Stress-epenthesis interaction and defect-driven rules

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Contents

Symbols and abbreviations

/ /	boundaries of the input form
[ ]	boundaries of the output form
||	introduces a set of discretionary constraints
%	word edge
☞	Winner candidate in an OT tableau
☜	Candidate that wins in reality, but not in the tableau
HS	Harmonic Serialism
OT	Optimality Theory
OT-CC	Candidate Chains Theory
RBP	Rule-Based Phonology
SPE	The Sound Pattern of English (Chomsky and Halle, 1968)
LSR	Local Syllable Restructuring
LUM	Localised Unfaithful Mapping
H	heavy syllable
L	light syllable

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Abstract

This thesis is concerned with the interaction of two phenomena: vowel epenthesis and stress assignment. Vowels are potential targets for stress, and they count for determining the stress window in systems where stress is grammaticaly predictable. Epenthetic vowels, however, are often exceptional in this respect. There is an array of languages where epenthetic vowels shun stress, or in some other way disrupt canonical stress assignment. The two conditions, unstressability and metrical invisibility of epenthetic vowels, are not universally connected. On the contrary, in a number of languages epenthetic vowels are (only) partially visible to metrical structure.

The present thesis brings together the relevant cases, and proposes a formal analysis of the attested facts. The languages under scrutiny are: Swahili (Bantu), Dakota (Siouan), Mohawk (Iroquoian), Winnebago/Hocank (Siouan), Yimas (Sepik-Ranu), and Selayarese (Makassar). Data from loanwords in North Kyungsang Korean and Japanese are also presented, but not formally analysed, as the stress turns out not to be gramatically predictable.

The proposed analysis is framed in the defect-driven rule formalism (Frampton, 2008), a serial framework where phonological rules are triggered by defects in the input string. The analysis provides an extension of Frampton's model, by considering defect-driven rule interaction and ordering.

The discussion bears on the treatment of opacity in different theories of the nature of the phonological component, as well as on the issues involving serial derivations vs. parallel evaluation, and the role of rules and constraints in modelling phonological computation. It is argued that the data considered here necessitates a serial analysis, and that within serial frameworks, the defect-driven rule formalism makes the most accurate empirical predictions for the current dataset.

Keywords:
stress, epenthesis, defect-driven rules, prosodic opacity

Chapter 1

Introduction

The primary goal of this thesis is to deliver a formal analysis of a range of metrical (in)visibility patterns connected to the interaction of stress and vowel epenthesis. The other, closely interlocked, goal is to explore the nature of rule interaction in the defect-driven rule formalism (Frampton, 2008).

1.1 Stress and epenthesis

It has been observed cross-linguistically that epenthetic vowels may disrupt regular stress assignment. An example comes from *e*-epenthesis in Mohawk. The regular penultimate stress pattern is disrupted by vowel epenthesis, as exemplified in (1).

(1) Stress in Mohawk (Hagstrom, 1997):

a. Canonical penultimate stress:

/wak-haratat-u-hatye/	wakharatatuhátye	‘I go along lifting up’
/hra-kw-as/	rákwas	‘he picks it’
/k-atirut-haˀ/	katirúthaˀ	’I pull it’

b. Non-canonical stress in words with epenthetic *e*:

/ʌ-k-r-ʌ-ˀ/	ʌ́ke̲rʌˀ	‘I will put it into a container’
/waˀ-t-k-atat-nak-ˀ/	waˀkatáte̲nake̲ˀ	‘I scratched myself’
/t-ʌ-k-hkw-ˀ/	tʌ́ke̲hkwe̲ˀ	‘I’ll lift it’

As evident from the data in (1-a), the penultimate syllable in Mohawk carries marries main stress. However, the data in (1-b) constitute an exception to this generalisation, as the stress shifts to the left of the penultimate syllable. This happens when the penultimate, and/or final vowel is epenthetic. It appears that the epenthetic vowels in (1-b) cannot be stressed, and they do not count for determining the bisyllabic stress window at the right edge. This phenomenon is referred to as metrical invisibility of epenthetic vowels (Hagstrom, 1997).

A closer survey of visibility of epenthetic vowels reveals a surprising array of highly complex opacity effects (the tern ‘opacity’ in this case denotes non-surface true generalisations). As it turns out, the metrical invisibility of epenthetic vowels tends to be only partial, i.e. epenthetic vowels are invisible to stress assignment only in some contexts, depending on the type or the position of epenthesis. Thus, for example, Mohawk has another type of *e*-epenthesis which is fully visible to metrical structure, illustrated by the data in (2).

(2) Canonical stress assignment in words with epenthetic vowels in Mohawk

/s-rho-s/	sérhos	‘you coat it with something’
/sa-s-ahkt/	sasáhket	‘go back’

As evident from data in (2), *some* epenthetic vowels do not only count for the stress window, but can also bear stress in penultimate position.

Some accounts propose that stressing of epenthetic vowels are cross-linguistically avoided (Broselow, 1982; Kenstowicz, 2007). Alderete (1995, 1999) and Broselow (2008) explain this pattern via special faithfulness relationships (faithfulness to prosodic heads). Specifically, prominent positions (foot head, head foot) require a correspondent in the input, thus, for example, head foot might be placed in a non-canonical position, so that it does not contain epenthetic vowels. These analyses are rejected in the present work. It is shown that Prosodic Faithfulness Theory fails to account for all the attested patterns of metrical invisibility. It is further argued that there is nothing inherent about unstressability, or unfootability of epenthetic vowels. Instead, it is proposed that metrical invisibility of epenthetic vowels is an epiphenomenon of serial ordering, whereby metrically invisible epenthetic vowels are analysed as inserted after stress assignment.

Serial ordering has been criticised as an explanation for metrical invisibility effects in the works of Alderete (1995, 1999), Shinohara (2000) and Broselow (2008). Indeed, it is not immediately obvious how rule ordering can derive some complex *partial* visibility effects. An example of such criticism comes from Broselow (2008), who develops an elaborate analysis to account for some cases of partial metrical visibility in Selayarese. The analysis, however, still makes false predictions for some other cases as illustrated in (3).

(3) Wrong predictions made by rule ordering in Selayarese (Broselow, 2008)

	/sahal/	/solder/
Final extrametricality	saha(l)	solder
Syllabification, epenthesis	sa.ha(l)	so.lo.de(r)
Stress assignment	sá.ha(l)	so.ló.de(r)
Syllabification, epenthesis	sá.ha(l)	so.ló.de(r)
Loss of extrametricality	sá.hal	so.ló.der
Syllabification, epenthesis	sá.ha.la	so.ló.de.re
Output	sá.ha.la	*so.ló.de.re
Attested	sá.ha.la	so.lo.dé.re

The present thesis addresses Broselow’s criticism, by proposing that the failure of rule ordering in modelling Selayarese in (3) is a problem of the particular analysis, but not of the entire framework. An alternative serial analysis is developed in Chapter 4 which makes correct predictions for the Selayarese data. It is argued that partial metrical visibility can be conditioned by multiple factors, such as rule persistence, rule sandwiching, or output well-formedness condition on metrical structure which trigger repair rules. While all of these ideas feature in phonological literature, they have not been incorporated into a unified analyses of the attested metrical visibility effects in epenthetic vowels. This work proposes such an analysis within a formalism which predicts that in some cases epenthetic vowels will only be partially visible to stress assignment.

1.2 Defect-driven rules

The formalism used in this work is that of defect-driven rules (Frampton, 2008). Frampton sketches out a proposal for how rules and constraints interact in a formal model of grammar. The architecture comprises a set output conditions. A failure of a phonological input to satisfy these codntions triggers the application of a rule. Rules comprise a set of ordered repairs, whose operation is limited by derivational constraints. The general defect-driven rule format (4) involves two general parts, Preamble and Body. The Preamble comprises the functions involved in finding targets for rule applications. It specifies what kind of elements are to satisfy what condition, and in what order the defective elements are picked out for repair. The Body of the rule comprises a set of ordered repairs and a set of derivational constraints on those repairs.

(4) Defect-driven rule format (Frampton, 2008):

a. $\underbrace{\text{Type; Condition; Order}}_{\text{Preamble}} \; :: \; \underbrace{\text{Rule(s); Constraint Set}}_{\text{Body}}$

b.

Type:	defines the element on which the condition operates
Condition:	expresses the target
Order:	ranks the violations and determines the order in which the rule(s) attemps to remove them
Rule(s):	defines the type of repair rule(s) available
Constraint Set:	lists constraints on the application of repair rules

Frampton (2008) proposes how the defect-driven rules on stress assignment and syllabification work. The present work takes this proposal a step further, examining how rules interact. It is proposed that defect-driven rules are, by definition, persistent, i.e. applying at any point of the derivation where the conditions for rule application are met (Chafe, 1968; Myers, 1991). It is shown that the predictions following from rule persistence are met by a number of phenomena that arise where stress and epenthesis interact, surpassing the predictions made by strictly ordered rules.

On the theoretical side, the defect-driven rule formalism has a number of advantages. The formalism does not introduce new assumptions, or new phonological insights. It is rather a formal implementation of ideas and intuitions expressed in numerous other phonological studies. The formalism brings together the concepts of iterativity, directionality, constraints, constraint ranking and violability, and locality.

1.2.1 Iterativity and directionality

The issues of iterativity and directionality go back to the discussion on how rules apply: whether they apply globally (simultaneously in all the environments that meet the structural condition of a given rule), or whether they apply only at one locus at a given point and proceed in a given direction. In prosodic phonology the latter view of rule application is usually assumed. Directional assignment of iterative feet is the basis of the algorithm employed in some of the most influential studies of prosodic phonology and metrical theory (Halle and Vergnaud, 1987; Hayes, 1995). The arguments for iterative foot assignment draw on the typology of prosodic systems, where some structures appear only at an edge. For example, there are systems where degenerate feet occur only in imparisyllabic forms and only in the rightmost position (this type of structure will be argued by the present work to appear in Winnebago). The effect is attributed to the left-to-right application of rules: a rule assigns binary constituents left-to-right, and one unary foot at the right edge, where there is not enough prosodic material to build a binary foot. Similar insights concerning iterativity and directionality are shared by prosodic phonologists working in serial OT (Pruitt 2008 on foot assignment in Harmonic Serialism).

Traditional approaches to segmental rules, the prime example being SPE, seem to assume the global application of segmental rules: a rule applies to all targets that meet a certain structural condition, and after that, the rule terminates. However, it is not inconceivable that a rule applies strictly locally in an iterative fashion, but the effect is global, so iterativity will hardly leave any traces. However, iterativity in rule application has been argued for by some phonologists, mostly on the basis of opacity effects (Anderson, 1969; Johnson, 1971; Morin and Friedman, 1971; Kenstowicz and Kisseberth, 1977, 1979). Similarly, Vaux (2008) provides arguments for iterativity in rule application on the basis of iterative sequential optionality.

Finally, iterativity in the implementation of structural changes is also implemented in the frameworks of Harmonic Serialism and Candidate Chains Theory (McCarthy, 2000, 2007, in press) in the assumption on gradualness. A single step in derivation may bring about at most one, strictly local, structural change (though serial OT still awaits a formalisation in terms of directionality, especially with respect to segmental changes).

Directionality belongs to the Order parameter in Frampton's defect-driven rule format. The rules are strictly local (e.g. the footing rules insert only one delimiter at a time), and the iterative application is conditioned by the defects specified in the preamble. A rule applies until all defects identified by the target condition have been removed, or until the possibilities of repair have been exhausted.

1.2.2 Constraints on the output and constraint ranking

The formal implementation of defect is one of the crucial differences between Frampton's (2008) formalism and the traditional rule-based phonology (RBP). The traditional rule-based approach is that rules apply when their structural conditions are met. In Frampton's approach rules apply when the input fails to satisfy a target condition. Formally, the condition specified in the preamble evaluates the current input. The failure of the input to satisfy the condition triggers the application of the repair.

This approach builds up on the insight going back to Kisseberth (1970), that some rules apply only when the input of a rule violates some constraint and the output does not. Also, as Kisseberth (1970) notes, in some languagues rule seem to conspire to produce a given output, or, more specifically, to avoid certain structures in the output. This observation gave rise to discussions on constraints on phonological representations (Clements and Keyser, 1983; Prince, 1984; Kiparsky, 1985; Borowsky, 1986; Itô, 1986). The research on constraints culminated in the rise of a constraint-only theory of phonological computation, Optimality Theory (Prince and Smolensky, 2004 [1993]).

The central notions in the Optimality Theory are those of constraints and ranking. Markedness constraints express the set of structures that are avoided in language. Constraint rankings reflect the observations that some constraints are violated to avoid a violation of another (higher-ranked) constraint. This insight finds its way into the formalism of Frampton (2008) in the form of discretionary constraints, with the crucial difference that Frampton's constraints are derivational, and not representational (constraints limit the activity of the repairs, but they do not trigger any operations). Some constraints on the repairs are strict; a repair that would violate these constraints does not apply, even if it fails to remove the repair-trigerring defect (which is also a constraint). Discretionary constraints, on the other hand, might be violated to avoid a violation of the strict constraint and the constraint embedded in the formulation of a given defect. In that way the current formalism embraces the notion of constraint ranking, which is, arguably, one of the most important insights of OT.

A question arises at this point: why separate the constraints into two, or three different classes and why make them interact with repairs (which are also ranked). It is a common argument that a rule-only, or a constraint-only theory is more parsimonious, and the argument is brought about by the proponents of both theories. However, in practice, the strict approach is rarely upheld by actual analyses. Rule-based analyses do employ the notion of inviolable constraints, or filters (cf. the discussion in the present section on filters in rule-based phonology)[1]. Similarly, structural changes translated into OT Faithfulness violations are not conceptually far removed from repairs. Faithfulness constraints are essentially restrictions against insertion and deletion (of features, segments or structure). These particular operations are supplied in classic OT by the function Gen which generates an infinite number of candidates which are then evaluated by constraints on the structure, and constraints against structural changes.

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[1] As an alternative to filters, Reiss (2008) argues for a rules-only appraoch, which however has not as yet been tested.

The key word here is ‘infinite’; delegating structural transformations to Gen happens at the cost of considerable increase in the computational load (Calabrese, 2005). On the other hand, ranked repairs allow one and only one type of structural change.

This brings back the problem of multiple rankings. The advantage of the OT solution is that all the constraints interact in a single ranking, while the current formalism has separate rankings for repairs and constraints, and the rankings are strictly local, specific to a particular rule (which effectively means a multiplication of rankings in a language conditoned by the number of rules). All other things being equal, the single ranking solution would be superior to the multiple rankings one. However, unique ranking, and the closely related notion of global optimisation lie at heart of serious problems encountered by OT. These problems are discussed in the following section on locality, and the solutions are suggested within the strictly local approach taken by Frampton (2008).

1.2.3 Locality

One of the tenets of OT is global optimisation: one established constraint hierarchy is applied to every input. This hierarchy picks out the best representation (OT), or best representation at each pass. However, that particular property of OT is responsible for the issues that the theory has in dealing with the opacity problem.

The derivation involves a number of intermediate representations, which feed into the following rules. The concept of ordering is the tool used in RBP to account for cases of non-surface true generalisations, otherwise known as opacity effects. RBP attributes opacity to ordering. Some rules might affect the environment for the application of subsequent rules (Kiparsky, 1973; Kenstowicz and Kisseberth, 1977, 1979), thus obscuring certain processes observed in the phonology of a language (*counterfeeding* and *counterbleeding* interactions).

If a rule A creates additional environment (additional inputs) for the application of rule B, A is said to *feed* B. If A applies before B then, the rules are said to apply in a *feeding* order. If, on the other hand, B precedes A, the two are said to apply in a *counterfeeding* order. Counterfeeding rule interaction yields surface opacity of the type exemplified by the following data from Isthmus Nahuat (Kager, 1999, 374). Isthmus Nahuat has a proces of apocope, where a word-final vowel deletes.

(5) Apocope
/támi/ [tám] ‘it ends’

Isthmus Nahuat has also a devoicing process which applies to word-final consonants, illustrated in (6).

(6) Devoicing
/tájoːl/ [tájoːl̥] ‘shelled corn’

However, the devoicing fails to apply in words where the word-final consonant is underlyingly followed by a vowel, as shown in (7).

(7) Opacity
/ʃikɑkíli/ [ʃikɑkíl] ‘put it in it’

In a rule-based approach, the interaction is attributed to rule-ordering; apocope counterfeeds devoicing, resulting in surface opacity. The relevant ordering is in (8).

(8) Counterfeeding

Input	ʃikɑkíli
Devoicing	—
Apocope	ʃikɑkíl
Output	ʃikɑkíl

In an OT analysis, these facts cannot be captured under standard assumptions, due to a ranking paradox conditioned by globality. For the winner to win, Ident(voice) would have to dominate FinalDevoicing. However, the existence of forms like (6), leads to the opposing conclusion that FinalDevoicing should dominate Ident(Voice)

(9) Ranking paradox
ʃikɑkíl ≻ ʃikɑkíl̥; Ident(voice) ≫ FinalDevoicing
tájoːl̥ ≻ tájoːl ; FinalDevoicing ≫ Ident(voice)

Importantly, the problem of opacity is not solved by giving up parallelism alone. Serial variants of OT, like Harmonic Serialism, introduce serial derivations, however that assumption does not suffice for HS to model opacity effects, as illustrated by McCarthy (2007). Another solution to the problem of opacity proposed by McCarthy (2007) is the Candidate Chains Theory (OT-CC), which introduces serial derivations and Precedence constraints which impose an order of Faithfulness violations. In OT-CC chains of minimally different candidate are supplied by Gen, and at each pass through the grammar, the most harmonic candidate is picked. Prec constraints specify the order in which candidates violate Faithfulness constraints, so the most harmonic candidate in terms of Markedness might still lose in the ranking, failing to satisfy the relevant Prec constraint.

However, with two types of extrinsic ordering OT-CC does not fare better than the current formalism with respect to number of rankings. Prec constraints are a major concession to RBP, in introducing extrinsic ordering of processing. At the same time, OT-CC fails to derive some types of opacity like rule sandwiching or Duke-of-York effects. In addition, OT-CC presents an extremely complex computational task; at every pass through grammar all candidates for the chain must be evaluated by the global constraint ranking, and checked for the order of violations implemented by the Prec constraints.

The two rankings in the current formalism play a different function. The rankings are very local to the rule in question and they are there to specify what different repairs and in which order can apply to remove a given structural defect. The constraints on the repairs specify what kind of ill-formed structures must not be derived by the repairs. The constraints are present in the system mostly to capture the conditional applications of some rules, of the type: 'Apply the change unless...', or 'Apply the change only if...', and to rank ill-formed structures on a scale, so as to pick the best repair strategy to satisfy a given structural condition. In that way the present formalism captures the phonological intuitions concerning conspiracies, constraints and ranking, but without the computational load introduced by a function like Gen and without globality effects that prevent attested opaque derivations (global Eval).

1.3 Outline of the thesis

The remainder of the thesis organised as follows.

Chapter 2 introduces the typology of metrical visibility effects that follow from the interaction of stress and vowel epenthesis. Data from the following languages are presented: Swahili (Bantu), Dakota (Siouan), Mohawk (Iroquoian), Winnebago/Hocank (Siouan), Yimas (Sepik-Ranu), Selayarese (Makassar), North Kyungsang Korean and Japanese. The data from North Kyungsang Korean and Japanese are excluded from further analysis as the stress is argued to be lexically determined, *contra* Broselow (2008) and Shinohara (2000).

Chapter 3 introduces the defect-driven rule formalism. The basic rule format is explained and exemplified by rules on stress assignment and syllabification. Extensions to the model are proposed to accommodate rule interaction. The extensions involve condition ranking and rule persistency.

Chapter 4 puts forward a formal analysis of stress-epenthesis interaction using the default-driven rule format. Rules conditioning stress and epenthesis in all languages in question are considered, followed by a discussion on how the rules interact. It is argued that the defect-driven rule formalism provides a consistent, finite and empirically accurate analysis of all the patterns considered.

Chapter 5 surveys the existing accounts of stress-epenthesis interaction in the phonological literature. The chapter begins by addressing the parallel accounts of stress-epenthesis interaction in the works of Alderete (1995, 1999) and Broselow (2008). It is argued that the analyses suffer from undergeneration in some cases [Mohawk, (Alderete, 1995)], and therefore the parallel account cannot be considered as generalising to all the relevant cases. Furthermore, theoretical issues for the parallel analyses are pointed out. The discussion then moves on to the proposal of Halle and Vergnaud (1987) for stress-epenthesis interaction in Winnebago, which is rejected on empirical grounds. Finally, the formalism of Halle and Idsardi (1995) is considered.

Chapter 6 considers two serial constraint-based frameworks alternative to defect-driven rule formalism: Stratal OT and Harmonic Serialism. The two frameworks are introduced, and potential analyses using these theories are sketched for a selection of languages analysed in the present work. It is argued that Stratal OT, although empirically adequate, is inappropriate for the current data in the absence of clear morphosyntactic evidence for cyclicity. Harmonic Serialism is rejected on empirical grounds, as it fails to derive the attested patterns. In addition, it is argued that HS suffers from a number of theoretical issues which raise conceptual and empirical objections, and excessively limit the predictive power of the theory.

Chapter 7 concludes the discussion and proposes directions for further research.

Chapter 2

Typology of stress-epenthesis interactions

2.1 Complete metrical (in)visibility

The typological survey of stress-epenthesis interactions begins with radical cases of metrical visibility or metrical invisibility. The term ‘complete metrical visibility’ refers to cases where epenthetic vowels do not disturb stress assignment, i.e. the stress is always transparent in the output. An example of such system is Swahili (Bantu, East Africa). Stress in Swahili is penultimate, as illustrated by the following alternations in (1).

(1) Penultimate stress in Swahili (Ashton, 1944; Polomé, 1967; Broselow, 1982; Alderete, 1995)

jíko	‘kitchen’
jikóni	‘in the kitchen’
nilimpíga	‘I hit him’
nitakupíga	‘I shall hit him’

Swahili has an optional process of *i* epenthesis in some loans. The epenthesis does not trigger exceptional stress; in words with a final epenthetic vowel, stress still falls on the penult, as shown in (2).

(2) Penultimate stress in Swahili loans

tíket	∼	tikéti̱	‘ticket’
rátli	∼	ratí̱li	‘pound’

The data in (2) shows that the epenthetic *i* in the final syllable counts for penultimate stress assignment. Epenthetic *i* can also be stressed itself, if it is in the penultimate syllable.

At the other end of the scale are cases where epenthetic vowels are neither stressed, nor do they count for determining the landing site for stress. An example of such language given by Alderete (1995) is Dakota (Siouan, Midwest U.S. and Canada). Main stress in Dakota is peninitial, i.e. it falls on the second syllable counting from the left edge (3).

(3) Peninitial stress in Dakota (Shaw, 1976, 1985; Alderete, 1995)

č^{h}i-kté	‘I kill you’
ma-yá-kte	‘you kill me’
wičhá-ya-kte	‘you kill them’
o-wíčha-ya-kte	‘you kill them there’

An exceptional initial stress pattern is observed in monosyllabic words containing a root-final consonant. Such words surface with an epenthetic *a*, which does not carry stress.

(4) Exceptional initial stress in Dakota (Shaw, 1976, 1985; Alderete, 1995)

/ček/	čéka	‘stagger’
/khuš/	khúža	‘lazy’
/čap/	čápa	‘trot’

From the examples in (4) it follows that epenthetic vowels cannot bear stress. However, it is not clear that they do not count for determining the stress window. Convincing cases of absolute metrical invisibility (unstressability and unfootability) do not seem to be readily available, which is an issue that will be revisited in the forthcoming discussion.

2.2 Partial metrical visibility

2.2.1 Mohawk

Mohawk (Iroquoian, Northern New York) has a pattern of *e*-epenthesis into consonant clusters (Michelson, 1988). The epenthesis has the effect of partial metrical visibility; epenthesis into triconsonantal clusters is visible to metrical structure, but epenthesis into biconsonantal clusters is not visible to stress assignment rules (Michelson, 1988; Hagstrom, 1997; Bye, 2001).

The regular stress in Mohawk falls on the penult, as exemplified in (5).

(5) Canonical penultimate stress in Mohawk[1]

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[1] All Mohawk data are from Hagstrom (1997)

/wak-haratat-u-hatye/	wakharatatuhátye	‘I go along lifting up’
/hra-kw-as/	rákwas	‘he picks it’
/k-atirut-haˀ/	katirúthaˀ	’I pull it’
/k-ohar-haˀ/	kohárhaˀ	‘I attach it’
/k-ataˀkerahkw-haˀ/	k-ataˀkerákw-haˀ	‘I float’
/k-oˀkwat-s/	kóˀkwats	‘I dig’
/te-k-yaˀk-s/	tékyaˀks	‘I break it in two’

The stressed syllable must be heavy (CVː or CVC); if the stress is assigned to an underlyingly short open syllable, the syllable is lengthened.

(6) Penultimate lengthening in Mohawk

/wak-ashet-u/	wakashéːtu	‘I have counted it’
/k-akʌˀrokew-as/	k-akʌˀrokéːw-as	‘I am dusting’
/k-hyatu-s/	khyáːtus	‘I write’
/k-haratat-s/	kharáːtats	‘I am lifting it up a little (with a lever)’

E-epenthesis in Mohawk occurs in three types of contexts:

1. to separate a consonant from a following sonorant /n r w/
2. between a consonant and a final glottal stop
3. in clusters of three consonants: /CCC/ → [CeCC], but /$\left\{\begin{array}{c}\mathrm{h}\\ \mathrm{s}\end{array}\right\}$CC/ → [$\left\{\begin{array}{c}\mathrm{h}\\ \mathrm{s}\end{array}\right\}$ CeC]

The first two types of epenthesis involve biconsonantal clusters, and they are both invisible to the metrical structure. The stress is assigned to the underlyingly penultimate nucleus. If the penult or the final syllable contains an epenthetic vowel, stress shifts to the antepenult. If there are two epenthetic vowels in the last three syllables of the word (final and penultimate, final and antepenulimate, penultimate and antepenultimate), stress shifts to the pre-antepenult.

(7) Metrically invisible epenthesis in Mohawk

/ʌ-k-r-ʌ-ˀ/	ʌ́kerʌˀ	‘I will put it into a container’
/te-k-rik-s/	tékeriks	‘I put them together’
/t-ʌ-k-ahsutr-ʌˀ/	tʌkahsúterʌˀ	‘I will splice it’
/w-akra-s/	wákeras	‘it smells’
/waˀ-t-k-atat-nak-ˀ/	waˀkatátenakeˀ	‘I scratched myself’
/ʌ-k-arat-ˀ/	ʌkáːrateˀ	‘I lay myself down’
/ro-kut-ot-ˀ/	rokúːtoteˀ	‘he has a bump on his nose’
/t-ʌ-k-rik-ˀ/	tʌ́kerikeˀ	‘I’ll put together side by side’
/o-nraht-ˀ/	ónerahteˀ	‘leaf’
/t-ʌ-k-hkw-ˀ/	tʌ́kehkweˀ	‘I’ll lift it’

However, as shown in (8), epenthesis into *triconsonantal* clusters is visible to prosodic structure. Epenthetic vowels of this type count for the stress assignment, and can themselves receive stress.

(8) Metrically visible epenthesis in Mohawk:

/wak-nyak-s/	waké̲nyaks	‘I get married’
/s-rho-s/	sé̲rhos	‘you coat it with something’
/te-k-ahsutr-ha^{ʔ}/	tekahsuté̲rha^{ʔ}	‘I splice it’
/s-k-ahkt-s/	skáhke̲ts	‘I got back’
/sa-s-ahkt/	sasáhke̲t	‘go back’

2.2.2 Winnebago

This section presents the well-known interaction of stress and Dorsey's Law in Winnebago (Siouan, Midwest U.S.). All the data presented are from Miner (1979, 1989). Primary stress in Winnebago falls on the third mora counting from the left edge (or second mora in bimoraic words). Secondary stress falls on every other mora, beginning with the mora bearing the main stress.[2]

(9) Basic stress patterns in Winnebago

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[2] There is some disagreement in the literature concerning secondary stress assignment in Winnebago. Miner (1979) reports a ternary alternation of secondary stress, but Miner (1989) and Hale and White Eagle (1980) claim that the alternation is binary. The issue is of minor relevance to the present work, as the discussion is mainly concerned with primary stress. Here I will assume the binary alternation of secondary stress.

$\sigma_{\mu\mu}$

zíi	‘yellow, orange’
nį́i	‘water’
sgáa	‘white’
wáa	‘snow’

$\sigma_{\mu}\sigma_{\mu}$

hiwą́x	‘to ask’
hosgáč	‘playground’
raǰóx	‘to break in the mouth’
waǰé	‘dress’

$\sigma_{\mu\mu}\sigma_{\mu}$

čiiną́k	‘town’
booką́	‘to knock over’
haag-rá	‘the rear part’
hąąhé	‘night’

$\sigma_{\mu}\sigma_{\mu}\sigma_{\mu}$

wanįgį́k	‘bird’
hipirák	‘belt’
waxirí	‘to squash’
giǰiré	‘to help’

$\sigma_{\mu\mu}\sigma_{\mu}\sigma_{\mu}$

xǰaaną́ne	‘yesterday’
taanį́žu	‘sugar’
aačgą́nąk	‘to lift out’
hąąhé-re	‘last night’

$\sigma_{\mu}\sigma_{\mu}\sigma_{\mu}\sigma_{\mu}$

wiščįgéga	‘Hare’
hinųbą́hą	‘second’

Dorsey’s Law is the name used in the literature to denote epenthesis in Winnebago. Dorsey’s Law breaks clusters of a voiceless obstruent followed by a sonorant, by copying the immediately following vowel.

