Weak Edges and Final Geminates in Swiss German*

Philip Spaelti
UCSC
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1. Introduction

A fundamental property of geminate consonants, geminates for short, is that they contribute to syllable weight in a similar manner than does vowel length. This property is expressed directly in a theory that treats geminates as consonants associated with an underlying mora (Prince 1980, McCarthy & Prince 1986). This paper defends the view that underlying moraicity is in fact the only distinguishing characteristic of geminates. Such a treatment is more restrictive than a theory that sees geminates as double consonants, since it predicts that geminates do not have two 'halves' that can be manipulated independandly. For example in a theory which considers geminates double consonants, extrametricality could affect only one of the pair. This is exactly the approach taken by Levin (1989), in work on noun lengthening in Ponapean, arguing that the moraic theory of geminates is inadequate.

Virtually the same phenomenon occurs in Swiss German. Analyzing these cases within the framework of Optimality Theory (Prince &Smolensky 1993, henceforth P&S), gives a rather different picture however. The treatment of geminates as underlyingly moraic consonants makes exactly the right predictions. In addition, the analysis has consequences for the application of extrametricality. Extrametricality is abandoned, and replaced by a much more restrictive notion of 'edge weakening'. Finally the moraic conception of geminates is argued to give a better account of the overall distribtion of geminates.

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2. Theoretical background

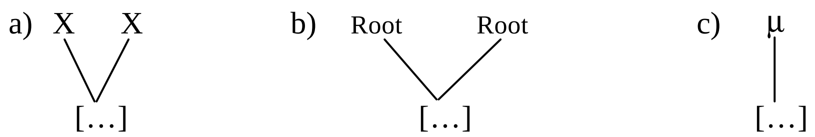
A traditional view of geminates holds that they consist of two identical consonants in a row, something which can be represented as in (1). This is for example the view of SPE, a theory which has the segment as its base.

(1) $\ldots C_i\, C_i \ldots$ 'bi-segmental representation'

If we adopt standard assumptions about syllabification such as a sonority profile that is strictly increasing in the onset and strictly declining in the coda, as well as possibly some constraint against homorganic clusters in onsets, then the sequence in (1) will be syllabified across two syllables. This constitutes an important advantage of the bi-segmental representation, since there is an immediate explanation for the fact that the majority of languages with geminates restrict these to intersyllabic position, and fail to have them word-initially or finally. The strong claim of this theory, that geminates can appear *only* intersyllabically, is unfortunately untenable, since a number of languages are counterexamples (Germanic languages, e.g., Swedish and Norwegian; Micronesian languages, e.g., Trukese, Ponapean, Mortlokese; Berber; Kabardian; Seri; Southern Italian; Malay; among others).

A result of the development of Metrical (Kahn 1976, Liberman & Prince 1977) and Autosegmental phonology (Goldsmith 1976) has been the abandonment of the strict notion of segment. This in turn has led to a better conception of geminates, one where the timing of the geminate is independent of the quality. Among the possible conceptions of geminates that arise are the following alternatives:

(2)



'bi-skeletal rep.' 'two-root-node rep.' 'moraic rep.'

The bi-skeletal representation (2a) (Levin 1985, McCarthy 1979) is dependent on a timing tier of either X or CV slots. Under such a view, geminates are elements that are linked to two slots, as opposed to standard consonants, which are linked to only one. The two-root-node representation (2b) (Selkirk 1990) is similar in many ways to the bi-skeletal representation, except that the timing is handled by the root nodes instead of the problematic X-slots. Both of these views retain the idea that geminates are 'two' of something, as opposed to plain consonants which are just 'one'. Because of this feature I will call such representations 'binary'.

In sharp contrast to the binary view of geminates is the moraic representation, shown in (2c) (Prince 1980, McCarthy & Prince 1986, Hayes 1989). Under this view, geminates are not inherently doubly linked at all. Instead they are distinguished from ordinary consonants by their moraic weight. Geminates will become doubly-linked segments if they are at the end of a syllable and can then be linked as onset to the adjacent syllable.

The important distinction between the two conceptions is that in the binary representations the extra quantity of geminates is encoded in the inherent 'two-ness', while the moraic representation indicates the extra quantity through the underlyingly associated mora. This distinction will lead to verifiable predictions about the behavior of geminates. Since the moraic representation still assumes double linking when geminates are in intersyllabic position, the place to look for a distinction is when the geminates are in peripheral position. Such a situation arises in Glarnertüütsch (henceforth GT), a Swiss German dialect spoken in the Canton of Glarus, which has word final geminates. These are illustrated in (3)[1].

