satisfy top-ranked ALIGN-Right (root, Prosodic Word). West Germanic gemination will also be considered, in which gemination counterbleeds WEIGHT-BY-POSITION.

5.1 Voiced stop geminates in Catalan

5.1.1 Introduction

The main purpose of this chapter is to show how the process of voiced stop gemination that applies in Central Catalan finds a straightforward explanation in HS. In Catalan, labial and velar voiced stops followed by an alveolar lateral (/bl/, /gl/) surface as geminates ([b.bl], [g.gl]) in root-final position (Bermúdez-Otero 2000, Bonet and Lloret 1998, Fabra 1912, Mascaró 1976, 2003, Recasens 1991, 1993, Colina 1995, Jiménez 1997, Wheeler 1979, 1986, 2005, Pons-Moll 2004, 2011). Otherwise, if these clusters precede a vowel belonging to the root, voiced stops spirantize and the cluster is parsed as a complex onset ([.βlV], [.ɣlV]). It is argued that gemination is only triggered when the voiced stop is syllabified in coda position (Mascaró 1987), and in order to fix an ill-formed rising sonority intersyllabic contact (Colina 1995, Jiménez 1997, Pons-Moll 2004, 2011). This process of voiced stop gemination stands in a counterbleeding relation with vowel epenthesis and morphological affixation. The insertion of an epenthetic schwa or the presence of a vowel-initial derivational or inflectional suffix does not block gemination, although the presence of these vowels makes up the phonological context that could bleed the application of the gemination process, that is, the voiced stop syllabified as the first element of a complex onset. In order to explain these facts, I make use of the theory of serial syllabification presented in chapter 2, and suggest that the binary operation core syllabification can create complex minor syllables, and cannot operate with two adjacent segments if one of them, but not the other, is integrated into a prosodic category higher than the syllable. This means that prosodic categories create opaque domains for syllabification. This assumption, together with serial prosodification, guarantees that vowels outside the root, either epenthetic or inflectional, are not available for syllabification purposes when the root is first parsed into its own prosodic word.

5.1.2 Data

In Central Catalan, voiced stops in underlying /bl/ and /gl/ clusters undergo a process of gemination provided that those clusters are root-final, as in (1).[1]

Note that the examples in (1) surface with a peripheral schwa because tautosyllabic coda clusters with a flat or rising sonority profile are prohibited and repaired through epenthesis, with the exception of clusters in which the second consonant is /s/.[2]

(1) Root-final gemination

/pɔbl/	[pɔb.blə]	"town"
/dobl/	[dob.blə]	"double"
/pusibl/	[pu.sib.blə]	"possible"
/segl/	[seg.glə]	"century"

The presence of an inflectional suffix such as the feminine morph does not block gemination, because the consonantal cluster is actually root-final.[3]

(2) Root-final gemination in the presence of inflectional suffixes

/regl+ə/	[reg.glə]	"rule"
/kobl+ə/	[kob.blə]	"stanza"

Elsewhere, that is, when those clusters are not root-final, voiced stops undergo spirantization and they are syllabified as the first element of a complex onset. These root-internal clusters are always followed by a vowel belonging to the root.[4]

[1] As Mascaró [1987] points out, alternations between [b.b] and [β] are allomorphic in nature: [di.ab.blə] "devil" ∼ [di.ə.βɔ.lik] "devilish"; [mɔb.blə] "piece of furniture" ∼ [mu.βi.lja.ɾi] "furniture"; [nob.blə] "noble" ∼ [nu.βi.lja.ɾi] "relative to nobility"; [bu.lub.blə] "voluble" ∼ [bu.lu.βi.li.tat] "volubility".

[2] Following other scholars, the schwa in (1) is treated as an epenthetic vowel. Its appearance is easily explained as a fixing strategy to an otherwise unsyllabifiable rising-sonority cluster of consonants. It is true that this schwa is also found in words such as [ɔm+ə] "man", where positing epenthesis would be unmotivated (*cf.* masculine [am+Ø] "hook"), but positing a process of epenthesis in (1) is supported by the fact that the unmarked masculine morph in Catalan is a zero morph ([dob.blə] "double", and [dub.bl+a] "to double"). The schwa in (2), however, corresponds to the unmarked feminine morph in Catalan.

[3] Voiced stop geminates are found in all kinds of derivatives, in both derivational and inflectional contexts: [pub.bl+ik] "public", [dub.bl+ə.ɣ+a] "to fold", [ə.#rəg.gl+a] "to fix".

[4] No tautosyllabic *dl* clusters are found in Catalan.

(3) Spirantization

/ɛglug+ə/	[ɛ.ɣlu.ɣə]	"eclogue"
/pɾublɛm+ə/	[pɾu.βlɛ.mə]	"problem"
/ublid+aɾ/	[u.βli.da]	"to forget"
/publi/	[pu.βli]	"Publius"

When the second element of the cluster is a flap (/bɾ/, /gɾ/), voiced stops do not geminate, but they spirantize.

(4) Spirantization

/pɔbɾ/	[pɔ.βɾə]	"poor"
/agɾ/	[a.ɣɾə]	"sour"

Although the aforementioned data correspond to the general pattern described for Central Catalan in many varieties, /bl/ and /gl/ clusters can also be subject to a process of devoicing and be syllabified in onset position ([pɔ.plə]) or undergo a two-step process of devoicing and gemination ([pɔp.plə]) (Mascaró 1976). Other dialects such as Majorcan Catalan seem to have generalized gemination in those contexts in which the cluster is not root-final (Mascaró p.c.), and Western Catalan completely lacks geminates of that type. It is not the purpose of this chapter, however, to address all this dialectal variation.

5.1.3 HS analysis

Root-internal clusters

This subsection presents a HS account of those forms that include a root-internal /bl/ cluster that is always followed by a vowel belonging to the root. In these cases, the voiced stop undergoes spirantization and surfaces in onset position along with the following lateral (/publi/ → [pu.βli]).

The first step of the HS derivation appears in tableau (158), where the relevant syllable-building operations are included. At this step of the derivation, candidate (a) is the winner, which shows the application of core syllabification with mora. This candidate minimally violates PARSE-SEGMENT, and violates neither *σ/O,R, which assigns one violation mark for every moraic obstruent or sonorant as a syllable head, nor *COMPLEX-SYLLABLE-HEAD, which is violated by candidate (g). The cover constraint *COMPLEX-SYLLABLE-HEAD, which will be split into two more specific constraints in the next subsections, is a markedness constraint that stands in a stringency relation with the less stringent constraint SYLLABLE-HEAD, the markedness constraint against minor syllables. Both constraints are defined in (5) and (6) below.

(5) SYLLABLE-HEAD (SYLL-HEAD)

Assign one violation mark for every syllable that does not dominate at least one mora. (Elfner 2009)

(6) *COMPLEX-SYLLABLE-HEAD (*COMPL-SYLL-HEAD)

Assign one violation mark for every complex syllable that does not dominate at least one mora.

The winner harmonically bounds all the other candidates.

Tableau 158: Step 1: /publi/ → (pu_{μ})bli

/publi/	*σ/O,R	Prs-Seg	Syll-Head	*Compl-Syll-Head
a. ☞ σ μ publ i		3		
b. σ μ publ i	1 W	4 W		
c. σ μ publ i		4 W		
d. σ μ publ i	1 W	4 W		
e. σ μ publ i	1 W	4 W		
f. σ μ publ i		4 W		
g. σ publ i		3	1 W	1 W

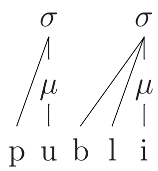
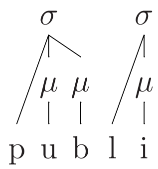
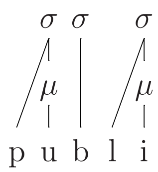
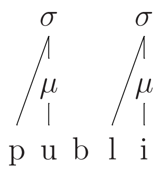
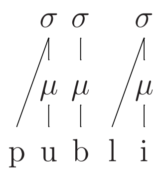
At the second step of the derivation, the result of applying again core syllabification minimally violates PARSE-SEGMENT and does not violate any other constraint. The most harmonic candidate, candidate (a), harmonically bounds all the other candidates.

Tableau 159: Step 2: /(pu$_\mu$)bli/ → (pu$_\mu$)b(li$_\mu$)

/(pu$_\mu$)bli/	*σ/O,R	Prs-Seg	Syll-Head	*Compl-Syll-Head
a. ☞ σ σ μ μ publi		1		
b. σ $\mu\mu$ publi		2 W		
c. $\sigma\sigma$ μ publi		2 W	1 W	
d. σ σ μ publi		1	1 W	1 W
e. σ σ μ μ publi	1 W	1		
f. $\sigma\sigma$ $\mu\mu$ publi	1 W	2 W		
g. σ μ publi		3 W		

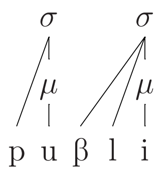
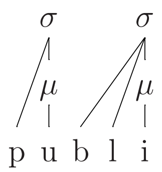
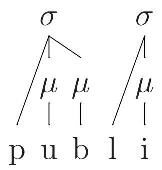
At the next step, the input contains only one unparsed segment. The winning candidate in tableau (160), candidate (a), is the one in which the unparsed voiced stop is parsed as the first element of a complex onset to the second syllable. Applying onset adjunction is more harmonic than applying coda adjunction, as candidate (b) shows, because No-Coda dominates *Complex-Onset. *Complex-Onset is dominated by Syllable-Head, as the comparison between candidate (a) and candidate (c) illustrates. The fully faithful candidate, candidate (d), is also ruled out because it fatally violates Parse-Segment, which also dominates *Complex-Onset. The selected candidate also violates a low-ranked markedness constraint against postvocalic voiced stops. For ease of exposition, I use an ad hoc constraint *V.b..., which is violated by every voiced stop preceded by a heterosyllabic vowel. The satisfaction of this markedness constraint will trigger spirantization.

Tableau 160: Step 3: /(pu$_\mu$)b(li$_\mu$)/ → (pu$_\mu$)(bli$_\mu$)

/(pu$_\mu$)b(li$_\mu$)/	*σ/O,R	PRS-SEG	SYLL-HEAD	NO-CODA	*COMPL-ONS	*V.b...
a. ☞ 					1	1
b. 				1 W	L	L
c. 			1 W		L	1
d. 		1 W			L	L
e. 	1 W				L	1

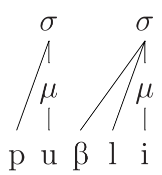
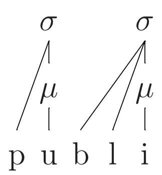
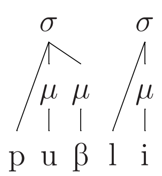
At the fourth step, spirantization applies in order to remove the violation of *V.b.... This constraint dominates the faithfulness constraint IDENT(continuant) (ID(cont)), which assigns one violation mark for every corresponding segments in the input and output with a different specification of the feature [continuant]. NO-CODA also dominates IDENT(continuant).

Tableau 161: Step 4: /(pu$_\mu$)(bli$_\mu$)/ → (pu$_\mu$)(βli$_\mu$)

/(pu$_\mu$)(bli$_\mu$)/	NO-CODA	*COMPL-ONS	*V.b...	ID(cont)
a. ☞ 		1		1
b. 		1	1 W	L
c. 	1 W	L		L

The derivation converges at the next step of the derivation, where no harmonic improvement is achievable.

Tableau 162: Step 5: convergence on (pu$_\mu$)(βli$_\mu$)

/(pu$_\mu$)(βli$_\mu$)/	NO-CODA	*COMPL-ONS	*V.b...	ID(cont)
a. ☞ 		1		
b. 		1	1 W	1 W
c. 	1 W	L		

To sum up, when the cluster /bl/ appears root-internally and followed by a vowel belonging to the root, gemination is blocked because the voiced stop is syllabified as the first element of a complex onset at step 3 of the derivation. The process of gemination, as will be made clear in the next subsection, can only apply as long as the voiced stop is parsed in coda position.

Root-final /bl/ clusters

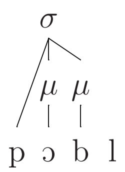
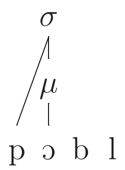
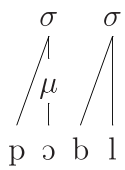
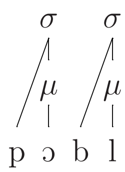
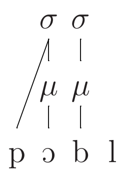
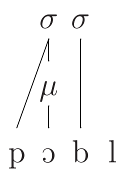
The analysis of the cases in which a /bl/ cluster appears root-finally is given in this subsection. The first step of the derivation, in which a core syllable is created, is omitted here. The difference between an input containing a /bl/ cluster root-finally and an input containing the same cluster root-internally arises at the second step of the derivation. Given the absence of a vowel in an input such as /pɔbl/, core syllabification, as candidate (d) in tableau (163) illustrates, does not represent a harmonically-improving step because *σ/O,R dominates PARSE-SEGMENT. The winning candidate is then candidate (a), the one that parses the voiced stop in coda position to the previously existing syllable. However, there is the possibility of building a syllable that parses the /bl/ cluster together, as candidate (c) shows. This operation would completely satisfy PARSE-SEGMENT. However, this potential candidate is ruled out because it fatally violates a markedness constraint that, for clarity of exposition, is written here as *(bl)-SYLLABLE-HEAD. I give a definition of this constraint in (7).

(7) *(bl)-SYLLABLE-HEAD

Assign one violation mark for every complex minor syllable (b/gl) that does not dominate at least one mora.

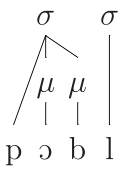
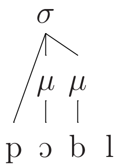
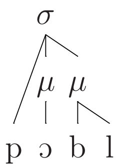
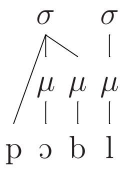
This chapter argues for the existence of a universal fixed hierarchy of sonority-based markedness constraints on possible complex onsets in minor syllables that stand in a stringency relation with SYLLABLE-HEAD. Following Pons-Moll [2011], I assume that laterals are less sonorous than flaps in Romance. This universal constraint hierarchy is based on the *Sonority Dispersion Principle* (Clements 1990), according to which the more sonority distance between the segments in a complex onset, the better. Given that flaps are more sonorous than laterals, a complex minor syllable like (b/gɾ) will always be more harmonic than a complex minor syllable like (b/gl). This is expressed by ranking *(bl)-SYLLABLE-HEAD over *(bɾ)-SYLLABLE-HEAD. As can be seen in the following tableau, *(bl)-SYLLABLE-HEAD also outranks PARSE-SEGMENT.