(10) a. Dorsey’s Law (Miner, 1989)

$$\underset{1}{\begin{bmatrix} -\text{son} \\ -\text{voice} \end{bmatrix}} \quad \underset{2}{\begin{bmatrix} -\text{syl} \\ +\text{son} \end{bmatrix}} \quad \underset{3}{\begin{bmatrix} +\text{syl} \end{bmatrix}} \quad \rightarrow 1\ 3\ 2\ 3$$

b. Examples
kwe →kewe
kri → kiri
pną →pąną

For the most part, stress in DL words applies regularly, the main stress falling on the third mora (or on the second mora in bimoraic words).

(11) Regular stress pattern in DL words[3]:

a.	[CVCV]		
	/kre/	ke̲ré	‘to leave returning’
	/šroš/	šo̲róš	‘to be on the way returning’
	/xruč/	xu̲rúč	‘to inch along’
b.	[CVCV]CV		
	/šwažok/	ša̲wažók	‘you mash’
	/krahe/	ka̲rahé	‘to be on the way returning’
	/xrehi/	xe̲rehí	‘to boil’
c.	[CVCV]CVCV		
	/šwazokǰį/	ša̲wazókǰį	‘you mash hard’
	/kreǰųsep/	ke̲reǰų́sep	‘Black Hawk’
	/prağųčge/	pa̲rağų́čge	‘in formation’
	/xroǰike/	xo̲roǰíke	‘hollow’
d.	CV[CVCV]		
	/hipres/	hipe̲rés	‘to know’
	/gisną/	gisą̲ną́	‘to remove’
	/rukrex/	ruke̲réx	‘tattoo’
e.	CVCV[CVCV]		
	/hoǰisną/	hoǰisą̲́ną	‘recently’
	/hirupnį/	hirupį̲́nį	‘to twist’
	/hačąkre/	hačąké̲re	‘with difficulty’
f.	CVV[CVCV]		
	/mąąšrač/	mąąšá̲rač	‘you promise’
	/boopres/	boopé̲res	‘to sober up’
	/haapruč/	haapú̲ruč	‘common elder’
g.	[CVCV] [CVCV]		
	/propro/	po̲ropó̲o̲ro	‘spherical’
	/krikrix/	ki̲rikí̲rix	‘thick’ (as fluid)
	/krepną/	ke̲repą̲́ną	‘unit of ten’
	/šruxruk/	šu̲ruxú̲ruk	‘you earn’

---

[3] Square brackets denote DL sequences.

In some DL words, however, stress falls on the *fourth* mora.

(12) Exceptional stress assignment in DL words

a.		CV[CVCV]CV	
	/hošwaza/	hoša̲wazá	‘you are ill’
	/hikroko/	hiko̲rohó	‘to prepare’
	/hikruni̧/	hiku̲runí̧	‘tangled’
b.		CV[CVCV] [CVCV]	
	/wakripras/	waki̲ripá̲ras	‘flat insect’
	/giknąknąp/	giką̲nąką̲́nąp	‘shiny’
	/wakrikrik/	waki̲rikí̲rik	‘slipper elm’
c.		CV[CVCV] [CVCV] [CVCV]	
	/wakripropro/	waki̲ripó̲ropò̲ro	‘spherical insect’

Unlike Mohawk, Winnebago does not lend itself to a clear surface generalisation about what conditions the visibility of the epenthetic vowel. The intuition is that metrical visibility is conditioned by the metrical structure itself, though any generalisation there would need to make some assumptions about the prosodic structure of Winnebago. The complexity of the task of summing up the Winnebago facts in a concise way is reflected in the following quote from Miner (1989)

> It seems that the closest we can come to a generalisation, given only assumptions made so far, is to say that a DL sequence counts as two moras except when it follows the first syllable of the word: if in that case (A) the first syllable is short and if (B) the DL sequence is followed by at least one mora, the DL sequence counts as one mora; but if either (A) or (B) is not the case, then a DL sequence counts as two moras, and further if the preceding syllable is short, the DL sequence is accented on its second mora, while if the preceding syllable is long the DL sequence is accented on its first mora.

Without attempting a similarly complex generalisation, the present section only proposes that epenthetic vowels in Winnebago can, in principle, be metrically visible (they do not inherently repel stress), but there is contextual metrical invisibility, whose exact nature is subject to analytic intepretation, which will be undertaken in Section 3 of Chapter 4.

2.2.3 Yimas

Yimas, a Sepik-Ranu language of Papua New Guinea provides yet another type of condition on metrical visibility effects. The main stress in Yimas is initial, as illustrated by the data in (13).

(13) Initial stress in Yimas (Foley, 1986; Alderete, 1999)

wáŋkaŋ	‘bird’
kúlanaŋ	‘walk’
wúratàkay	‘turtle’
mámantàkarman	‘land crab’

The initial epenthetic vowel does not receive stress in the following forms, as shown in (14).

(14) Metrically invisible epenthesis

/pkam/	pɨ̱kám	‘skin of back’
/tmi/	tɨ̱mí	‘say’
/kcakk/	kɨ̱cákɨ̱	‘cut’
/nmpanmara/	nɨ̱mpánmara	‘stomach’

However, there are cases where the initial epenthetic vowel *can* bear stress (15).

(15) Metrically visible epenthesis in Yimas:

/tkt/	tɨ̱́kɨ̱t	‘chair’
/klwa/	kɨ̱́lɨ̱wa	‘flower’
/krmknawt/	krɨ̱́mkɨ̱nawt	‘wasp’
/tmpnawkwan/	tɨ̱́mpɨ̱nàwkwan	‘sago palm’

The emerging generalisation for the metrical visibility of epenthetic vowels in Yimas is that an initial epenthetic vowel is only visible when immediately followed by another epenthetic vowel. Alternatively, the generalisation can be stated in terms of cluster complexity (as in Mohawk): epenthesis into triconsonantal and more complex clusters is metrically visible, but epenthesis into bisconsonantal clusters is not.

2.2.4 Selayarese

Selayarese, a Makassar language of Indonesia, displays an interesting pattern of stress-epenthesis interaction in loanwords. Native vocabulary of Selayarese has penultimate stress in monomorphemic words, as follows from the data in (16).

(16) Penultimate stress in Selayarese (Mithun and Basri, 1986; Broselow, 2008)

sahála	‘sea cucumber’
palóla	‘eggplant’
balíkaʔ	‘arm’
sampúlo	‘ten’
búlaŋ	‘moon, month’
tímbo	‘grow’
góntiŋ	‘scissors’
barámbaŋ	‘chest’
kalihára	‘ant’
kalumánti	‘big black ant’

However, there is also a group of monomorphemic words with the main stress on the antepenult (17).

(17) Antepenultimate stress in monomorphemes (Mithun and Basri, 1986; Broselow, 2008)

sáhala	‘profit’
lámbere	‘long’
bótoro	‘gamble’
sússulu	‘burn’
páʔrisi	‘painful’
hállasa	‘suffer’
maŋkásara	‘Makassar’
kasíssili	‘mosquito’
barúasa	‘cookie’
salúara	‘pants’

Broselow (2008) argues that monomorphemic words with antepenultimate stress are exceptional, and that they form a uniform group: they all end in a vowel preceded by /r/, /l/, or /s/, which are not possible codas in Selayarese, and the final vowel is a copy of the preceding vowel. Because of this, the final vowel in these monomorphemes is standardly analysed as epenthetic, e.g. by Mithun and Basri (1986); Piggot (1985); Basri et al. (1997) [though the epenthetic status of the final vowel is not supported by morphophonemic alternations].

Loanwords into Selayarese from Bahasa Indonesian display a degree of vowel epenthesis. Assuming that penultimate stress in Selayarese is indeed default, the following forms with epenthetic vowels show regular stress assignment.

(18) Metrically visible epenthesis

a.

kará̲tu	‘card’
surú̲ga	‘heaven’
baká̲ri	proper name
burú̲haŋ	proper name
ramá̲li	proper name

b.	solodére	‘weld’
	koronéle	‘corner kick’
	karatísi	‘ticket’
	tarapála	‘tarpauline’
	tapasére	‘interpretetation’

The following words, however, have a stress shift to the antepenult.

(19) Metrically invisible epenthesis

bótolo	‘bottle’
séntere	‘flashlight’
kálasa	‘class’
bérasa	‘rice’
kábala	‘cable’
kábara	‘news’
kíkiri	‘metal file’
balábasa	‘ruler’

It appears that epenthetic vowels in the penults are visible to prosodic structure (18-a). Word-final epenthesis is generally invisible to prosodic structure (19), unless both the final and the antepenultimate vowel are epenthetic (18-b).

2.2.5 North Kyungsang Korean

North Kyungsang Korean is reported by Broselow (2008) as an example of a system with partial metrical visibility of epenthetic vowels. However, the generalisations about stress in North Kyungsang Korean made by Broselow (2008) are brought into question by the data presented in this section. The data suggest that stress in NK Korean is not in fact grammatically predictable, and therefore it is not analysed in the present work.

North Kyungsang Korean is a pitch accent system, with mostly lexical stress in the native vocabulary.

(20) Unpredictable surface stress in North Kyungsang Korean (Kenstowicz and Sohn, 2001; Broselow, 2008)

a.	hárépi	‘grandfather’
b.	kámani	‘rice bag’
	ká	‘kind’
c.	kurúma	‘cart’
	kací	‘eggplant’

Broselow (2008), citing Kenstowicz and Sohn (2001) argues that stress in loanwords is predictable: it is generally penultimate, but a final heavy is accented when preceded by a light syllable. Broselow (2008) analyses this pattern as a word-final moraic trochee.

(21) Stress in North Korean loans

a.	ĹL	
	k^{h}ít^{h}a	‘guitar’
	amerík^{h}a	‘America’
	k^{h}ellip^{h}onía	‘California’
b.	LH́	
	k^{h}epinét	‘cabinet’

North Korean loans with epenthetic vowels follow the pattern in (21), where the right aligned bimoraic stress window contains only one epenthetic vowel which is in the final position.

(22) Metrically visible epenthesis

t^{h}enís$\underline{ɨ}$	‘tennis’
te.í.t$^{h}\underline{ɨ}$	‘date’
ma.ú.s$\underline{ɨ}$	‘mouse’
ma.í.k$^{h}\underline{ɨ}$	‘mike’
k$\underline{ɨ}$rás$\underline{ɨ}$	‘glass’
k$\underline{ɨ}$lláp$\underline{ɨ}$	‘glove’

If the two-mora stress window contains two epenthetic vowels, stress shifts to the antepenult.

(23) Exceptional antepenultimate stress

t^{h}ós$\underline{ɨ}$t$\underline{ɨ}$	‘toast’
pés$\underline{ɨ}$t$^{h}\underline{ɨ}$	‘best’
réph$\underline{ɨ}$t$^{h}\underline{ɨ}$	‘left’
t^{h}éks$\underline{ɨ}$t$^{h}\underline{ɨ}$	‘text’
kíp$^{h}\underline{ɨ}$t$^{h}\underline{ɨ}$	‘gift’
p^{h}ás$\underline{ɨ}$t$^{h}\underline{ɨ}$	‘first’

In the forms where only the surface penultimate syllable contains an epenthetic vowel, stress shifts to the final syllable, as shown in (24).

(24) Exceptional final stress

met$^{h}\underline{ɨ}$ró	‘metro’
nig$\underline{ɨ}$ró	‘negro’
k^{h}ont$^{h}\underline{ɨ}$ról	‘control’

On the basis of the data Broselow (2008) concludes that in North Kyungsang Korean stress avoids epenthetic vowels. This observation is quite stable on the basis of the available data, though Kenstowicz and Sohn (2001) do report occasional cases of stressed epenthetic vowels (25).

(25) Stressed epenthetic vowels

allekɨ̱́ro	‘allegro’
kʰarisɨ̱́ma	‘charisma’
pakɨ̱́na	‘Wagner’
kɨ̱risɨ̱́to	‘Christ’

Kenstowicz and Sohn (2001) propose that stressed epenthetic vowels have been reanalysed as underlyingly present, and therefore capable of bearing accent. However, there are further problems with the generalisation concerning the default penultimate stress. From the data in Kenstowicz and Sohn (2001) it emerges that there is a tendency for assigning penultimate accent in loanwords, but the pattern is by no means exceptionless. First, the final trochee can be either moraic or syllabic, as illustrated by the data in (26)

(26)

a. LH́

pɨracíl	‘Brazil’
kʰaramél	‘caramel’
allatín	‘Aladdin’

b. ĹH

eərópik	‘aerobics’
kʰátʰɨn	‘cotton’
épʰɨl	‘apple’

Also, in words with two light syllables at the right edge, both penultimate and final accent is found, as demonstrated in (27).

(27) Variation in accent assignment

a. ĹL

akesári	‘accessory’
sinéma	‘cinema’
hépʰi	‘happy’
airóni	‘irony’
míni	‘mini’

b. LĹ

pallé	‘ballet’
panană	‘banana’
kʰamerá	‘camera’
pʰianó	‘piano’

The conclusion to draw from the data above is that stress in North Kyunsang Korean is not predictable. While it is mostly true that epenthetic vowels are not stressed in North Kyungsang Korean, their relationship with footing is rather elusive, as there seems to be variation in accent assignment that is not grammatically predictible. Broselow’s (2008) generalisation that the stress pattern is a word-final moraic trochee holds for a subset of data only. In the absence of a stable generalisation, the present work concludes that stress in North Kyungsang Korean loanwords is lexically determined, and thus it will not be formally analysed in a generative model.

2.2.6 Japanese

French loanwords in Japanese have been argued by Shinohara (2000) to have default stress placement on the penultimate mora. Shinohara (2000) develops an analysis of partial metrical visibility of epenthetic vowels in Japanese based on this generalisation. However, careful examination of the data reveals that, as in North Kyungsang Korean, default stress placement in loanwords is merely a tendency. There are exceptions to this pattern, and considerable inter speaker variation. Therefore, it is concluded here that the stress pattern found in French loanwords in Japanese is not grammaticaly predictable.

Shinohara (2000) discusses the patterns of English and French loanword adaptations into Japanese and argues that while loans from English seem to have a lexical accent, loans from French display a predictable stress pattern. Shinohara (2000) attributes this difference to different perception of English and French inputs by the Japanese speakers; English is analysed as having lexical stress, which is faithfully preserved in Japanese, while French is analysed as a productive stress pattern, which is then adapted to Japanese accent rules. Shinohara (2000) analyses the default accent placement being the antepenultimate mora. This pattern is preserved in the following French loans into Japanese (28).

(28) Regular stress in French loans (Shinohara, 2000)

ótari	‘otary’
masíkuri	‘machicolation’
aréruto	‘alert’
torabésuti	‘travesty’

Antepenulimate accent is observed both in words with and without epenthetic vowels. However, if the surface antepenultimate mora is epenthetic, the accent shifts (29).

(29) Accent shift in French loanwords (Shinohara, 2000)

sutíro	‘pen’
aburíko	‘apricot’
dakutíro	‘typing’
kokuríko	‘poppy’
patoróna	‘patronate’
sérukuru	‘circle’
supékutoru	‘spectrum’

The surface generalisation for the dataset in (29) is the following. Epenthetic vowels in Japanese loanwords cannot receive stress. If the surface antepenultimate mora is epenthetic, the accent shifts to the penult. However, if the penult also contains an epenthetic segment, the accent shifts to the pre-antepenult. Epenthetic vowels do not affect accentuation when they appear in positions where they would not receive stress.

However, looking back at the data in (29), another generalistion appears available. All the forms have stress on the underlyingly penultimate nucleus. This generalisation turns out very stable for all the loanwords with epenthetic vowels. This calls into question the generalisation that default accent in French loans is antepenultimate. What is more, Shinohara (2000) reports that there is a considerable degree of interspeaker variation: some speakers have regularly penultimate stress, as shown by the data in (30).

(30)	roborúsjoɴ	‘Reblochon’
	riberúzoɴ	‘delivery’
	imazíne	‘to imagine’
	rokaríze	‘to locate’

The same speakers consistenly avoid stressing epenthetic vowels in:

(31)	koɴkóku̲te	‘to prepare’
	sekésu̲to̲re	‘to sequester’
	ɸíru̲to̲re	‘to filter’

These data suggest a different generalisation: stress is underlyingly assigned to the penultimate nucleus and that vowels epenthesised later are invisible to stress assignment.

The present approach does not question the avoidance of stress on epenthetic vowels but it does question the generalisation that default stress placement in French loanwords in Japanese is the antepenult. A considerable amount of data points to the stress being assigned to the underlyingly penultimate nucleus. However, the exact placement of accent seems to be governed by tendencies rather than stable rules of grammar. In addition, there is interspeaker variation. The facts must be properly elucidated before any formal analysis is undertaken, which is why the analysis put forward in this thesis does not address Japanese.

2.3 Summary

The current picture of stress-epenthesis interaction patterns is by no means exhaustive. Further examples of partial metrical visibility include native vocabulary of Lenakel (Alderete, 1999) and various dialects of Arabic (Broselow, 1982; Kabrah, 2004), loanwords in Fijian (Kenstowicz, 2007), and no doubt many others. The primary purpose of bringing the data together was to show what generalisations need to be accounted for by any analysis of stress-epenthesis interaction patterns. The relevant generalisations are the following.

1. Epenthetic vowels may be entirely visible to stress (Swahili)

2. Epenthetic vowels may be partially visible to metrical structure, subject to the complexity of the cluster into which the vowel is epenthesised (Mohawk), or subject to where the vowel is epenthesised in the word (Winnebago, Yimas)

3. Epenthetic can receive stress while being otherwise transparent to prosodic structure (Selayarese)

Curiously, we have not seen a clear case of entire metrical invisibility of epenthetic vowels. Dakota, discussed in Section 2.1, is a potential candidate, but it might just as well be the type where epenthetic vowels cannot receive stress.

Chapter 3

Formalism

3.1 Defect-driven rules (Frampton, 2008)

The analysis put forward in this work builds on the formal theory proposed by Frampton (2008). Frampton's formalism employs defect-driven iterative rules, thus combining insights from rule-based and constraint-based theories of phonology. Phonological derivation is serial, and it proceeds in minimal steps. Every stage of the derivation introduces at most one structural change and only at a single locus. This assumption concerning rule application differentiates the Defect-Driven Rule formalism (DDR) from standard RBP, where rules can introduce multiple structural changes simultaneously. Another important property of rule application in DDR is that all rules apply directionally from left to right, or from right to left[1]. A simple example of such application is the following illustration of footing.

(1) Delimiter insertion (Frampton, 2008):
$\times\ \times\ \ \times\ \times\ \ \times \rightarrow \times\ \times \rangle\ \times\ \times\ \ \times \rightarrow \times\ \times \rangle\ \times\ \times \rangle\ \times$

The derivation in (1) illustrates a left-to-right binary foot assignment. Every structural change consists in the insertion of a single foot delimiter. The minimal possible number of delimiters is used to achieve the binary grouping. This view of footing is very much resemblant of the algorithm proposed by Idsardi (1992), and further developed by Halle and Idsardi (1995). However, the present model differs from Idsardi's in two respects. First, the changes are minimal. The algorithm can never insert more than one bracket at a time. Second, the mechanism triggering the rule application is not included in the structural condition of the rule itself. Instead, the application of rules is triggered by *defects in the input.* In the case of (1) the structural defect repaired by the rule is a stressable element that is not placed in the context of a delimiter. (Frampton, 2008) calls this condition Right Angle-Delimited (⟩-Delimited). A stressable element which does not satisfy the ⟩-Delimited condition is defective. Defects in the representation

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[1] Some defect-driven rules have additional restrictions on directional application, e.g. syllabification rules pick out vowels for repair first.

are annotated by asterisks in the derivations in (2).

(2) $\times\ {}^*\!\times\ \ {}^*\!\times\ \ {}^*\!\times\ \ {}^*\!\times$

So far the defect-driven rule on footing is unconstrained, which means that it can repair the defective structure in different possibly undesirable ways, exemplified in (3).

(3) a. $\times\ {}^*\!\times\ \ {}^*\!\times\ \ {}^*\!\times\ \ {}^*\!\times\ \rightarrow \times\ \times\rangle\ \ \times\ {}^*\!\times\ \ {}^*\!\times \rightarrow \times\ \times\rangle\ \ \times\ \times\rangle\ \ \times$

b. $\times\ {}^*\!\times\ \ {}^*\!\times\ \ {}^*\!\times\ \ {}^*\!\times\ \rightarrow \times\ \times\rangle\ \ \times\ {}^*\!\times\ \ {}^*\!\times\ \rightarrow \times\ \times\rangle\ \ \times\rangle\ \times\ \ {}^*\!\times\ \rightarrow \times\ \times\rangle\ \ \times\rangle\ \times\rangle\ \ \times$

c. $\times\ {}^*\!\times\ \ {}^*\!\times\ \ {}^*\!\times\ \ {}^*\!\times\ \rightarrow \times\rangle\ \times\ \ {}^*\!\times\ \ {}^*\!\times\ \ {}^*\!\times\ \rightarrow \times\rangle\ \times\rangle\ \ \times\ \ {}^*\!\times\ \ {}^*\!\times\ \rightarrow \times\rangle\ \ \times\rangle\ \ \times\rangle\ \times\ \ {}^*\!\times\ \rightarrow \times\rangle\ \ \times\rangle\ \ \times\rangle\ \ \times\rangle\ \ \times$

To prevent derivations like b. and c., constraints on repairs are introduced. The relevant constraint in the present case is *Uny, which bans the formation of unary feet.

(4) *Uny

$${}^*\left\{\begin{array}{c}\rangle\\ \%\end{array}\right\}\times\rangle$$

The format of the Defect-Driven Rules proposed by Frampton (2008) is in (5), repeated from Chapter 1.

(5) Defect-Driven Rule format (Frampton, 2008):

a. Type; Condition; Order :: Rule(s); Constraint Set
Preamble Body

b.

Type:	defines the element on which the condition operates
Condition:	expresses the target
Order:	ranks the violations and determines the order in which the rule attemps to remove them
Rule(s):	defines the type of repair rule(s) available
Constraint Set:	lists constraints on the application of repair rules

The expression of the grouping rule analysed so far according to the Defect-Driven Rule Format is in (6).

(6) Stressable Element ; ⟩-Delimited ; Left :: $\emptyset\rightarrow\rangle$; {*Uny}

The preamble specifies that the present rule on delimiting applies to stressable elements and that it applies left-to-right. The body of the formula specifies what repairs may be used to remove the defect. In this case the relevant repairs include the right delimiter insertion (as opposed to, e.g. left-delimiter insertion, or the erasure of the defective element). The derivational constraint *Uny in the body of the rule is only visible to repairs. The constraint blocks delimiter insertion if such insertion would create a unary foot.

The final element of Frampton's formalism to be introduced at this point is discretionary constraints. The *Uny constraint used so far is a strict constraint on repair application. Repairs do not apply if their application would violate the constraint. Discretionary constraints are a new class of constraints, which can be violated only as a last resort. This type of phenomenon is captured in the current formalism by marking *Uny as a discretionary constraint. *Uny can be violated if only if the particular defect cannot be removed otherwise. Discretionary constraints are like OT constraints in the sense that they are violable. A discretionary constraint can be violated to satisfy a strict constraint, or the condition defined in the preamble. A question arises whether discretionary constraints can be ranked, so that a discretionary constraint could be violated to satisfy a higher-ranked discretionary constraint. (Frampton, 2008, 225-226) considers this option, but does not discuss cases where discretionary constraint ranking is necessary, nor does he propose a formal implementation of such ranking. The present work does not consider cases that would require discretionary constraint ranking. The issue of such ranking is therefore left to further research.

Frampton's example of a system involving discretionary constraints is Southern Paiute, with the following footing rule (discretionary constraints are introduced by the || sign).

(7) Footing in Southern Paiute (Frampton, 2008)
Stressable Element ; ⟩-Delimited ; Left :: Ø→⟩ ; {*⟩% || *Uny}

The rule conditions the left-to-right insertion of the right delimiter. The repairs create minimally binary constituents, to satisfy the constraint *Uny. However, the derivations must not violate the strict constraint *⟩% (no word-final delimiter). Therefore, in parisyllabic forms, a unary foot may be assigned to remove the defect without inserting an edge-adjacent right delimiter. Sample derivations follow.

(8) a. × *× → ×⟩ ×
cf. × ×⟩ excluded by *⟩%
b. × *× *× → × ×⟩ ×
c. × *× *× *× → × ×⟩ × *× → × ×⟩ ×⟩ ×
cf. × ×⟩ × ×⟩ excluded by *⟩%
d. × *× *× *× *× → × ×⟩ × *× *× → × ×⟩ × ×⟩ ×

The effect is the phenomenon called iambic reversal, identified in Southern Paiute by Hayes (1995). Southern Pauite assigns iambs from left-to-right, but in parisyllabic words the stress falls on the penult, clashing with the preceding antepenultimate stress. This phenomenon was analysed by Hayes (1995) as an assignment of word-final trochee in parisyllabic form, to avoid the stress placement on the final syllable.

(9) Iambic reversal in Southern Paiute (Hayes, 1995)

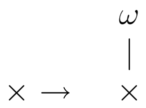
$$\begin{array}{cccccc} & \times & & \times & \\ \langle\times & \times\rangle & \langle & \times & \times\rangle \\ . & . & & . & . \end{array}$$

Frampton (2008) attributes the stress clash to edge marking rather than headedness, and assigns a non-final unary foot, rather than a final trochee, with the same empirical effect. [2]

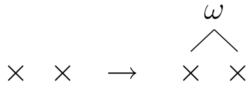
Frampton (2008) discusses also how syllabification can be approached in the Defect-Driven Rule format. Syllabification rules will condition some cases of epenthesis, and therefore the rule format is briefly introduced here.

Syllable in Frampton's approach is built on demisyllables. Demisyllables are clusters of timing slots, abstract marks projected by every segment. There are two basic types of clusters, singlet and doublet.

(10) a. Form Singlet:



b. Form Doublet:



Every cluster contains a nucleus. All languages discussed in this thesis can only have vowels as nuclei, and therefore they only allow clusters that contain a vowel[3]. The repair Form Doublet operates to the left of the timing slot that it targets. The adjoined timing slot is always to the left of the targeted ×. As a result, a vowel is preferably syllabified with a preceding rather than with a following consonant. The following basic rule triggers the (C)V(C) type of syllabification.

(11) $$\text{Timing Slot; Clustered, } \begin{pmatrix} \text{Vowel} \\ \text{Left} \end{pmatrix} :: \begin{bmatrix} \text{Form Doublet} \\ \text{Form Singlet} \end{bmatrix} ; \{\text{*Tri}\}$$

The direction specified in the rule is left-to-right, but there is an additional condition that vowels are picked out for repair first. A conjunction of the two yields the defect searching algorithm that picks the leftmost vowel for repair first. The rule proceeds from

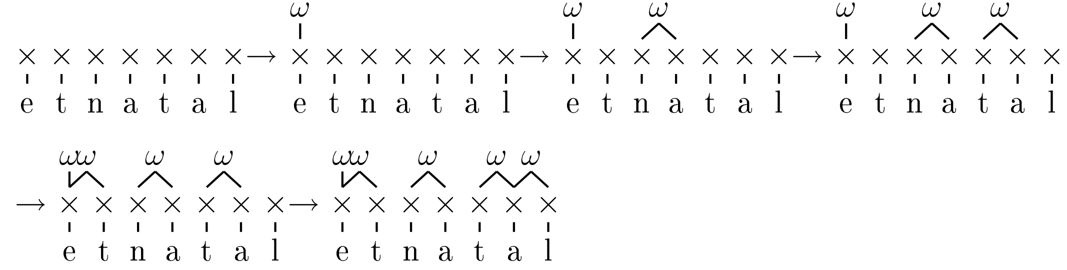
---

[2] Alternatively, the same effect could be rendered through translating Hayse's analysis into Frampton's formalism. Such analysis would posit binary feet and a rule on head assignment that assigns a word-final trochee to avoid a word-final stress. The head assignment rule schema is proposed in this thesis as an extention to Frampton (2008).

[3] To account for languages where sonorants can be nuclei Frampton proposes a parameter which he calls core structural inventory (CSI). CSI determines what phonemes are picked out in a language as possible nuclei, and in what order.

to left to right until there are no defective *vowels* left. At that point the rule resumes at the left edge repairing all the remaining defective elements (effectively consonants). A sample derivation is in (12).

(12) Frampton (2008):



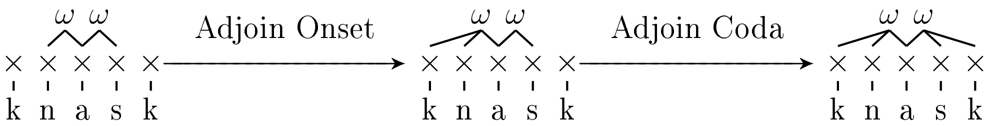
A syllable may be defined as a string of contiguous clusters that have a segment in common. The maximal set of clusters in a syllable is specified by a derivational constraint, e.g. *Bin or *Tri.

(13) a. *Bin
Do not group together two or more clusters.
b. *Tri
Do not group together three or moer clusters.

In languages that allow codas, the maximal number of clusters a syllable can contain is two, one onset cluster and one coda cluster. Onset clusters are right-headed and coda clusters are left-headed. Clusters are preferably right-headed (CV.CV preferred over CVC.V). Complex onsets and complex codas may be formed through adjunction, provided that adjunction repair is specified in the rule format, as exemplified in (14).

(14) a. $\text{Timing Slot; Clustered,} \begin{pmatrix}\text{Vowel}\\ \text{Left}\end{pmatrix} :: \begin{bmatrix}\text{Form Doublet}\\ \text{Form Singlet}\\ \text{Adjoin Onset}\\ \text{Adjoin Coda}\end{bmatrix} ;\ \{\text{*Tri}\}$

b.



The syllable in (14) is still formed over two demisyllables, so it does not violate *Bin. Complex onsets and complex codas are formed through adjunction of consonants to previously formed clusters.

3.2 Extensions

Frampton's proposal is a set of formal restrictions on unifying conspiring repairs within the defect-driven rule format. However, Frampton does not consider the issue of rule interaction or rule ordering. The present analysis takes the format of defect-driven rules and applies it to prosodic rules as well as segmental rules. In order to account for the interactions between stress and epenthesis, this analysis must address the issue of how independent rules (triggered by different types of defects) interact in the system. The basic assumption will be extrinsic rule-ordering. Defect-driven rules apply in a particular order, along the lines of Kiparsky (1973).

The order in which rules apply is determined by the ranking of relevant conditions exemplified here by the ranking of two conditions, on footing and head assignment. The head assignment rule itself introduced in (15-b) is also an extension to Frampton's original proposal.

(15) a. Footing:
Stressable Element ; ⟩-Delimited ; Left :: Ø→⟩ ; {*Uny}
b. Head Assignment:
Foot ; Headed ; Left :: Ø→ × ; {*Clash}

The head assignment rule proposed here is triggered by the condition that every foot (every group of ⟩-delimited ×'s) be headed. The rule proceeds left-to-right. As a result, the leftmost element in every foot projects a level 2 gridmark. Prominence projection by neighbouring elements is prevented by the derivational constraint *Clash.

The two conditons, on footing and head assignment, can be logically ranked in two different ways. The ranking is graphically represented with the use of ≫ sign. The leftmost condition must be satisfied first, followed by the next condition in rank, etc. (16). If the condition on footing outranks the condition on head assignment, all foot boundaries are assigned prior to the assignment of all heads.

(16) a. ×-delimited ≫ Ft-headed
b. $\times \;\; {}^{*}\times \;\; \times \;\; \times \;\; \times \xrightarrow{\text{Ft}} \times \;\; \times\rangle \;\; \times \;\; {}^{*}\times \;\; \times \xrightarrow{\text{Ft}} \overset{*}{\times} \;\; \times\rangle \;\; \times \;\; \times\rangle \;\; \times$
$\xrightarrow{\text{Hd}} \overset{\times}{\times} \;\; \times\rangle \;\; \overset{*}{\times} \;\; \times\rangle \;\; \times \xrightarrow{\text{Hd}} \overset{\times}{\times} \;\; \times\rangle \;\; \overset{\times}{\times} \;\; \times\rangle \;\; \times$

However, if the condition on head assignment outranks the condition on footing, a head must be assigned every time there is a foot. The footing rule feeds the head assignment rule; every time a foot is assigned a head defect is created, which must be repaired before the footing rule can continue, as illustrated by the derivation in (17-a).

(17) a. Ft-headed ≫ ×-delimited
b. $\times \;\; {}^{*}\times \;\; \times \;\; \times \;\; \times \xrightarrow{\text{Gr}} \overset{*}{\times} \;\; \times\rangle \;\; \times \;\; \times \;\; \times \xrightarrow{\text{Hd}} \overset{\times}{\times} \;\; \times\rangle \;\; \times \;\; {}^{*}\times \;\; \times$

$$\xrightarrow{\text{Gr}} \begin{array}{ccccc} \times & & * & & \\ \times & \times\rangle & \times & \times\rangle & \times \end{array} \xrightarrow{\text{Hd}} \begin{array}{ccccc} \times & & \times & & \\ \times & \times\rangle & \times & \times\rangle & \times \end{array}$$

Defect-driven rules can be deferred until a higher-ranked defect has been removed, but ultimately they must apply whenever there is a relevant defect in the output. In that way, all defect-driven rules are persistent, and they may reapply at any stage of the derivation. Persistent rules are not a new concept. The notion goes back to Chafe (1968), who discusses diachronic rules that apply consistently at different historical stages. Myers (1991) transposes that concept to synchronic rules and discusses the types of rules that can be persistent, like syllabification and footing.

What is new about the current proposal is that in principle *any* rule is persistent. This prediction, although not addressed by Frampton, follows straightforwardly from the conditions on application of defect-driven rules. A rule applies to meet an output condition, and the order in application is determined by condition ranking. If a form is derived where a high-ranked condition is not met, a rule repairing this defect will apply. There is nothing in the system that could render a rule inactive at any stage of derivation; the only thing that can prevent rule application is a violation of a strict constraint. This assumption makes certain predictions about what is a possible derivation. Chapter 4 discusses the implications of persistence for stress-epenthesis interaction. The implications for other phenomena remain to be investigated.

Persisent rules are not unlike filters. Myers (1991) argues that peristent rules and filters are two interpretations of the same phenomenon: they explain why certain structures are never present in a language. However, filters predict that certain structures can never be derived, while peristent rules say that ill-formed structure might be derived by some rule, but it will be immediately repaired. The latter approach is used in this work, following the basic condition on defect locality. Defects are local to the rule that repairs them, and therefore some other rule may derive a defective structure. What is more, this defective structure might surface if the rule driven by a particular defect does not have sufficient means to remove it.

3.3 Summary

The basic theoretical assumptions made by the present work are as follows:

1. Rules are serially ordered and defect driven. The condition on the highest-ordered rule scans the input for violations. If violations are detected, the structure is repaired in a fashion determined by the set of available repairs and the constraints on repairs. Once a rule terminates, the next rule in the ranking applies

2. Rules are persistent. They apply immediately when their structural conditions are met, unless there is a higher ranking defect that must be removed first.

3. Constraints are either strict, or discretionary. Strict constraints are never violated, even to remove the original defect. Discretionary constraints might be violated,

but only as a last resort (to avoid the violation of a strict constraint, or the violation of the original condition).

4. Constraints are strictly local. They are only visible to their local rule, as opposed to OT markedness constraints which are output well-formedness restrictions.

Chapter 4

Stress-epenthesis interactions in the defect-driven rule format

This chapter presentes an analysis of stress-epenthesis interactions using defect-driven rules, whose format is repeated in (1) from Chapter 3.

(1) Defect-driven rule format (Frampton, 2008):

a. Type; Condition; Order :: Rule(s); Constraint Set
Preamble Body

b.

Type:	defines the element on which the condition operates
Condition:	expresses the target
Order:	ranks the violations and determines the order in which the rule attemps to remove them
Rule(s):	defines the type of repair rule(s) available
Constraint Set:	lists constraints on the application of repair rules

The basic schema for the epenthesis and stress rules, and rule interaction, are discussed on a case by case basis. The focus is on condition ranking and its influence on the order in which defect-driven rules apply.

Section 1 discusses how different rankings of conditions on syllabification and culminativity predict cases of complete visibility and complete invisibility of epenthetic vowels.

Section 2 discusses the following prediction that follows from persistence of the footing rule. Vowel epenthesis creates a defect in the form of a non-bracket delimited ×. If only one vowel is epenthesised, the defect might not be removed due to derivational constraints on foot minimality. However, once enough material is epenthesised (two adjacent stressable elements), footing must re-apply. Thus, the prediction is that a system might exist when the epenthesis of a single nucleus does not lead to a formation of a new foot, so the epenthetic nucleus is invisible to prosodic structure. However, when two adjacent nuclei are epenthesised, a new foot must be added. Exactly this type of interaction is found in Yimas analysed in Section 2.

Section 3 addresses the case of Winnebago where foot assignment and epenthesis are analysed as applying directionally left to right, iterating locally. This type of rule interaction is conditioned by feeding relationship and ranking.

Section 4 proposes a defect-driven implementation of the rule sandwiching analysis of Mohawk (Bye, 2001).

Section 5 discusses the case of Selayarese which illustrates another property of defect-driven rules, namely locality. Constraints and conditions are strictly local to a specific rule, which means that another rule can derive an ill-formed structure which is subsequently repaired by a rescue rule. This type of rule interaction in Selayarese is a source of metrical visibility of vowels epenthesised inside a foot.

Section 6 summarises the discussion.

4.1 Complete metrical (in)visibility

The cases of complete metrical visibility or invisibility follow straightforwardly from the ordering of stress and epenthesis rules. Epenthetic vowels are visible to metrical structure when epenthesis precedes stress (Swahili), but invisible when stress precedes epenthesis. Such analysis has been pursued in earlier rule-based approaches to stress-epenthesis interaction (Broselow, 1982), and is translated here into the effect triggered by condition ranking. The ranking determines the order for the defects to be removed with consequences for rule ordering; the higher ranked the condition, the earlier the relevant rule applies.

Swahili is an example of a case where the condition triggering epenthesis outranks the condition that triggers stress assignment. Epenthesis in Swahili is attributed here to a repair on a strict CV syllabification rule. The basic syllabification rule, introduced in Chapter 3, builds clusters over timing slots. Derivational constraints restrict the maximal number of clusters in a syllable. A CV syllable type, found in Swahili is restricted by the constraint *Bin, which says that a syllable contains at most one cluster (2-b). Since clusters are preferably onset clusters, the constraint effectively prevents codas.

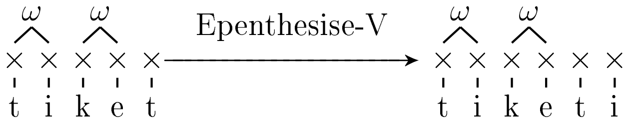
(2) a. Syllabification:

$$\text{Timing Slot ; Clustered ; } \begin{pmatrix}\text{Vowel}\\ \text{Left}\end{pmatrix} :: \begin{bmatrix}\text{Form Doublet}\\ \text{Form Singlet}\\ \text{Epenthesise V}\end{bmatrix} \text{ ; } \{\text{*Bin}\}$$

b. *Bin:
Do not group together two or more clusters.

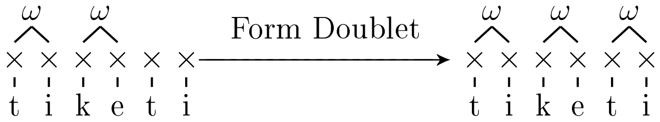
Epenthesis is a last resort repair on syllable structure. It applies when a timing slot cannot be clustered in a doublet without violating *Bin. The repair Form Singlet cannot apply either, as the timing slot is projected by a consonant, and consonants cannot be nuclei in Swahili. In such cases a vowel is epenthesised, as shown in (3).

(3)



Epenthesis produces a defect which can be removed by the repair Form Doublet, and the defect-driven rule applies in a persistent fashion.

(4)



Swahili will be analysed here as not having foot structure. Penultimate stress assignment will be analysed as a repair of the Prosodic Word-Headed defect, which requires that every Prosodic Word contain a stressable element that projects a level 2 gridmark (culminativity). The rule applies from right to left and the repair is constrained by a ban on word-final stress (Nonfinal).

(5) a. × ; Pwd-Hd ; Right :: Ø→ × ; {Nonfinal}

b. PWd-Hd:

$$[\times\ \times\ \times\times] \rightarrow [\times\times\ \overset{\times}{\times}\ \times]$$

c. Nonfinal:

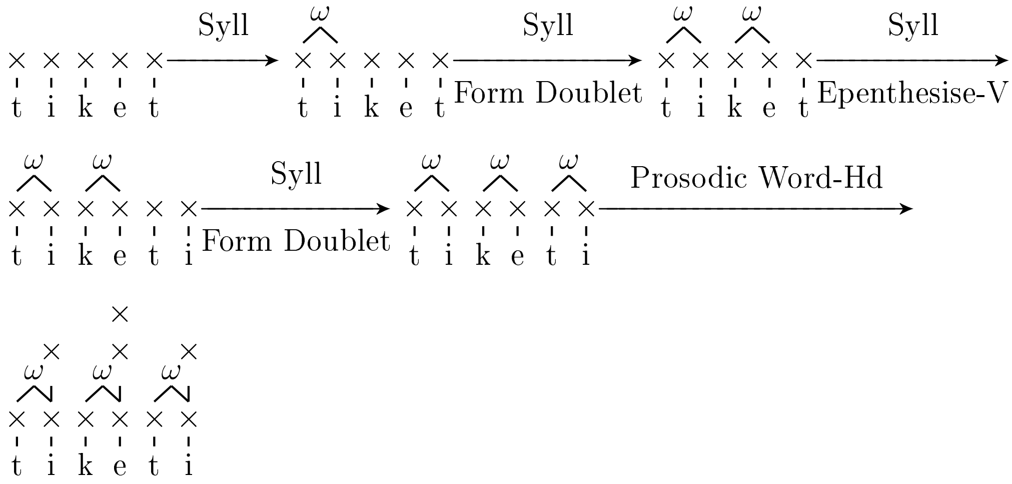
$$*\overset{\times}{\times}\%$$

The defect in the output (unheaded Prosodic Word) triggers the application of the rule which proceeds right-to-left. The first possible target is the final syllable, but the main stress cannot be assigned there without violating Nonfinal. Therefore the algorithm moves further to the left and assigns stress to the next available target, which is the penultimate nucleus.

In Swahili the condition on syllabification outranks PWd-Hd (6-a), which means that syllabification applies always before the Prosodic Word Head is assigned, as illustrated by the derivation in (6-b):

(6) a. Timing Slot-Clustered $\gg$ PWd-Hd

b.



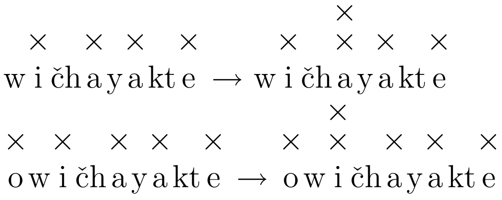
The Dakota case illustrates the opposite ranking. The condition that triggers epenthesis outranks the condition on main stress assignment. The epenthesis condition is analysed here as a Word-Minimality Effect.

(7) a. PWd ; Wd-Min ; Right :: Ø→ V
b. Word-Minimality (Wd-Min)
$[_{\text{PWd}}\ \sigma\sigma]$
c. Derivations
ček → čeka
khuš → khuža

Dakota is reported as a main-stress only language, with the main stress falling on the peninitial syllable (Shaw, 1976, 1985; Kennedy, 1994). This system will be analysed here as not having foot structure. As in the case of Swahili, stress will be determined by the PWd-Hd defect which triggers the following rule in (8-a).

(8) a. PWd ; PWd-Hd ; Left :: Ø→ × ; || {Noninitial}

b. NonInitial
$*\%\overset{\times}{\times}$
c. Derivations

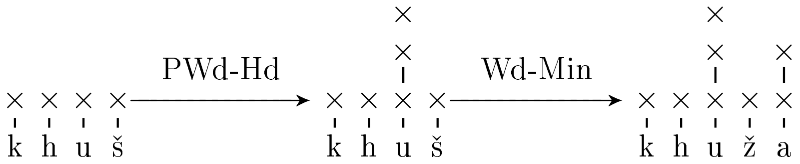


The rule is constrained by the discretionary Noninitial, which says that the main stress may only fall on the initial syllable if there is no other way to remove the PWd-Hd Defect.

The ranking for Dakota determines that the condition on main stress outranks the one on minimality, which means that the higher-ranked defect triggers stress assignment before a vowel is epenthesised to satisfy word minimality.

(9) a. PWd-Hd $\gg$ Wd-Min

b.



The cases analysed here involve systems with no iterative foot structure. Notice that the presence of rules on iterative feet present a challenge to cases where the epenthesis defect is high-ranked. In the defect-driven rule format all rules are potentially persistent. Therefore, whenever epenthesis introduces new stressable elements, new defects are potentially added (unfooted ×'s). This type of derivation might trigger the re-application of the footing rule, unless prevented by some derivational constraints.

4.2 Yimas

This section presents an analysis of stress-epenthesis interaction in Yimas. A single epenthetic vowel is invisible to prosodic structure yielding uncanonical surface stress, but epenthesis of two vowels in adjacent syllables gives canonical stress assignment, as the two epenthetic vowels are footed together. This section shows how persistent rule application predicts precisely the type of interaction found in Yimas. All rules apply persistently so the footing rule re-applies at any stage of the derivation if there is enough material to form an additional foot. However, when only one nucleus is added, derivational constraints prevent the formation of a unary foot. Thus, depending on whether one or two adjacent nuclei are epenthesised, surface stress is exceptional or regular.

4.2.1 Footing and Head Assignment

Main stress in Yimas is initial. As far as foot structure is concerned, Yimas assigns trochees left to right, with a final lapse in imparisyllabic forms (degenerate feet are disallowed). The pattern is exemplified in (10).

(10) Stress in Yimas (Foley, 1986; Alderete, 1999)

(wáŋ.kaŋ)	'bird'
(kú.la)naŋ	'walk'
(wú.ra)(tà.kay)	'turtle'
(má.man)(tà.kar)man	'land crab'

This pattern is captured in the defect-driven rules formalism by the following set of rules on grouping and headedess.

(11) a. Grouping
× ; ⟩-Delimited ; Left :: Ø→ ⟩ ; {*Uny}
b. Headedness:
Foot ; Headed ; Left :: Ø→ × ; {Head-L}

The rule in (11-a) assigns binary feet from left to right, but it does not create a word-final orphan in imparisyllabic forms, as the *Uny constraint is strict (it is never violated by the repair).

(12) a. $\times\times\times \rightarrow \times\ \times\rangle\times$

b. $\times\times\times\times \rightarrow \times\ \times\rangle\times\times \rightarrow \times\ \times\rangle\ \times\ \times\rangle$

c. $\times\times\times\times\times \rightarrow \times\ \times\rangle\times\times\times \rightarrow \times\ \times\rangle\ \times\ \times\rangle\times$

The imparisyllabic forms in a. and c. contain word-final defects, which cannot be repaired by the rule in (11-a), so the derivation terminates.

Headedness, as defined in (11-b) is a property of the foot. Therefore, a defective (non-delimited) element may not be a head. Defective unheaded feet are created by the rule of foot assignment. The defect is repaired by the rule on head assignment, as shown in (13).

(13) a. $\times\ \times\rangle\ \times \rightarrow \overset{\times}{\times}\ \times\rangle\ \times$

b. $\times\ \times\rangle\ \times\ \times\rangle \rightarrow \overset{\times}{\times}\ \times\rangle\ \overset{\times}{\times}\ \times\rangle$

c. $\times\ \times\rangle\ \times\ \times\rangle\ \times \rightarrow \overset{\times}{\times}\ \times\rangle\ \overset{\times}{\times}\ \times\rangle\ \times$

The main stress rule will be attributed to the PWd-Hd condition which applies from left-to-right. This direction, in the absence of constraints, predicts that word-level stress is leftmost.

(14) a. Main stress rule
PWd ; PWd-Hd ; Left :: Ø→ ×
b. Derivations

(i) $\overset{\times}{\times}\ \times\rangle\ \times \rightarrow \overset{\times}{\overset{\times}{\times}}\ \times\rangle\ \times$

(ii) $\overset{\times}{\times}\ \times\rangle\ \overset{\times}{\times}\ \times\rangle \rightarrow \overset{\times}{\overset{\times}{\times}}\ \times\rangle\ \overset{\times}{\times}\ \times\rangle$

$$\begin{array}{llllllllll} & & & & & & \times & & & \\ & \times & & \times & & & \times & & \times & \\ \text{(iii)} & \times & \times\rangle & \times & \times\rangle & \rightarrow & \times & \times\rangle & \times & \times\rangle \end{array}$$

4.2.2 Epenthesis

The proposal here will be that epenthesis in Yimas is driven by restrictions on syllable structure. The structure is governed by certain restrictions on both onsets and codas. There are almost no complex onsets on the surface. The only exception is found in sequences of a stop followed by /r/ or /w/, as shown in (15).

(15)

$\boxed{\text{kr}}$í̱mki̱nawt	‘wasp’
tí̱mpi̱nàw$\boxed{\text{kw}}$an	‘sago palm’

All other types of complex onsets are broken up by epenthetic vowels, as illustrated in (16).

(16) Avoidance of complex onsets

/$\boxed{\text{pk}}$am/	pi̱kam	‘skin of back’
/$\boxed{\text{nm}}$panmara/	ni̱mpanmara	‘stomach’
/$\boxed{\text{tm}}$i/	ti̱mi	‘say’

On the basis of this observation a constraint on the complex onsets will be proposed, which licenses complex onsets only when they consist of a stop followed by /r/ or /w/, ComplexOnsCond. The constraint restricts the derivation to applying only when a specific requirement is met (‘Do something only if...’).

(17) ComplexOnsCond

IF Complex Onset THEN Stop $\left\{\begin{array}{c} \text{r} \\ \text{w} \end{array}\right\}$ V

When it comes to codas, only /r/ are allowed in codas word-medially (18).

(18) Word-medial codas

ni̱$\boxed{\text{m}}$pa$\boxed{\text{n}}$mara	‘stomach’
wa$\boxed{\text{ŋ}}$ka$\boxed{\text{ŋ}}$	‘bird’
mama$\boxed{\text{n}}$taka$\boxed{\text{r}}$ma $\boxed{\text{n}}$	‘stomach’

Word-medial codas are proposed to be licensed by the constraint CodaCond, defined in (19).

(19) CodaCond

$$\text{If Coda then} \left\{ \begin{array}{c} [\text{Nasal}] \\ \text{r} \end{array} \right\}$$

CodaCond specifies that codas are licensed only when they contain a nasal or /r/.

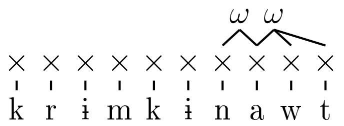
In addition, complex consonant clusters are found in word-final position, as illustrated by the data in (20).

(20) Word-final consonant clusters

tɨ̲kɨ̲t	‘chair’
krɨ̲́mkɨ̲nawt	‘wasp’

Exceptionality of word-final consonants is a common cross-linguistic phenomenon (Hayes, 1982; Levin, 1985; Myers, 1987; Kaye, 1990; Harris, 1997). To account for this fact the present work will tentatively propose that word-final codas are adjoined to word structure, and thus they fall outside the scope of regular syllabification. Graphically, adjunction will be represented as in (21).

(21)



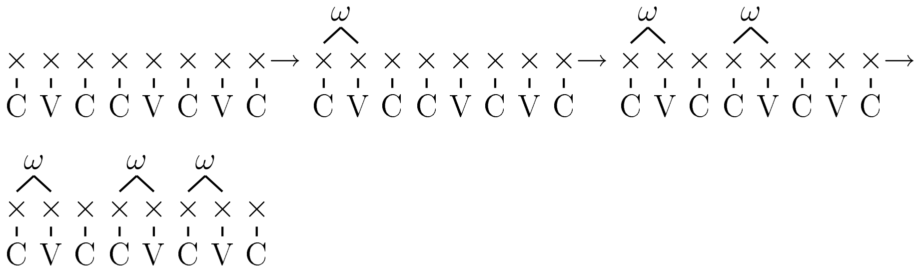
All complex onsets other than the ones licensed by (17) are avoided. The same goes for codas other than the type licensed by (19). The avoidance will be expressed by the general syllabification rule which targets the CV type of syllable, as proposed earlier for Swahili. The rule is defined in (22).

(22) Syllabification rule[1]

a. $\text{Timing Slot; Clustered;} \begin{pmatrix} \text{Vowel} \\ \text{Left} \end{pmatrix} :: \text{Form Doublet ; \{*Bin\}}$

Under the present version of the rule, the derivation cannot form coda clusters, leaving all non-onset consonants unclustered, as shown in (23).

(23)



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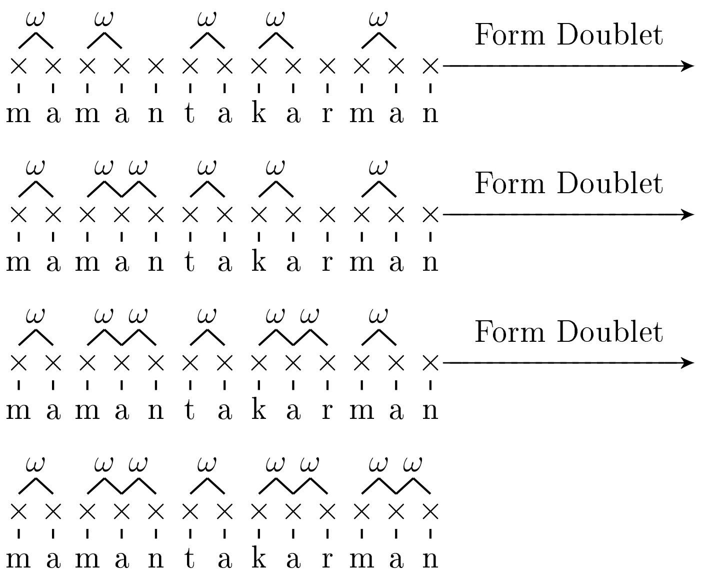
[1] In the absence of onsetless syllables in the current dataset, the repair Form Singlet is omitted in this and the following versions of the rule.

To allow the formation of coda clusters in the environments licensed by (19), it will be proposed that the derivational constraint *Bin is violable. It may be violated to syllabify post-vocalic Nasals or r, where there is no vowel following. The revised version of the rule is stated in (24-a).

(24) a. Revised syllabification rule

$$\text{Timing Slot; Clustered; } \begin{pmatrix}\text{Vowel}\\ \text{Left}\end{pmatrix} :: \begin{bmatrix}\text{Form Doublet}\\ \text{Adjoin Coda}\end{bmatrix} \text{; \{CodaCond || *Bin\}}$$

b.



In the example above all the codas are licensed, as they conform to the condition that codas must be nasal, or rhotic. Therefore, the timing slots are clustered to the right of the preceding vowel. The derivational constraint CodaCond licenses the violation of *Bin so that a coda cluster may be formed.

Classifying *Bin as a violable constraint requires an adjustment in the syllabification rule, so that sets of more than two clusters are excluded. This is implemented by the discretionary constraint *Tri, which prohibits sets of more than two clusters.

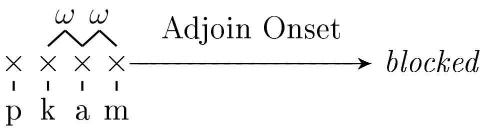
Complex onsets necessitate an additional type of repair on the syllabification rule, i.e. Adjoin Onset. The repair allows for the formation of complex onsets if a given consonant cannot be syllabified in any other way. The repair is limited by the derivational constraint ComplexOnsCond in (17). The revised rule and a sample derivation follow.

(25) a.

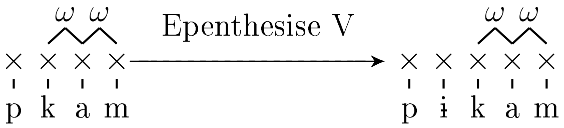
$$\text{Timing Slot; Clustered; } \begin{pmatrix}\text{Vowel}\\ \text{Left}\end{pmatrix} :: \begin{bmatrix}\text{Form Doublet}\\ \text{Adjoin Onset}\end{bmatrix} \text{; \{*Tri, CodaCond, ComplexOnsCond || *Bin\}}$$

b.


The rule above allows to syllabification of the data discussed so far. However, it fails to syllabify some of the inputs, like the one in (26).

(26)


In the example above, the repair Adjoin Onset cannot apply, as it is not licensed by the Onset Condition. None of the other previously specified repairs is sufficient to syllabify the string. This is where vowel epenthesis applies as a last-resort repair on syllable structure.

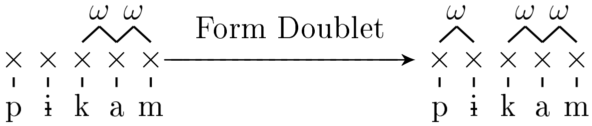
(27)


Inclusion of the epenthesis repair into the syllabification rule gives the final definition of the rule (28).

(28) Final version of the syllabification rule

Timing Slot; Clustered; $\begin{pmatrix}\text{Vowel}\\ \text{Left}\end{pmatrix}$ :: $\begin{bmatrix}\text{Form Doublet}\\ \text{Adjoin Onset}\\ \text{Epenthesise V}\end{bmatrix}$; {*Tri, CodaCond, ComplexOnsCond || *Bin}

Vowel epenthesis creates two defects in the output, which are again scanned by the original condition and appropriate repairs apply. As a result, a doublet is formed incorporating the epenthesised vowel and the consonant to its left, as shown in (29).