Tableau 163: Step 2: /(pɔ$_\mu$)bl/ → (pɔ$_\mu$b$_\mu$)l

/(pɔ$_\mu$)bl/	*σ/O,R	*(bl)-SYLL-HEAD	PRS-SEG	SYLL-HEAD	NO-CODA	*V.b...
a. ☞ 			1		1	
b. 			2 W		L	
c. 		1 W	L	1 W	L	1 W
d. 	1 W		L		L	1 W
e. 	1 W		1		L	1 W
f. 			1	1 W	L	1 W

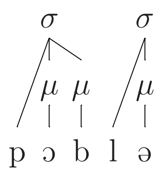
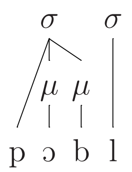
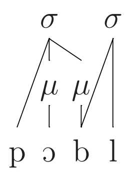
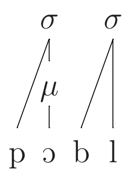
At the third step of the derivation, the unsyllabified lateral is parsed into a unary minor syllable, as candidate (a) in tableau (164) shows. This is the most harmonic candidate at this stage of the derivation because all the segments have been parsed into syllables. PARSE-SEGMENT thus dominates SYLLABLE-HEAD. The winning candidate violates a constraint not presented yet, namely SYLLABLE - CONTACT (SYLL-CONT) (see, among others, Gouskova 2004), which prohibits heterosyllabic clusters with a flat or rising sonority profile. Applying again coda adjunction to (pɔb) would result in a complex coda with an intrasyllabic rising sonority profile, *(pɔbl), as candidate (c) illustrates, which is banned by SONORITY-SEQUENCING (SON-SEQ) (Baertsch 2002). The markedness constraint SONORITY-SEQUENCING militates against complex codas in which the first element is less sonorous than the second one. The last candidate is also ruled out because it violates the higher-ranked constraint *σ/O,R. The next tableau demonstrates that both SONORITY-SEQUENCING and PARSE-SEGMENT dominate SYLLABLE-CONTACT and SYLLABLE-HEAD, which is also dominated by *σ/O,R.

Tableau 164: Step 3: /(pɔ$_\mu$b$_\mu$)l/ → (pɔ$_\mu$b$_\mu$)(l)

/(pɔ$_\mu$b$_\mu$)l/	*σ/O,R	Son-Seq	Prs-Seg	Syll-Cont	Syll-Head	No-Coda
a. ☞ 				1	1	1
b. 			1 W	L	L	1
c. 		1 W		L	L	1
d. 	1 W			1	L	1

At the next step, the winning candidate is the one that removes the violation of Syllable-Head by epenthesizing a schwa, which is correlated with a Dep-V violation. Gemination, on the one hand, and resyllabification, on the other hand, are not harmonically improving operations at this stage of the derivation because of the high ranking of *(bl)-Syllable-Head, which rules out candidate (c) in tableau (165). The high ranking of a faithfulness constraint against mora deletion, Max-μ, which is violated by candidate (d), is also included in tableau (165). The constraint *(bl)-Syllable-Head thus dominates Syllable-Contact.

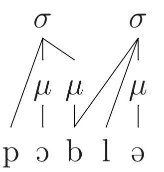
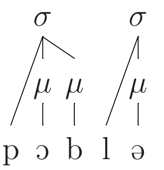
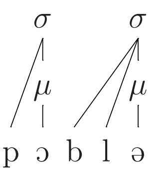
Tableau 165: Step 4: /(pɔ$_{\mu}$b$_{\mu}$)(l)/ → (pɔ$_{\mu}$b$_{\mu}$)(lə$_{\mu}$)

/(pɔ$_{\mu}$b$_{\mu}$)(l)/	MAX-μ	*(bl)-SYLL-HEAD	SYLL-CONT	SYLL-HEAD	NO-CODA	DEP-V
a. ☞ 			1		1	1
b. 			1	1 W	1	L
c. 		1 W	L	1 W	1	L
d. 	1 W	1 W	L	1 W	L	L

At the fifth step of the derivation, gemination is able to apply in order to avoid a rising sonority profile between the two heterosyllabic consonants. Resyllabification is blocked by the activity of MAX-μ.[5] The winning candidate, candidate (a), thus violates the low-ranked markedness constraint NO-GEMINATE (NO-GEM), which assigns one violation mark for every root node multiply linked to higher prosodic tiers.

[5]In the next chapter, I will treat resyllabification as a two-step process of first link insertion and then link deletion, meaning that resyllabification is always preceded by gemination. In this analysis, I still assume that resyllabification is accomplished at a single step for the sake of clarity.

Tableau 166: Step 5: /(pɔ$_\mu$b$_\mu$)(lə$_\mu$)/ → (pɔ$_\mu$b$_\mu$)(blə$_\mu$)

/(pɔ$_\mu$b$_\mu$)(lə$_\mu$)/	Max-μ	Syll-Cont	No-Coda	*Comp-Ons	No-Gem
a. ☞ 			1	1	1
b. 		1 W	1	L	L
c. 	1 W		L	1	L

Convergence is met at the next step of the derivation, omitted here. The analysis proposed so far has demonstrated that the opaque interaction between gemination and schwa epenthesis, which stand in a counterbleeding relation, is straightforwardly captured in HS, where processes are applied in a step-wise manner under the same constraint hierarchy.

Root-final /bɾ/ clusters

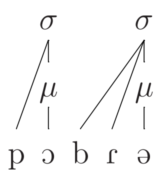
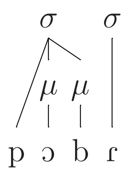
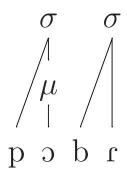
At this point of the discussion, those inputs containing a /bɾ/ cluster root-finally can be compared with those containing a /bl/ cluster. The crucial difference between an input like /pɔbl/ and an input like /pɔbɾ/ is that in the former case, as has been demonstrated, the creation of a complex minor syllable is not possible at the second step of the derivation because of the ranking *(bl)-Syllable-Head ≫ Parse-Segment. However, if Parse-Segment dominates *(bɾ)-Syllable-Head, then a binary complex minor syllable with an empty nucleus emerges as the most harmonic candidate at the second step of the derivation for inputs with a root-final /bɾ/ cluster. Then, if the voiced stop is syllabified not in coda position but rather in onset position, there is no chance for gemination to apply later in the derivation because SYLLABLE-CONTACT is already satisfied. The second step for /pɔbɾ/ is illustrated below.

Tableau 167: Step 2: /(pɔ$_{\mu}$)bɾ/ → (pɔ$_{\mu}$)(bɾ)

/(pɔ$_{\mu}$)bɾ/	PRS-SEG	*(bɾ)-SYLL-HEAD	SYLL-HEAD	NO-CODA	*COMP-ONS	*V.b...
a. ☞ σ σ μ p ɔ b ɾ		2	1		1	1
b. σ μ p ɔ b ɾ	2 W	L	L		L	L
c. σ μ μ p ɔ b ɾ	1 W	L	L	1 W	L	L

Then an epenthetic schwa is inserted because this is the most harmonic operation that compels the satisfaction of SYLLABLE-HEAD, given the ranking SYLLABLE-HEAD ≫ DEP-V.

Tableau 168: Step 3: /(pɔ$_\mu$)(bɾ)/ → (pɔ$_\mu$)(bɾə$_\mu$)

/(pɔ$_\mu$)(bɾ)/	*(bɾ)-SYLL-HEAD	SYLL-HEAD	DEP-V	*COMP-ONS	*V.b...
a. ☞ 			1	1	1
b. 		1 W	L	L	L
c. 	1 W	1 W	L	1	1

Later on, spirantization applies in order to satisfy *V.b.... The derivation converges at the next step of the derivation, not shown here.[6]

[6] McCarthy (p.c.) suggests that there could be a competition between building a (moraic) syllable (bl$_\mu$) or (bɾ$_\mu$) *versus* adjoining the /b/ as a coda to the preceding syllable. If *NUCLEUS/l ≫ NO-CODA ≫ *NUCLEUS/ɾ, this result would be obtained. However, the problem with this analysis is that in both /pobl/ and /pobɾ/ schwa epenthesis applies. If a grammar selects (po)(bɾ$_\mu$), then there would be no reason to insert a schwa. And a derivation like (po)(bɾ$_\mu$) > (po)(bɾ) > (po)(bɾə$_\mu$), in which first a complex moraic syllable (bɾ$_\mu$) is built, then the mora headed by ɾ is deleted, and after that epenthesis applies, would not be harmonically improving, so there is a reason for wanting the (bɾ) syllable to be headless, and non-moraic.

Tableau 169: Step 4: /(pɔ$_\mu$)(bɾə$_\mu$)/ → (pɔ$_\mu$)(βɾə$_\mu$)

/(pɔ$_\mu$)(bɾə$_\mu$)/	No-Coda	*Comp	*V.b...	Id[cont]
a. ☞ σ σ μ μ p ɔ β ɾ ə		1		1
b. σ σ μ μ p ɔ b ɾ ə		1	1 W	L
c. σ σ μ μ μ p ɔ b ɾ ə	1 W	L		L

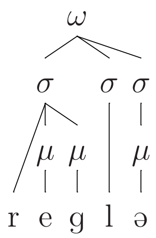
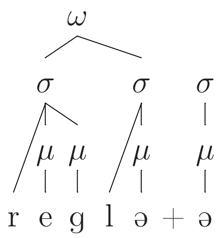
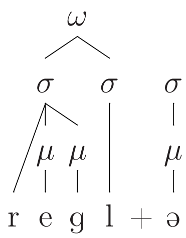
In this subsection, it has been shown that the ranking between the constraints *(bl)-Syllalbe-Head and *(bɾ)-Syllalbe-Head with respect to Parse-Segment, namely *(bl)-Syllalbe-Head ≫ Parse-Segment ≫ *(bɾ)-Syllable-Head, explains the asymmetry between those inputs containing a root-final /bl/ cluster and those containing /bɾ/. The fact that *(bl)-Syllalbe-Head is higher-ranked forces the voiced stop to be syllabified in coda position, at the expense of violating Parse-Segment, which triggers gemination later on in the derivation in order to fix an intersyllabic rising sonority contact.

Voiced stop plus lateral root-final clusters followed by overt inflectional suffixes

Voiced stop gemination also stands in a counterbleeding relation with morphological affixation. The presence of a vowel-initial derivational or inflectional suffix does not block gemination, although the presence of vowel-initial suffixes introduces the phonological context that could bleed the application of the process by allowing core syllabification to apply to those sequences.

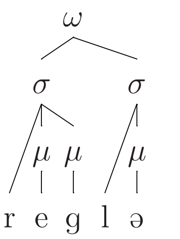
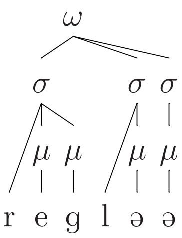
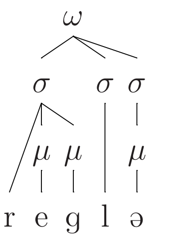
As introduced in chapter 2, I propose that prosodic categories higher than the syllable create opaque domains for syllabification. This explains why an input like /regl+ə/, consisting of a root followed by the inflectional feminine morph, as opposed to /publi/, where the last vowel belongs to the underlying lexical form of the root, escapes spirantization and undergoes gemination if first the root is parsed into its own prosodic word. The vowel belonging to the feminine morph cannot be integrated into a syllable together with the last consonant of the root at the steps of the derivation in which syllabification applies because there is a prosodic word dominating the root but not the affix, which creates an opaque domain for syllabification. This situation emerges if a prosody-morphology interface constraint requiring the right edge of the root to be aligned with some prosodic word, ALIGN-Right (root, Prosodic Word) (AL-R(Rt, PWd)) dominates PARSE-SEGMENT. If the alignment constraint is first satisfied, the root in /regl+ə/ is syllabified the same way as /pɔbl/, where the voiced stop is parsed as a syllable coda and the lateral forms a unary minor syllable. The vowel belonging to the suffix is parsed into its own syllable, yielding the intermediate representation [(re$_\mu$g$_\mu$)(l)]+(ə$_\mu$). Then, syllable adjunction is the most harmonic candidate given the ranking PARSE-SYLLABLE $\gg$ SYLLABLE-HEAD, as tableau (170) demonstrates. The winning candidate in that tableau is candidate (a). Recall that when the last syllable of the string is adjoined to the already existing prosodic word, ALIGN-Right (root, Prosodic Word) is not violated because 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. This idea was first presented in (6), chapter 3. The symbol "+" indicates that there is a prosodic word boundary separating the root and the affix, as shown by candidates b and c.

Tableau 170: $/[(re_{\mu}g_{\mu})(l)]{+}(ə_{\mu})/ \rightarrow [(re_{\mu}g_{\mu})(l)(ə_{\mu})]$

$/[(re_{\mu}g_{\mu})(l)]{+}(ə_{\mu})/$	PRS-SYLL	SYLL-CONT	SYLL-HEAD	DEP-V
a. ☞ 		1	1	
b. 	1 W	1	L	1 W
c. 	1 W	1	1	

At this point of the derivation, syllabification is sensitive to the whole string of segments dominated by the prosodic word. SYLLABLE-HEAD must thus be satisfied. Among the alternatives, conflating the single minor syllable together with the onsetless syllable into one syllable is the most harmonic one, given that this operation is not correlated with any violation of a faithfulness constraint, in contrast to inserting an epenthetic vowel, correlated with a DEP-V violation. This is demonstrated in the next tableau.

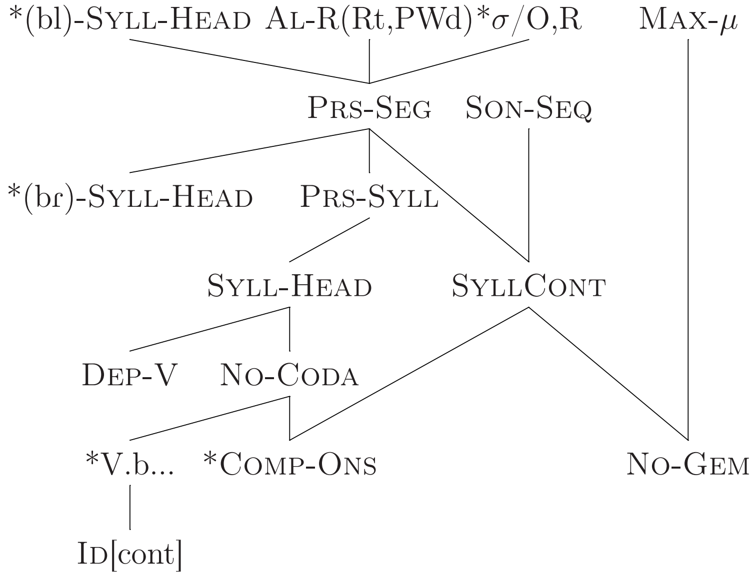
Tableau 171: /[(re$_{\mu}$g$_{\mu}$)(l)(ə$_{\mu}$)]/ → [(re$_{\mu}$g$_{\mu}$)(lə$_{\mu}$)]

/[(re$_{\mu}$g$_{\mu}$)(l)(ə$_{\mu}$)]/	SYLL-CONT	SYLL-HEAD	DEP-V
a. ☞ 	1		
b. 	1		1 W
c. 	1	1 W	

At this point of the derivation, the input /[(re$_{\mu}$g$_{\mu}$)(lə$_{\mu}$)]/ is parallel to the input /(pɔ$_{\mu}$b$_{\mu}$)(lə$_{\mu}$)/ in tableau (166). Gemination applies at the next step to satisfy SYLLABLE-CONTACT, not shown here (see tableau 166).

The final ranking of the whole set of constraints presented so far appears in (8) as a Hasse diagram.

(8) Hasse diagram for Catalan voiced stop gemination



5.2 West Germanic gemination

5.2.1 Introduction

West Germanic gemination shows some parallels with Catalan voiced stop gemination. In this section, it is demonstrated that West Germanic gemination finds a straightforward explanation in HS if syllable-building operations are blocked from operating with two segments if one of these segments, but not the other, is contained in a prosodic category higher than the syllable, meaning that prosodic boundaries define domains for syllabification.

5.2.2 Data

In West Germanic, all consonants except /r/ geminated when immediately followed by /j/.[7] The following data exemplify pre-jod gemination in West Germanic.

[7] I will ignore West Germanic gemination of voiceless stops before liquids in this analysis.

(1) (a) Gemination after a short vowel (Bermúdez-Otero 1999)

Gothic	Old Saxon	Old English	Old High German	
saljan	sellien	sellan	zellen	"offer.INF"
kunjis	kunnies	cynnes	chunnes	"race.GEN.SG"
hafjan	(af)hebbien	hebban	heffen	"lift.INF"
bidjan	biddien	biddan	bitten	"ask.INF"

(b) Gemination after a long vowel (Bermúdez-Otero 1999)

Gothic	Old Saxon	Old English	Old High German	Old Upper German	
dailjan	deːlien	doeːlan	teilen	(ar)teillan	"divide.INF"
weːnjan	waːnian	weːnan	waːnen	(far)vvaːnnan	"expect.INF"
lausjan	loːsian	lyːsan	loːsen	loːssan	"release.INF"
foːdjan	foːdian	feːdan	fuoten	vuottan	"feed.INF"

[8]

[8] Vennemann [1988] states that "resyllabification [...] would be contrary to the Weight

In Common Germanic, Cj clusters were heterosyllabic. This is known as Sievers' Law. In OT, Sievers' Law is explained by ranking $*_{\sigma}$[Cj over SYLLABLE-CONTACT (Bermúdez-Otero 1999). As Bermúdez-Otero [1999] states, West Germanic gemination applied to the syllabified output of Sievers' Law, fixing CONTACT violations in heterosyllabic clusters. In this analysis, I assume Bermúdez-Otero [2001]'s interpretation of the facts:

> In West Germanic, Cj clusters were split in the first round of syllabification. This placed the first consonant in the coda, where it projected a mora by Weight by Position [...]. Typically, however, the resulting syllable contact had a rising sonority profile, in violation of CONTACT [...]. This marked structure was subsequently repaired by adjoining the first member of the cluster to the onset of the following syllable. Nonetheless, the first consonant retained its moraic and consequently surfaced as a geminate, despite no longer fulfilling the structural description of Weight by Position. Thus, the resyllabification of Cj clusters counterbled Weight by Position (Bermúdez-Otero 2001:21-22).

Bermúdez-Otero [2001]'s analysis of West Germanic gemination supports Stratal OT. Opaque mora preservation is thus explained as the demotion of $*_{\sigma}$[Cj relative to SYLLABLE-CONTACT in the postlexical level. In the next section, I present a HS analysis of the data and show that no constraint permutation is needed to account for West Germanic gemination.

5.2.3 HS analysis

Opaque mora preservation in West Germanic seems to be parallel to opaque mora preservation in geminating dialects of Ancient Greek (which will be analysed in the next chapter). But this similarity is superficial.

Law" (Vennemann 1988:45), as opposed to gemination. But Bermúdez-Otero [1999] shows that Vennemann's explanation could not work for Old Upper German (*i.e.*, loːssan), so a constraint requiring stressed syllables to be heavy like PEAK-PROMINENCE, or more standard STRESS-TO-WEIGHT, cannot explain why gemination occurs even in those cases where the stressed syllable is already heavy.

In dialects of Ancient Greek, gemination was driven by the satisfaction of ONSET after deletion. In West Germanic gemination, however, the constraint responsible for syllabifying the Cj cluster heterosyllabically, $*_{\sigma}$[Cj, which must dominate SYLLABLE-CONTACT, is also violated when gemination applies in order to satisfy SYLLABLE-CONTACT, giving rise to a ranking paradox between step 1 and step 2 in HS, as shown in the tableaux below.

Tableau 172: Step 1: /bid-I-an/ → $(\text{bi}_{\mu}\text{d}_{\mu})(\text{ja}_{\mu}\text{n}_{\mu})$

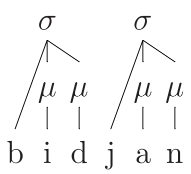
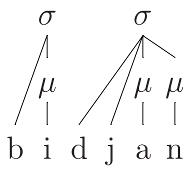
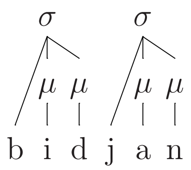
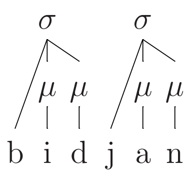
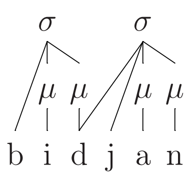
/bid-I-an/	$*_{\sigma}$[Cj	SYLL-CONT
a. ☞ 		1
b. 	1 W	L

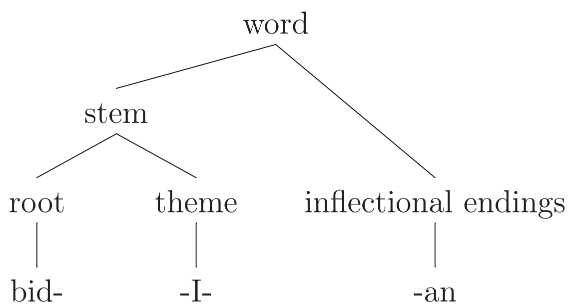
Tableau 173: Step 2: convergence on $*(\text{bi}_{\mu}\text{d}_{\mu})(\text{ja}_{\mu}\text{n}_{\mu})$

	$*_{\sigma}$[Cj	SYLL-CONT
a. ☞ 	L	1 W
b. ☹ 	1	

I present an alternative analysis that takes into consideration the morphological make-up of the word and propose that syllabification is sensitive to mophological boundaries. I claim that $*_{\sigma}$[Cj is not responsible for syllabifying Cj clusters heterosyllabically, allowing for the ranking Syllable-Contact $\gg$ $*_{\sigma}$[Cj, which is necessary to motivate gemination. The key idea is that a prosody-morphology alignment constraint requiring the left and right edges of every root to coincide with the left and right edges of some prosodic word, Align-Left/Right (root, Prosodic Word) (Al-L/R(rt, PWd)), forces Cj clusters to be syllabified heterosyllabically at the first step of the derivation because that prosodic word creates an opaque domain for binary syllable formation operations.[9]

In (2), I give the morphological constituency of weak verbs in Proto-Germanic (Bermúdez-Otero p.c.):

(2) Morphological constituency of weak verbs in Proto-Germanic



Below I give the HS analysis of pre-jod gemination after a short and a long vowel in Old Saxon and Old English. After short vowels, there is gemination, and the jod surfaces as a non-moraic glide. At the first step of the derivation, the root is contained in a prosodic word before syllabification. This is due to the ranking Align-Left/Right (root, Prosodic Word) $\gg$ Parse-Segment.

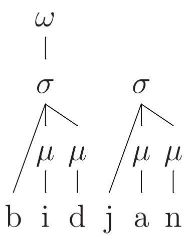
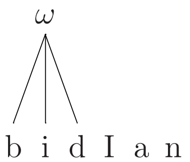
[9] Eulàlia Bonet (p.c.) suggests that an Align-Right (root, σ) constraint requiring the right edge of every root to coincide with the right edge of some syllable would do the same job, even in a POT analysis.

Tableau 174: Step 1: /bid-I-an/ → [bid]I-an

/bid-I-an/	AL-L/R(rt, PWd)	PRS-SEG
a. ☞ ω b i d I a n		6
b. σ σ μ μ μ μ b i d j a n	1 W	L
c. σ σ μ μ μ b i d j a n	1 W	L
d. b i d I a n	1 W	6

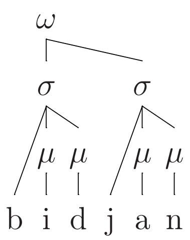
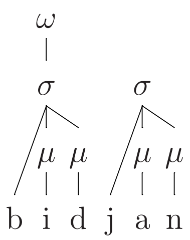
At step 2 of the derivation, syllabification applies. The fact that the root is contained in its own prosodic word blocks syllabifiying the Cj cluster tautosyllabically, because the C is contained in a prosodic constituent, in this case a prosodic word, that creates an opaque domain for syllable formation operations. The fact that the Cj cluster is syllabified heterosyllabically introduces a SYLLABLE-CONTACT violation. Here syllabification is accomplished at once for the sake of clarity, but as a separate step, in accordance with the operation-based definition of gradualness defended here.

Tableau 175: Step 2: /[bid]Ian/ → $[(\text{bi}_\mu \text{d}_\mu)](\text{ja}_\mu \text{n}_\mu)$

/[bid]Ian/	PRS-SEG	SYLL-CONT	PRS-SYLL
a. ☞ 		1	1
b. 	6 W	L	L

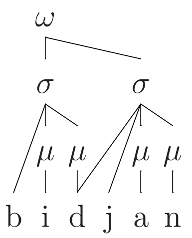
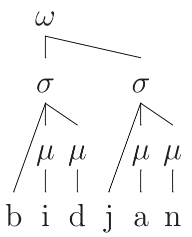
At step 3, PARSE-SYLLABLE is satisfied and the unparsed syllable is integrated into the already existing prosodic word. Notice that I am omitting metrical foot building in this analysis.

Tableau 176: Step 3: $/[(\text{bi}_\mu \text{d}_\mu)](\text{ja}_\mu \text{n}_\mu)/ \rightarrow [(\text{bi}_\mu \text{d}_\mu)(\text{ja}_\mu \text{n}_\mu)]$

$/[(\text{bi}_\mu \text{d}_\mu)](\text{ja}_\mu \text{n}_\mu)/$	SYLL-CONT	PRS-SYLL
a. ☞ 	1	
b. 	1	1 W

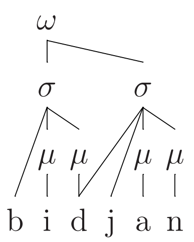
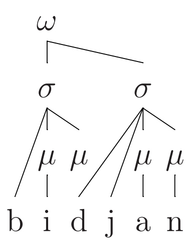
At step 4, gemination occurs as a response to satisfy SYLLABLE-CONTACT. Gemination is interpreted as the operation of inserting a link between the root node syllabified in coda position and the syllable node of the following syllable.

Tableau 177: Step 4: /[(bi$_{\mu}$d$_{\mu}$)(ja$_{\mu}$n$_{\mu}$)]/ $\rightarrow$ [(bi$_{\mu}$d$_{\mu}$)(dja$_{\mu}$n$_{\mu}$)]

/[(bi$_{\mu}$d$_{\mu}$)(ja$_{\mu}$n$_{\mu}$)]/	Syll-Cont	$*_{\sigma}$[Cj	Dep-Link	No-Gem
a. ☞ 		1	1	1
b. 	1 W	L	L	L

Convergence is reached at step 5 of the derivation. Candidate (b) in the tableau below is ruled out because of the high ranking of Max-Link-μ (as will be argued in the next chapter, candidate (b) is the necessary step before complete resyllabification, which I will claim is a two-step process).

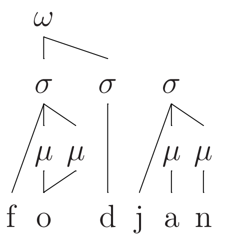
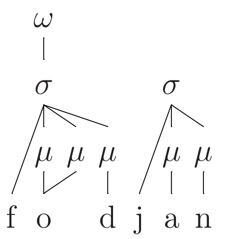
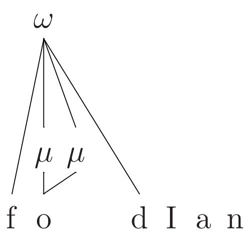
Tableau 178: convergence on [(bi$_{\mu}$d$_{\mu}$)(dja$_{\mu}$n$_{\mu}$)]

/[(bi$_{\mu}$d$_{\mu}$)(dja$_{\mu}$n$_{\mu}$)]/	Max-Link-μ	$*_{\sigma}$[Cj	No-Gem
a. ☞ 		1	1
b. 	1 W	1	L

In the case of gemination after a long vowel, the first step of the derivation is parallel to that in tableau (174). First the root is contained in its own prosodic word before syllabification applies given the ranking ALIGN-Left/Right (root, Prosodic Word) $\gg$ PARSE-SEGMENT. The first step is omitted.