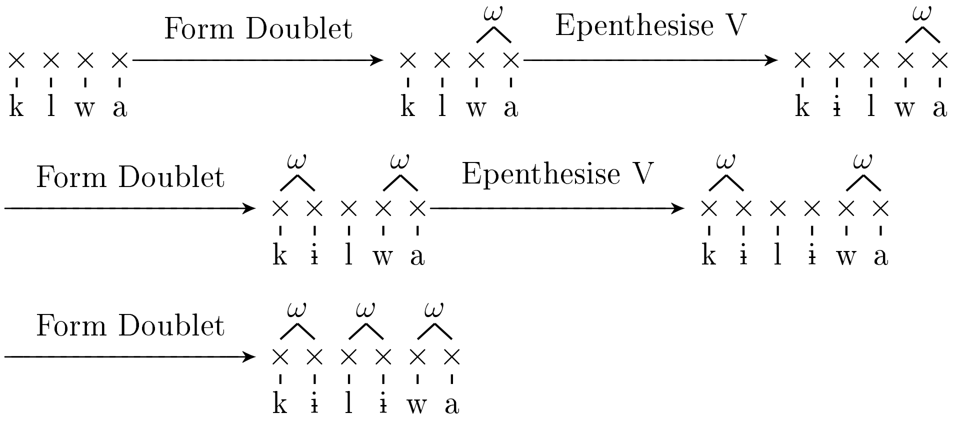
(29)


The repairs apply in a specific order determined by a ranking of repairs specific to any given rule. Epenthesis is the last repair to apply, and therefore epenthesis will not be used in cases where the defect can be removed by e.g. coda formation restricted by CodaCond.

(30) Unattested:

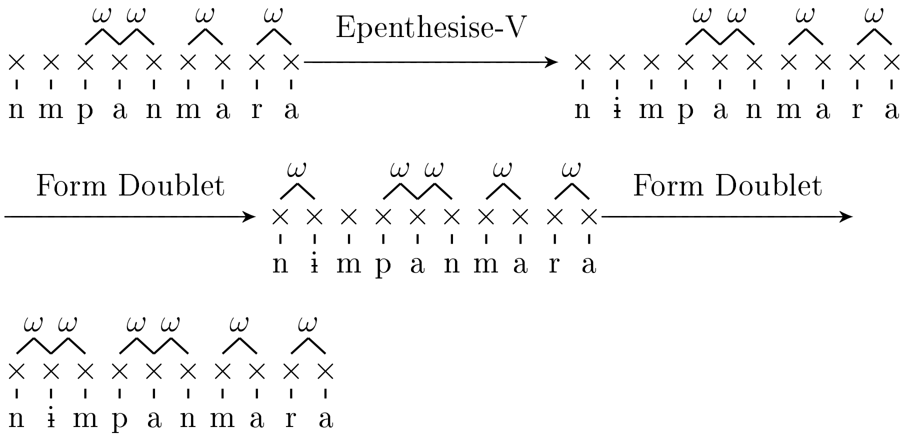

Where two defects are of the same rank (two vowel defects or two consonant defects) and they cannot be repaired in any other way than epenthesis, the rule applies from left to right[2].

(31)



Once epenthesis has applied, all repairs scan the same string, and the highest-ranked one applies. Therefore, in the example below, a coda cluster is formed over the epenthetic vowel and the consonant to its right.

(32)



Finally, constraints are visible to all repairs. Thus, for example, the licensing condition on complex onsets is visible to the epenthesis repair, which allows for a complex onset where it complies with the well-formedness condition. Therefore, the minimal number of vowels are epenthesised to break up a cluster, forming a complex onset and allowing a coda where appropriate.

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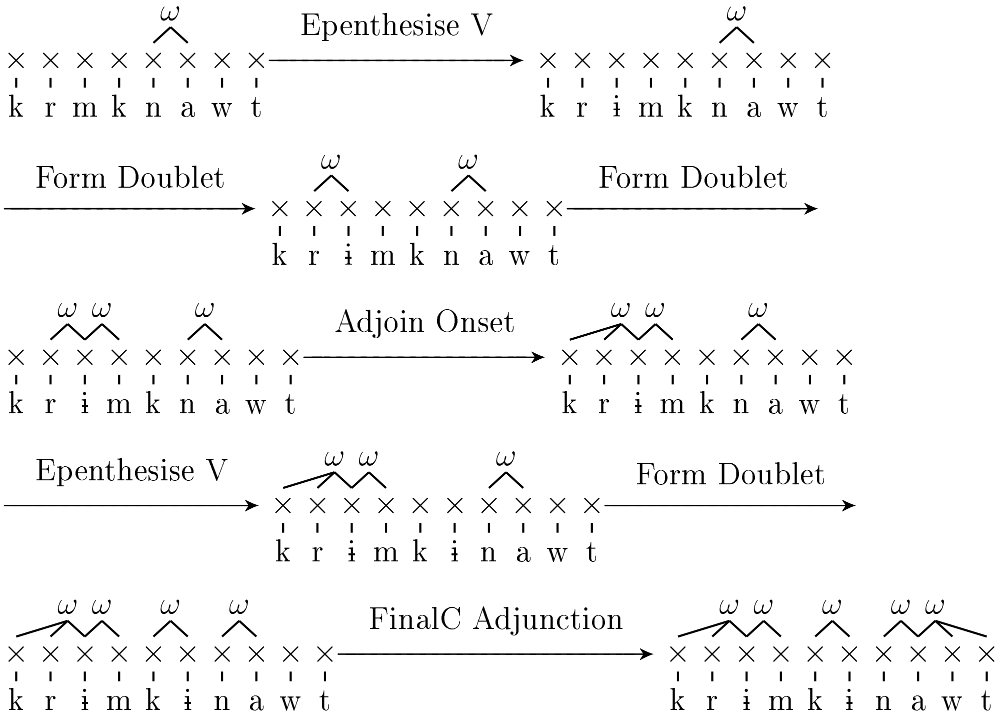
[2] Direction is in no way crucial in this case. Left-to-right is simply assumed as the default direction for syllabification.

(33)



4.2.3 Rule interaction and partial visibility

The metrical visibility effects of epenthetic vowels in Yimas follow from the ranking of the three conditions: on footing, heading and syllabification. Invisibility of single epenthetic vowels (34) to metrical structure follows from ranking foot assignment and head assignment over epenthesis.

(34)	/pkam/	pɨ̲kám	'skin of back'
	/tmi/	tɨ̲mí	'say'
	/kcakk/	kɨ̲cákɨ̲	'cut'
	/nmpanmara/	nɨ̲mpánmara	'stomach'

However, when the first two vowels in a word are epenthetic, persistent footing and the head-assignment rule apply, which results in the first epenthetic vowel being stressed, as shown in (35).

(35)	/tkt/	tɨ̲́kɨ̲t	'chair'
	/klwa/	kɨ̲́lɨ̲wa	'flower'
	/krmknawt/	krɨ̲́mkɨ̲nawt	'wasp'
	/tmpnawkwan/	tɨ̲́mpɨ̲nàwkwan	'sago palm'

The metrically invisible epenthesis in (34) follows from the syllabification-triggering defect being ranked lower than the defect that trigger footing and head assignment (36).

(36) Partial condition ranking
×-delimited ≫ Ft-headed ≫ Timing-Slot Clustered

As a result of the ranking in (36), the defective clusters can only be repaired after feet and foot heads have been assigned. This is illustrated by the derivation in (37).

(37)
$$\text{pk}\overset{\times}{\text{a}}\text{m} \xrightarrow{\text{Ft}} \text{pk}\overset{\times\rangle}{\text{a}}\text{ m} \xrightarrow{\text{Hd}} \text{pk}\overset{\overset{\times}{\times\rangle}}{\text{a}}\text{ m} \xrightarrow{\text{Ep}} \text{p}\overset{\times}{\text{ɨ}}\text{ k}\overset{\overset{\times}{\times\rangle}}{\text{a}}\text{ m}$$

This case involves a violation of the constraint *Uny, as a unary foot is assigned in a monosyllabic word. The unary foot assignment is quite necessary if the foot is to be assigned a head *before* the prosodic word head is assigned. It will be assumed that monosyllabic words are exceptional due to strict layering: in languages with iterative foot structure Prosodic Word must contain at least one foot. To satisfy this condition, unary feet are allowed in monosyllabic words. Formally, this proposal will be implemented by a licensing condition on unary feet in monosyllabic words (Strict Layering). The condition is defined in (38).

(38) Strict layering
If %×⟩ then %×⟩%

Strict layering licenses foot assignment in monosyllabis word, allowing derivations like the one in (37). Except in monosyllabis words, *Uny blocks the assignment of unary feet. As a result, in polisyllabic words a single initial epenthetic vowel does not trigger the application of peristent footing, as shown in (39).

(39)
$$\text{n}\overset{\times}{\text{ɨ}}\text{mp}\overset{\overset{\times}{\times}}{\text{a}}\text{nm}\overset{\times\rangle}{\text{a}}\text{ r}\overset{\times}{\text{a}} \xrightarrow{\text{Ft}} \textit{blocked by *Uny}$$

The current version of the rules and the established ranking predict also that epenthetic vowels *are* visible to stress assignment, whenever the epenthesis repair inserts two adjacent vowels. Two adjacent epenthetic vowels constitute enough material to create an additional foot without violating *Uny, so perisistent footing applies, followed by head assignment. A sample derivation is in (40). The choice of particular defect-driven rule (labelled under the arrows) is determined by the condition ranking specified in (36). The choice of particular repair (labelled above the arrows) is determined by the repair order internal to every rule. Out of all syllabification repairs only epenethesis is represented in (40), as it is the only repair that is relevant for the footing rule.

(40)
$$\text{tmpn}\overset{\times}{\text{a}}\text{wkw}\overset{\times}{\text{a}}\text{n} \xrightarrow[\times\text{-Delimited}]{\text{Ft}} \text{tmpn}\overset{\times}{\text{a}}\text{wkw}\overset{\times\rangle}{\text{a}}\;\text{n} \xrightarrow[\text{Ft-headed}]{\text{Hd}}$$

$$\text{tmpn}\overset{\times}{\overset{\times}{\text{a}}}\text{wkw}\overset{\times\rangle}{\text{a}}\;\text{n} \xrightarrow[\text{Str.El.-Clustered}]{\text{Ep}} \text{t}\,\overset{\times}{\text{ɨ}}\,\text{mpn}\overset{\times}{\overset{\times}{\text{a}}}\text{wkw}\overset{\times\rangle}{\text{a}}\;\text{n} \xrightarrow[\times\text{-Delimited}]{\text{Ft}} \textit{blocked by *Uny}$$

$$\xrightarrow[\text{Str.El.-Clustered}]{\text{Ep}} \text{t}\,\overset{\times}{\text{ɨ}}\,\text{mp}\,\overset{\times}{\text{ɨ}}\,\text{n}\overset{\times}{\overset{\times}{\text{a}}}\text{wkw}\overset{\times\rangle}{\text{a}}\;\text{n} \xrightarrow[\times\text{-Delimited}]{\text{Ft}} \text{t}\,\overset{\times}{\text{ɨ}}\,\text{mp}\,\overset{\times\rangle}{\text{ɨ}}\;\text{n}\overset{\times}{\overset{\times}{\text{a}}}\text{wkw}\overset{\times\rangle}{\text{a}}\;\text{n}$$

$$\xrightarrow[\text{Ft-Headed}]{\text{Hd}} \text{t}\,\overset{\times}{\overset{\times}{\text{ɨ}}}\,\text{mp}\,\overset{\times\rangle}{\text{ɨ}}\;\text{n}\overset{\times}{\overset{\times}{\text{a}}}\text{wkw}\overset{\times\rangle}{\text{a}}\;\text{n}$$

As a final comment, the condition on culminativity (PWd-Headed) must be ranked lowest of all, for the epenthetic vowels to carry the main stress; the main stress being the last condition to satisfy, falls on the epenthetic vowel. An example of epenthetic vowels bearing stress is in (41).

(41)
$$\text{t}\,\overset{\times}{\overset{\times}{\text{ɨ}}}\,\text{mp}\,\overset{\times\rangle}{\text{ɨ}}\;\text{n}\overset{\times}{\overset{\times}{\text{a}}}\text{wkw}\overset{\times\rangle}{\text{a}}\;\text{n} \xrightarrow[\text{PWd-Hd}]{\text{Hd}} \text{t}\,\overset{\times}{\overset{\times}{\overset{\times}{\text{ɨ}}}}\,\text{mp}\,\overset{\times\rangle}{\text{ɨ}}\;\text{n}\overset{\times}{\overset{\times}{\text{a}}}\text{wkw}\overset{\times\rangle}{\text{a}}\;\text{n}$$

The final rules and condition ranking for Yimas are in (42).

(42) a. ×-Delimited ≫ Ft-Headed ≫ Timing slot-Clustered ≫ PWd-Headed

b. (i) Str. el. ; ⟩-delimited ; Left :: Ø→ ⟩ ; {*Uny, Strict Layering}
(ii) Foot ; Headed ; Left :: Ø→ × ;{ Head-L}
(iii) Timing Slot; Clustered; $\begin{pmatrix}\text{Vowel}\\ \text{Left}\end{pmatrix}$ :: $\begin{bmatrix}\text{Form Doublet}\\ \text{Adjoin Onset}\\ \text{Epenthesise V}\end{bmatrix}$; {*Tri, CodaCond, ComplexOnsCond || *Bin}

(iv) PWd ; Headed ; Left :: Ø→ ×

Under the analysis, the assignment of metrical structure both precedes and follows the syllabification (and therefore also epenthesis), under the view that footing applies whenever there is material to be footed, and that foot heads are assigned whenever there is a foot. Therefore, when two adjacent vowels are inserted, they form an extra foot. Metrical invisibility of single epenthetic vowels is conditioned by a number of facts. First, foot assignment precedes syllabification, since it is triggered by a higher-ranked condition. Second, a defective single unfooted × cannot be repaired due to the derivational constraint *Uny. Third, previously assigned foot structure cannot be deleted.

4.3 Winnebago

In Winnebago epenthetic vowels display a partial metrical visibility effect conditioned by positional restrictions. This section provides a formal analysis of stress-epenthesis interaction in Winnebago in the defect-driven rule format. It is argued that the partial visibility of epenthetic vowels in Winnebago follows from the local iteration of rules on epenthesis, footing and head assignment, all of which proceed from left to right. The local iteration is formally implemented in the defect-driven rule formalism through persistency and ranking; any high-ranked condition might trigger the application of a rule at any given point in the derivation, if the condition is violated by the derived structure. It is also argued that this type of rule interaction makes correct predictions about the full array of patterns attested for Winnebago, as opposed to models where rules are strictly ordered and do not apply persistently.

4.3.1 Stress in Winnebago

The main stress in Winnebago is assigned to the third mora from the left, regardless of how the first two morae are syllabified (one heavy syllable, or two lights), as follows from the data in (43).

(43) Main stress on the postpeninitial mora

$\sigma_{\mu\mu}\sigma_{\mu}\sigma_{\mu}$	
xǰaaną́ne	‘yesterday’
taaní̧žu	‘sugar’
aačgą́nąk	‘to lift out’
hąąhé-re	‘last night’
$\sigma_{\mu}\sigma_{\mu}\sigma_{\mu}\sigma_{\mu}$	
wiščįgéga	‘Hare’
hinųbą́hą	‘second’

Secondary stress iterates from the main stress in a binary fashion from left to right (Miner, 1979; Halle and Vergnaud, 1987). Following Alderete (1995), foot structure in Winnebago will be analysed as a left-aligned, left-to-right trochee with initial extrametricality. Initial extrametricality is interpreted here as the absence of a foot head in the word-initial foot. This effect is easily achieved in the defect-driven rule formalism by two strict constraints local to the head assigning rule, NonInitial and Head-L. These two strict constraints prevent foot assignment in the initial foot.

(44) a. Footing: Str. element ; ⟩-delimited ; Left :: Ø→ ⟩ ; {|| *Uny}
Head assignment: Foot ; Headed ; Left :: Ø→ × ;{ Noninitial, Head-L}
b. Noninitial

The initial nucleus does not project a level 2 gridmark
Head-L
Foot head is leftmost in a foot.

The rule on Footing in (44-a) is constrained by the discretionary *Uny, which allows degenerate feet at the right edge. Sample derivations are in (45).

(45) a.
                                        ×
×× ×   ××⟩ ×   ××⟩ ×⟩   ××⟩ ×⟩
booką → boo ką → boo ką → boo ką

b.
                                                        ×
× × × ×   × ×⟩ × ×   × ×⟩ × ×⟩   × ×⟩ × ×⟩
wiščįgega → wiščį gega → wiščį gega → wiščį gega

Main stress is assigned to the leftmost head by a separate rule. The rule is triggered by the condition that prosodic word be headed. The main stress rule, like the head assignment rule must be constrained by Noninitial. The rule must also be constrained by *Clash, so that it does not build main stress in a way that would clash with the following foot head.

(46) a. Main stress: PWd ; Headed ; Left :: Ø→ × ; {Noninitial, *Clash}

b.
                              ×
           ×   ×
× ×⟩ × ×⟩   × ×⟩ × ×⟩
wiščį gega → wiščį gega *cf.:*

×
×   ×
× ×⟩ × ×⟩
*wiščį gega *blocked by Noninitial*

    ×
    × ×
× ×⟩ × ×⟩
*wiščį gega *blocked by *Clash*

The constraint *Clash is strict. Noninitiality, on the other hand is discretionary. A prosodic word may receive initial main stress, but only when it consists of one foot built over a heavy syllable. This is to avoid a violation of another strict constraint which requires that in a heavy syllable the first mora is stressed, as shown in (47).

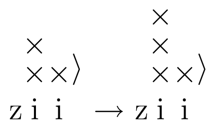
(47) $*[_{\sigma}\mu\acute{\mu}]$

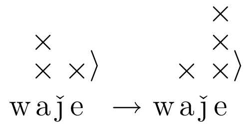
The revised version of the main stress rule is then the following.

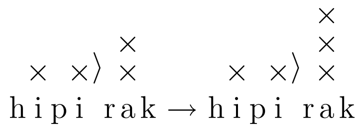
(48) Main stress
PWd ; Headed ; Left :: Ø→ × ; {$*[_{\sigma}\mu\acute{\mu}]$, *Clash || Noninitial}

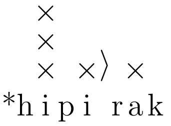
Sample derivations are in (49).

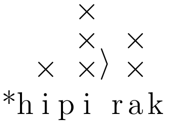
(49)

a. 
*Violates Noninitial to saitisfy *[$_{\sigma}\mu\acute{\mu}$] and PWd-Hd*

b. 
No violation. Main Stress cannot apply to the first × due to Noninitial, so the stress is applied to the next element to the right. No clash.

c. 
No violation. cf.:


violates Noninitiality


*violates *Clash*

4.3.2 Stress-Dorsey's Law interaction

With the basic conditions on Winnebago stress in mind, let us consider the interaction of stress and Dorsey's Law (DL). In most cases, the epenthetic vowels inserted by DL are visible to stress assignment, as shown in (50).

(50) Regular stress pattern in DL words (square brackets denote DL sequences)

a. [CVCV]
/kre/ ke̲ré 'to leave returning'

b. [CVCV]CV
/krahe/ ka̲rahé 'to be on the way returning'

c. [CVCV]CVCV
/xroǰike/ xo̲roǰíke 'hollow'

d. CV[CVCV]
/hipres/ hipe̲rés 'to know'

e. CVCV[CVCV]
/hoǰisną/ hoǰisą̲́ną 'recently'

f. CVV[CVCV]
/boopres/ boopé̲res 'to sober up'

g. [CVCV] [CVCV]
/krikrix/ ki̲rikí̲rix 'thick' (as fluid)

However, in the cases in (51), the application of Dorsey's Law results in opaque stress assignment, with the main stress of fourth mora from the left.

(51) Exceptional stress assignment in DL words:

a.	CV[CVCV]CV		
	/hikroko/	hik$\underline{o}$rohó	'to prepare'
b.	CV[CVCV] [CVCV]		
	/wakripras/	wak$\underline{i}$rip$\underline{\acute{a}}$ras	'flat insect'
c.	CV[CVCV] [CVCV] [CVCV]		
	/wakripropro/	wak$\underline{i}$rip$\underline{\acute{o}}$rop$\underline{\grave{o}}$ro	'spherical insect'

On the basis of the data the following generalisation emerges. Those epenthetic vowels which are visible to metrical structure are leftmost in a foot (under the left-to-right trochee assumption)[3]. The epenthetic vowels which are invisible to metrical structure are in the middle of a ternary foot. What appears to be the case is that whenever Dorsey's Law applies into the leftmost syllable in a foot (a head), it is visible to the footing. When it applies into the foot dependent, it does not influence the placement of the foot boundary and it remains invisible to metrical structure.

The generalisation can be analytically expressed in the following way. Dorsey's Law applies into elements that are edge-adjacent. The generalisation is reflected by following rule in (52).

(52) a. Edgemost DL sequence ; *Clustered ; Left :: Ø→ V

b. Edgemost DL sequence:
a sequence of stop followed by a sonorant followed by a vowel which occurs adajcently to an edge (a foot edge or a word edge), formally:
DL sequence: [Stop][Sonorant][Vowel]

$$\text{Edgemost: } \left\{ \begin{array}{c} \%\underline{\quad} \\ \underline{\quad}\% \\ \underline{\quad}\rangle \\ \rangle\underline{\quad} \end{array} \right\}$$

The condition on Dorsey's Law application n (52) outranks the foot assignment, so that DL applies whenever it is adjacent to word edges first. This application is immediately followed by footing.

(53) a. Edgemost DL sequence-*Clustered $\gg$ ×(Nucleus)-Delimited

b. (i)

$$\begin{array}{c} \times\ \times\ \ \times \\ \text{xr o ǰ i k e} \end{array} \xrightarrow{\text{DL}} \begin{array}{c} \times\ \ \times\ \ \times\ \ \times \\ \text{x o r o ǰ i k e} \end{array} \xrightarrow{\text{Ft}} \begin{array}{c} \times\ \ \times\rangle\ \times\ \ \times \\ \text{x o r o ǰ i k e} \end{array}$$

---

[3] An exception is *hipres*, where the epenthetic vowel is visible to metrical structure, even though it is not leftmost. This irregularity is consistent with non-canonical behaviour of shorter words in Winnebago. The pattern can be explained by the proposed analysis, as demonstrated in (66).

(ii) $$\text{kr}\overset{\times}{\text{i}}\,\text{kr}\overset{\times}{\text{i}}\,\text{x} \xrightarrow{\text{DL}} \text{k}\overset{\times}{\text{i}}\,\text{r}\overset{\times}{\text{i}}\,\text{kr}\overset{\times}{\text{i}}\,\text{x} \xrightarrow{\text{DL}} \text{k}\overset{\times}{\text{i}}\,\text{r}\overset{\times}{\text{i}}\,\text{k}\overset{\times}{\text{i}}\,\text{r}\overset{\times}{\text{i}}\,\text{x} \xrightarrow{\text{Ft}}$$

$$\text{k}\overset{\times}{\text{i}}\,\text{r}\overset{\times\rangle}{\text{i}}\ \ \text{k}\overset{\times}{\text{i}}\,\text{r}\overset{\times}{\text{i}}\,\text{x} \xrightarrow{\text{Ft}} \text{k}\overset{\times}{\text{i}}\,\text{r}\overset{\times\rangle}{\text{i}}\ \ \text{k}\overset{\times}{\text{i}}\,\text{r}\overset{\times\rangle}{\text{i}}\ \ \text{x}$$

DL applies not only when the DL sequence is adjacent to a word edge, but also when adjacent to a foot boundary. In this way, footing feeds DL, so even though DL is ranked before footing, it applies second here because it is persistent.

(54) $$\text{h}\overset{\times}{\text{i}}\,\text{kr}\overset{\times}{\text{o}}\,\text{h}\overset{\times}{\text{o}} \xrightarrow{\text{Ft}} \text{h}\overset{\times}{\text{i}}\,\text{kr}\overset{\times\rangle}{\text{o}}\ \ \text{h}\overset{\times}{\text{o}} \xrightarrow{\text{DL}} \text{h}\overset{\times}{\text{i}}\,\text{k}\overset{\times}{\text{o}}\,\text{r}\overset{\times\rangle}{\text{o}}\ \ \text{h}\overset{\times}{\text{o}}$$

The application of DL cannot remove a previously assigned delimiter. However, it creates a defect in the form of undelimited ×. At this point persistent footing is expected to apply, as in (55).

(55) $$\text{h}\overset{\times}{\text{i}}\,\text{k}\overset{\times}{\text{o}}\,\text{r}\overset{\times\rangle}{\text{o}}\ \ \text{h}\overset{\times}{\text{o}} \rightarrow \text{h}\overset{\times}{\text{i}}\,\text{k}\overset{\times\rangle}{\text{o}}\ \ \text{r}\overset{\times\rangle}{\text{o}}\ \ \text{h}\overset{\times}{\text{o}}$$

With this footing, there are two potential heads, as shown in (56).

(56) $$\text{h}\overset{\times}{\text{i}}\,\text{k}\overset{\times\rangle}{\text{o}}\ \ \text{r}\boxed{\overset{\times}{\text{o}}}\rangle\ \ \text{h}\boxed{\overset{\times}{\text{o}}}$$

A left-to-right head assignment algorithm operating on this input would predict the following incorrect stress assignment.

(57) $${}^{*}\text{h}\overset{\times}{\text{i}}\,\text{k}\overset{\times\rangle}{\text{o}}\ \ \text{r}\overset{\times}{\overset{\times\rangle}{\text{o}}}\ \ \text{h}\overset{\times}{\text{o}}$$

The attested stress is on the fourth mora, as shown in (58).

(58) $$\text{h}\overset{\times}{\text{i}}\,\text{k}\overset{\times\rangle}{\text{o}}\ \ \text{r}\overset{\times\rangle}{\text{o}}\ \ \text{h}\overset{\times}{\overset{\times}{\text{o}}}$$

This head assignment can be derived under the conditions specified in (59).

(59)
- a. Head is an edge marker rather than a property of the foot (Head is assigned at an edge before the edge is delimited)
- b. Head assignment outranks footing (Head is assigned before the persistent footing rule assigns an extra foot within the ternary foot)
- c. Head assignment is constrained by *Clash

Conditions a. and c. can be satisified by the following revision of the Head-assignment rule.

(60) ⟩ ; Hd-Adjacent ; Left :: Ø→ × ; {*Noninitial, Head-L, *Clash}

Condition b. is satisfied by ranking the Head-Assignment rule over the footing rule.

(61) ⟩ Hd-Adjacent ≫ ×-Delimited

Head assignment is fed by footing, so no heads can be assigned before a delimiter is inserted. However, once there is a delimiter, it must be immediately followed by a head. The ranking of conditions predicts that the head rule and the foot rule are strictly intertwined: a head must be assigned every time a delimiter is inserted. Coming back to the derivation in (55), the order of head assignment and footing, plus the constraint *Clash yield the following derivation of *hikorohó*.

(62)
$$\begin{array}{l} \times\ \times\ \times\rangle\ \ \times \\ \text{hikoro ho} \end{array} \xrightarrow{\text{Hd}} \begin{array}{l} \times \\ \times\ \times\ \times\rangle\ \ \times \\ \text{hikoro ho} \end{array} \xrightarrow{\text{Ft}} \begin{array}{l} \times \\ \times\ \times\rangle\ \times\rangle\ \ \times \\ \text{hiko ro ho} \end{array} \xrightarrow{\text{Hd}} \textit{blocked by *Clash}$$

The condition on Dorsey's Law outranks head assignment (63-a). As a result, vowels derived by DL are heads.

(63) a. Edgemost DL - *Clustered≫ ⟩ Hd-Adjacent ≫ ×-delimited

b.
$$\begin{array}{l} \times\ \ \times\ \ \times\ \ \times \\ \text{wakr i propro} \end{array} \xrightarrow{\text{DL}} \begin{array}{l} \times\ \ \times\ \ \times\ \times\ \times \\ \text{wakr i proporo} \end{array} \xrightarrow{\text{Ft}} \begin{array}{l} \times\ \ \times\rangle\ \ \times\ \times\ \times \\ \text{wakr i proporo} \end{array} \xrightarrow{\text{DL}}$$

$$\begin{array}{l} \times\ \times\ \times\rangle\ \ \times\ \times\ \times \\ \text{wakiri proporo} \end{array} \xrightarrow{\text{DL}} \begin{array}{l} \times\ \times\ \times\rangle\ \ \times\ \times\ \times\ \times \\ \text{wakiri poroporo} \end{array} \xrightarrow{\text{Hd}}$$

$$\begin{array}{l} \\ \times\ \times\ \times\rangle \\ \text{wakiri p} \end{array} \boxed{\begin{array}{c} \times \\ \times \\ \text{o} \end{array}} \begin{array}{l} \\ \times\ \times\ \times \\ \text{roporo} \end{array} \xrightarrow{\text{Ft}} \begin{array}{l} \times \\ \times\ \times\ \times\rangle\ \ \times\ \times\rangle\ \times\ \times \\ \text{wakiri poro poro} \end{array} \xrightarrow{\text{Hd}}$$

$$\begin{array}{l} \times\times \\ \times\ \times\ \times\rangle\ \ \times\ \times\rangle\ \ \times\ \times \\ \text{wakiri poro poro} \end{array} \xrightarrow{\text{Ft}} \begin{array}{l} \times\times \\ \times\ \times\rangle\ \times\rangle\ \ \times\ \times\rangle\ \ \times\ \times \\ \text{waki ri poro poro} \end{array}$$

If DL applied after head assignment, the expected derivation would incorrectly derive wakiriporóporo, as illustrated in (64).