At the second step of the derivation, syllabification applies. Given the high ranking of a markedness constraint against super-heavy syllables, $*_{\sigma}\mu\mu\mu$, the C after the long vowel cannot be parsed together with the long vowel. Instead, it is syllabified as a minor syllable, meaning that $*_{\sigma}\mu\mu\mu$ dominates SYLLABLE-HEAD.[10]

Tableau 179: Step 2: /[fo$_{\mu\mu}$d]I-an/ $\rightarrow$ [(fo$_{\mu\mu}$)(d)](ja$_{\mu}$n$_{\mu}$)

/[fo$_{\mu\mu}$d]I-an/	PRS-SEG	$*_{\sigma}\mu\mu\mu$	SYLL-HEAD	PRS-SYLL
a. ☞ 			1	1
b. 		1 W	L	1
c. 	6 W		L	L

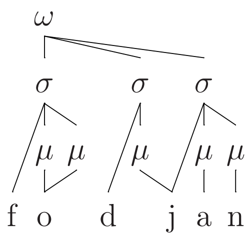
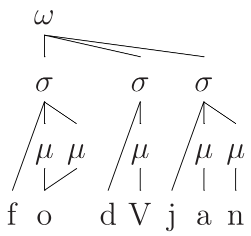
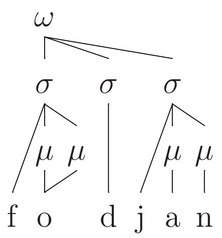
At step 3, omitted here, the unparsed syllable is adjoined to the already

[10] The reverse ranking between SYLLABLE-HEAD and $*_{\sigma}\mu\mu\mu$ is found in Old Upper German, in which there is also gemination after long vowels.

existing prosodic word in order to satisfy Parse-Syllable.

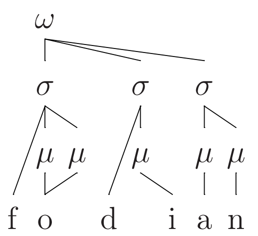
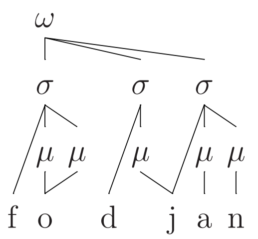
At step 4, Syllable-Head can be satisfied by inserting a new association line between the root node of the high vocoid and the syllable node of the preceding syllable in order for this root node to act as the moraic nucleus of the input minor syllable. This operation is more harmonic than epenthesizing a vowel because Dep-V dominates Dep-Link. Candidate (b) inserts a V, which stands for an epenthetic vowel. Both epenthesis and link insertion incur a Dep-μ violation, included in tableau (180).

Tableau 180: Step 4: $/[(fo_{\mu\mu})(d)(ja_{\mu}n_{\mu})]/ \rightarrow [(fo_{\mu\mu})(di_{\mu})(ja_{\mu}n_{\mu})]$

$/[(fo_{\mu\mu})(d)(ja_{\mu}n_{\mu})]/$	Syll-Head	Dep-V	Dep-Link	Dep-μ
a. ☞ 			1	1
b. 		1 W	L	1
c. 	1 W		L	L

The selected candidate $[(fo_{\mu\mu})(di_{\mu})(ja_{\mu}n_{\mu})]$ was attested in Old Saxon and Old English, but also the form with hiatus $[(fo_{\mu\mu})(di_{\mu})(a_{\mu}n_{\mu})]$. The former is obtained by ranking a constraint against doubly linked root nodes, which I will refer to as Non-Geminate (Non-Gem), over Max-Link-σ.

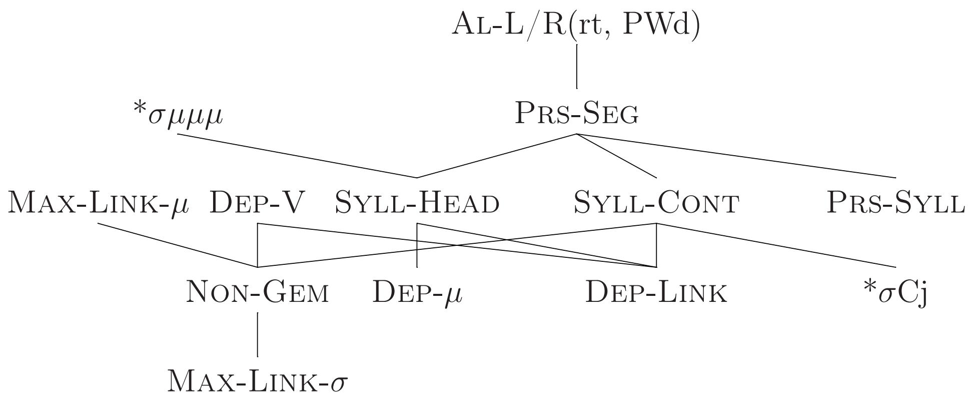
Tableau 181: Step 5: $/[(\text{fo}_{\mu\mu})(\text{di}_{\mu})(\text{ja}_{\mu}\text{n}_{\mu})]/ \rightarrow [(\text{fo}_{\mu\mu})(\text{di}_{\mu})(\text{a}_{\mu}\text{n}_{\mu})]$

$/[(\text{fo}_{\mu\mu})(\text{di}_{\mu})(\text{ja}_{\mu}\text{n}_{\mu})]/$	Non-Gem	Max-Link-σ
a. ☞ 		1
b. 	1 W	L

Convergence is achieved at step 6 of the derivation.

The grammar that accounts for West Germanic gemination is illustrated as a Hasse Diagram in (3).

(3) Hasse diagram for West Germanic gemination



5.3 Conclusion

This section has presented a HS analysis of voiced stop gemination in Catalan and has shown how this serial model without strata is able to derive some opaque forms which show counterbleeding interactions between voiced stop gemination, schwa epenthesis, and affixation.

The analysis rescues two essential ideas found in previous literature on voiced stop gemination in Catalan, namely that gemination only applies when voiced stops are parsed in coda position (Mascaró 1987) and as a strategy to avoid a rising syllable contact (Bermúdez-Otero 2000, Colina 1995, Jiménez 1997, Pons-Moll 2004, 2011). The data analyzed in this paper require a crucial ordering between three different phonological operations: syllabification, epenthesis, and gemination. The interaction between these operations can be straightforwardly accounted for in HS if all prosody-building operations count as a single step. Two different proposals about syllabification have been made that explain the asymmetries between voiced stop plus lateral root-final clusters, with or without inflectional suffixes, on the one hand, and voiced stop plus tap clusters, on the other. I have proposed that the binary operation core syllabification can create complex minor syllables and cannot operate with two adjacent segments if one of these segments, but not the other, is integrated into a prosodic category higher than the syllable. This situation allows us to posit a universal fixed hierarchy of markedness constraints disfavoring those complex onset configurations based on the Sonority Dispersion Principle (Clements 1990), according to which a complex minor syllable like (bl) is more marked than a complex minor syllable like (bɾ), given that taps behave more sonorously than laterals in Romance (Pons-Moll 2011). The constraint ranking *(bl)-Syllable-Head ≫ Parse-Segment ≫ *(bɾ)-Syllable-Head explains the difference between [pɔb.blə], with gemination, and [pɔ.βɾə], with spirantization. Second, the asymmetry between /publi/ → [pu.βli], with spirantization, and /regl+ə/ → [reg.glə], with gemination, is explained by resorting to the idea that the presence of a prosodic word boundary creates an opaque domain for syllabification operations. This restriction on Gen in syllable formation operations together with the ranking Align-Right (root, Prosodic Word) ≫ Parse-Segment ensures that words with voiced stop plus lateral root-final clusters with overt suffixes (*i.e.*, /regl+ə/) behave like words without overt morphs (*i.e.*, /pɔbl/), which show gemination, instead of behaving like words with a final vowel belonging to the root (*i.e.*, /publi/), which undergo spirantization.

The analysis of West Germanic gemination in Old Saxon and Old English builds on the same ideas that have also been proved to be useful in accounting for /s/ aspiration in Spanish (chapter 3) and cyclic syllabification in Khalkha Mongolian (chapter 4).

Chapter 6

Opaque weight by position II: compensatory (vowel) lengthening

Abstract

This chapter argues, on the basis of classic compensatory lengthening (CL), opaque vowel lengthening (VL), and deletion-triggered gemination, in favor of HS. I demonstrate that a set of phonological processes that involves opaque mora preservation, in which weight by position overapplies, finds a straightforward and more unified explanation in terms of HS if certain assumptions about the gradual nature of Gen are assumed, namely that (a) syllabification is subject to the gradualness requirement on Gen; (b) deletion is a two-step process that begins with debuccalisation (McCarthy 2008b); and (c) resyllabification is a two-step process of association-plus-delinking of autosegmental association lines, meaning that gemination is always a necessary step before resyllabification. The empirical coverage includes synchronic CL in Komi (Shaw 2009); non-local CL and gemination in dialects of Ancient Greek (Ingria 1980, Steriade 1982, Hock 1986, Hayes 1989); and opaque VL in Friulian (Hualde 1990) and Alsatian French (Montreuil 2010).

6.1 Introduction

By opaque mora preservation I refer to cases of opacity by overapplication of weight by position (Hayes 1989, Bermúdez-Otero 1999). The application of weight by position, that is to say, the fact that in some languages coda consonants are moraic (weight-contributing), can be counterbled by processes such as final devoicing, gemination, and resyllabification. When this happens, the structural description of weight by position, that is, a single coda consonant linked to its own mora, is obscured in the surface representation.

The nature of coda resyllabification

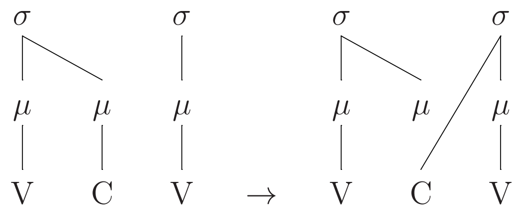
Resyllabifying a coda consonant as the onset of a following onsetless syllable always improves markedness because both Onset and No-Coda are satisfied.

According to McCarthy [2008c], "It is generally understood that resyllabification of a consonant is cost-free in faithfulness terms" (McCarthy 2008c:517). Later on, McCarthy [2010] similarly states that "Gen is limited to a single unfaithful operation at a time, but there is no limit on faithful operations. Syncope, epenthesis, feature change, and so on are unfaithful operations, so each of them requires a separate derivational step. But resyllabification is a faithful operation. It is therefore possible to combine syncope and resyllabification into a single derivational step" (McCarthy 2010:12). However, McCarthy [2008c, 2010]'s statements deserve further scrutiny in an operation-based definition of gradualness.

If an operation-based definition of gradualness is assumed, resyllabification, being a separate operation that cannot co-occur with other phonological operations, can be defined in two different ways:

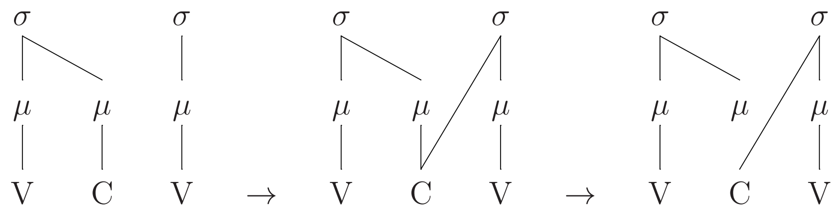
- As a delinking-cum-association one-step process (which leaves an unassociated, floating mora):

(1) Resyllabification as a one-step process



- As an association-plus-delinking two-step process (meaning that a resyllabified consonant is always derived from an intermediate geminated configuration at a previous intermediate level of representation).

(2) Resyllabification as a two-step process



I will argue in favor of the idea that resyllabification is an association-plus-delinking two-step process in HS. Resyllabification actually incurs two violations of two different faithfulness constraints, namely Dep-Link-σ and Max-Link-µ.

One empirical argument in favor of resyllabification as a two-step process is the inter-dialectal variation in some dialects of Ancient Greek in the way they satisfy the constraint Onset after onset deletion followed by a closed syllable. Some dialects show gemination of the coda consonant, which is enough to satisfy Onset. Other dialects display VL, meaning that the intermediate geminated configuration is followed by delinking and then vowel lengthening. If gemination is understood as a necessary previous step before complete resyllabification, then both patterns are explained in unison.

Gen's set of autosegmental operations and Con

Autosegmental operations are split into two different types: insertions and deletions. Below I propose how to define some faithfulness constraints on moraicity in HS.

(3) a. Insertions:

- A prosodic category and a single association line linking it to some pre-existing segment. This operation violates:
  - DEP-μ: If σ_1 in S_1 dominates n moras and σ_2 in S_2 dominates m moras, where $m > n$, assign $m - n$ violation marks. See chapter 2 for a discussion of DEP-μ in HS.
    * This operation does not violate DEP-LINK-μ. DEP-LINK-μ is only violated if both a mora and a segment are present in the input, meaning that a new autosegmental relation is present in the output but not in the input.
- A single association line linking two elements, a prosodic category and a pre-existing segment. This operation violates:
  - DEP-LINK-μ: Let x_1 be a segment in S_1 that is in correspondence with a segment x_2 in S_2, and μ_1 in S_1 in correspondence with μ_2 in S_2. Assign one violation mark if x_2 is linked with μ_2 in S_2 and x_1 is not linked with μ_1 in S_1.
  - DEP-LINK-σ: Let x_1 be a segment in S_1 linked with μ_1 that is in correspondence with a segment x_2 in S_2 linked with μ_2, and σ_1 a syllable in S_1 that is in correspondence with σ_2 in S_2. Assign one violation mark if x_2 is linked with σ_2 and x_1 is not linked with σ_1.

(4) b. Deletions:

- A prosodic category and a single association line linking it to some pre-existing segment. This operation violates:
  - MAX-μ: Assign one violation mark for every mora present in the input that has no correspondent in the output.[1]

[1]This definition is the standard one found in Morén [1999]. A more detailed investigation of this constraint and its effects in HS go beyond the purpose of the analysis in this chapter, and I leave it for further research.

* This operation does not violate MAX-LINK-μ. MAX-LINK-μ is only violated if both a mora and a segment are present in the input, meaning that a new autosegmental relation is present in the input but not in the output.

- An association line linking two elements, a prosodic category and a pre-existing segment. This operation violates:
  - MAX-LINK-μ: Let x_1 be a segment in S_1 that is in correspondence with a segment x_2 in S_2, and μ_1 in S_1 in correspondence with μ_2 in S_2. Assign one violation mark if x_1 is linked with μ_1 in S_1 and x_2 is not linked with μ_2 in S_2.
  - MAX-LINK-σ: Let x_1 be a segment in S_1 linked with μ_1 that is in correspondence with a segment x_2 in S_2 linked with μ_2, and σ_1 a syllable in S_1 that is in correspondence with σ_2 in S_2. Assign one violation mark if x_1 is linked with σ_1 and x_2 is not linked with σ_2.

A crucial aspect is that association lines represent relations between segments and prosodic categories, but not true autosegmental entities. If x and y are linked in the input, and either x or y is deleted, then automatically the association line linking them disappears because no relation stands with just one element. In other words, an association line cannot exist if one of the linkable elements lacks. This is why inserting or deleting a prosodic category automatically inserts or deletes an association line without violating DEP-LINK-μ and MAX-LINK-μ respectively.

6.2 Synchronic classic CL in Komi

I claim in this section that HS derives classic CL only if two independently motivated proposals about the gradual nature of GEN are considered together: first, that syllabification is serially built in harmonically improving single steps, and second that deletion of a coda consonant is a two-step process that begins with debuccalisation (McCarthy 2008b).

Komi, a Uralic Finno-Permic language spoken in northeastern Russia (Batalova 1982), does not allow /l/ in syllable coda position; this is enforced by deletion. Other consonants in syllable coda position surface as such and do not delete. The process of *l*-deletion triggers concomitant lengthening of the preceding vowel. When a vowel-initial suffix is added the /l/ is syllabified in syllable onset position and thus neither deletion nor vowel lengthening occurs.

This process of CL is synchronically productive, as shown by the following morphophonological alternations taken from Shaw [2009].

(1) CL before consonant-initial suffix

Stem	1SG.PAST (-i)	INFINITIVE (-ni)	
/kɨl/	[kɨ.li]	[kɨː.ni]	"to hear"
/ol/	[o.li]	[oː.ni]	"to live"
/çɨl/	[çɨ.li]	[çɨː.ni]	"to sing"
/algɨ/	[aː.gɨ.ji]	[aː.gɨ.ni]	"to scream"
/palgɨ/	[paː.gɨ.ji]	[paː.gɨ.ni]	"to wear"
/pol/	[po.li]	[poː.ni]	"to fear"

CL before a zero morpheme

Stem	ELATIVE.SG (-ɨs)	NOM.SG (-∅)	
/nɨl/	[nɨ.lɨs]	[nɨː]	"house"
/vəl/	[və.lɨs]	[vəː]	"lake"
/pil/	[pi.lɨs]	[piː]	"son"
/pul/	[pu.lɨs]	[puː]	"tree"
/pɨl/	[pɨ.lɨs]	[pɨː]	"river"
/lol/	[lo.lɨs]	[loː]	"fir tree"

Classic CL occurs when a mora-bearing coda consonant is deleted and its mora reassociates with a preceding vowel. In other words, the deleted weighted consonant is replaced by a lengthened vowel. This phenomenon is usually referred to as CL via mora preservation. If classic CL is claimed to be a process involving mora preservation,[2] POT fails to select the right output because

[2]This idea is not new. It can be traced back to the nineteenth century, when CL was defined as "absorption by a vowel of the time of a lost following consonant" (Whitney 1889:84).

the condition that makes weight by position applicable, namely the presence of a coda consonant, is non-surface-apparent. This means that deletion of a mora-bearing coda consonant counterbleeds weight by position.[3]

In a POT analysis, candidate (b) in tableau (182), the actual opaque output, incurs one more violation of the faithfulness constraint against inserting moras, DEP-μ, than candidate (a), the transparent one. The problem is that there is no top-ranked markedness constraint that compels the extra violation of DEP-μ in candidate (b), which is less faithful than candidate (a) without apparent motivation. The last two candidates lose because they violate one or both of the top-ranked markedness constraints, namely WEIGHT-BY-POSITION, requiring coda consonants to project their own mora, and NO-CODA(l), prohibiting [l] in syllable coda position.

[3]In Sprouse [1997] opacity in POT is evaded because inputs are enriched with prosodic information. Other alternatives that do not escape the basic architectural assumptions of POT are found in Hermans [2001] and Topintzi [2006], in which classic CL is argued to be a non-mora preservation process. Campos-Astorkiza [in press] also argues against a mora-preservation approach to CL based on perceptual similarity.

Tableau 182: classic CL in POT

/pol-ni/	WBP	NO-CODA(l)	DEP-μ	MAX-C
a. ☞ σ σ μ μ p o n i			2 L	1
b. ☹ σ σ μ μ μ p o n i			3	1
c. σ σ μ μ μ p o l n i		1 W	3	L
d. σ σ μ μ p o l n i	1 W	1 W	2 L	L

In a theory of HS in which syllabification is not subject to gradualness and deletion is understood as a one-step process, HS cannot deal with classic CL.

In Komi, NO-CODA(l) dominates the anti-deletion faithfulness constraint MAX-C. But with this ranking only candidate (a) in tableau (183), the transparent candidate, can be selected at step 1 of the derivation. But candidate (b) is the necessary candidate to be fed back to GEN at the next step of the derivation because it contains the extra mora that is the source of VL.

Tableau 183: Syllabification not subject to gradualness + deletion as a one-step process

/pil-Ø/	No-Coda(l)	Max-C
a. ☞ σ μ p i	L	1 W
b. ☹ σ μ μ p i l	1	

In a theory in which syllabification is gradual and deletion counts as a single-step process, HS cannot deal with classic CL either.

The tableau below shows that Max-C would outrank both Dep-μ and No-Coda(l) at the second step of the derivation in order for candidate (b) to be selected. But the opposite ranking is required in order to derive *l*-deletion, and constraint permutation is not allowed at different derivational steps in HS.

Tableau 184: Step 2: gradual syllabification + deletion as a one-step process

/(pi$_{\mu}$)l/	Dep-μ	No-Coda(l)	Max-C
a. ☞ σ μ p i	L	L	1 W
b. ☹ σ μ μ p i l	1	1	

Only a combined theory of gradual syllabification and deletion as a two-step process in HS accounts for classic CL.[4]

[4] In a model with non-gradual syllabification and deletion as a two-step process, classic CL could also be accounted for. Nevertheless, gradual syllabification is necessary to explain opaque VL in Friulian and Alsatian French, so this alternative must be discarded.

The next tableaux illustrate that a harmonically improving derivation towards classic CL is possible if syllabification is gradual and deletion counts as a two-step process.

At the first step, the candidate in which a core syllable has been projected, (pi$_\mu$)l, is selected as the most harmonic candidate because this is the only operation that maximally satisfies the markedness constraint enforcing syllabification, PARSE-SEGMENT. Capital L represents a debuccalised, placeless lateral, which represents the necessary step before root node deletion. Remember that I propose that DEP-μ is not violated when the input lacks syllables.

Tableau 185: Step 1: /pil+Ø/ → (pi$_\mu$)l

/pil+Ø/	PRS-SEG	DEP-μ	MAX(pl)	HAVE-PL
a. ☞ σ μ p i l	1			
b. σ μ p i l	2 W			
c. p i l	3 W			
d. p i L	3 W		1 W	1 W

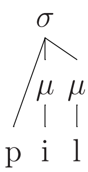
At the next step, candidate (a) satisfies PARSE-SEGMENT because of the adjunction of the last consonant to the already existing syllable, (pi$_\mu$l$_\mu$). At this step, the transparent candidate with complete deletion is not a possible GEN-generated candidate because deletion is a two-step process. Opacity is then evaded. The constraint PARSE-SEGMENT can also be satisfied by inserting a mora link between the last consonant and the mora headed by the vowel, as candidate (b) illustrates, but this possibility is ruled out because of the activity of WEIGHT-BY-POSITION. The fully faithful candidate (c) and candidate (d), which shows debuccalisation, are ruled out because they fatally violate the top-ranked constraint PARSE-SEGMENT.

Tableau 186: Step 2: /(pi$_{\mu}$)l/ → (pi$_{\mu}$l$_{\mu}$)

/(pi$_{\mu}$)l/	PRS-SEG	WBP	DEP-μ	NO-CODA(l)
a. ☞ σ μ μ p i l			1	1
b. σ μ p i l		1 W	L	1
c. σ μ p i l	1 W		L	L
d. σ μ p i L	1 W		L	L

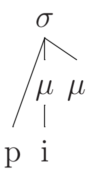
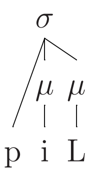
It is at the third step of the derivation that debuccalisation applies, (pi$_{\mu}$L$_{\mu}$). Candidate (a) is more harmonic than candidate (b) because it satisfies NO-CODA(l) by deleting the place feature associated with the coda consonant.

Tableau 187: Step 3: $/(\mathrm{pi}_{\mu}\mathrm{l}_{\mu})/ \rightarrow (\mathrm{pi}_{\mu}\mathrm{L}_{\mu})$

$/(\mathrm{pi}_{\mu}\mathrm{l}_{\mu})/$	NO-CODA(l)	MAX(pl)	HAVE-PL
a. ☞ 		1	1
b. 	1 W	L	L

At step 4, deletion of the root node takes place because HAVE-PLACE dominates MAX-C and a markedness constraint against moras that are not linked to any segment, *FLOATINGμ (*FLOATμ).

Tableau 188: Step 4: $/(\mathrm{pi}_{\mu}\mathrm{L}_{\mu})/ \rightarrow (\mathrm{pi}_{\mu}{}^{\mu})$

$/(\mathrm{pi}_{\mu}\mathrm{L}_{\mu})/$	HAVE-PL	MAX-C	*FLOATμ
a. ☞ 		1	1
b. 	1 W	L	L

At step 5, two operations are at play. Deletion of the floating mora is excluded because of the higher ranked position of MAX-μ. Inserting a mora link is the most harmonic operation because *FLOATINGμ is satisfied, and only low-ranked DEP-LINK-μ is violated. This is why candidate (a) emerges as the optimal candidate.

Tableau 189: Step 5: /(pi$_{\mu}{}^{\mu}$)/ → (pi$_{\mu\mu}$)

/(pi$_{\mu}{}^{\mu}$)/	MAX-μ	*FLOATμ	DEP-LINK-μ	NO-LONG-V
a. ☞ σ μ μ p i			1	1
b. σ μ μ p i		1 W	L	L
c. σ μ p i	1 W		L	L

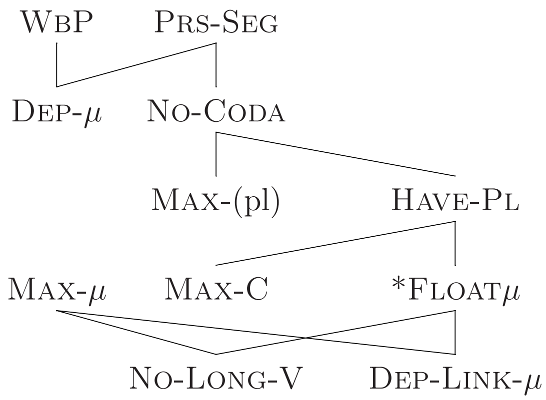
Convergence is reached at the next step of the derivation, where MAX-μ must also dominate the markedness constraint against long vowels, NO-LONG-VOWEL (*V$_{\mu\mu}$ in chapter 2).

Tableau 190: Step 6: convergence on piː

/(pi$_{\mu\mu}$)/	MAX-μ	NO-LONG-V
a. ☞ σ μ μ p i		1
b. σ μ p i	1 W	L

The Hasse diagram below summarizes the necessary ranking arguments to obtain classic CL in HS for Komi.

(2) Hasse diagram for Komi



6.3 Non-local CL (double flop) and gemination in Ancient Greek

In this section, I claim that resyllabification is the result of an association-plus-delinking two-step process in HS. By assuming this, the two distinct patterns of opaque gemination and vowel lengthening found in different dialects of Ancient Greek can be explained in a uniform way.

Different types of consonant deletions gave rise to CL in dialects of Ancient Greek (Steriade 1982).

(1) (a) pre-consonantal *w*-deletion in East Ionic (Ingria 1980, Steriade 1982, Wetzels 1986, Hayes 1989)

odwos	oː.dos	"threshold"
ksenwos	kseː.nos	"stranger"
kalwos	kaː.los	"beautiful"
derwaː	deː.raː	"neck"
wiswos	wiː.sos	"equal"

(2) (a) When /w/ was not pre-consonantal or was followed by a tautosyllabic segment, *w*-deletion did not give rise to CL (Ingria 1980, Steriade 1982, Wetzels 1986, Hayes 1989)

woikos	oi.kos	"house"
dweyos	de.os	"fear"
newos	ne.os	"new"

- *j*-deletion and *s*-deletion following sonorant segments gave rise either to CL or gemination, depending on the dialect.

(3) (a) *j*-deletion (Ingria 1980, Wetzels 1986)

	Lesbian/Thessalian	*Elsewhere*	
klin-joː	klin.noː	kliː.noː	"tend"
krin-joː	krin.noː	kriː.noː	"judge"
phther-joː	phther.roː	ptheː.roː	"destroy"
awer-joː	a.er.roː	a.eː.roː	"lift"
ojktir-joː	ojk.tir.roː	ojk.tiː.roː	"complain"
kten-joː	kten.noː	kteː.noː	"kill"

(b) *s*-deletion following sonorants (Ingria 1980)

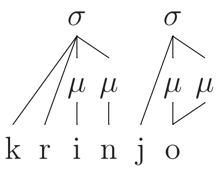
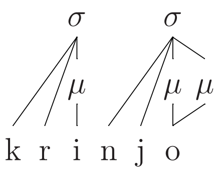
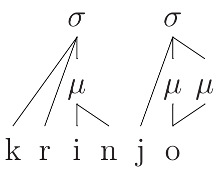
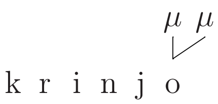
	Lesbian/Thessalian	*Elsewhere*	
ekrinsa	e.krin.na	e.kriː.na	"judge"
aːngelsa	aːn.gel.la	aːn.geː.la	"announce"
aphthersa	aph.ther.ra	eph.theː.ra	"destroy"
bolsaː	bol.laː	boː.laː	"council"
awsoːs	aw.woːs	aː.woːs	"dawn"

Lesbian and Thessalian gemination

The geminating dialects are easily captured in HS, in which the derivation proceeds as follows: syllabification, deletion and gemination. Consider *j*-gemination. Once postconsonantal *j*-deletion applies, the preceding consonant is reassociated with the syllable node of the following syllable, giving rise to a geminated root-node.