(64)
$$\begin{array}{l} \times\ \times\ \times\rangle\ \ \times\ \times\ \times \\ \text{wakiri proporo} \end{array} \xrightarrow{\text{Hd}} \begin{array}{l} \times \\ \times\ \times\ \times\rangle\ \ \times\ \times\ \times \\ \text{wakiri proporo} \end{array} \xrightarrow{\text{DL}} \begin{array}{l} \times \\ \times\ \times\ \times\rangle\ \ \times\ \times\ \times\ \times \\ \text{*wakiri poroporo} \end{array}$$

This example shows how crucial it is for the analysis that the rules iterate locally. Dorsey's Law applies locally before head assignement, and head assignment precedes foot assignment. In that way DL sequences can determine the subsequent footing if they follow the word edge, or if the follow a foot edge. However, when DL sequences precede a non-final foot edge, they are opaque to the following footing. Similarly, due to the local interaction of rules, epenthetic vowels inserted by DL can be heads.

The final ranking for conditions on stress and Dorsey's Law and the exact formulation of the rules is in (65).

(65) a. Edgemost DL-*Clustered ≫ ⟩-Hd adjacent ≫ ×-⟩ delimited ≫ ≫ Prosodic Word - Headed

b. (i) Edgemost DL sequence ; *Clustered ; Left :: Ø→ V

(ii) ⟩ ; Hd-Adjacent ; Left :: Ø→ × ; {*Noninitial, Head-L, *Clash}

(iii) Footing: Str. element ; ⟩-delimited ; Left :: Ø→ ⟩ ; {|| *Uny}

(iv) Main stress: PWd ; Headed ; Left :: Ø→ × ; {$*[_{\sigma}\mu\acute{\mu}]$, *Clash || Noninitial}

Sample derivations follow.

(66) a.

$$\mathrm{h\overset{\times}{i}pr\overset{\times}{e}s} \xrightarrow{\text{DL}} \mathrm{h\overset{\times}{i}p\overset{\times}{e}r\overset{\times}{e}s} \xrightarrow{\text{Ft}} \mathrm{h\overset{\times}{i}p\overset{\times\rangle}{e}\ r\overset{\times}{e}s} \xrightarrow{\text{Hd}} \mathrm{h\overset{\times}{i}p\overset{\times\rangle}{e}\ r\overset{\overset{\times}{\times}}{e}s} \xrightarrow{\text{Ft}}$$

$$\mathrm{h\overset{\times}{i}p\overset{\times\rangle}{e}\ r\overset{\overset{\times}{\times\rangle}}{e}\ s} \xrightarrow{\text{Main Stress}} \mathrm{h\overset{\times}{i}p\overset{\times\rangle}{e}\ r\overset{\overset{\times}{\overset{\times}{\times\rangle}}}{e}\ s}$$

b.

$$\mathrm{w\overset{\times}{a}kr\overset{\times}{i}pr\overset{\times}{a}s} \xrightarrow{\text{DL}} \mathrm{w\overset{\times}{a}kr\overset{\times}{i}p\overset{\times}{a}r\overset{\times}{a}s} \xrightarrow{\text{Ft}} \mathrm{w\overset{\times}{a}kr\overset{\times\rangle}{i}\ p\overset{\times}{a}r\overset{\times}{a}s} \xrightarrow{\text{DL}}$$

$$\mathrm{w\overset{\times}{a}k\overset{\times}{i}r\overset{\times\rangle}{i}\ p\overset{\times}{a}r\overset{\times}{a}s} \xrightarrow{\text{Hd}} \mathrm{w\overset{\times}{a}k\overset{\times}{i}r\overset{\times\rangle}{i}\ p\overset{\overset{\times}{\times}}{a}r\overset{\times}{a}s} \xrightarrow{\text{Ft}} \mathrm{w\overset{\times}{a}k\overset{\times\rangle}{i}\ r\overset{\times\rangle}{i}\ p\overset{\overset{\times}{\times}}{a}r\overset{\times}{a}s}$$

$$\xrightarrow{\text{Main Stress}} \mathrm{w\overset{\times}{a}k\overset{\times\rangle}{i}\ r\overset{\times\rangle}{i}\ p\overset{\overset{\times}{\overset{\times}{\times}}}{a}r\overset{\times}{a}s}$$

The rule interaction conditions the following interaction of stress and Dorsey's Law. Dorsey's Law applies in edgemost syllable and when it immediately precedes or follows a foot delimiter. As a result, epenthetic vowels are visible to metrical structure except when a DL sequence immediately precedes a foot edge. The interaction is strictly local and conditioned by ranking and persistence. Lower ranked rules feed higher ranked rules, so that higher ranked rules apply in a persistent fashion. The locality is the source of partial metrical opacity; if the interaction were global, all DL vowels would be visible to stress assignment.

4.4 Mohawk

Mohawk displays partial visibility effects conditioned by the type of cluster to which epenthesis applies. The pattern found in Mohawk is analysed in Bye (2001) as rule sandwiching where the stress rule applies in between the rules on triconsonantal and biconsonantal epenthesis. This section shows how rule sandwiching can be modelled in the defect-driven rule formalism by means of ranking on conditions that determines rule ordering. Epenthesis into triconsonantal clusters is analysed as a repair on syllabification, so it applies whenever a string is syllabified. Epenthesis into biconsonantal clusters is ascribed to a late rule that repairs certain types of clusters. The ranking of the syllabification condition above head assignment in the prosodic word predicts the metrical visibility of vowels epenthesised into triconsonantal cluster. The ranking of the stress condition above the condition on epenthesis in certain types of biconsonantal clusters predicts that epenthesis into biconsonantal clusters is metrically invisible. In this way, the condition ranking achieves the effect of extrinsic rule ordering of the SPE-style rules type.

4.4.1 Stress in Mohawk

Mohawk has penultimate stress with no reported iterative foot structure (67).

(67) Penultimate stress in Mohawk (Hagstrom, 1997):

/wak-haratat-u-hatye/	wakharatatuhátye	‘I go along lifting up’
/hra-kw-as/	rákwas	‘he picks it’
/k-atirut-haˀ/	katirúthaˀ	’I pull it’
/k-ohar-haˀ/	kohárhaˀ	‘I attach it’
/k-ataˀkerahkw-haˀ/	k-ataˀkerákw-haˀ	‘I float’
/k-oˀkwat-s/	kóˀkwats	‘I dig’
/te-k-yaˀk-s/	tékyaˀks	‘I break it in two’

As in the case of Swahili and Dakota, non-iterative foot stress will be attributed to condition on the Prosodic Word as having main stress. The defect-driven rule for this condition is in (68).

(68) PWd ; Headed ; Right :: Ø→ × ; {Nonfinal}

The defect conditioning main stress requires that level 2 gridmark be projected by one stressable element. The repair applies from right to left, but it skips the final syllable, due to the derivational constraint NonFinal. As a result, main stress is assigned to the penult.

The penultimate stress pattern is not disrupted by epenthesis into triconsonantal clusters, as shown in (69).

(69)	/wak-nyak-s/	waké̲nyaks	‘I get married’
	/s-rho-s/	sé̲rhos	‘you coat it with something’
	/te-k-ahsutr-haˀ/	tekahsuté̲rhaˀ	‘I splice it’
	/s-k-ahkt-s/	skáhke̲ts	‘I got back’
	/sa-s-ahkt/	sasáhke̲t	‘go back’

In the forms in (69), stress falls regularly on the penultimate vowel, regardless of whether the penultimate or the final vowel is epenthetic. However, epenthesis into biconsonantal clusters is metrically invisible; it is not counted by the stress rule and the epenthetic vowels do not receive stress, as illustrated by the data in (70).

(70)	/ʌ-k-r-ʌ-ˀ/	ʌ́ke̲rʌˀ	‘I will put it into a container’
	/te-k-rik-s/	téke̲riks	‘I put them together’
	/t-ʌ-k-ahsutr-ʌˀ/	tʌkahsúte̲rʌˀ	‘I will splice it’
	/w-akra-s/	wáke̲ras	‘it smells’
	/waˀ-t-k-atat-nak-ˀ/	waˀkatáte̲nake̲ˀ	‘I scratched myself’
	/ʌ-k-arat-ˀ/	ʌkáːrate̲ˀ	‘I lay myself down’
	/ro-kut-ot-ˀ/	rokúːtote̲ˀ	‘he has a bump on his nose’
	/t-ʌ-k-rik-ˀ/	tʌ́ke̲rike̲ˀ	‘I’ll put together side by side’
	/o-nraht-ˀ/	óne̲rahte̲ˀ	‘leaf’
	/t-ʌ-k-hkw-ˀ/	tʌ́ke̲hkwe̲ˀ	‘I’ll lift it’

Hagstrom (1997) and Bye (2001) analyse the Mohawk stress-epenthesis interaction as a rule sandwiching effect. *E*-epenthesis is approached in that analysis as comprising two independent types of epenthesis, with the stress rule ‘sandwiched’ in between (71).

(71) Rule sandwiching in Mohawk (Hagstrom, 1997)

Underlying	/wak-njak-s/	/ʌ-k-r-ʌʔ/
Ø→ e/C__CC	wakenjaks	—
Penult stress	waˈkenjaks	ˈʌkrʌʔ
Ø→ e/C__resonant	—	ˈʌkerʌʔ
Surface	[waˈkenjaks]	[ˈʌkerʌʔ]

The same basic insight that there are two independent epenthesis types in Mohawk is shared by the present approach. The following section is devoted into formalising the idea using the defect-driven rule format.

4.4.2 Epenthesis in Mohawk

Epenthesis into triconsonantal clusters is analysed here as conditioned by a high-ranked condition against triconsonantal clusters. It will be expressed as a defect related to syllable structure. Following Frampton (2008), syllabification is expressed here as a triggered by the condition that timing slots be clustered. The rule must account for the following observations concerning the syllable structure in Mohawk.

(72) a. Codas are allowed, but complex codas occur only word-finally:

kóˀkwa$\boxed{\text{ts}}$	‘I dig’
tékyaˀ$\boxed{\text{ks}}$	‘I break it in two’

b. Only /kw/ is allowed as a complex onset:

tʌkeh$\boxed{\text{kw}}$eˀ	‘I’ll lift it’

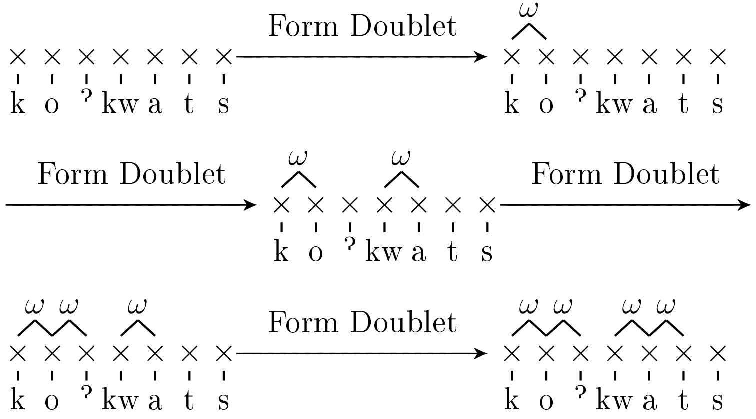
The *kw* sequence will be treated for the present purposes as a single segment. An account of word-final complex codas is not incorporated into the analysis. The exceptionality of word-final is a recurring pattern cross-linguistically, and it has already been mentioned in the discussion of Yimas in the present work. A possible proposal is that word-final codas are not syllabified, or that they are adjoined to syllable structure. As in Yimas, the adjunction solution will be tenatively pursued here in some representations, but it will not be formalised in a rule. It is left for further research to determine whether final consonant adjunction is preferable over extrametricality, and if so, what is its status (defect-driven rule vs. repair on syllabification and when exactly it applies).

The basic syllable structure in Mohawk is CVC, which follows from the following syllabification rule.

(73) Syllabification rule

a. Timing Slot; Clustered; $\begin{pmatrix}\text{Vowel}\\ \text{Left}\end{pmatrix}$ :: $\begin{bmatrix}\text{Form Doublet}\\ \text{Form Singlet}\end{bmatrix}$; {*Tri}

b. Sample derivation:



The algorithm picks out vowels for repair first and forms onset clusters over every vowel and a consonant to its left. The remaining consonants are syllabified as codas.

Vowel epenthesis is added to the rule as a last resort repair, when a cluster canot be syllabified. Effectively, the epenthesis applies in triconsonantal clusters.

(74) Revised syllabification rule

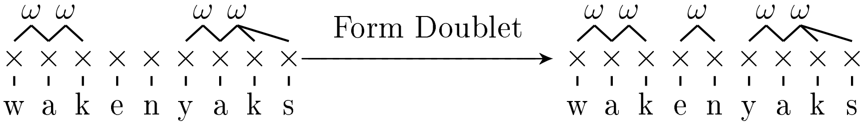
a. Timing Slot; Clustered; $\begin{pmatrix}\text{Vowel}\\ \text{Left}\end{pmatrix}$ :: $\begin{bmatrix}\text{Form Doublet}\\ \text{Form Singlet}\\ \text{Epenthesise-V}\end{bmatrix}$; {*Tri}

b. Sample derivation

The present analysis does not pursue an explicit explanation for where vowel is epenthesised with respect to the unclustered consonant (/CCC/ → [CeCC], but /$\left\{\begin{matrix}\text{h}\\ \text{s}\end{matrix}\right\}$CC/ → [$\left\{\begin{matrix}\text{h}\\ \text{s}\end{matrix}\right\}$ CeC]).

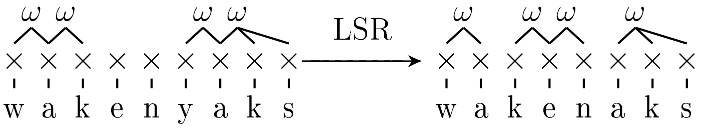
After the vowel has been epenthesised, syllabification re-applies. The basic formation of the rule predicts that a doublet will be formed over the unclustered timing slots, as illustrated in (75).

(75)



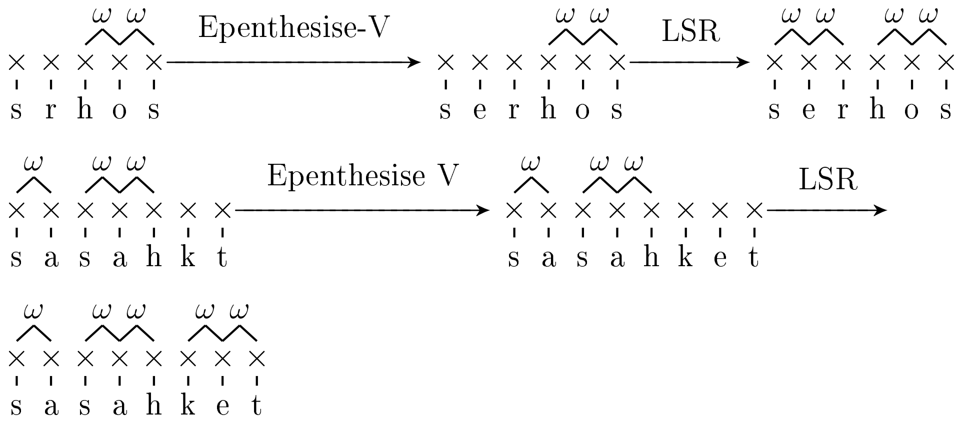
This type of rule interaction yields a non-canonical syllabification, where a consonant (k) is syllabified as a coda, rather than an onset. This might be potentially problematic, although it is quite possible that where derivation intereferes with syllabification, irregular patterns may arise. To deal with cases like this, Frampton (2008) proposes a repair on syllable structure called Local Syllable Restructuring (LSR). LSR is capable of fixing locally structures like the one in (76) by delinking a coda and forming an onset cluster (76).

(76)



More examples follow.

(77)

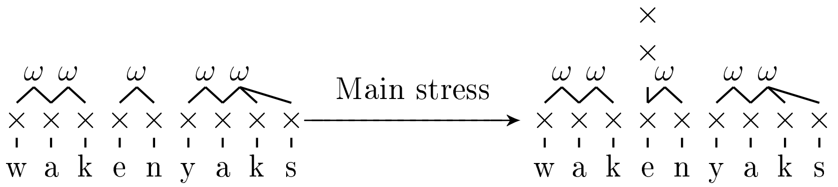


LSR is not included in the final ranking for Mohawk, as it is not entirely clear that re-syllabification does indeed occur. LSR is acknowledged here, though, as a potential solution for changing a derived syllable structure.

4.4.3 Condition ranking and interaction

The condition on syllabification is high-ranked, which means it must be immediately satisfied. As a result, the syllabification rule applies first until all the timing slots have been clustered. Only then does the main stress rule (68) apply, which then takes into consideration the epenthetic vowels inserted by the repair on syllabification.

(78)



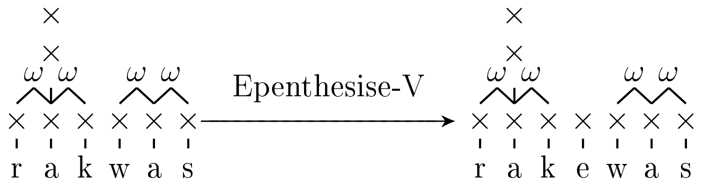
Epenthesis into biconsonantal cluster is conditioned by a linear sonority requirement. The requirement breaks down the sequences of obstruents followed by sonorants and word-final sequences of obstruents and glottal stops. Both types of sequences are repaired by epenthesising the vowel *e*.

(79)

$$\text{Obs; *Obs}\left\{\begin{array}{c}\text{r}\\ \text{w}\\ \text{ʔ\%}\end{array}\right\}\text{; Left :: Epenthesise-V}$$

The defect is low ranked, which makes the epenthesis into biconsonantal clusters a late rule, deferred until after main stress assignment (80).

(80)



Epenthesis inserts a new unclustered timing slot. The prediction made by the syllabification rule is that the timing slot must be clustered. However, the V cannot cluster with either preceding or following C without making a triplet. Therefore, the derivation will either terminate, leaving the epenthetic vowel unsyllabified, or LSR applies, delinking the preceding coda and making an onset cluster over the delinked coda consonant and the epenthesised vowel (cf. (76) and the related discussion).

The main stress rule does not re-apply after the biconsonantal epenthesis, as the Prosodic Word is already headed, so there is no output defect that could trigger the application of the rule. The surface stress is then uncanonical (not penultimate), but that does not condition re-assignment of the stress. In the proposed analysis of Mohawk, penultimate stress is an effect of the rule application rather than a well-formedness condition. Specifically, the derivational constraint Nonfinal on a right-to-left main stress rule. However, there is no rule that states explicitly that main stress in Mohawk is penultimate. Therefore, non-penultimate main stress in the output does not violate any output condition, and does not trigger a repair.

The final ranking for Mohawk is in (81).

(81) a. Timing slot-Clustered ≫ Prosodic Word-Headed ≫ *Obs $\left\{\begin{array}{c} \mathrm{r} \\ \mathrm{w} \\ ?\% \end{array}\right\}$

b. (i) Timing Slot; Clustered; $\begin{pmatrix} \text{Vowel} \\ \text{Left} \end{pmatrix}$ :: $\begin{bmatrix} \text{Form Doublet} \\ \text{Form Singlet} \\ \text{Epenethesise-V} \end{bmatrix}$; {*Tri}

(ii) PWd ; Headed ; Right :: $\emptyset \rightarrow \times$; {Nonfinal}

(iii) Obs; *Obs $\left\{\begin{array}{c} \mathrm{r} \\ \mathrm{w} \\ ?\% \end{array}\right\}$; Left :: Epenthesise-V

The analysis preserves the basic insight that the *e*-epenthesis in Mohawk comprises two independent processes. Epenthesis into triconsonantal clusters is analysed here as a repair on syllable structure: a V is inserted to syllabify the string. Since the syllabification condition is high-ranked, the syllabification rule (and repair epenthesis where applicable) will apply early. Main stress assignment follows, yielding penultimate stress at the post-syllabification stage of derivation. Epenthesis into biconsonantal clusters is implemented by an independent rule. However, as the condition on epenthesis is low-ranked, epenthesis applies after the main stress assignment, resulting in non-canonical (non-penultimate) main stress.

Stress is not approached here as a property of the syllable. Such analysis would seem welcome, as it is consistent with the Prosodic Hierarchy; stress must be deferred until after syllabification, because an ill-formed syllable cannot project a higher level gridmark. This type of ordering, however, is not universal as we have seen in the cases of Dakota and Yimas. Therefore, the conditions on syllabification and stress assignment are consequently treated here as independent; stress is a property of an abstract stressable element, rather than a property of the syllable.

4.5 Selayarese

Epenthetic vowels in Selayarese behave inconsistently with respect to determining the stress window for main stress assignment (canonically penultimate). The pattern cannot be modelled through mere ordering of stress and epenthesis, nor does it lend itself to a rule-sandwiching analysis of the Mohawk type. For this reason, Selayarese has been considered a particularly difficult case for serial approaches (Broselow, 2008). This section proposes a serial account of Selayarese, where epenthesis follows stress, thus making some epenthetic vowels invisible to prosodic structure (not counting for the stress window). However, in cases where epenthesis creates a ternary foot, an output condition against ternary feet is violated. That condition must be subsequently repaired by deletion and re-assignment of the prosodic structure. Epenthetic vowels inserted into binary feet create a defect and trigger re-assignment of prosodic structure. As a result, these epenthetic vowels are metrically visible and count for determining the stress window. The analysis is modelled in the defect-driven rule formalism. A set of repairs is proposed that can destroy an ill-formed prosodic structure which is subsequently re-assigned by the persistent rule on footing.

4.5.1 Analysis outline

The penultimate stress in Selayarese is disrupted by epenthesis into the final syllable, as illustrated by the data in (82).

(82)	a.	séntere	‘flashlight’
		kálasa	‘class’
		bérasa	‘rice’
		kábala	‘cable’
		kábara	‘news’
		kíkiri	‘metal file’
		balábasa	‘ruler’

Importantly, the data above involve epenthesis into final syllable *only*. When final epenthesis is accompanied by a word-medial epenthesis, the stress assignment is regular (83-a). Similarly, when epenthesis applies only word-medially, stress falls regularly on the penult (83-b).

(83)	a.	solodére	‘weld’
		koronéle	‘corner kick’
		karatísi	‘ticket’
		tarapála	‘tarpauline’
		tapasére	‘interpretetation’

b.		
	kará̲tu	‘card’
	surú̲ga	‘heaven’
	baká̲ri	proper name
	burú̲haŋ	proper name
	ramá̲li	proper name

Broselow (2008) argues that this case is a major challenge for rule-based phonology, as ordering epenthesis either after or before stress assignment makes false predictions. Broselow (2008) proposes that Selayarese avoids having epenthetic vowels in the head foot, hence final epenthesis results in a misaligned foot (84).

(84) (bó.to)lo̲

However, when there is no way to form a binary head foot without epenthetic vowels (there are no two adjacent syllables with non-epenthetic vowels), the stress pattern is canonical (85).

(85) solo̲(dé.re̲)
ka.(rá̲.tu)

The analysis proposed by Broselow (2008) requires an output constraint that militates against epenthetic vowels in prominent positions. However, such approach is problematic, as the constraint requires seeing derivational history. The position taken by the present work is that no output constraint should be able to see whether a vowel is epenthetic or not. Instead, an analysis is proposed that models the Selayarese data by ordering and constraints on metrical structure.

The crucial insight of the present analysis is that final epenthesis in Selayarese follows footing. Epenthesis into the final syllable applies to the righ of a foot, not affecting the metrical structure. However, epenthesis applying inside a foot creates a ternary foot which is subsequently destroyed and the metrical structure is rebuilt. The analysis is very much like Domino Condition proposed for Winnebago by Halle and Vergnaud (1987). An illustration using SPE-style rules is in (86).

(86)			
	Footing	⟨ × ×⟩ k a r.t u	⟨ × × ⟩ b o.t o l
	Epenthesis	⟨ × × ×⟩ k a.r a.t u	⟨ × × ⟩× b o.t o l
	Ternary foot erasure	× × × k a.r a.t u	—
	Footing	× ⟨ × ×⟩ k a. r a.t u	—
	Output	karátu	bótolo

The analysis can be rendered in the defect-driven rule format if Selayarese is analysed as having foot structure. The proposal is formalised in the following section.

4.5.2 Stress in Selayarese

In order to formalise the idea that Selayarese avoids ternary feet, foot structure must be posited for the language, even though Selayarese has no secondary stress. Foot structure was not posited in this work for other languages with main stress only (Swahili, Mohawk), though only to keep the structural assumptions minimal. The interaction of stress and epenthesis in Selayarese will be taken as evidence for foot structure, which will be assumed here to be right-to-left trochee. In addition, Selayarese will be analysed as a language where the word edges cannot serve as foot delimiters. This will be reflect by a condition on strict ×-delimiter adjacency accompanied by constraints on the distribution of delimiters:

(87) a. $\times\ ;\ \langle\text{-adjacent}\ ;\ \text{Right} :: \begin{bmatrix} \varnothing\rightarrow \langle \\ \varnothing\rightarrow \rangle \end{bmatrix}\ ;\ \{{*}\text{Uny},\ {*}\langle\%,\ {*}\%\rangle,\ {*}\rangle\times\%\}$

b. $\times\ \times\ \times \rightarrow \times\ \times\ \times\rangle \rightarrow \times\ \langle\times\ \times\rangle$

$\times\ \times\ \times\ \times \rightarrow \times\ \times\ \times\ \times\rangle \rightarrow \times\ \times\ \langle\times\ \times\rangle \rightarrow \langle\times\ \times\ \langle\times\ \times\rangle$

$\times\ \times\ \times\ \times\ \times \rightarrow \times\ \times\ \times\ \times\ \times\rangle \rightarrow \times\ \times\ \times\ \langle\times\ \times\rangle \rightarrow \times\ \langle\times\ \times\ \langle\times\ \times\rangle$

The rule applies right-to-left. The first defect is on the rightmost ×, and the defect can only be removed by inserting a right delimiter at the right edge. A left delimiter cannot be inserted there due to the constraint $*\langle\%$. It cannot be inserted left to the × either, due to *Uny. Therefore a right delimiter must be inserted, and it is inserted to the right of the rightmost ×, as the insertion to the left is prevented by $*\rangle\times\%$. The rule format ensures that the first inserted delimiter is always the rightmost $\rangle$. After this, a formation of binary feet through recursive insertion of $\langle$ removes all the remaining defects.

It might be that the requirement concerning foot delimiters on both edges is universal, and that foot and word edges must coincide (no right foot edges at the left edge of the word, no left foot edges at the right edge of the word). In an OT model, this kind of restrictions would be expected to be encoded in Gen. However, it is not clear where universality comes in the defect-driven rule formalism. Therefore, the policy adopted here is that derivations involve the minimal required number of delimiters, and all constraints are explicitly formulated, including $*\langle\%$ and $*\%\rangle$.

In the absence of secondary stress in Selayarese, no rule on head assignment will be postulated. Instead, there is a rule on main stress assignment, which is sensitive to foot boundaries. The rule is formulated in (88).

(88) $\text{Prosodic Word}\ ;\ \text{Headed}\ ;\ \text{Right} :: \varnothing\rightarrow \times\ ;\ \{\langle\overset{\times}{\times}\}$

The rule applies from right to left and it builds the head of the prosodic word right after the rightmost left delimiter (effectively it makes a trochee of the rightmost foot), as shown in (89).

(89)
$$\times\ \langle\times\ \times\rangle \rightarrow \times\ \langle\overset{\times}{\times}\ \times\rangle$$
$$\langle\times\ \times\ \langle\times\ \times\rangle \rightarrow \langle\times\ \times\ \langle\overset{\times}{\times}\ \times\rangle$$
$$\times\ \langle\times\ \times\ \langle\times\ \times\rangle \rightarrow \times\ \langle\times\ \times\ \langle\overset{\times}{\times}\ \times\rangle$$

Finally, a provision must be introduced against ternary feet. A ternary foot contains a defect in the form of a non-delimiter adjacent × (90).

(90) $\langle\times\ {}^{*}\times\times\rangle$

The current rule on footing cannot remove the defect, as its only available repair is right- and left- delimiter insertion. However, an insertion of a delimiter inside a ternary foot would violate *Uny, so the repair will not apply. Therefore a separate defect-driven rule will be introduced which erases previously assigned structure upon formation of a ternary foot. The rescue rule is in (91-a).

(91) a. Foot ; Bin ; Right :: $\begin{bmatrix} \rangle \rightarrow \emptyset \\ \langle \rightarrow \emptyset \end{bmatrix}$

b. $\langle\times\ \times\times\rangle \rightarrow \times\ \times\times$

After the rule erases previously assigned structure, the defect on non-delimiter adjacent gridmarks will trigger the re-application of persistent footing.

4.5.3 Syllabification conditioned epenthesis

Let us now turn to the condition that triggers epenthesis in Selayarese. The condition is proposed here to be syllable structure, much like in Swahili, Yimas and Mohawk. The syllable in Selayarese is mostly CVC, where codas can only be nasal and glottal codas[4]. Examples of forms with nasal codas are in (92).

(92) sam.pu.lo
tim.bo
paʔ.ri.si

Licensing of nasal and glottal codas is expressed by the Coda Condition (CodaCond) in (93).