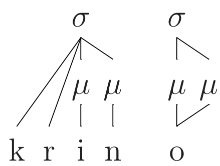
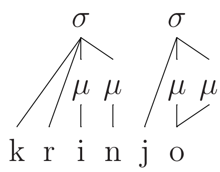
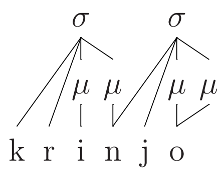
At step 1 of the derivation, as already noted, syllabification applies. As Steriade [1982] suggests, /w/ was first syllabified as being heterosyllabic with respect to the preceding consonant. I derive this syllabification pattern by ranking a markedness constraint prohibiting a consonant plus glide complex onset, $*_{\sigma}$[CG, above the markedness constraint against heterosyllabic contacts with a rising sonority profile, Syllable-Contact. In the tableau below, whole syllabification is achieved at a single step for the sake of clarity.

Tableau 191: Step 1: /krin-jo$_{\mu\mu}$/ → (kri$_{\mu}$n$_{\mu}$)(jo$_{\mu\mu}$)

/krin-jo$_{\mu\mu}$/	PRS-SEG	WBP	$*_{\sigma}$[CG	*j	SYLL-CONT
a. ☞ 				1	1
b. 			1 W	1	L
c. 		1 W		1	1
d. 	5 W			L	L
e. 	6 W			1	L

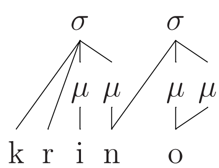
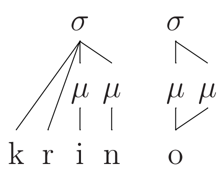
At step 2, *j*-deletion applies in order to satisfy the markedness constraint against occurrences of [j], *j.

Tableau 192: Step 2: /(kri$_{\mu}$n$_{\mu}$)(jo$_{\mu\mu}$)/ → (kri$_{\mu}$n$_{\mu}$)(o$_{\mu\mu}$)

/(kri$_{\mu}$n$_{\mu}$)(jo$_{\mu\mu}$)/	*j	Syll-Cont	Max-C	Onset
a. ☞ 		1	1	1
b. 	1 W	1	L	L
c. 	1 W	L	L	L

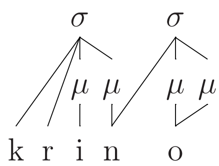
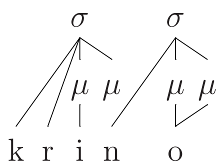
At step 3, gemination takes place in order to satisfy Onset. The winning candidate showing gemination violates the low-ranked markedness constraint against multiply-linked consonantal root nodes, No-Geminate (Hall 2003).

Tableau 193: Step 3: /(kri$_{\mu}$n$_{\mu}$)(o$_{\mu\mu}$)/ → (kri$_{\mu}$n$_{\mu}$)(no$_{\mu\mu}$)

/(kri$_{\mu}$n$_{\mu}$)(o$_{\mu\mu}$)/	Onset	Dep-Link-σ	No-Gem
a. ☞ 		1	1
b. 	1 W	L	L

Convergence is achieved at step 4 of the derivation, where it is demonstrated that Max-Link-μ must dominate No-Geminate.

Tableau 194: Step 4: convergence on $(\text{kri}_{\mu}\text{n}_{\mu})(\text{no}_{\mu\mu})$

$/(\text{kri}_{\mu}\text{n}_{\mu})(\text{no}_{\mu\mu})/$	MAX-LINK-μ	NO-GEM	*FLOATμ
a. ☞ 		1	
b. 	1 W	L	1 W

CL (elsewhere)

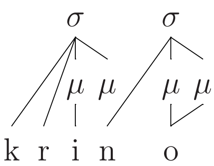
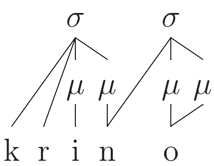
Steriade [1982] and Wetzels [1986] showed that non-local CL in Ancient Greek could only be explained by resorting to double flop. Consider *w*-deletion. Once postconsonantal *w*-deletion applied, the preceding consonant resyllabified to fill the vacated C-slot, leaving a floating mora that reassociated with the preceding vowel, giving rise to CL. Their interpretation of the facts is easily captured in HS.

The steps corresponding to syllabification, *j*-deletion and, as I propose, also gemination, are the same as those established for the geminating dialects.

Those dialects undergoing CL instead of gemination differ in the ranking between NO-GEMINATE and MAX-LINK-μ. In these dialects, a geminated consonant must be fixed by means of degemination, giving rise to complete resyllabification. Then the mora left behind is reassociated with the preceding vowel. I omit here the first three steps, which correspond to those in tableaux (191), (192), and (193).

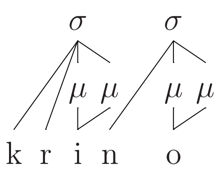
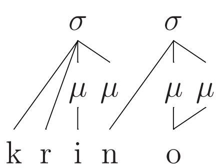
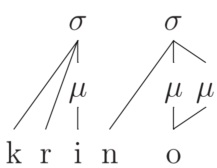
At step 4 of the derivation, once a geminated root node has been selected as the most harmonic candidate at step 3 in order to satisfy ONSET caused by *j*-deletion, the ranking NO-GEMINATE ≫ MAX-LINK-μ, *FLOATINGμ is responsible for selecting the candidate with resyllabification, which leaves a floating mora.

Tableau 195: Step 4: $/(\text{kri}_\mu \text{n}_\mu)(\text{no}_{\mu\mu})/ \rightarrow (\text{kri}_\mu{}^\mu)(\text{no}_{\mu\mu})$

$/(\text{kri}_\mu \text{n}_\mu)(\text{no}_{\mu\mu})/$	NO-GEM	MAX-LINK-μ	*FLOATμ
a. ☞ 		1	1
b. 	1 W	L	L

At step 5, the floating mora is reassociated with the vowel, giving rise to CL. MAX-μ must also dominate DEP-LINK-μ and NO-LONG-V.

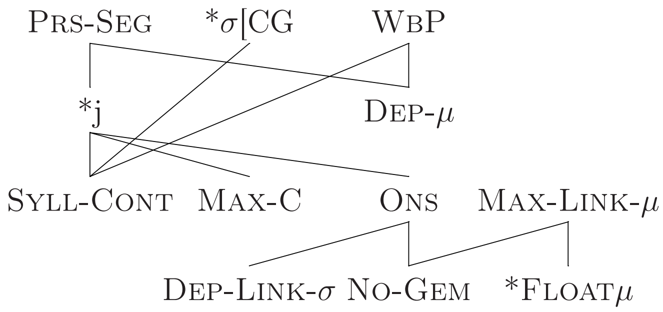
Tableau 196: Step 5: $/(\text{kri}_\mu{}^\mu)(\text{no}_{\mu\mu})/ \rightarrow (\text{kri}_{\mu\mu})(\text{no}_{\mu\mu})$

$/(\text{kri}_\mu{}^\mu)(\text{no}_{\mu\mu})/$	MAX-μ	*FLOATμ	DEP-LINK-μ	NO-LONG-V
a. ☞ 			1	1
b. 		1 W	L	L
c. 	1 W		L	L

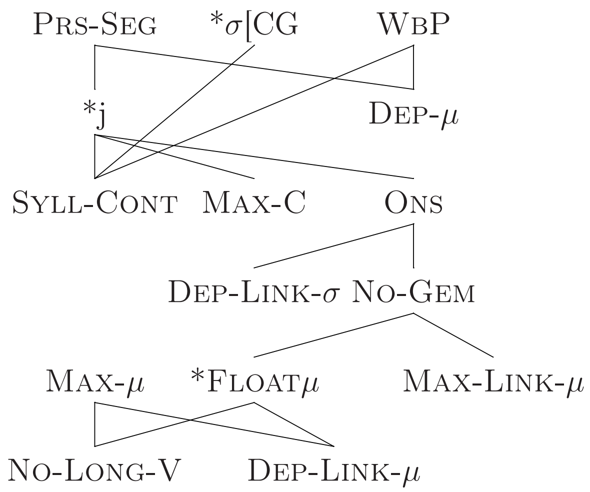
The derivation converges at step 6, omitted here.

The Hasse Diagram in (4) illustrates the ranking arguments necessary to obtain gemination for Lesbian and Thessalian. That in (5) exemplifies the ranking arguments needed to obtain CL in all other dialects of Ancient Greek.

(4) Hasse diagram for Lesbian and Thessalian



(5) Hasse diagram for the remaining dialects of Ancient Greek



6.4 Opaque VL in Friulian and Alsatian French

An HS analysis of opaque VL in two Romance varieties, Friulian[5] and Alsatian French[6], is presented in this section. In contrast to classic CL, in these two languages VL is triggered not by deletion of a mora-bearing coda and subsequent association of the vowel with the mora left behind but instead

[5]Friulian belongs to the Rhaeto-Romance subfamily of Romance languages and is spoken in the Friuli region of northeastern Italy.

[6]Alsatian French must not be confused with Alsatian, a Low Alemannic German dialect also spoken in Alsace, a region of northeastern France.

by a process of VL that applies before underlying voiced obstruents in coda position.

6.4.1 Friulian

Friulian presents a fully productive synchronic alternation between long and short vowels in some morphologically related words (Hualde 1990).[7] As can be seen in (1), when a stressed vowel precedes an underlying voiced obstruent that surfaces in word-final coda position as a voiceless obstruent due to word-final obstruent devoicing, the vowel is lengthened. However, when the same vowel precedes an underlying root-final voiced obstruent that surfaces in onset position due to the presence of a vowel-initial inflectional or derivational affix, the vowel remains short. When post-vocalic obstruents are underlyingly voiceless, as can be seen in (2), vowels do not undergo lengthening.

(1) Vowel length alternations in Friulian (Hualde 1990)

[ˈloːf]	“wolf.masc”	[ˈlo.ve]	“wolf.fem”
[ˈfreːt]	“cold.masc”	[ˈfre.de]	“cold.fem”
[sa.ˈvuːt]	“known.masc”	[sa.ˈvu.de]	“known.fem”
[fi.ˈniːt]	“finished.masc”	[fi.ˈni.de]	“finished.fem”
[ˈnaːf]	“ship”	[na.vi.ˈgaː]	“to navigate”
[fa.ˈmoːs]	“famous.masc”	[fa.ˈmo.ze]	“famous.fem”
[ˈlaːk]	“lake”	[la.ˈgu.ne]	“lagoon”

(2) Non-alternating forms in Friulian (Hualde 1990)

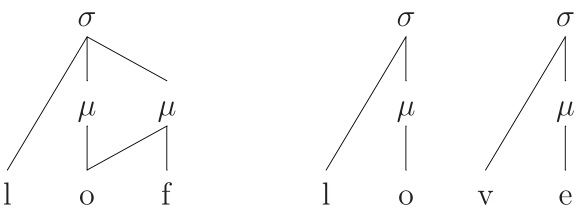
[ˈskrit]	“written.masc”	[ˈskri.te]	“written.fem”
[ˈfat]	“made.masc”	[ˈfa.te]	“made.fem”
[ˈmat]	“crazy.masc”	[ˈma.te]	“crazy.fem”
[ˈpak]	“package”	[pa.ˈkut]	“package.dim”
[ˈklap]	“stone”	[kla.pa.ˈdaː]	“to stone”

[7] Long vowels in Friulian are not only the result of a predictable VL process but also phonemic. See Prieto [1992] for a diachronic study of the origin of underlying long vowels in Friulian.

With respect to the forms [na.vi.ˈgaː] and [kla.pa.ˈdaː], the source of word-final long vowels in these cases is the diachronic loss of the infinitive morph /r/, which triggered classic CL. This specific case of classic CL in infinitive forms is synchronically opaque (*i.e.*, it became lexicalized) because /r/ does not surface under any circumstance in Modern Friulian (Paolo Roseano p.c.).

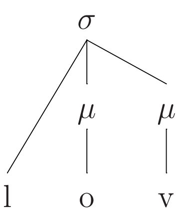
I interpret VL in Friulian as a sonority-related mora-sharing process (Hualde 1990, Zec 2003; and Montreuil 2010 for the same process in Lorraine French). In (3), the output moraic representations of the pair [ˈloːf]-[ˈlo.ve] are illustrated. VL is represented as a mora-sharing configuration, where the vowel is doubly linked to its own mora and the extra mora associated with the coda consonant. When the root-final voiced consonant is syllabified in onset position due to the presence of a vowel-initial inflectional or derivational suffix, the vowel is not lengthened because onsets do not contribute to syllabic weight.

(3) Surface representation of the pair [ˈloːf]-[ˈlo.ve]



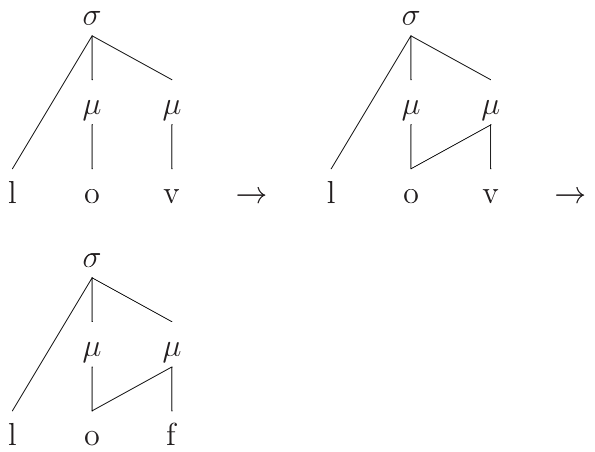
I propose that VL is triggered by the satisfaction of WEIGHT-BY-POSITION and the markedness constraint *μHEAD/C[+voice], a more specific version of *μ/C (Broselow et al. 1997), which militates against voiced consonants that are mora heads. The representation in (4) violates *μHEAD/C[+voice], although it satisfies WEIGHT-BY-POSITION.