(93) CodaCond

$$\text{IF Coda THEN} \begin{Bmatrix} \text{Nasal} \\ \text{Glottal} \end{Bmatrix}$$

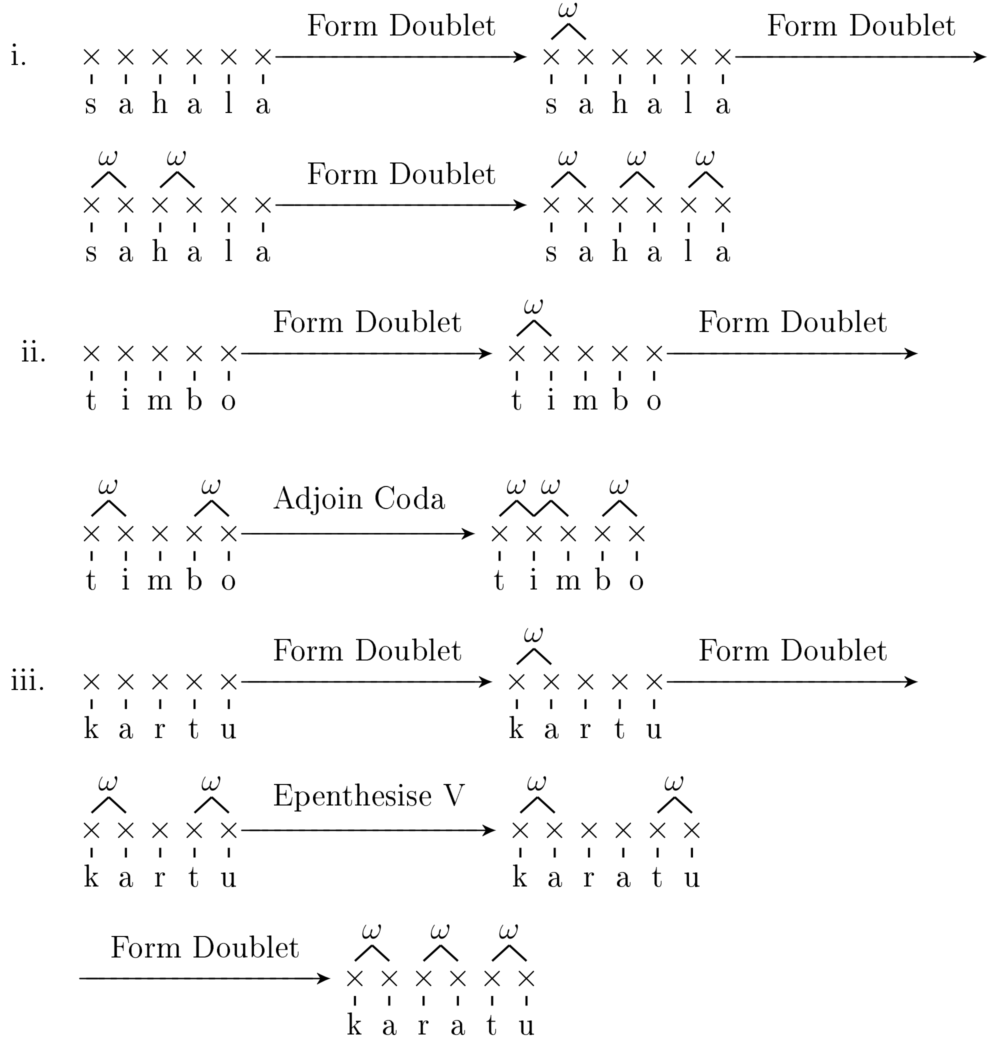
---

[4] This generalisation might need some refinement with respect to neighbouring segments, as nasal codas are also sometimes avoided, e.g. ram<u>a</u>li. Also, the present generalisation does not consider geminates

Coda condition is a licensing constraint on the syllabification rule (94-a). The rule creates CVC syllables. when codas are nasal or glottal, else CV syllables.

(94) a. Timing Slot, Clustered ; $\begin{pmatrix}\text{Vowel}\\ \text{Left}\end{pmatrix}$ :: $\begin{bmatrix}\text{Form Doublet}\\ \text{Form Singlet}\\ \text{Epenthesise V}\end{bmatrix}$; {CodaCond}

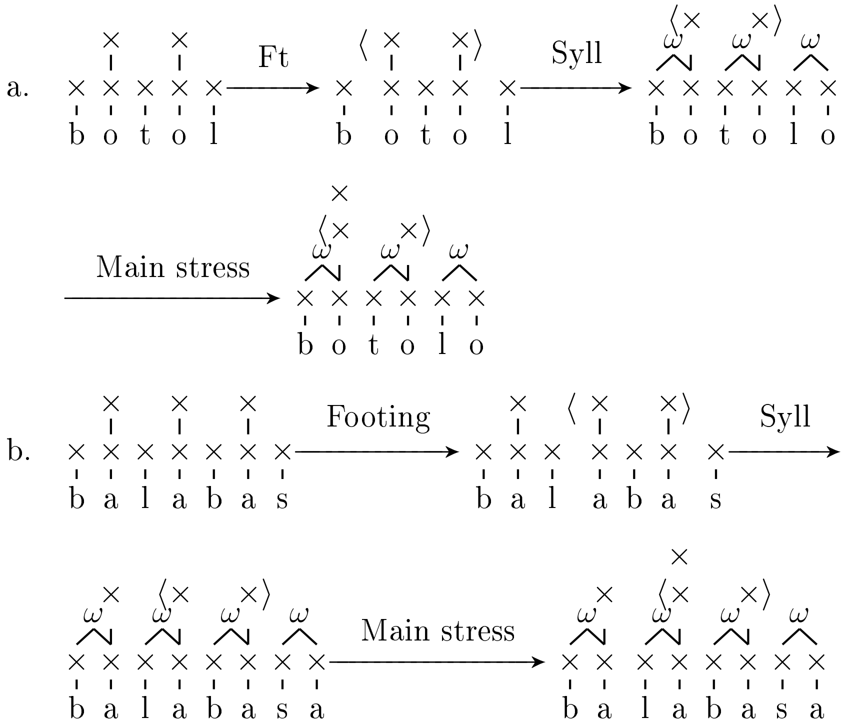
b. Sample derivations:



4.5.4 Interaction of stress and syllabification conditions

The interaction of stress and epenthesis in Selayarese follows from the ranking of the conditions involved. Foot assignment precedes syllabification, and syllabification is followed by main stress assignment. This ordering conditions the following non-canonical stress patterns (for expository purposes only the final result of the application of every rule is represented).

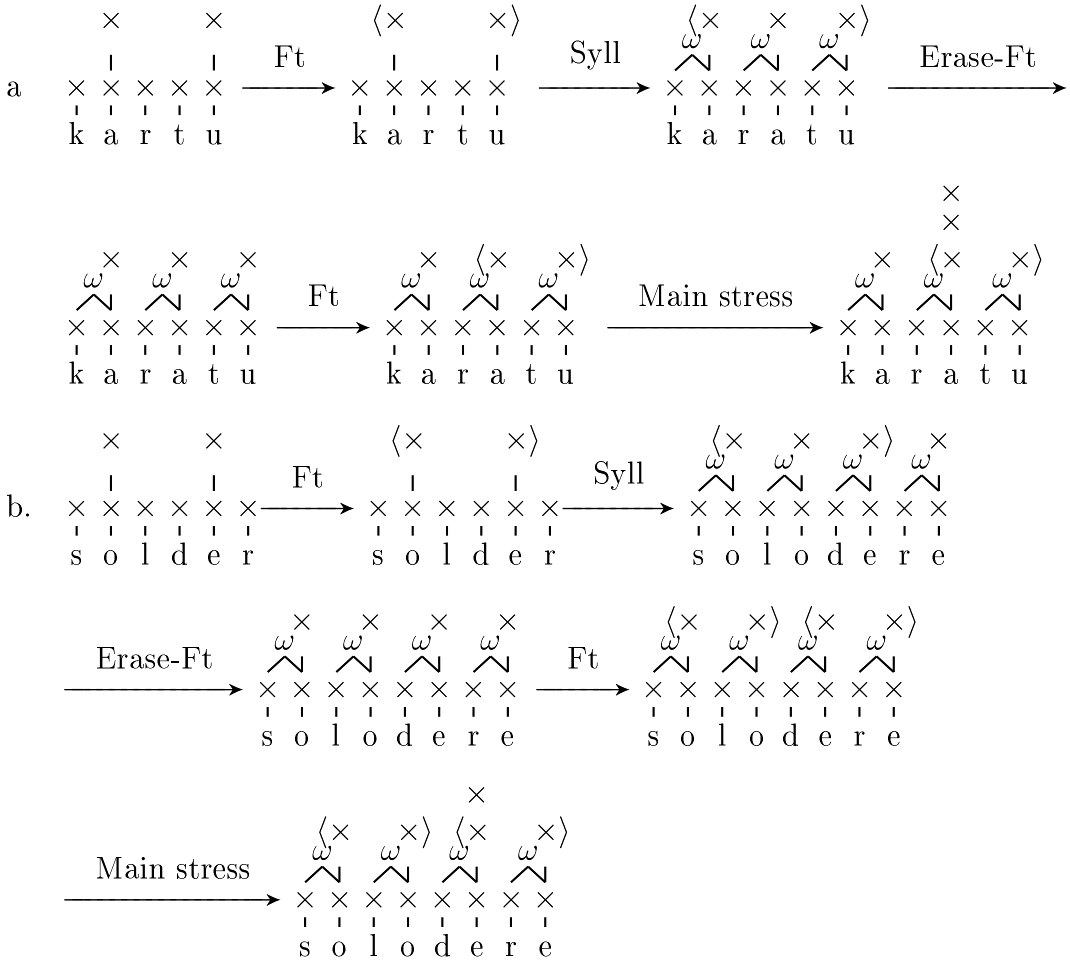
(95)



In the derivations above the conditions on footing and syllabification are disjunctive; the footing rule operates on abstract gridmarks projected by the nuclei, and the syllabification rule operates on timing slots projected by all segments. Footing applies prior to syllabification. The syllabification rule adds a gridmark to the right of the previously assigned foot, not deriving any defects in metrical structure. The late main stress rule assigns stress to the rightmost foot, which results in opaque antepenultimate surface stress.

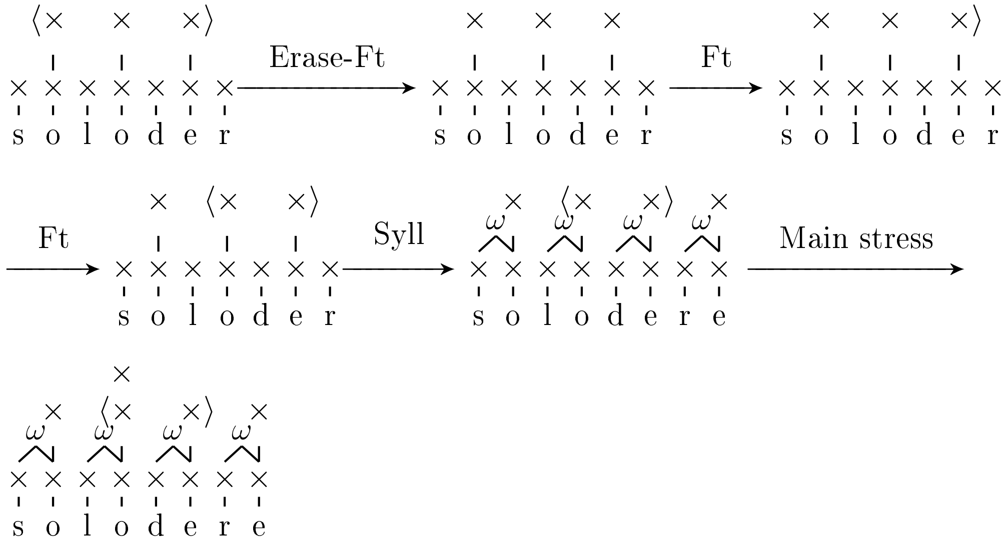
The situation is different when epenthesis adds a stressable element inside a previously assigned foot. Such addition creates a ternary foot, which violates a high-ranked condition against ternary feet. The condition triggers erasure of the foot structure, and the footing begins from scratch. The re-applying footing rule considers the epenthetic ×, and the stress falls regularly on the penult. A sample derivation follows.

(96)



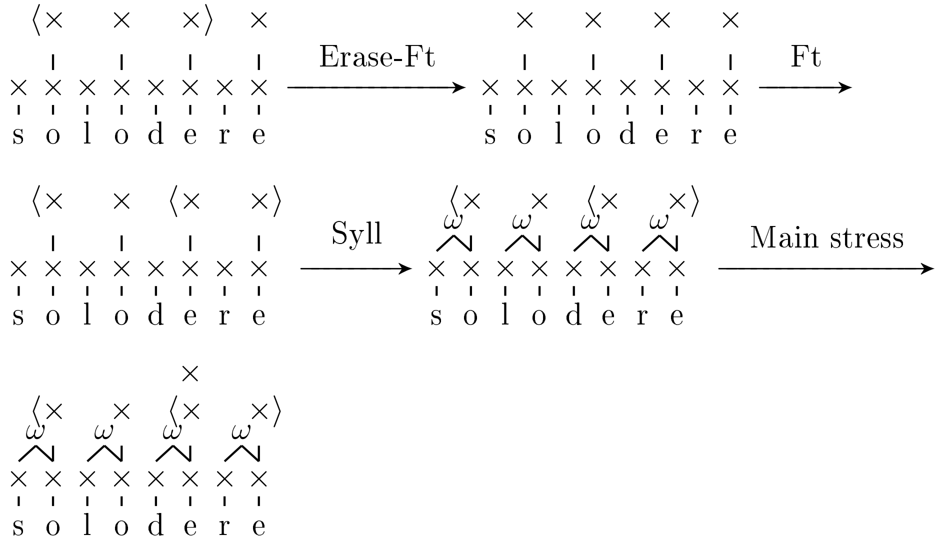
This type of rule interaction is conditioned by a ranking where the footing condition dominates the condition on syllabification. The condition on foot binarity must outrank the condition on footing, so that the whole of metrical structure can be erased before footing reapplies. This ranking creates a minor problem: if foot binarity ranks higher than the footing condition, and the footing condition ranks higher than the condition on syllabification, then foot binarity must by transitivity outrank syllabification. This means that the formation of a ternary foot by a repair on syllabification temporarily terminates the syllabification rule. This incorrectly predicts the derivation in (97).

(97)



The ranking predicts that the ill-formed foot is erased and footing applies before the final vowel is epenthesised. The problem is removed by the reversal of the syllabification rule, so that it applies from right to left. In that way the final vowel is epenthesised first. Epenthesis is to the left of a foot, so no defect in the prosodic structure is derived. Continuing syllabification rule epenthesises an ×, creating a ternary foot, which leads to the erasure of prosodic structure and a new round of footing. As a result, stress falls regularly on the penult, as shown in (98).

(98)



The final rule formulation and ranking for Selayarese is in (99).

(99) a. Foot-Bin ≫ ×-⟨ adjacent ≫ Timing Slot-Clustered ≫ Prosodic Word-Headed

b. (i) Foot ; Bin ; Right :: $\begin{bmatrix} \rangle \to \emptyset \\ \langle \to \emptyset \end{bmatrix}$

(ii) × ; ⟨-adjacent ; Right :: $\begin{bmatrix} \emptyset \to \langle \\ \emptyset \to \rangle \end{bmatrix}$; {*Uny, *⟨%, *%⟩, *⟩×%}

(iii) Timing Slot, Clustered ; $\begin{pmatrix}\text{Vowel}\\ \text{Right}\end{pmatrix}$ :: $\begin{bmatrix}\text{Form Doublet}\\ \text{Form Singlet}\\ \text{Epenthesise V}\end{bmatrix}$; {Coda-Cond }

(iv) Prosodic Word ; Headed ; Right :: $\emptyset \rightarrow \overset{\times}{\times}$; $\{\langle\times\rangle\}$

The basic insight is that Selayarese has foot structure and a high-ranked condition against ternary foot. Footing applies before epenthesis. If epenthesis creates a ternary foot, that foot is destroyed and metrical structure is built from scratch. In such a case, stress is regular, as the footing includes epenthetic vowels. However, when epenthesis applies outside a foot, no defects are derived in the metrical structure, so the main stress is assigned according to the early footing. All the rules apply from right to left.

The analysis derives the stress patterns found in words with epenthetic vowels without global constraints that punish epenthetic vowels in prominent positions. In that way well-formednes conditions on the output are strictly output oriented, i.e. they only evaluate the current output of the derivation, without evaluating the former status of the structure (e.g. the absence of epenthetic vowels underlyingly). All the patterns are derived through ordering of repairs on metrical structure, and no additional phonological relationships (e.g. prosodic faithfulness) need to be postulated.

4.6 Summary

The basic assumption of the defect-driven rules formalism is that processes are triggered by conditions on the output, and that defects in the input are removed in the order conditioned by a ranking. Rule ordering follows from ranking only. A rule can in principle apply persistently re-occuring at a later stage if a defective structure has been derived by another rule. The formalism provides a consistent and empirically adequate model of the typology of stress-epenthesis interactions found in Dakota, Swahili, Yimas, Winnebago, Mohawk, and Selayarese.

The defect-driven rule formalism achieves the level of analytic insight that comes from other serial aproaches in serial ordering of stress and epenthesis in Mohawk, Swahili and Dakota. The present analysis eschews output constraints that prohibit epenthetic vowels in prominent metrical positions, as proposed for Yimas (Alderete, 1999), or Selayarese (Broselow, 2008). Instead, the Yimas pattern is modelled as a result of the interaction of ordered persistent rules whose application is restricted by derivational constraints against unary feet. Similarly, what appears to be an avoidance of epenthetic vowels in foot heads in Selayarese is argued to be an epiphenomenon of conditions on footing, epenthesis, as well as an output condition that militates against ternary feet.

The formalism is quite uniquely successful in modelling the complex interaction of stress and Dorsey's Law in Winnebago by allowing that rules iterate strictly locally by applying persistently in derived environments. This type of rule interaction follows from ranking and the relevant formulation of rules. In Winnebago rules triggered by lower-ranked conditions (footing) produce an output that violates a higher-ranked condition. As a result, the two rules iterate only locally, repeating the iteration from left to right. This type of ordering obscures surface generalisations, creating opacity effects.

Importantly, the notion of opacity requires a substantial revision under the current formalism. Some default patterns found in a language are analysed here as a result, but not a target of rule application. An example is penultimate main stress in Mohawk. The pattern falls out from the interaction of rules and constraints: a right-to-left main stress rule assigns the main stress to the first available nucleus. However, main stress assignment to the final nucleus is blocked by the constraint Nonfinal, which is how main stress is assigned to the next available target, i.e. the penult. The penultimate nucleus is not explicitly targeted as the default for stress by any output condition. Therefore, if main stress is assigned to a non-penultimate nucleus in the course of the derivation, the irregularity is not a case of opacity, but rather non-canonicality that follows from the way constraints and repairs interact in the system. The non-canonicality does not violate any output constraint. In that way, the defect-driven rule formalism is different than, for example, Optimality Theory, where non-canonical stress would violate some markedness constraint, and so it would need to be licensed by some other high-ranked constraint.

An important prediction of the defect-driven rule formalism with respect to stress-epenthesis interaction is that epenthetic vowels can be entirely invisible to the main stress (epenthetic *e* in biconsonantal clusters in Mohawk), but they are at least partially visible to the structure where there is iterative footing (Yimas). The prediction follows from rule persistency. Footing re-applies whenever there are sufficient unfooted nuclei. Epenthesis inserts additional nuclei, thus creating defects which trigger the re-application of the footing rule. In contrast, models with non-persistent rules would predict the existence of systems where epenthetic vowels are entirely invisible to foot structure.

Finally, the defect-driven rule formalism is myopic. Any output well-formedness condition found in a language is only visible to the repairs that target that condition. Similarly, derivational constraints are only visible to repairs that these constraints are specified for. An example is Selayarese, where there is an output condition against ternary feet which triggers a deletion repair. However, this condition is not visible to repairs on other conditions, which is how a repair on the syllabification condition (epenthesis) can and does create a ternary foot in the derivation. This property of the defect-driven rule formalism differentiates it from, e.g. Harmonic Serialism, where derivation can only apply where it improves harmony across the board.

Chapter 5

Stress-epenthesis interactions in the phonological literature

This chapter discusses other formal accounts of stress-epenthesis interactions proposed in the literature. Section 1 focuses on the notion of faithfulness to prosodic heads, which has been proposed within the framework of Optimality Theory by Alderete (1995), and further developed by Alderete (1999), and Broselow (2008). Section 2 discusses the existing derivational accounts of Winnebago, focusing on the restructuring principle proposed by Hale and White Eagle (1980) and its famous reinterpretation by Halle and Vergnaud (1987) known as the Domino Condition. Section 3 turns towards the account of Winnebago as proposed by Halle and Idsardi (1995). The three approaches are discussed and evaluated against the approach pursued by the present work.

5.1 Parallel approaches to stress-epenthesis interaction

In Classic Optimality Theory (Prince and Smolensky, 2004 [1993]; McCarthy and Prince, 1993; Kager, 1999), the parallel interaction of constraints triggering epenthesis and stress only predicts metrical transparency of epenthetic vowels. This is because the markedness constraints responsible for stress assignment evaluate the output, where the epenthetic vowels have already surfaced. In order to account for metrical invisibility effects of (some) epenthetic vowels (Dakota, Mohawk, Winnebago), phonologists working within this framework have proposed the existence of more complex faithfulness constraints.

Faithfulness to prosodic heads is a notion going back to Alderete (1995), and further developed by Broselow (2008). The core concept is that metrically prominent positions in a prosodic word may be required to meet specific faithfulness requirements, e.g. a stressed vowel might be required to be underlyingly present. Alderete (1995) argues for the proposal on the basis of the well-attested phenomenon of unstressed vowel reduction [e.g. Russian; Jones and Ward (1969); Boyanus (1955); Kenstowicz and

Kisseberth (1979)]. Alderete's explanation is that stressed vowels, being prominent, have to be faithful to their underlying feature specifications, which is dealt with by a special faithfulness constraint that refers to prosodic heads only. The constraint schema is given in (1).

(1) Head(PCat)-Ident(F) (Alderete, 1995)
Correspondent segment in prosodic heads PCat agree in value for feature [F]. If PCat is a prosodic head, PCat contains β, and $\Re\beta$, then α and and β agree in the value of F.

For the cases of stress-epenthesis interaction, Alderete (1995) proposes a family of prosodic dependency constraints, which refer to the head syllable (i.e. the syllable bearing the main stress) and the head foot.

(2) a. Head-Dep
Every segment in the prosodic head has a correspondent in the input.

b. Head(σ)-Dep
Every segment in the head syllable has a correspondent in the input.

Using these constraints, Alderete (1995) derives a factorial typology, where different degrees of metrical visibility follow from the permutation of the constraints in (2). Unfortunately, the application of the analysis to particular case studies is not problem-free, as will be demonstrated on the examples of Mohawk and Winnebago.

5.1.1 Alderete (1995) on Mohawk

Let us consider Mohawk, where epenthesis into triconsonantal clusters is metrically visible, but epenthesis into biconsonantal clusters is not. This interaction is discussed in Chapter 4 of the present thesis, where it is proposed that epenthesis into triconsonantal clusters is conditioned by the rule on syllabification which precedes stress assignment. Epenthesis into biconsonantal clusters, on the other hand, is conditioned by a late rule (after stress assignment), which is why vowels epenthesised into biconsonantal clusters are metrically invisible. Alderete (1995) reanalyses this generalisations in prosodic terms and presents four classes of words containing epenthetic vowels. The partial metrical visibility effects are then attributed to the following ranking given in (3).

(3) Partial Metrical Transparency of Epenthesis in Mohawk (Alderete, 1995)

a. Constraints

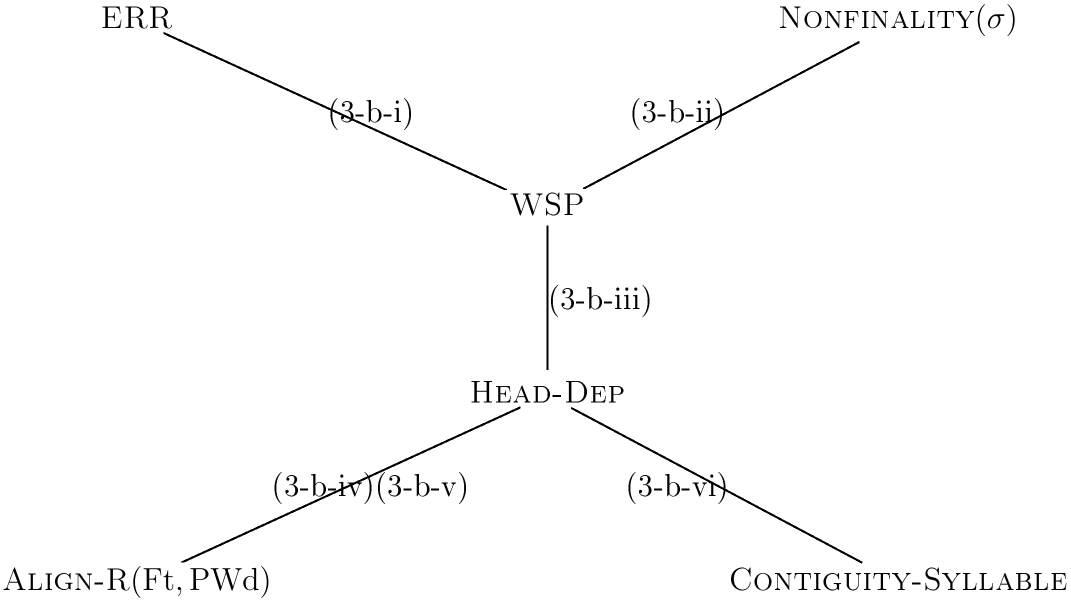
(i) End Rule Right (ERR)
Head foot is not followed by another foot.

(ii) Weight-to-Stress Principle
If heavy then stressed.
(iii) Contiguity-Syllable
Syllables in a foot are adjacent.

b. Ranking arguments (Curly brackets denote the head foot)

(i) ERR ≫ WSP :
(war){(hé̲r.noˀ)} ≻ {(wár)}(he̲r.noˀ)
(ii) Nonfinality(σ) ≫ WSP:
...{(σ́H)} ≻ ...σ{(H́)}
(iii) WSP ≫ Head-Dep :
waˀ{(hé̲r.hoˀ)} ≻ {(wáˀ)he̲r(hoˀ)}
(iv) Head-Dep ≫ Align-R(Ft,PWd):
waˀ{(kyéː.ri)}te̲ˀ≻ (waˀ.kye){(ríː.te̲ˀ)}
(v) Head(σ)Dep ≫ Align-R(Ft,PWd):
yo{(ˀá.we̲)}yV ≻ (yo.ˀa){(wé̲.yV)}
(vi) Head-Dep ≫ Contiguity-Syllable:
yo{(ˀá)we̲(yV)} ≻ (yo.ˀa){(wé̲.yV)}

c. Final ranking[1]



Mohawk stress (penultimate with lengthening of the stressed syllable) is analysed as having a right-aligned syllabic trochee. Stress-assignment is thus conditioned by an alignment constraint Align-R(F, PrWd), Foot Binarity (Ft-Bin) and Weight-to-Stress

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[1] It appears that Head(σ)-Dep is subsumed under Head-Dep in the ranking, though this relationship is not made explicit by Alderete.

principle (WSP). All the factors responsible for stress assignment and two types of prosodic faithfulness are involved in determining the metrical visibility effects.

Without going into the fine details of the analysis, let us point out some problems. Some questions relate to the use of the Weight-to-Stress Principle (Prince, 1990), whose high rank conditions a number of interactions. Crucially, WSP is responsible for stressing of the epenthetic vowel in some forms, as exemplified in (3-b-iii), even though this causes a violation to Head-Dep. An immediate objection to this analysis is that there is no independent evidence in Mohawk for the WSP. Heavy antepenults, or heavy ultima do *not* attract stress. Alderete reverses the argument, saying that this is no evidence *against* WSP, and proposes a twofold explanation for why WSP is normally not active in Mohawk. Heavy final syllables are not stressed due to the undominated Nonfinality(σ). The avoidance of stressing heavy antepenults is attributed to the stress window effect which follows from the ranking of ERR[2] over WSP.

(4) Stress-window effect

HLL	ERR	WSP
a. ☞ (H)(ĹL)		*
b. (H́)(LL)	*!	

However, the tableau in (4) does not consider two other candidates where one or two of the light syllables remain unparsed, both of which are locally more harmonic than the winner in (4), as illustrated by the tableau in (5).

(5) Stress-window effects vs. non-exhaustive parsing

HLL	ERR	WSP
a. ☜ (H)(ĹL)		*
b. (H́L)L		
c. (H́)LL		

At this stage the question arises which constraint in the global interaction makes candidates b. and c. more harmonic than a. It cannot be an Align-R constraint, whether categorical Align-R(PWd,Ft), or gradient Align-R(Ft). Align-R(Ft) is explicitly argued to be dominated by WSP. Align-R(PWd,Ft) is not discussed, but the condition is very much the same: some cases of stress-epenthesis interactions are analysed as misalignment caused by WSP and Head-Dep. This leaves the possibility of Parse-σ which prefers candidate a. to b. or c. in the tableau in (5), thanks to exhaustive pars-

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[2] Alderete (1995) uses the constraint Align-R(PrWd,{F}), which is violated by every foot that interferes between the right edge of the Prosodic Word and the head foot. In the present discussion the equivalent constraint ERR (End-Rule-Right) is used, mostly for the sake of clarity, given that two other Align-R constraints are considered

ing. Alderete (1995) proposes that Parse-σ dominate Align-R, but does not discuss how Parse-σ ranks with respect to WSP. Looking back at the tableau in (5), Parse-σ would have to dominate WSP for the candidate a. to win. However, once that ranking is introduced, problems arise for the original analysis, which relies on non-exhaustive parsing at places. An illustration involves the tableau in (6).

(6) Optimisation of non-exhaustive parsing in Alderete's (1995) analysis[3]

onrahtˀ	Head-Dep	Contiguity-Syllable
a. ☞ {(ó)ne(rah)}teˀ		*
b. (one)(ráhteˀ)	*!	

Dominating WSP, Parse-σ dominates by transitivity also Head-Dep (cf. the ranking in (3)). The winner in (6) would then lose, incurring a violation to the higher-ranked Parse-σ.

The Prosodic Faithfulness analysis relies on one controversial representational assumption, namely optimising discontinuous feet. An example is (6), where the winner builds a foot on two non-adjacent syllables to prevent the head foot from containing an epenthetic segment. The condition that a foot consists of two adjacent syllables is expressed by a violable constraint in Alderete's analysis (Contiguity-Syll). However, the adjacency of syllables in a foot is a standard enough assumption to be implicitly considered universal in most metrical analyses. The idea that this condition is violable is controversial enough to require substantial evidence (which Alderete (1995) does not give).

On the whole, the translation of the triconsonant-biconsonant variable in Mohawk into a weight-driven relationship does not appear particularly successful. The approach necessitates the use of WSP, even though canonical stress in Mohawk is weight-insensitive. High ranking of WSP entails a proliferation of rankings, such as high-ranking of Nonfinality(σ), which is needed to exclude final stress, an observation that simply falls out once Mohawk stress is analysed as a right-aligned syllabic trochee. Another controversial constraint involved is Contiguity-Syll, which predicts that feet are optionally built on adjacent syllables. What is more, the interaction of all these constraints with prosodic faithfulness only succeeds locally. Once stress-epenthesis based ranking arguments are compared with other facts in the language, it becomes obvious that the analysis involves ranking paradoxes.

The failure to deliver a successful account of the Mohawk facts challenges Faithfulness to Prosodic Heads as a complete theory of stress-epenthesis interaction in parallel OT[4]. Also, as we will see in the following section, the theory raises some concerns in

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[3] Curly brackets denote the head foot.

[4] The Mohawk case does not feature in a later article by Alderete (1999), where the notion of Head Dependence in stress-epenthesis interactions is further explored in the context of Dakota, Selayarese and Yimas.

its treatment of Winnebago in the work of Broselow (2008).

5.1.2 Broselow (2008) on Winnebago

Broselow (2008) applies prosodic faithfulness to other cases of stress-epenthesis interaction, crucially Selayarase and North Kyungsang Korean loanwords, as well as Winnebago native vocabuary. The Selayarase and North Kyungsang Korean cases are Broselow's primary studies, used against the derivational approaches. The Winnebago case is an extension of the approach, and is the case that will be addressed here.

Broselow proposes that Winnebago is also a case where epenthetic segments are dispreferred as foot heads. This is formally implemented by the high-ranking of the HeadSyll-Dep constraint given in (7).

(7) HeadSyll-Dep formulation by Broselow (2008)
Every segment contained in the head of a foot in S_2 has a correspondent in S_1 (epenthetic vowels cannot be the head of a foot).

An immediate challenge to the generalisation that epenthetic vowels cannot be heads is an abundance of Winnebago words, where the epenthetic vowels bear stress. Examples are in (8).

(8) Stressed epenthetic vowels in Winnebago

a.	hoǰisą̱́ną	‘recently’
	hirupį̱́nį	‘to twist’
	hačąké̱re	’with difficulty’
b.	mąąšá̱rač	‘you promise’
	boopé̱res	‘to sober up’
	haapú̱ruč	‘common elder’
c.	po̱ropó̱o̱ro	‘spherical’
	ki̱rikí̱rix	‘thick’ (as fluid)
	ke̱repą̱́ną	‘unit of ten’
	šu̱ruxú̱ruk	‘you earn’
d.	waki̱ripá̱ras	‘flat insect’
	giką̱nąką̱́nąp	‘shiny’
	waki̱rikí̱rik	‘slipper elm’

Broselow's (2008) solution to this problem is analysing Winnebago as a *postaccenting* system. The proposal is that the preferred docking sites for stress are not phonological heads, but the vowels following a foot. The idea is formally translated into the constraint ranking in (9).

(9) Postaccenting
PostAccenting $\gg$ HeadSyllAccent $\gg$ *Accent

a. PostAccenting
The syllable to the right of a foot should be accented.
b. HeadSyllAccent
The head of a foot should be accented.
c. *Accent
Vowels should not be accented.

Postaccenting opens the way for the analysis of exceptional stress in Dorsey's Law words as cases of misalignment conditioned by the avoidance of epenthetic vowels in the head positions.

Footing in Winnebago starts preferentially at the left edge and continues iteratively towards the right. The stressed syllable follows the foot, as shown in the tableau in (10).

(10)

hokwe	HeadSyll-Dep	Align-L	PostAccent	HeadSyllAccent
a. ☞ (hoke̲)wé				*
b. (hoké̲)we			*!	

However if the second syllable in the word is epenthetic, the high-ranked HeadSyllDep triggers misalignment of the initial foot. In consequence, the main stress is assigned to the fourth syllable counting from the left edge, as shown in (11).

(11)

wakripras	HeadSyll-Dep	Align-L	PostAccent	HeadSyllAccent
a. ☞ wa(ki̲ri)(pá̲ras)		*		**
b. wa(ki̲rí)(pa̲rás)		*	*!	
c. (waki̲)rí(pa̲rás)	*!			*
d. (waki̲)(rípa̲)rás	*!*			**

Postaccenting is critical here for ruling out candidate b. wa(ki̲rí)(pa̲rás), with the main stress on the head of the initial foot.

Unfortunately, this theoretical take is not problem-free. Postaccenting is somewhat resemblant of the phenomenon known as peak delay. Peak delay is a case when the F_0 peak (one of the phonetic correlates of stress) ocuurs after the prosodically prominent syllables, sometimes causing a mismatch between the prosodically and perceptually prominent syllable (Silverman and Pierrehumbert, 1990; de Jong, 1994; Prieto et al., 1995). Broselow (2008) does not make it clear that her proposal of postaccenting in Winnebago is peak delay, as identifying peak delay is not possible without a phonetic analysis. Still, the treatment of postaccenting in Winnebago is troubling *vis à vis* any peak delay cases, as postaccenting is being analysed by Broselow (2008) as a phonological phenomenon. The accent is not merely a phonetic delay with respect to the phonological prominence. The constraints in (9) can see accent, so accent must be some kind of phonological object, which is entirely independent of metrical structure: it can be associated with some parts of structure, but does not have to be. In such a view of accent, the existence of metrical structure loses some of its significance. Also, once accent is viewed as an independent object that can be freely associated with either heads or non-heads, a number of insights in the metrical theory are lost, as one of the basic assumptions of the theory is that phonological prominence can only be associated with head constituents.

Just as in the case of discontinuous feet (Alderete, 1995), phonological postaccenting compromises so many fundamental assumptions of the metrical theory, that considerable evidence would be needed to adopt it. However, the only argument seems to be that postaccenting, together with left-alignment avoids positing initial extrametricality. The gain, however, is modest, given that noninitiality is posited nonetheless, in the form of the constraint NoInitialAccent. Otherwise, postaccenting is only justified by the fact that it allows to derive the Winnebago facts using only two levels, though there is also a degree of circularity involved in reasoning that epenthetic vowels cannot be heads, and therefore syllables are not heads whenever they contain an epenthetic vowel.

Otherwise, having assumed the left-to-right iambic analysis and postaccentuating, the analysis by Broselow (2008) needs ultimately to resort to using a number of additional constraints, none of which are independently motivated. Examples include the previously mentioned NoInitialAccent, OCP, or HeavyHeadAccent which attracts stress to heavy syllables, but only when they are heads.

5.1.3 Predictive power of faithfulness to prosodic heads

One of the main arguments of Alderete (1995) in favour of prosodic faithfulness is that it allows us to derive a neat typology of stress-epenthesis interactions. This argument is seriously challenged by the wrong predictions the approach makes for Mohawk, as argued in 5.1.1. Also, the analyses discussed in the present section do not simply follow from a permutation of a few constraints. On the contrary, the approach entails quite a few otherwise unmotivated constraints. In some cases (WSP in Mohawk), these constraints introduce paradoxes when compared with the previously established constraint interaction pattern for canonical stress assignment. What is more, in the two study cases, prosodic faithfulness necessitates rather dubious ad hoc theoretical assumptions (discontinuous feet, postaccenting), assumptions that seem to be made to save an analysis that has already failed for other cases. The analysis only works neatly for Selayarese. However, Selayarese does not present an insurmountable challenge for a serial approach either, as demonstrated in Chapter 4.

5.2 Metrical conditions on epenthesis in Winnebago

This section addresses the derivational analyses of Winnebago in the literature, specifically towards the metrically conditioned account of stress-Dorsey's Law interaction (Hale and White Eagle, 1980; Halle and Vergnaud, 1987). Both of these accounts involve similar insights embedded in different representational approaches: Hale and White Eagle (1980) represent prosodic structure by means of trees, while Halle and Vergnaud (1987) represent stress on a bracketed grid. Both accounts analyse Winnebago stress as a non-initial left-to-right iambic system, which translates into following sample representations of foot structure, represented here on a grid.

(12) Left-to-right iambs in Winnebago

```
             ×
        ×⟨×  ×⟩
a.      či i.ną k       'town'
              ×
        ×  ⟨× ×⟩
b.      wan į.gį k      'bird'
             ×
        ×⟨×  ×⟩ ×
c.      xǰa a.ną ne     'yesterday'
              ×
        ×  ⟨× ×⟩ ×
d.      wišč į.ge ga    'Hare'
```

The metrically conditioned analyses propose that the assignment of foot structure precedes Dorsey's Law. Alone, this assumption predicts that vowels epenthesised by Dorsey's Law will be transparent to stress assignment (they will create exceptional surface stress patterns) like in the derivation in (13).

(13)

```
UR                  /hikroho/
                            ×
                     ×  ⟨×  ×⟩
Stress assignment   hikr o.ho
                               ×
                     × × ⟨×   ×⟩
Dorsey's Law        hi kor o.ho
--------------------------------
Output              hikorohó
```

However, as we have seen, some vowels inserted by Dorsey's Law are visible to metrical structure. Hale and White Eagle (1980) and Halle and Vergnaud (1987) attribute this effect to a prosodic repair that fixes ill-formed prosodic constituents derived by the application of Dorsey's Law. The 'ill-formed constituents' correspond effectively to ternary feet. The assumption, illustrated in (13) is that an epenthetic vowel inserted to the left of a bounded constitutent (a foot) is invisible to stress assignment. However, if the base vowel in an underlying Dorsey's Law syllable is stressed, the epenthetic DL vowel is inserted inside a constituent, as in the example in (14).

(14)

UR	/hoǰisną/
Stress assignment	× × ⟨× ×⟩ h o ǰ i .sn ą́
Dorsey's Law	× × ⟨× × ×⟩ h o ǰ i .s a n ą́

The result of Dorsey's Law is thus a ternary constituent, which triggers an application of a subsequent restructuring principle (Hale and White Eagle, 1980), called the Domino Condition by Halle and Vergnaud (1987). The Domino Condition destroys the ill-formed constituent, as well as all the structure to its right (in a left-to-right system), to reintroduce the prosodic structure there. A sample derivation follows in (15).

(15)

UR	/hoǰisną/
Stress assignment	× × ⟨× ×⟩ h o ǰ i .sn ą́
Dorsey's Law	× × ⟨× × ×⟩ h o ǰ i .s a n ą́
Domino Condition	× × ⟨× ×⟩ × h o ǰ i .s a n ą́
Output	hoǰisą́ną

Unfortunately, as pointed out by Miner (1989), these analyses makes false predictions in the case of word-initial Dorsey's Law sequences. According to Halle and Vergnaud (1987), the word-initial mora in Winnebago is extrametrical. Therefore, epenthesis to the left of that mora does not apply inside any constituent, so it is predicted not to trigger the Domino Condition, resulting in an irregular surface stress. However, this prediction is not borne out by the data in (16), as word-initial Dorsey's Law sequences are visible to prosodic structure.

(16) a.

UR	/xroǰike/
Stress assignment	× × ⟨× ×⟩ xr o ǰ i .k e
Dorsey's Law	× × × ⟨× ×⟩ x o r o ǰ i .k e
Domino Condition	—
Output	*xoroǰiké
Attested	xoroǰíke

b.

UR	/krikrix/
Stress assignment	$\begin{array}{ccccc} & & & \times & \\ & \times & & \langle\times\rangle & \\ \text{kr} & \text{i} & \text{kr} & \text{i} & \text{x} \end{array}$
Dorsey's Law	$\begin{array}{ccccccccc} & & & & & & & \times & \\ & \times & & \times & & \times & & \langle\times\rangle & \\ \text{k} & \text{i} & \text{r} & \text{i} & \text{k} & \text{i} & \text{r} & \text{i} & \text{x} \end{array}$
Domino Condition	—
Output	*kirikiríx
Attested	kirikírix

Domino Condition is used in the present work in the analysis of Selayarese. However, for empirical reasons the Domino Condition is not adopted here in the analysis of Winnebago.

5.3 Dorsey's Law in the delimiter-first prosodic algorithm (Halle and Idsardi, 1995)

Halle and Idsardi (1995) provide a novel and empirically adequate account of the Winnebago stress assignment in Dorsey's Law words. The account is rooted in an original prosodic algorithm, where stress is represented on a bracketed grid. The idea is that stressable elements project a series of abstract marks. These marks are grouped into units by means of delimiter (parenthesis) insertion. One of the marks inside a consituent then projects onto the next level (level 1), where, again, marks are grouped into units. Finally, one of the marks of level 1 projects onto the next level. The projecting grid marks correspond to the prominence-bearing units in a prosodic word. According to the Halle and Idsardi (1995) algorithm, languages differ in which delimiter (left/right) determines the footing, and which element (left/right) projects the head at what level. These are expressed in terms of parameter settings. The following derivation is an illustration of how the algorithm is applied.

(17) a. Project:

$$\begin{array}{ccccccccccccccc} \times & & & \times & & \times & \times & & & \times & & & \times & & \text{line 0} \\ \text{a} & \text{u} & \text{t} & \text{o} & \text{b} & \text{i} & \text{o} & \text{g} & \text{r} & \text{a} & \text{p} & \text{h} & \text{i} & \text{c} & \end{array}$$

b. Group:

$$\begin{array}{ccccccccccccccc} (\times & & & \times & & (\times & \times & & & (\times & & & \times & & \text{line 0} \\ \text{a} & \text{u} & \text{t} & \text{o} & \text{b} & \text{i} & \text{o} & \text{g} & \text{r} & \text{a} & \text{p} & \text{h} & \text{i} & \text{c} & \end{array}$$

c. Project:

```
 ×              ×           ×                 line 1
(×        ×    (×  ×       (×        ×        line 0
 a  u  t  o  b  i  o  g  r  a  p  h  i  c
```

d. Group:

```
 ×              ×           ×)                line 1
(×        × (×  ×       (×        ×           line 0
 a  u  t  o  b  i  o  g  r  a  p  h  i  c
```

e. Project:

```
                            ×                 line 2
 ×              ×           ×)                line 1
(×        ×    (×  ×       (×        ×        line 0
 a  u  t  o  b  i  o  g  r  a  p  h  i  c
```

With the basic properties of the algorithm in mind, let us consider how Winnebago stress is derived. The crucial factor is the foot structure determined at line 0. Every syllable of the underlying representation projects a grid mark at line 0. Winnebago is weight-sensitive, which is formally captured by the heavy syllables (long vowels and diphthongs) projecting a left delimiter. This operation is followed by the edge marking, and iterative constituent construction (ICC, left-to-right). Halle and Idsardi (1995) treat Dorsey's Law sequences like heavy syllables, which means that DL sequences project a left parenthesis at line 0 (unless they are word-final, which is governed by a separate constraint against orphans, Avoid (×#. Dorsey's Law applies after the initial left-delimiter projection but before the edge marking. In that way, epenthesis is sandwiched, as it were, between two stages of the prosodic structure assignment.

(18) Sample line 0 operations in Winnebago (Halle and Idsardi, 1995)

Project:L	× × × h o j i s n a	⟨× × k r e p n a	× ⟨× × h i k r o h o	× ⟨× × w a k r i p r a s
DL	× × × × h o j i s a n a	× ⟨× × × k e r e p a n a	× × ⟨× × h i k o r o h o	× × ⟨× × × w a k i r i p a r a s
Edge LRL:	× ⟨× × × h o j i s a n a			
ICC:R	× ⟨× ×⟩ × h o j i s a n a	× ⟨× ×⟩ × k e r e p a n a	× × ⟨× ×⟩ h i k o r o h o	× × ⟨× ×⟩ × w a k i r i p a r a s
Head:R	× × ⟨× ×⟩ × h o j i s a n a	× × ⟨× ×⟩ × k e r e p a n a	× × × ⟨× ×⟩ h i k o r o h o	× × × ⟨× ×⟩ × w a k i r i p a r a s

This presentation of the Halle and Idsardi (1995) formalism and analysis of Winnebago is rather sketchy, as it only intends to give a basic idea of what kind of formal assumptions are involved in the Halle and Idsardi (1995) analysis. The major asset of the analysis is its descriptive adequacy. Halle and Idsardi (1995) provide a very careful discussion of different prosodic environments where DL applies and give derivations of all the classes, with correct results in all cases. Also, the approach is extendable to other cases of partial metrical visibility of epenthesis. For example, Mohawk would involve a parenthesis projection by triconosonantal clusters, but not biconsonantal clusters, followed by epenthesis. Cases of metrical full metrical (in)visibility are also easily captured by the ordering of stress and epenthesis.

Nevertheless, the Halle and Idsardi (1995) formalism is not pursued by the present work. The main reason for this is the generality of scope. The defect-driven rule format is used in this work to account for both, stress assignment *and* epenthesis. The Halle and Idsardi (1995) formalism, on the other hand, focuses on stress assignment only; its application in e.g. syllabification does not seem to have been considered as yet. Interesting as it would be to explore the possible extentions, it is not a goal of the present thesis which is concerned with testing some of the predictions made my defect-driven rules and rule persistence.

5.4 Summary

The typology of stress-epenthesis interactions involves some complex cases of partial metrical visibility effects that have been discussed at length in the previous chapters of this work. Serial approaches provide a uniform way of analysing the cases involved according to the ordering of stress and epenthesis rules. Faithfulness to prosodic heads is intended for the same purpose within parallel OT. However, as we have seen in 5.1, faithfulness to prosodic heads suffers from a degree of undergeneration, as it in its current shape fails to account for all the relevant data in Mohawk. What is more, faithfulness to prosodic heads involves positing a whole new phonological relationship, which is not very well supported by the data. On the contrary, applying the head faithfulness approach to phonological alternations results in highly complex analyses with non-standard representational assumptions. A serial approach orders well-attested phonological processes rather than posit complex hierarchical faithfulness distinctions. The only theoretical assumption a serial approach has to make is, indeed, that phonological derivations are serial. However, since that assumption is supported by a wide range of phonological processes inaccesible to parallel approaches (e.g. phonological opacity), the assumption is not unfounded. Therefore, the position taken in this work is that a serial approach to stress-epenthesis interactions provides better empirical results than a parallel account, and it does so with fewer theoretical assumptions.

In comparison to Domino Condition (Section 5.2), the defect-driven rule-based analysis fares better empirically, in escaping the undergeneration issues of Halle and Vergnaud (1987). The current analysis presents also an alternative to the formalism of Halle and Idsardi (1995), in developing an account based on serial interaction of persistent rules.

Chapter 6

Serial constraint-based alternatives

As argued in the previous chapter, the range of data on stress-epenthesis interaction elude Classic Optimality Theory(Prince and Smolensky, 2004 [1993]; McCarthy and Prince, 1993; Kager, 1999). However, we have yet to consider serial constraint-based models other than the defect-driven rule formalism. The purpose of this chapter is to review two serial constraint-based approaches that feature prominently in recent literature, i.e. Stratal Optimality Theory (Kiparsky, 2000; Bermúdez-Otero, forthcoming) and Harmonic Serialism (McCarthy, 2000, in press; Kimper, 2008; Pruitt, 2008). Both theories combine the OT architecture with serial ordering restricted by means of morphophonological strata (Stratal OT) or gradualness (HS). A Stratal OT and an HS analysis of selected stress-epenthesis data are attempted in this chapter in order to test how serial OT fares compared to the defect-driven rules formalism.

Section 1 considers the cyclic constraint-based approach of Stratal Optimality Theory. It is shown how the stress-epenthesis data can be technically modelled within the Stratal OT architecture. However, on the basis of the current data, the domains for the application of stress and epenthesis do not seem to have very clear morphosyntactic correlates. Therefore, the Stratal-OT analysis of the present data remains ad hoc unless independent morphological evidence is uncovered by further research.

Section 2 introduces the formalism of HS, and attempts to model some of the attested opacity effects within the framework. It is shown that HS falls short of generating the attested data, due to global evaluation and the way Faithfulness violations are assessed. In addition, it is argued that some basic conceptual issues (harmonic ascent, gradualness) remain to be satisfactorily resolved.

6.1 Stratal OT

6.1.1 Introduction

Stratal OT (Kiparsky, 2000; Bermúdez-Otero, forthcoming) introduces derivations into OT by positing different strata in grammar with potentially different constraint rankings of the same constraint set. Phonology recurs at different levels corresponding to different morphosyntactic domains. The output of the first stratum serves as the input to the next one. The grammar at any stratum is a classic OT grammar; phonological processes are analysed through constraint interaction, and in that way the element of parallel evaluation is preserved.

Stratal OT provides quite a straightforward way of modelling opacity, by allowing different constraint rankings at different strata. The way opacity is implemented is by restricting the application of some phonological processes to one stratum only, by means of constraint re-ranking. The constraint ranking at Stem Level models a phonological process A, and the ranking at Word Level models a phonological process B. If A counterfeeds, or counterbleeds B, the result is surface opacity.

6.1.2 Stress-Dorsey's Law interaction in Stratal OT

This section provides an account of the Winnebago data within Stratal OT, Winnebago being probably the most convincing case for the defect-driven rule formalism. The key to analysing the interaction of stress and Dorsey's Law in Stratal OT is the proposal that Dorsey's Law applies first in rising sonority sequences that precede the edgemost vowels (DL1). That application of DL is followed by stress assignment and by the application of DL in all the remaining environments (DL2), producing a rule sandwiching effect, as in (1).

(1)

Input	/šwazokǰį/	/krepną/	/wakripras/
DL1	šawazokǰį	kerepąną	wakriparas
Stress	šawazókǰį	kerepą́ną	wakripáras
DL2	—	—	wakiripáras
Oytput	[šawazókǰį]	[kerepą́ną]	[wakiripáras]

The architecture of Stratal OT provides a way of modelling rule sandwiching. The serial application of DL1 (context-specific) and DL2 (general) is implemented by means of splitting them into two different strata: DL1 applies at level 1 (which is assumed to correspond to Stem Level), and DL2 applies at level 2 (assumed to be Word Level). Stress is assigned at the Stem Level. Analysing DL1 and stress assignment simultaneously, constraints at Stem Level eliminate rising sonority consonant clusters preceding initial and final nuclei. DL1 is implemented by means of two positional constraints defined in (2).

(2) a. $*\text{CRV}_{\text{init}}$

An initial nucleus is not preceded by a rising sonority consonant cluster.

b. $*\text{CRV}_{\text{fin}}$

A final nucleus is not preceded by a rising sonority consonant cluster.

The two constraints in (2) are positional variants of a more general constraint against rising sonority consonant clusters, defined in (3).

(3) *CRV
A nucleus is not preceded by a rising sonority consonant cluster

The faithfulness constraint against epenthesis is Dep-V.

(4) Dep-V (McCarthy and Prince, 1995)
Every output vowel has a correspondent in the input.

The discussion of constraints responsible for stress assignment will be left aside here, as whatever constraints are used does not influence the stress-epenthesis interaction processes which are the subject of the analysis. The following constraint will be used as a shorthand for the set of constraints that yield main stress on the peninitial mora.

(5) Stress$[_{\mu\mu\acute{\mu}}$
Stress the third mora from the left.

Ranking of the positional constraints in (2) above Dep-V, and ranking Dep-V above the general constraint *CRV has the effect of DL1; it epenthesises a vowel to break up rising sonority onsets in strong positions only.

(6) DL1 (Stem Level)

	wakripras	*CRV$_{\text{init}}$	*CRV$_{\text{fin}}$	Stress$[_{\mu\mu\acute{\mu}}$	Dep-V	*CRV
a.	☞ wa.kri.pá.ras				*	*
b.	wa.ki.rí.pa.ras				**!	
c.	wa.kri.pa.ras			*!	*	*
d.	wa.kri.prás		*!			**

At the Stem Level DL is prevented from applying in weak positions. Candidate b. is subomptimal, because the global application of DL incurs an extra Dep-V violation, as compared to the winner. Candidate c. loses by not assigning stress at the Stem Level, and thus violating the undominated Stress$[_{\mu\mu\acute{\mu}}$. The faithful candidate d. loses by violating the undominated constraint *CRV$_{\text{fin}}$, by epenthesising into the final syllable.

Ranking *CRV above Dep-V has the effect of Dorsey's Law applying globally, as the ranking eliminates all rising-sonority consonant clusters regardless of position. The domination of *CRV above Dep-V makes the ranking of *CRV, *CRV$_{\text{init}}$ and *CRV$_{\text{fin}}$, irrelevant, due to the stringency relations, since any violation of the positional constraints of a violation to the global one.

DL2 applies at the Word Level, only after DL1 has applied. The surface opacity in Winnebago follows from the counterfeeding ordering of stress and DL2. The Stratal OT way of capturing this is rendering the stress assignment rules inactive at the Word Level.

This is implemented by the high-ranking of the faithfulness constraint Ident(Stress), which preserves the stress once it has been assigned to a syllable.

(7) Ident(Stress)
Every stressed element in the input is stressed in the output, and every stressed element in the output is stressed in the input.

This constraint is inactive at Stem Level, as the input (=Underlying Representation) has no stress (which is also why Ident(Stress) cannot be crucially ranked st Stem Level). At Word Level Ident(Stress) becomes active, as the input (=output of the Stem Level stratum) has been assigned stress. Ident(Stress) outranks Stress$[_{\mu\mu\acute{\mu}}$, preserving the previously assigned stress, as illustrated in (8).

(8) DL2 (Word Level)

wakripáras	*CRV	Ident(Stress)	Dep-V	Stress$[_{\mu\mu\acute{\mu}}$
a. ☞ wakiripáras			*	*
b. wakiríparas		*!	*	
c. wakripáras	*!			

Where there is no environment for the application of DL1, the Stem Level grammar will only assign stress, which is then preserved faithfully, after DL2 has applied at Word Level, as shown in (9).

(9) a. Stem Level

hošwaza	*CRV$_{\text{init}}$	*CRV$_{\text{fin}}$	Stress$[_{\mu\mu\acute{\mu}}$	Dep-V	*CRV
a. ☞ hošwazá					*
b. hošawáza				*!	

b. Word Level

hošwazá	*CRV	Ident(Stress)	Dep-V	Stress$[_{\mu\mu\acute{\mu}}$
a. ☞ hošawazá			*	*
b. hošawáza		*!	*	
c. hošwazá	*!			

6.1.3 Problems

The rule-sandwiching analysis of Dorsey's Law run into problems in deriving the form [wakiripóropòro], with three DL sequences. The analysis incorrectly predicts main stress on the fifth mora, as shown in (10).

(10) Derivation of [wakiripóropòro]

Input	/wakripropro/
DL1	wakriproporo
Stress	wakripróporò
DL2	wakiriporóporò
Output	*[wakiriporóporò]
Attested	wakiripóropòro

In (10) DL1 applies in the final syllable, skipping two other potential context for the application of Dorsey's Law. The subsequent stress assignment rule assigns main stress to the third mora at this stage of derivation. After DL2, however, the stressed mora becomes the fifth mora. In that way, the analysis incorrectly predicts the main stress assignment.

The exact same is the problem that Stratal OT has with this particular form, if using the constraint *CRV$_{\text{fin}}$. A potential solution could be implementing the generalisation that DL1 prevents consonant clusters preceding a stressed vowel more directly, by using the constraint [*CRV]/$\acute{\sigma}$ introduced in (11).

(11) *CRV́
A stressed nucleus is not preceded by a rising sonority consonant cluster.

However, that solution fails, as the there are too many repair strategies to satisfy the restriction against consonant clusters preceding stressed vowels. The constraint can be satisfied either by epenthesising a vowel into the underlyingly second or third syllable, as shown in (12).