(4) *μHEAD/C[+voice]-violating representation



In (5), I show the derivation of the mapping /lov/ → [loːf], which is discussed below.

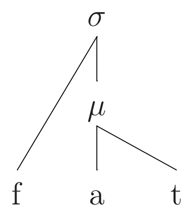
(5) Derivation of the mapping /lov/ → [loːf]



In the first representation in (5), Weight-by-Position is satisfied, resulting in a *μHead/C[+voice]-violating configuration, meaning that the former constraint dominates the latter. Then *μHead/C[+voice] is satisfied by means of adding a link between the vowel and the mora already associated with the voiced obstruent, meaning that *μHead/C[+voice] dominates Dep-Link-μ. This is so because *μHead/C is only violated if the mora is exclusively linked to a consonant. Finally the voiced consonant undergoes word-final obstruent devoicing. The last representation in (5) does not violate the constraint *μHead/C[−voice], the counterpart constraint of *μHead/C[+voice], because the mora linked to the consonant is licensed by being also linked to the vowel. The second representation in (5) does not violate *μHead/C[+voice] for the same reason.

I interpret the lack of VL as the result of the constraint ranking *μHead/C [−voice] ≫ Weight-by-Position. A weightless voiceless coda is represented as in (6). Lengthening is then blocked in inputs like /fat/ because there is only one mora to start with. This ranking implements Hualde [1990]'s interpretation of the facts, where only voiced segments in coda position are weight-contributing: "If we assume that only voiced segments in a rime can be mora-bearing units in present-day Friulian, the devoicing of a final consonant will set its associated mora afloat. This mora would then be linked to the vowel in the same rime, giving rise to a bimoraic vowel. In this way Final Devoicing would appear as automatically triggering Vowel Lengthening" (Hualde 1990:43).

(6) Weightless coda



The most interesting aspect of the data presented so far is that VL, as triggered by the presence of an underlying voiced coda consonant, becomes a non-surface-apparent generalization due to word-final obstruent devoicing. The data in the left column in (1) exemplify cases of overapplication of VL because at the surface there is no voiced coda consonant, which is the triggering environment for VL, due to the interaction of word-final obstruent devoicing. Word-final obstruent devoicing thus counterbleeds VL. I will argue below that these facts can only be accounted for if gradual syllabification in HS is assumed.

If we try to implement this analysis in POT, there is no way to motivate vowel lengthening given that both devoiced and voiceless consonants are treated equally by markedness constraints on potential mora-bearing segments. At the surface, there is no distinction between devoiced and voiceless segments.[8] In fact, following the Richness of the Base hypotheses (Prince and Smolensky 1993/2004), the moraicity of underlying voiced segments must be derived by the OT grammar, and not stipulated in the lexicon.

Unlike POT, HS with gradual syllabification gives the vowel length alternations in (1) and the lack of VL in (2) the same ranking.

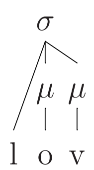
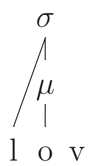
[8]But see Iosad [2010] for a strictly parallel OT account of vowel lengthening in Friulian based on a substance-free phonology perspective, in which devoiced and voiceless segments are represented differently.

(7) Partial ranking for Friulian

*μHead/C[−voice] ≫ Weight-by-Position ≫ *μHead/C[+voice] ≫ Dep-Link-μ

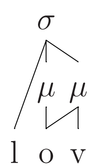
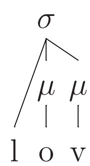
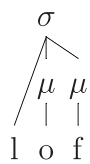
To begin the analysis, consider the input /lov/. Core syllabification is the most harmonic candidate at step 1. At the second step of the derivation, the voiced consonant following the vowel is adjoined to the existing syllable as a mora-bearing coda, as candidate (a) in tableau (197) shows. The selection of candidate (a) instead of candidate (b) derives from a crucial ranking, in which Weight-by-Position outranks *μHead/C[+voice]. Candidate (c), the fully faithful parse of the input, fatally violates the top-ranked constraint Parse-Segment.

Tableau 197: Step 2: /(lo$_{\mu}$)v/ → (lo$_{\mu}$v$_{\mu}$)

/(lo$_{\mu}$)v/	Prs-Seg	WbP	Dep-μ	*μHead/C[+voice]	Dep-Link-μ	*VcdObs/Coda
a. ☞ 			1	1		1
b. 		1 W	L	L		1
c. 	1 W		L	L		L

At the third step of the derivation, lengthening takes place. Candidate (b) is eliminated because it violates *μHead/C[+voice]. Candidate (c), with devoicing, fatally violates the top- ranked constraint *μHEAD/C[−voice], which must dominate WEIGHT-BY-POSITION, and thus dominates *μHEAD /C[+voice] by transitivity. Candidate (a) is the optimal candidate, in which the vowel links to the second mora, because it satisfies *μHEAD/C[+voice] at the expense of violating the low-ranked constraint DEP-LINK-μ.

Tableau 198: Step 3: /(lo$_{μ}$v$_{μ}$)/ → (lo$_{μ}$v$_{μ}$)

(lo$_{μ}$v$_{μ}$)	*μHEAD/C[−voice]	*μHEAD/C[+voice]	DEP-LINK-μ	*VCDOBS/CODA
a. ☞ 			1	1
b. 		1 W	L	1
c. 	1 W		L	L

Devoicing applies at the next step of the derivation, omitted here. The positional markedness constraint *VOICEDOBSTRUENT/CODA (Prince and Smolensky 1993/2004) dominating IDENT(voice) is responsible for this. Notice that when devoicing has the chance to apply after lengthening, the top-ranked markedness constraint *μHEAD/C[−voice], violated by candidate (c) in tableau (198), is vacuously satisfied because the mora linked to the voiceless obstruent is also linked to the vowel.

Consider now the input /fat/. After applying core syllabification at step 1, the underlying voiceless obstruent adjoins to the previously built syllable as a weightless coda at step 2 because of the ranking *µHEAD/C[−voice] ≫ WEIGHT-BY-POSITION.

Tableau 199: Step 2: /(fa$_{\mu}$)t/ → (faµt)

/(fa$_{\mu}$)t/	*µHEAD/C[−voice]	WBP
a. ☞ σ μ f a t		1
b. σ μ μ f a t	1 W	L

At the next step of the derivation, lengthening has no chance to apply and the derivation gets stuck because no harmonic improvement is possible.

The ranking arguments that derive opaque VL in Friulian appear below as a Hasse Diagram.

(8) Hasse diagram for Friulian

*μHEAD[-voice] MAX-μ PRS-SEG

WBP

*μHEAD[+voice] DEP-μ *VCDOBST/CODA

DEP-LINK-μ ID(VC)

VCDOBST

In this subsection, it has been demonstrated that overapplication of VL in Friulian is straightforwardly accounted for in HS because VL and word-final obstruent devoicing are forced to apply at different derivational steps.

6.4.2 Alsatian French

In Alsatian French, root-final stop plus lateral sequences, which show a rising sonority profile, are fixed by means of word-medial schwa epenthesis: /sikl/ → [ˈsi.kəl] "cycle"; /kupl/ → [ˈku.pəl] "couple" (Montreuil 2010). The interesting data come from root-final /bl/ clusters. In Alsatian French, as in Friulian, the source of vowel length is the mora projected by a voiced coda consonant.

Moreover, syllable-final obstruent devoicing applies in Alsatian French, giving rise to the opaque mapping /tabl/ → [ˈtaː.pəl] "table", where syllable-final obstruent devoicing counterbleeds VL. As Montreuil [2010] points out, epenthesis also needs to follow devoicing. If epenthesis were to precede devoicing, there would be no reason to devoice the obstruent since the stop would be syllabified in onset position, and devoicing only applies in coda position, yielding transparent *[ˈta.bəl]. This double counterbleeding ordering relation between VL and devoicing, on the one hand, and devoicing and epenthesis, on the other hand, is exemplified in (9).

(9) Rule-based derivation (Montreuil 2010)

input:		/tabl/
vowel lengthening		taːbl
	counterbleeds	
devoicing		taːpl
	counterbleeds	
epenthesis		taːp.əl
	feeds	
resyllabification		[taː.pəl]

The same ranking that has been proposed for opaque VL in Friulian also applies in Alsatian French. However, some additional constraints must be included in order to account for schwa epenthesis. PARSE-SEGMENT must dominate SYLLABLE-HEAD in order for GEN to build a minor syllable, and SYLLABLE-HEAD must outrank DEP-V, DEP-μ, and DEP-LINK-μ because the syllable headed by an empty nucleus is fixed by means of schwa epenthesis.

The HS derivation of the input /tabl/ is then as follows: /tabl/ $\rightarrow$ $(\text{ta}_\mu)\text{bl} \rightarrow (\text{ta}_\mu\text{b}_\mu)\text{l} \rightarrow (\text{ta}_\mu\text{b}_\mu)(\text{l}) \rightarrow (\text{ta}\mu\text{b}_\mu)(\text{l}) \rightarrow (\text{ta}\mu\text{p}_\mu)(\text{l}) \rightarrow (\text{ta}\mu\text{p}_\mu)(\text{ə}_\mu\text{l})$ $\rightarrow (\text{ta}_\mu{}^\mu)(\text{pə}_\mu\text{l}) \rightarrow (\text{ta}_{\mu\mu})(\text{pə}_\mu\text{l})$. The harmonic improvement tableau (200) illustrates this derivation by showing the winning candidates at each derivational step. For the sake of clarity, only the constraints that are violated by the winning candidates are included in this tableau. Notice that resyllabification is represented at a single step in the following derivation.

Tableau 200: harmonic improvement tableau for Alsatian French

/tabl/	Prs-Seg	Syll-Head	*μHd/C[+voice]	Dep-μ	Dep-V	Ons	*VcdObs/Coda	*Floatμ	Dep-Link-μ	Id(vc)	*VcdObs
Step 1. $(\text{ta}_\mu)\text{bl}$ *is more harmonic than*	2										1
Step 2. $(\text{ta}_\mu\text{b}_\mu)\text{l}$ *is more harmonic than*	1		1	1			1				1
Step 3. $(\text{ta}_\mu\text{b}_\mu)(\text{l})$ *is more harmonic than*		1	1				1				1
Step 4. $(\text{ta}\mu\text{b}_\mu)(\text{l})$ *is more harmonic than*		1					1		1		1
Step 5. $(\text{ta}\mu\text{p}_\mu)(\text{l})$ *is more harmonic than*		1								1	
Step 6. $(\text{ta}\mu\text{p}_\mu)(\text{ə}_\mu\text{l})$ *is more harmonic than*				1	1	1					
Step 7. $(\text{ta}_\mu{}^\mu)(\text{pə}_\mu\text{l})$ *is more harmonic than*								1			
Step 8. $(\text{ta}_{\mu\mu})(\text{pə}_\mu\text{l})$									1		

At the first step of the derivation, core syllabification applies. This is the most harmonic operation because the winning candidate minimally violates the top-ranked constraint Parse-Segment. Then /b/ is adjoined to the previously existing syllable as a weight-contributing coda, and the top-ranked constraint Weight-by-Position not included in tableau (200), is satisfied. At the third step, /l/ must be parsed as a minor syllable because PARSE-SEGMENT dominates SYLLABLE-HEAD. The markedness constraint against mora-bearing voiced coda consonants *μHEAD/C[+voice] is satisfied by means of inserting a mora link between the vowel and the mora headed by the voiced coda consonant at the next step. Then syllable-final obstruent devoicing applies because the positional markedness constraint *VOICEDOBSTRUENT/CODA dominates IDENT(voice). At the next step, SYLLABLE-HEAD is satisfied by means of word-medial schwa epenthesis. At the seventh step, resyllabification applies and ONSET is satisfied. Finally, the satisfaction of *FLOATINGμ triggers VL. The derivation converges, and the actual opaque output [(ta$_{\mu\mu}$)(pə$_{\mu}$l)], with lengthening, devoicing, and schwa epenthesis, is obtained.

6.5 Derivational constrained-based alternatives

Apart from HS, other derivational versions of OT could in principle accommodate classic CL and opaque VL, namely OT with Candidate-Chains (OT-CC, McCarthy 2007a, Wolf 2008, 2011), and Stratal OT (Kiparsky 2000, Bermúdez-Otero to appear).

On the one hand, opaque VL in Lorraine French, which mirrors the Friulian data discussed here, and opaque VL in Alsatian French have been analyzed in OT-CC in Montreuil [2010]. Classic CL has also been analyzed in OT-CC in Shaw [2009]. On the other hand, in Kiparsky [2010] a Stratal OT account of non-classic CL in Finnish and Samothraki Greek is presented, in which the trigger of VL is not the loss of a coda consonant. The purpose of this section is not to review all these proposals but rather to show very briefly that classic CL and the type of opaque VL discussed so far find a simpler treatment in HS.

OT-CC needs PRECEDENCE constraints to deal with opacity. This type of metaconstraint forces a particular ordering among faithfulness violations between two consecutive members of a candidate chain. In Montreuil [2010]'s OT-CC analysis of Lorraine and Alsatian French, PRECEDENCE constraints forcing lengthening to apply before devoicing and devoicing before schwa epenthesis are needed. One could argue against PRECEDENCE constraints based on their *ad hoc* character. Why should a PRECEDENCE constraint state that an A faithfulness violation must precede a B faithfulness violation and not the other way around? In other words, one should be skeptical about their stipulative character, just as extrinsic rule ordering was seen as an undesirable artifact in rule-based phonology.

Regarding Stratal OT, classic CL could be easily accounted for because, although EVAL applies in parallel, ranking permutation is allowed at each morphological stratum. In order to derive classic CL, MAX must outrank NO-CODA at the stem-level phonology in order to select the candidate in which weight by position has applied. At the word-level phonology, the reverse ranking is needed, in which NO-CODA dominates MAX. The main problem with this kind of analysis is that, in many cases, no morphology at all is involved in classic CL or in the case of opaque VL in Alsatian French, in which lengthening also applies in monomorphemic words.