(12) Stem Level

wakripropro	*CRV$_{\text{init}}$	*CRV́	STRESS[$_{\mu\mu\acute{\mu}}$	DEP-V	*CRV
a. ☞ wa.kri.pó.ro.pro				*	**
b. ☞ wa.ki.rí.pro.pro				*	**
c. wa.kri.pró.pro		*!			***

Under this analysis, stress is assigned at the Stem Level and preserved faithfully at the Word Level. Therefore, the output of the Stem Level is candidate a. However, candidate b. is also optimal under the constraint ranking, but it is not a possible input to the Word Level, predicting incorrect stress in the ultimate output in (13).

(13) Word Level:

wa.ki.rí.pro.pro	*CRV	IDENT(Stress)	DEP-V	STRESS[$_{\mu\mu\acute{\mu}}$
a. ☜ wa.ki.ri.pó.ro.po.ro		*!	**	*
b. ☞ wa.ki.rí.po.ro.po.ro			**	

The attested winner a. is suboptimal in comparison with candidate b. which faithfully preserves the stress from the input.

What is more, the use of the constraint *CRV́ causes the same problem for the forms like /wakiripáras/, as illustrated in (14).

(14) Stem Level

wakripras	*CRV$_{\text{init}}$	*CRV́	STRESS[$_{\mu\mu\acute{\mu}}$	DEP-V	*CRV
a. ☞ wa.kri.pá.ras				*	*
b. ☞ wa.ki.rí.pras				*	*
c. wa.kri.prás		*!			**

Again, there is a tie between candidates a. and b., where both avoid a consonant cluster preceding a stressed syllable. However, as follows from (6), the attested candidate is the one which epenthesises first into the final syllable, which is an argument for the use of the constraint *CRV$_{\text{fin}}$ rather than *CRV́.

Coming back to the problem of [wa.ki.ri.pó.ro.po.ro], there are possibly other solutions that Stratal OT could pursue. Firstly, [wa.ki.ri.pó.ro.po.ro] is clearly a morphologically complex form, and can be analysed as a combination of two prosodified words: [wa.ki.rí] 'insect' and [po.ro.póo.ro] 'spherical'. Still, such analysis would need to account for why the stress is deleted from the canonically stressed mora (third mora), and preserved in the exceptional position (fourth mora). Technically, this could be achieved by analysing the compound by independent assignment of stress to the form derived from the underlying /wakripro/, and later merged with the reduplicative element po.ro. Again, however, an analysis like this would require independent support in the form of independent morphophonological evidence.

6.1.4 Evaluation and directions for research

One major problem of the analysis in the previous section is that the analysis does not comply with the basic assumption of Stratal OT that subsequent levels of grammar correspond to independently motivated morphosyntactic domains. Therefore, the analysis suffers from a degree of arbitrariness in the assignment of strata.

The present analysis does not exclude that there is a cyclic effect in the Winnebago data, or in all the others opaque cases of stress-epenthesis interaction. Evidence for cyclicity would certainly add to the level of insight reached by any serial formalism, including Stratal OT and defect-driven rules. Technically, both theories capable of deriving the pattern found in Winnebago, and probably all the other languages considered in this thesis. Regrettably, pursuing a detailed morphosyntactic analysis of all the languages considered is a project well beyond the scope of this thesis. The possibility, however, remains open for future investigation.

6.2 Harmonic Serialism

6.2.1 Theoretical basics

Harmonic Serialism [HS, McCarthy (2000, 2007); Kimper (2008); Pruitt (2008), Prince and Smolensky (2004 [1993])] derives a series of harmonically improving candidates by means of cyclical passes through the same parallel constraint ranking. Multiple passes are necessitated by the assumption of gradualness; only one structural change is permitted at a time in a single step of derivation. In HS the output of a pass through the grammar serves as the input to the same grammar at the next pass. Every output is optimising with respect to the original input, until the input and the output become identical and the grammar converges.

Certain attempts have been made to formalise the nature of successive steps in HS (McCarthy, in press). These overlap, to a great extent, with the theoretical foundations of the OT-CC (Candidate Chains) theory (McCarthy, 2007). Taking this one step further, McCarthy (forthcoming) incorporates the three basic formal properties of candidate chains into Harmonic Serialism. The following description of candidate chains in HS is mostly based on McCarthy (2007) discussion on OT-CC, the claim being that the properties of chains are the same in HS and OT-CC.

The idea of candidate chains is that output forms make up a chain defined by certain properties. McCarthy (in press) proposes a number of restrictions on what makes a legitimate candidate chain. The three basic restrictions are those of *initial candidate faithfulness*, *harmonic improvement* and *gradualness* (15). Harmonic improvement requires that every successive candidate improve Harmony. Informally, every successive candidate must satisfy a high-ranked markedness constraint violated by its predecessor in the chain. The satisfaction of markedness constraints entails faithfulness violations, restricted by gradualness. McCarthy's proposal is that any given candidate may violate only one basic faithfulness constraint in a single step of derivation. The somewhat informal term basic faithfulness constraint encompasses the family of Max, Dep, and Ident constraints, as proposed by McCarthy (2007). A single step of derivation may violate multiple non-basic faithfulness constraints.

(15) Definition of Candidate Chain (McCarthy, 2007)
A candidate chain associated with an input /in/ in a language with the con-

straint hierarchy $\mathcal{H}$ is an ordered n-tuple of forms $C = < f_0, f_1, \ldots, f_n >$ that meets the following conditions:

a. Initial form: F_0 is the faithful parse of /in/ that is most harmonic according to $\mathcal{H}$.

b. Gradualness: In every pair of immediately successive forms in C, $<\ldots, f_i, f_{i+1}, \ldots>(0 \leq i<n), f_{i+1}$ has all of f_i's localized unfaithful mappings relative to /in/, plus one more.

c. Local optimality (harmonic improvement + best violation): For every pair of immediately successive forms in C,$<\ldots, f_i, f_{i+1}, \ldots>(0 \leq i <n)$, where F is the basic faithfulness constraint violated by the LUM (localized unfaithful mapping) that distinguisjes f_{i+1} from f_i, f_{i+1} is more harmonic according to $\mathcal{H}$ than f_i and every other form that differs from f_i by a different F-violating LUM.

An illustration of a possible derivation comes from McCarthy (in press).

(16) <pap, pa.pi, pa.bi>

The derivation is gradual: in the first step it adds a DEP violation by epenthesising [i]. In the second step it adds an IDENT[voice] violation, by voicing [p]. the subchain <pap, pa.pi> is harmonically improving with respect to the NOCODA requirement. The subchain <pa.pi, pa.bi> is harmonically improving on intervocalic voicing $\text{*VC}_{\text{voiceless}}\text{V}$.

The assumptions introduced above eliminate a number of derivations as possible chains. For instance, <pap, pab, pa.bi> is not a possible derivation, as the subchain <pap,pab> does not involve harmonic improvement (the output is more marked than the input). Similarly, <pap, pabi> does not make a legitimate chain, as the derivation is not gradual: the output violates two basic faithfulness constraints IDENT(voice) and DEP-Vin a single step.

The basic assumptions behind HS ensure that harmonic improvement reflects the ranking of relevant markedness constraints. The successive steps of derivation must satisfy the high-ranked markedness constraints first. When it comes to faithfulness, however, the theory makes no predictions about the order in which violations are assigned. Faithfulness violations are counted (maximally one at a time), but not ranked. In some derivations, the ordering of faithfulness violations is restricted by the ranking. The chain in (16) exemplifies this. The violation of IDENT(voice) must precede the violation of DEP-V. If the order is reversed, the grammar will not converge. After the initial step of derivation (<pap, pa>, it is not possible to derive <pa, ..., pa.bi> in a way that is both gradual, and harmonically improving. <pa, pab, pa.bi> is not a possible chain, as the derivation <pa, pab> involves an output that is more marked than the input (no harmonic improvement).

To illustrate the harmonic improvement of candidate chains, harmonic improvement tableaux like the one in (17) will be used, following McCarthy (in press).

(17) Harmonic improvement tableau for <pap, pa.pi, pa.bi> (McCarthy, in press)

/pap/	No-Coda	*VC$_{\text{voiceless}}$	Dep	Ident(voice)
a. pap *is less harmonic than*	1!			
b. pa.pi *is less harmonic than*		1!	1	
c. pa.bi			1	1

The candidates in the tableau above represent successive steps in a derivation. The tableau includes the count of violations that each of the candidates incurs on each constraint. The exclamation mark denotes the violation of the highest-ranked constraint (very much like in a classic OT tableau). The successive removal of constraint violations with exclamation marks illustrates the harmonic improvement of the chain under the given constraint ranking. Faithfulness violations are counted with respect to the original input, as opposed to the preceding form in the chain.

6.2.2 Problems with global optimisation and harmonic improvement

Serial derivations in Harmonic Serialism are constrained by gradualness. A candidate chain must consist of harmonically improving candidates that are minimally different from each other, but otherwise at every step of the derivation the winner candidate must be the most harmonic according to the same ranking. Therefore, HS is prevented from taking 'false steps' (Zwicky, 1974). HS cannot intermediately derive unfaithful structures that are more marked than any previous candidate in a chain. This property of HS is argued in this section to be too restrictive on the basis of Winnebago data.

In HS every successive step of the derivation is prohibited from introducing new violations to highly ranked constraints. The consequences for the application of subsequent processes is the following. The first process to apply (process A) is the one conditioned by the active and high-ranked markedness constraint (constraint α). That process must then apply (whether at once or in minimal increments) until the constraint is satisfied, and the derivation moves on to apply the next process conditioned by the next constraint in rank. Process A could not re-apply at any later stage, as the environment conditioning it could not be derived (no derivation could add extra violations of α due to harmonic improvement).

Let us compare the consequences of this theoretical set-up with the analysis of Winnebago put forward in Chapter 4. The crucial insight there was that processes are triggered by globally ranked conditions, but they can iterate strictly locally, as illustrated by the derivation in (18), repeated from Chapter 4.

(18)

```
 ×  ×  ×  ×       DL     ×  ×  ×  × ×       Ft      ×  ×⟩  × × ×        DL
wakripropro  ———————→  wakriproporo  ———————→  wakri  proporo  ———————→

                                                                   ×
 × × ×⟩  × × ×       DL      × × ×⟩ × × × ×       Hd       × × ×⟩ × × × ×
wakiri  proporo  ———————→  wakiri  poroporo  ———————→  wakiri  poroporo

                         ×                             ×    ×
   Ft       × × ×⟩  × ×⟩ × ×       Hd      × × ×⟩ × ×⟩ × ×       Ft
———————→  wakiri  poro poro  ———————→  wakiri  poro poro  ———————→

          ×    ×
× ×⟩ ×⟩  × ×⟩ × ×
waki ri poro poro
```

The derivation where Footing, Dorsey's Law and Head assignment re-apply is not translatable into Harmonic Serialism; the derivation violates harmonic improvement, as demonstrated by the following sample HS derivation. For expository purposes the three processes are triggered by the following three conditions, translated below into somewhat informal OT costraints in (19).

(19)
a. Dorsey's Law applies when a DL sequence precedes an edgemost nucleus (a nucleus preceded/followed by a foot edge or a word edge): *EDGEMOST DL
b. Footing creates binary constituents left-to-right and is triggered by PARSE-σ (a constraint against syllables not delimited by feet)
c. Head assignment is triggered by a condition that feet have heads: constraint FT-TO-HD (Crowhurst, 1996)

Whichever way the three constraints are ranked in HS, the relevant processes apply once, globally and cannot re-apply. The application of a process is triggered by a violation of a markedness constraint, and once a violation of a constraint has been removed by in a harmonically improved chain, no further violations of that constraint may be added. Let us consider the ranking where *Edgemost DL is ranked above Parse-σ.

(20)

	/wakripropro/	*EDGEMOSTDL	PARSE-σ
a.	wakripropro *is less harmonic than*	1!	4
b.	wakriproporo *is **more** harmonic than*		5!
c.	wa$\boxed{\text{kri}}$⟩$\boxed{\text{pro}}$poro	2!	3

In the table in (20), candidate a. wakripropro incurs one violation of *Edgemost DL and four violations of PARSE-σ. The first application of Dorsey's Law (candidate b.) removes the high-rank violation of *EDGEMOST DL, and the derivation moves on to remove the violations of the lower-ranked PARSE-σ. This, however, introduces violations to the higher-ranked *EDGEMOSTDL and the derivation crashes. Thus the actual derivation proposed in the defect-driven rule analysis is impossible to model in HS. The derivation contains intermediate forms that are more marked than the input, so the successive outputs do not make a legitimate HS chain.

The problem seems to follow from the definition of the constraint *EDGEMOSTDL which might be violated with the introduction of a foot. This definition however is crucial, as follows from the discussion on the nature of Dorsey's Law discussed in Chapter 4. An alternative is a constraint *EDGEMOSTDL that only relates to word-edges and is not violated with the introduction of a foot boundary. This definition creates a rule sandwiching analysis, as discussed in the section on Stratal OT of the present chapter. In that approach DL in edgemost nuclei is conditioned by a high-ranked positional constraint. Dorsey's Law in other environments is conditioned by a global, lower ranked constraint *DL. However, just like the rule sandwiching analysis discussed in the previous section, HS makes false predictions about the placement of secondary stress, illustrated in (21).

(21)

	/wakripropro/	*WD-EDGEMOSTDL	PARSE-σ	*DL
a.	wakripropro *is less harmonic than*	1!	4	3
b.	wakriproporo *is less harmonic than*		5!	2
c.	wakri⟩proporo *is less harmonic than*		3!	2
d.	*wakri⟩propo⟩ro *is less harmonic than*		1!	2
e.	*wakri⟩propo⟩ro⟩ *is less harmonic than*			2!
f.	*wakiri⟩propo⟩ro⟩ *is less harmonic than*			1!
g.	*wakiri⟩poropo⟩ro⟩			

The stars in the table above denote forms that are falsely predicted by the grammar. The ranking allows a full parse and the application of Dorsey's Law in all relevant environments. However, due to the architecture of HS, the order in which processes apply is slightly different with respect to (18). After Dorsey's Law has applied in the edgemost DL sequences, the entire string must be parsed into the prosodic structure, and only after that can Dorsey's Law apply in the remaining environments. However, the modified order assigns the foot boundaries in wrong places, predicting the stress pattern *wakiripóroporò, as opposed to the attested wakiripóropòro. The problem cannot be solved by re-ranking, as ranking the constraint *DL above PARSE-σ makes an incorrect prediction of a different kind, namely all epenthetic vowels should be visible to stress, because they would all be inserted before footing.

The above example contains a simplified HS analysis and some structural changes are implemented in a way it is not standardly done in OT (e.g. the insertion of a single bracket). However, regardless of the representation, it is impossible for an HS analysis to reproduce the required order in (18) (that order being absolutely crucial for deriving the attested output).

A final comment that needs to be made has to do with the status of Harmonic Serialism as a theory of opacity. McCarthy (2007) observes that HS cannot model, and is not meant to model opaque derivations. Interestingly, the statement is only true for segmental opacity. As it turns out, under certain conditions HS can technically model prosodic opacity, including rule sandwiching. The derivation in (21) represents a rule sandwiching case, where Dorsey's Law applies in a more specific environment, followed by stress assignment and by the second round of Dorsey's Law application. However, no specific process (understood as a removal of a markedness violation) can occur at different stages of derivation, which means that processes cannot iterate in the way they do in the defect-driven rule formalism: sometimes introducing ill-formed structures that must be subsequently repaired by repeating a previously applied process. Therefore, HS excludes the existence of opacity with an intermediate 'false step' in the derivation. However, as opacity of this kind is found in Winnebago[1], HS is rendered descriptively inadequate.

6.2.3 Changes to derived structure

Another conceptual issue with Harmonic Serialism is what kinds of changes are available to prosodic structure once it is derived. This section shows how certain assumptions on HS, specifically the absence of any Faithfulness relationship between intermediate outputs, make it impossible to erase a previously assigned structure. In HS, prosodic structure is built gradually and preserved faithfully in the following steps of derivation (Pruitt, 2008; McCarthy, in press). Therefore, once assigned, no foot can be deleted. Due to this restriction, HS falls short of modelling the Selayarese data with no ready alternative solution for the derivational treatment of that dataset.

First, let us consider how prosodic structure is assigned in Harmonic Serialism, and what are the arguments for the faithful preservation of prosodic structure once it has been assigned. In the previous section (Winnebago) the assignment of prosodic structure (or more specifically, the assignment of every foot) is treated as an independent step in the HS derivation. This assumption is necesary to model opacity effects like the one in Mohawk: stress must precede epenthesis into biconsonantal clusters in order to model surface opacity.

(22) a. Constraints against biconsonantal clusters in Mohawk (Bye, 2001)

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[1] See Zwicky (1974) for more examples of derivations involving false steps.

*Cˀ]
Sequences of consonants followed by glottal stops are not permitted word-finally
*CR
Sequences of consonants followed by sonorant are not permitted

b.

	/t-ʌ-k-rik-ˀ/	Align-R(PWd-Ft)	*Cˀ]	CR	Dep-V
a.	tʌkrikˀ *is less harmonic than*	1!	1	1	
b.	(tʌ́krikˀ) *is less harmonic than*		1!	1	
c.	(tʌ́k.ri.keˀ) *is less harmonic than*			1!	1
d.	(tʌ́.ke.ri.keˀ)				2

As illustrated in the tableau above, stress assignment must crucially precede biconsonantal epenthesis, so assignment of prosodic structure must be an independent step in the derivation (it must not co-occur with epenthesis or any other process). Also, once assigned, the structure stays put. If the structure was subject to re-assignment governed by the markedness constraints at each stage of the derivation, it would be expected that prosodic structure is always transparent; in case of Mohawk the prediction would be that stress is always penultimate.

This is also the way stress is treated in the work of Pruitt (2008), who proposes that feet in HS are assigned one at a time, and once a foot has been assigned it cannot be changed. This conclusion follows logically from the assumptions by McCarthy (2007, in press), who proposes that all Faithfulness constraints are evaluated against the original input. There can be no Faithfulness constraint against deleting a previously assigned foot (Faithfulness only looks at the intermediate output and the original input, as opposed to two intermedate outputs), so the only way of constraining deletion is banning it altogether.

However, as we have seen in the case of Selayarese, deletion of some ill-formed structure can be the key to modelling opacity. The proposal put forward in Chapter 4 is that whenever a ternary foot is created by epenthesis, that foot must be deleted and stress is re-assigned from scratch. However, when epenthesis applies to the right of a foot, no ill-formed structure is created, resulting in opaque surface stress, as in (23) repeated from Chapter 4.

(23)	Footing	⟨ × ×⟩ kar.tu	⟨ × × ⟩ bo.tol
	Epenthesis	⟨ × × ×⟩ ka.ra.tu	⟨ × × ⟩× bo.tol
	Ternary foot erasure	× × × ka.ra.tu	—
	Footing	× ⟨ × ×⟩ ka. ra.tu	—
	Output	karátu	bótolo

Harmonic Serialism, in its current version, has no way of modelling this kind of interaction, as derived structure cannot be deleted. To remedy this problem, HS would need a substantial revision with Faithfulness constraints on prosodic structure comparing pairs of intermediate outputs. Without such revision, HS loses the insight that some opaque cases can result from modifying an ill-formed output.

6.2.4 Further issues and evaluation

We have seen so far that Harmonic Serialism is not descriptively adequate with respect to a range of data on stress-epenthesis interactions, crucially undergenerating in the cases of Winnebago and Selayarese. Some level of descriptive adequacy might be reached through revisions of HS, but iterative interaction is beyond the scope of Harmonic Serialism; in HS processes apply in all immediately relevant environments or not at all. This is a curious view of serial interaction. In one way, HS reverts to serial derivations of rule-based phonology, thus modelling some phonological patterns through ordering. However, in doing so, HS does not draw on the research tradition on *how* rules interact. The issue is not as trivial as isolated examples of counterfeeding or counterbleeding seem to suggest. The relevant questions are, among other things, whether rules can apply to their own output, and if so whether this is true of all rules, whether rules apply directionally, whether they can apply simultaneously. Some of these may be dismissed as theory-internal to the Rule-Based Phonology, but some are common to all serial approaches, as illustrated by the Winnebago case, where a directional iterative application of different processes is crucial to deriving the attested pattern. In the discussion on rule application, this thesis joins a long line of research which shows that rules do not simply apply to every input available at a given stage of derivation and then terminate (Chafe, 1968; Anderson, 1969; Kenstowicz and Kisseberth, 1977, 1979; Halle and Vergnaud, 1987; Myers, 1991). Harmonic Serialism, though, seems to perpetuate this simplified view.

Also, puzzlingly, HS gives up certain insights of classic Optimality Theory (e.g. the view of prosodic parsing), while preserving some of OT's most problematic concepts. One of them is global optimisation discussed in the previous section. Another is the concept of Gen. Gen in OT is a function of grammar that emits an infinite set of candidates. The infiniteness is the source of a major computational load (Calabrese, 2005), as well as computational issues [“(…)there are no general algorithms for finding the optimal members of an infinite set”(Frampton, 2001)]. How exactly Gen works has always been a major unresolved issue in OT. HS introduces additional concerns in this respect, as Gen is equipped with a new function. In HS, Gen emits only outputs that are minimally different from the current input. Minimal difference signifies a single violation of a basic faithfulness constraint (McCarthy, 2007). That makes the number of candidates finite, though still rather large. However, yet another issue arises in relation to gradualness. Somehow, Gen has to know which outputs are minimally different from the input. To be able to do that, Gen would either have to be able to see the constraints in Eval, or be equipped with some kind of set of possible non-recursive minimal-change inducing functions: a set of possible epentheses, deletions, metatheses, and so on. Gradual improvement delegated to Gen lies at the very heart of Harmonic Serialism architecture, and yet it is never explained or formalised in the literature on Harmonic Serialism or the Candidate-Chain Theory (McCarthy, 2000, 2007). In the absence of a proposal on the function of Gen, Harmonic Serialism is not a ready alternative computational solution to Rule-Based Phonology.

The rise of Harmonic Serialism is certainly a major shift from strictly parallel theories. However, HS is designed as a serial theory, which is somehow however still OT. As a result, a number of assumptions contraining the HS architecture seem to come from the theory rather than from the data. These assumptions include harmonic ascent, faithfulness to the original input and single edit embedded in Gen. As we have seen, most of these assumptions result in undergeneration of attested patterns. At the same time, at least for the current dataset, HS does not have insights to offer that are not available to Rule-Based Phonology. Therefore, the choice of framework for the current thesis is a theory that also relies on the notion of constraint and ranking, but reconceptualises global constraint evaluation and substitutes Gen with a finite set of ordered repairs.

Chapter 7

Conclusion

The purpose of the present work has been twofold. One aim was to deliver an analysis of the attested patterns of stress-epenthesis interactions within a single formal framework. The other aim was to test the limitations and predictions of the defect-driven rule formalism by Frampton (2008) on a new dataset and propose extentions.

Objections might be raised against the choice of a serial framework. A standard critique of serial approaches is expressed by the following quote by (Alderete, 1999, 29).

> “While the Rule Ordering theory can account for virtually every pattern of stress-epenthesis interaction, this theory fails to offer an explanation of the phenomena. The behavior of epenthetic vowels in stress is described by stipulating the required rule ordering, leaving us to wonder why the state of affairs could not be different.”

However, a mere stipulation of rule ordering is of limited help in some of the more complex cases of stress-epenthesis interaction. A prime example is Winnebago, which has been notoriously elusive of serial approaches, with the exception of the Halle and Idsardi (1995) analysis. Similarly, Selayarese has been cited as a major challenge for serial approaches, e.g. by Broselow (2008), because ordering alone does not predict the pattern; additional constraints on metrical structure need to be considered for the analysis to achieve descriptive adequacy. The two analyses as proposed in the present work are entirely novel, as is the serial analysis of Yimas.

Secondly, some attention must be drawn to what exactly should be considered an ‘explanation’ in phonology. Frampton (2001) makes the following comment on the notion of phonological explanation.

> “There is something very human and very comforting about teleological explanation. OT offers such comfort, because it gives the illusion that phonological processes are happening for an immediate reason. The metaphor is an input that is striving to conform as best it can to certain conflicting desiderata. Change/difference happens for a reason.”

Alderete (1999) seems to have such intutions about phonological explanation in proposing that the kind of ordering where prosodic structure is built bottom-up (syllabification/epenthesis followed by foot assignment) makes an attempt of an explanation of why things happen one way and not another, but that reverse ordering (stress followed by epenthesis) is arbitrary. However, things *could* happen either way. Or, in more neutral terms, the patterns predicted by both types of ordering are found. It is also not at all clear what is inherent in feet being built on syllables. While syllables are dominated by feet in the Prosodic Hierarchy, stress is not as much a property of a syllable as of a nucleus. In other words, syllable boundaries are not inherently required for the stress assignment; the two conditions are rather independent, and can apply in any order, as argued at length here.

Let us also consider the explanation that OT analyses offer for the opacity in stress-epenthesis interactions. Kenstowicz (2007) and Shinohara (2000) use the constraint *’v, to capture the supposedly robust generalisation that epenthetic vowels shun stress. The cited source of the generalisation is Broselow (1982). In the works of Alderete (1995, 1999) and Broselow (2008), the constraint *’v is translated into the technically equivalent constraint Head-Dep, which says that the head vowel must not be epenthetic. The two constraints immediately bring about certain conceptual issues. The term ‘epenthetic’ describes a relationship between input and output, and not in inherent property of an output vowel. What is more, the insight of the constraint is built on nothing more than a surface observation. An observation which, let us add, is not as cross-linguistically robust as it would seem. A survey of languages with epenthetic vowels revealed only two cases were absolutely no epenthetic vowels are stressed, Dakota and Japanese. In addition, the Dakota case included only one type of epenthesis in a restricted environment. In all the other surveyed languages at least some epenthetic vowels could bear stress. The conclusion that the OT accounts draw from this is that assigning stress to some epenthetic vowels follows from the conflict between their inherent instressability and constraints that require surface-transparent stress assignment. The conclusion proposed here, however, is that avoidance of stress by epenthetic vowels is an epiphenomenon, rather than a inherent property of explanatory value.

Finally, teleological considerations left aside, the array of languages analysed here in the serial framework has not seen a descriptively adequate parallel analysis. The crucial case is Mohawk where the asymmetry between epenthesis into biconsonantal and triconsonantal clusters eludes parallel approaches based on prosodic faithfulness. What is more, the existing parallel analyses of stress-epenthesis interaction, like the analysis of Winnebago by Broselow (2008) raise representational concerns that go beyond the concerns of phonological computation.

The defect-driven rules formalism provides the analytical tools sufficient for developing a descriptively adequate model of stress-epenthesis interactions found in Dakota, Swahili, Yimas, Winnebago, Mohawk and Selayarese. The cases of loanword adaptation in Japanese and North Kyungsang Korean have not been explored by the analysis, as the surface generalisations found in the literature concerning stress-epenthesis interactions in these languages turned out to be valid for only a subset of data. It turns out that stress-epenthesis interactions, diverse as they are, can be mostly modelled through the relevant ranking of four conditions: on epenthesis, foot assignment, foot-head assignment and main stress assignment. The ranking determines the order of application of the relevant defect-driven rules. All defect-driven rules are potentially persistent and apply at any stage of the derivation, provided that there are no higher-ranked defects that would necessitate a prior application of another rule. This particular theory of rule interaction proves particularly successful in modelling the interaction of stress and Dorsey's Law in Winnebago, where lower-ranked defects trigger rules that derive higher-ranked defects. As a result, the same rules may re-appear a number of times in a derivation, which is crucial to modelling the attested stress pattern in words with epenthetic vowels.

The defect-driven rule formalism embraces the concept of constraints and the role of constraints in triggering structural changes to the input. However, it crucially differs from OT in reducing the role of global evaluation. Here constraints are strictly local and they cannot block the application of rules other than the one rule for which a given constraint is specified. Reducing globality excludes concepts like harmonic ascent found in Harmonic Serialism. Defect-driven rules can deliver ill-formed structure, which might (but do not have to) be subsequently removed.

The particular model of rule interaction as predicted by the defect-driven rule formalism certainly deserves more research. Of immediate interest for the model are cases of counterfeeding opacity, or underapplication, where there is a surface defect that is not removed by the derivation. Defect-driven rules are not in principle restricted to any stage in the derivation, so counterfeeding opacity cannot be simply resolved by a failure of a rule to apply at a later stage. Therefore the model must pursue a solution for why it is not possible to remove some defects.

Another aspect that needs further research is the treatment of stress in the defect-driven rule formalism. The view of footing adopted here builds on Idsardi (1992); Halle and Idsardi (1995) and Frampton (2008). The basic policy adopted throughout was to make minimal assumptions about structure in each case. Thus languages with main stress only (Swahili, Dakota, Mohawk) were not analysed as having recursive foot structure. Similarly, word edge has been assumed to function as a delimiter equal to foot edges in Winnebago. However, the case of Selayarese seemed to require additional assumptions on both these conditions. Therefore, foot structure was posited for Selayarese despite the absence of secondary stress and the word edge could not serve as delimiter. In the absence of extensive research on the treatment of stress in the Defect-Driven framework, the present thesis has resorted to formal experiments in some places, some of which should hopefully be verified by future studies.

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