In HS, neither PRECEDENCE constraints nor ranking permutation is needed. Classic CL, double flop, and opaque VL are just a natural consequence of the intrinsic derivational nature of the theory imposed by the gradualness requirement on GEN, and are obtained under the same language-particular ranking of universal constraints.

6.6 Conclusion

Classic CL challenges POT because the conditions that make weight by position applicable are non-surface-apparent, meaning that deletion of a mora-bearing coda consonant counterbleeds weight by position. In this chapter I have argued in favor of HS. It has been shown that HS derives classic CL and double flop only if two independently motivated proposals about the gradual nature of GEN are considered together, namely that syllabification is built serially in harmonically improving steps, and that deletion of a coda consonant is a two-step process that begins with debuccalisation (McCarthy 2008b). These theoretical assumptions have also been extended to account for opaque interactions between VL and final obstruent devoicing in Friulian and Alsatian French, which also require syllable formation operations to apply before final devoicing and schwa epenthesis.

The contribution of this chapter has been twofold. From an empirical point of view, it has been demonstrated that HS is able to accommodate particular cases of counterbleeding opacity in which moraicity is involved. From an internal theoretical perspective, the proposed analyses have given additional support to these two hypotheses about the gradual nature of GEN.

Chapter 7

Conclusions

This dissertation has developed a novel theory of syllabification in Harmonic Serialism in order to account for specific cases of phonological opacity.

In chapter 2, I have presented a theory of serial syllabification in HS in which a finite set of syllable formation operations apply one at a time and directionally. This set of syllable-building operations allows for the creation of both unary and binary syllabic configurations that can be either moraic or not, giving rise to minor, moraless syllables. On the one hand, the possibility of inserting a mora or not and also the possibility of inserting a label C(oda) or not generate fully specified nucleusless syllabic configurations that have been proved to account for asymmetries in vowel epenthesis placement. These asymmetries have been illustrated with data from Iraqi and Cairene Arabic. On the other hand, a reformulation of the faithfulness constraint Dep-μ in the light of Harmonic Serialism has also been shown to solve some pathologies regarding unattested contrastive moraicity in coda consonants and unattested tautomorphemic contrastive syllabification firstly detected by Bermúdez-Otero [2001], Campos-Astorkiza [2004]. In this chapter, I have also defended the hypothesis that prosodification in Harmonic Serialism, including syllabification, is built in harmonically improving single steps, as already argued in Elfner [to appear], Pater [2012]. This idea follows from an operation-based definition of gradualness, as opposed to a faithfulness-based one, according to which all structure-changing and structure-building phonological operations count as a single step. Under this operation-based definition of gradualness, I defend the hypothesis that prosodic constituents higher than the syllable define opaque domains for syllable formation operations under certain structural conditions. In order for binary syllable formation operations to apply, a pair of segments x and y must stand in a linear immediate precedence relation. This is implicit in Elfner [2009]'s formulation of core syllabification. However, I also propose to further constrain the applicability of syllable formation operations through another universal condition, formalized in (1), which must be understood as an inherent property or feature of Gen.

(1) Gen-restrained syllable formation operations

Let (x, y) stand for a pair of segments *s.t.* x immediately precedes y, and PCat_1 and PCat_2 stand for prosodic categories higher than the syllable, where $\text{PCat}_2 > \text{PCat}_1$.

Syllable formation operations cannot simultaneously build or derivationally produce a binary syllable (xy) if there is a PCat_1 *s.t.* PCat_1 dominates x but not y, or y but not x, and there is no PCat_2 *s.t.* PCat_2 dominates both x and y.

As stated in (1), binary syllable formation operations, or unary operations that yield a binary syllable, are blocked when one of the two segments that stand in a phonological linear immediate precedence relation, but not the other, is dominated by a prosodic category higher than the syllable, and there is no other higher prosodic category that dominates both of them. This means that the presence of a prosodic category higher than the syllable creates an opaque domain for binary syllable formation operations.

That principle allows the transparent application of phonological operations at intermediate stages of prosodification that will not coincide with the prosodification of the final output, thus giving rise to cases of non-surface-apparent opacity.

Chapter 3 has addressed the case of opacity by overapplication of /s/ aspiration in Spanish due to word- and phrase-level resyllabification. The relative transparency of the aspiration process found in different dialects of Spanish is derived by the relative position that the markedness constraint Coda-Condition occupies with respect to two families of prosody-enforcing markedness constraints: Parse-Segment ≫ Parse-ProsodicWord, on the one hand, and two morphology-prosody alignment constraints, Align/Left (stem, Prosodic Word) ≫ Align/Left (Morphological Word, Prosodic Word), on the other. By way of illustration, consider a prefixed form like *de*[h]*armar* "to disarm", where *de*[h] is a prefix and *armar* the base. In this case, there is overapplication of /s/ aspiration because the structural context that makes /s/ aspiration applicable, that is, the /s/ syllabified in coda position, is not met in the surface due to the interaction with word-level resyllabification before vowel-initial bases. If the morphology-prosody alignment constraint Align/Left (stem, Prosodic Word) dominates Parse-Segment, at the first step of the derivation, only the base, but not the prefix, is contained in a prosodic word before syllable formation operations have had the chance to apply. At the next step of the derivation, syllable-building operations apply. However, given that there is a prosodic category higher than the syllable that dominates the first vowel of the base but not the last consonant of the prefix, and there is no other higher prosodic category dominating both of them, a binary syllable formation operation is blocked from operating with those two segments, then syllabifiying them heterosyllabically. This yields a situation in which the last consonant of the prefix, /s/, is syllabified in coda position. The ranking Coda-Condition ≫ Align/Left (Morphological Word, Prosodic Word) favors /s/ aspiration at the step of the derivation following syllabification. Then Align/Left (Morphological Word, Prosodic Word) is satisfied by adjoining the unparsed syllable to the already existing prosodic word. The presence of this prosodic category allows syllable formation operations to derive, through resyllabification, a binary syllable in which aspirated /h/ finally surfaces as the onset of the base-initial vowel. An operation-based definition of gradualness together with the principle in (1) satisfactorily accounts for this specific case of opacity by overapplication in Spanish in which resyllabification counterbleeds /s/ aspiration.

Chapter 4 has explored directional syllabification and vowel epenthesis placement in standard Ulaanbaatar Mongolian. It focuses on a specific case of cyclic syllabification in which the optimal directional syllabification pattern becomes opaque due to the morphological structure of non-monomorphemic words. Morphologically-driven opaque syllabification is observed by means of the location of epenthetic vowels. Mongolian has minimal pairs such as [xʊ.ʦət.la] and [xʊʦ.tə.la], where epenthesis placement varies depending on the location of morpheme boundaries. The inputs for the previous output forms are /xʊʦ-t-la/ and /xʊʦ-tl-a/, respectively. If GEN is restrained to maximally operate with two morphs in prosody-building operations such as prosodic word projection, different domains for syllabification are created at the steps of the derivation preceding syllabification for each of the inputs, namely /[xʊʦt]-la/ and /[xʊʦtl]-a/, respectively. These prosody-defined syllabification domains determine the exact location of epenthetic vowels because syllabification, and then epenthesis, apply before the whole input string is contained in the prosodic word. This situation is derived by the constraint ranking LX≈PR ≫ PARSE-SEGMENT ≫ PARSE-SYLLABLE. Once there is a prosodic word dominating the whole input string, syllable formation operations of adjustment, such as resyllabification, make the optimal directional syllabification pattern opaque. Again, an operation-based definition of gradualness together with the principle in (1) and the fact that GEN maximally operates with two morphs when projecting prosodic categories explain the existence of such opaque syllabification algorithms in some morphologically complex words in Mongolian.

Chapter 5 and 6 have focused on opaque weight by position in Harmonic Serialism.

Chapter 5 has concentrated on two cases of overapplication of weight by position found Catalan and West Germanic gemination. With respect to voiced stop gemination in Catalan, a crucial ordering between different phonological operations is required, namely syllabification, epenthesis, and gemination. The interaction between these operations can be straightforwardly accounted for in HS if the principle in (1) is taken into account. Moreover, two different proposals about syllabification have been made that explain the asymmetries between voiced stop plus lateral root-final clusters, with or without inflectional suffixes, on the one hand, and voiced stop plus tap clusters, on the other. I have proposed the existence of a universal fixed hierarchy of sonority-driven markedness constraints disfavoring complex minor syllables in which the segments are directly dominated by the syllable node and they have not projected the label C(oda) based on the Sonority Dispersion Principle (Clements 1990). According to this principle, a complex minor syllable like (bl) is more marked than a complex minor syllable like (bɾ), given that taps behave more sonorously than laterals in Romance (Pons-Moll 2011). The constraint ranking *(bl)-SYLLABLE-HEAD ≫ PARSE-SEGMENT ≫ *(bɾ)-SYLLABLE-HEAD explains the difference between [pɔb.blə], with gemination, and [ˈpɔ.βɾə], with spirantization. In both cases, there is a word-final epenthetic schwa. In the former case, the activity of top-ranked *(bl)-SYLLABLE-HEAD prevents a minor complex onset configuration (bl) and forces the voiced stop to be syllabified in coda position. Then the lateral is parsed as a unary minor syllable, which is later fixed by means of schwa epenthesis. Finally, the rising heterosyllabic profile (...b)(l...) is satisfied by means of link insertion, giving rise to gemination. This is not the case when the voiced stop is followed by a tap. In this case, parsing both segments as a minor complex onset configuration is the most harmonic operation given the ranking PARSE-SEGMENT ≫ *(bɾ)-SYLLABLE-HEAD. The asymmetry between /publi/ → [ˈpu.βli], with spirantization, and /regl+ə/ → [ˈreg.glə], with gemination, is explained by resorting to the idea that the presence of a prosodic category creates an opaque domain for syllabification operations, as stated in (1). First, only the root is contained in a prosodic word, which makes an input like /regl+ə/ parallel to /pɔbl/, and thus forces the voiced stop to be syllabified in coda position, the necessary context for gemination. This restriction on GEN in syllable formation operations together with the ranking ALIGN-Right (root, Prosodic Word) ≫ PARSE-SEGMENT ensures that words with voiced stop plus lateral root-final clusters with overt suffixes (*i.e.*, /regl+ə/) behave like words without overt morphs (*i.e.*, /pɔbl/), which show gemination, instead of behaving like words with a final vowel belonging to the root (*i.e.*, /publi/), which undergo spirantization.

Chapter 6 has also argued, on the basis of classic compensatory lengthening, opaque vowel lengthening, and deletion-triggered gemination, in favor of Harmonic Serialism. I have demonstrated that a set of phonological processes that involves opaque mora preservation, in which weight by position overapplies, finds a straightforward and more unified explanation in terms of Harmonic Serialism if certain assumptions about the gradual nature of GEN are assumed, to wit, (a) syllabification is subject to the gradualness requirement on GEN; (b) deletion is a two-step process that begins with debuccalisation (McCarthy 2008b); and (c) resyllabification is a two-step process of association-plus-delinking of autosegmental association lines, meaning that gemination is always a necessary step before resyllabification. The empirical coverage includes synchronic compensatory lengthening in Komi (Shaw 2009); non-local compensatory lengthening and gemination in dialects of Ancient Greek (Ingria 1980, Steriade 1982, Hock 1986, Hayes 1989); and opaque vowel lengthening in Friulian (Hualde 1990) and Alsatian French (Montreuil 2010). Classic compensatory lengthening challenges parallel Optimality Theory because the conditions that make weight by position applicable are non-surface-apparent, meaning that deletion of a mora-bearing coda consonant counterbleeds weight by position. But in Harmonic Serialism, classic compensatory lengthening is easily derived. If gradual syllabification and deletion as a two-step process are assumed, the transparent candidate with complete deletion is not a possible GEN-generated candidate at the step in which the coda consonant is parsed. This way, after syllabifying the consonant as a moraic coda, debuccalisation, and then root node deletion apply, leaving a floating mora that is later reassociated with the preceding vowel, giving rise to compensatory lengthening. These theoretical assumptions have also been extended to account for opaque interactions between vowel lengthening and final obstruent devoicing in Friulian and Alsatian French, which also require syllable formation operations to apply before final devoicing and schwa epenthesis. The contribution of this chapter has been twofold. From an empirical point of view, it has been demonstrated that Harmonic Serialism is able to accommodate particular cases of counterbleeding opacity in which moraicity is involved. From an internal theoretical perspective, the proposed analyses have given additional support to two independently motivated hypotheses about the gradual nature of GEN, namely serial syllabification, and deletion as a two-step process.

This dissertation represents just a small step towards understanding syllabification, syllable structure, and opacity in Harmonic Serialism. Future lines of research should be open. The consequences of adopting an operation-based definition of gradualness and the comparison between gradual *versus* non-gradual syllabification should be further developed in domains that now acquire a new and promising dimension in the light of Harmonic Serialism, like the topics discussed in this dissertation.

Harmonic Serialism is a theory of language typology. Hypotheses about the nature of Gen and Con in Harmonic Serialism can be easily falsified using the software OT-Help 2.0 (Staubs et al. 2010), which allows the user to define his or her own hypotheses about the set of universal constraints, as well as what it means to introduce one single modification with respect to any input. This software is a typology calculator that estimates the factorial typology from the user-defined sets of universal constraints, single operations on Gen, and lists of inputs. In the future, it would be of interest to use this software and test the hypotheses presented in this dissertation, and to confront them with a large set of data from different languages.

In accordance with this goal and following the research lines addressed in this dissertation, a more exhaustive study of vowel lengthening in Romance (not only Friulian, but also other Northern Italian dialects such as Milanese, and dialects of regional French) will be carried out in order to study how to define gradualness in Harmonic Serialism. A closer look at opaque mora preservation phenomena, both compensatory lengthening and gemination in languages that show a higher degree of complexity (Bermúdez-Otero 2001, Kiparsky 2010, Lin 1998, McCarthy 2003, Topintzi 2006, among others), will also be pursued in order to test the explanatory adequacy of Harmonic Serialism. Syllable typology within a large cross-linguistic perspective should also be investigated in the light of the duplication problem that the intrinsic nature of Harmonic Serialism raises, given that a constraint-based theory of grammar like Harmonic Serialism is only a good model if the list of operations included in Gen do not duplicate the job done by universal constraints.

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