(3)

xä**pp**	'Casper (name)'
be**tt**	'bed'
ro**kk**	'dress'
SI**ff**	'ship'
ro**ss**	'horse'
bU**SS**	'bush'
ta**xx**	'roof'
tU**ppf**	'spot'
xa**tts**	'cat'
mU**ttS**	'type of bread'
la**mm**	'lamb'
ha**NN**	'slope'
ba**ll**	'ball'

These geminates interact with a vowel lengthening process in a way which, at first sight, seems problematic for the moraic theory of geminates, but in fact can be shown to be a strong argument for the moraic conception of geminates, once we adopt an analysis in the framework of Optimality Theory (Prince & Smolensky 1993).

[1]A note on the transcription of vowels. I will be using ä, ö, Ü and ü for the umlauted counterparts of a, o, U and u respectively. Orthographic ö, Ü and ü stand for the front round vowels ø, Y and y, while ä is the low front vowel æ.

3. GT Monosyllabic Noun Lengthening

Vowel length alternations are found in GT in certain monosyllabic nouns, which have a long vowel in the singular, but a short vowel in the plural and the diminutive (Streiff 1915). Examples of this process are given in (4)[2]. A similar example which shows the short vowel only in the diminutive is given in (5).

(4)

singular	**plural**	**diminutive**	**gloss**
raad	red´r	redlI	‘wheel’
graab	greb´r	greblI	‘grave’
wIIs		wIslI	‘meadow’
haas	has´	häslI	‘rabbit’
jUUd	jUd´		‘Jew’

(5)

Slaag	Sleeg	SleglI	‘hit/blow’ (‘stroke’)

This alternation can best be interpreted as a case of lenghtening, with the proposed underlying forms for the items in (4 & 5) as shown in (6).

(6)

/rad/
/grab/
/wIs/
/has/
/jUd/
/Slag/

The conditions under which lengthening occurs are all and only those cases where the forms are monosyllabic. Whenever they become polysyllabic through affixation they preserve the short vowel. The crucial case here that shows this is *Sleeg* ‘blows’, since it is exactly in this case, where the plural form is not marked with a suffix leaving it monosyllabic, that a plural form shows a long vowel. Whenever the stem receives a suffix, making it polysyllabic, such as in *red´r* ‘wheels’, the stem vowel is short. The restriction of lengthening to monosyllabic words seems to indicate that such items are ‘too short’ and the lengthening can be interpreted as the enforcement of a minimal length requirement on GT words. The items that undergo lengthening are all of the type C_0VC. Assuming the last consonant is extrametrical, they consist of a single

[2] The change in vowel quality in these examples is due to a morphologically governed, and slightly idiosyncratic umlaut process. Umlaut has no effect on the vowel length, and can therefore be disregarded with respect to the problems discussed here.

light, i.e., monomoraic, syllable, and can therefore not constitute a foot without augmentation. This length requirement is therefore an instance of the minimal prosodic word in the sense of McCarthy and Prince (1986), which requires that a prosodic word be a bimoraic foot.

That this is indeed the correct analysis is supported by a number of facts. First there are no surface forms that are monosyllabic with a short vowel and a simple, i.e., non geminate, final consonant. In other words there are no forms such as those shown in (7), which contrast minimally with those in (4 & 5) above.

(7) * rad
* grab
* jUd
* Slag

Further there are examples with long vowels that do not alternate, shown in (8). These examples make it clear that an explanation of the length alternation as a shortening process is not possible.

(8)

singular	**plural**	**diminutive**	**gloss**
raat	räät	räätlI	'councilman'
taag	tääg	tääglI	‘day’
huus	hüüs´r	hüüslI	‘house’

Finally, the account proposed above relies crucially on the notion of final consonant extrametricality, and the fact that the examples under consideration all had only a single coda consonant. It is therefore expected that nouns with final consonant clusters should not undergo lengthening, and indeed they do not. For example:

(9)

singular	**diminutive**	**gloss**
hals	hälslI	‘throat’
xraft	xreftlI	‘strength’
gUmp	gÜmplI	‘jump’
hUnd	hÜndlI	‘dog’
xrants	xräntslI	‘wreath’

As these examples show, nouns with a short vowel followed by a consonant cluster keep the short vowel in their monosyllabic singular forms as well as in the polysyllabic diminutive. In this respect words with final geminates pattern with consonant clusters.

(10)

singular	**diminutive**	**gloss**
brätt	brättlI	‘board’
SlUkk	SlÜkklI	‘gulp, swallow’

The generalization which emerges is that lengthening of the vowel in a monosyllabic word in GT occurs when a short vowel is followed by a simple consonant. When the vowel is followed by more than one consonant, such as the cluster /ft/ in *xraft* ‘strength’ or the geminate /tt/ in *brätt* ‘board’, lengthening does not occur. This is exactly what the analysis predicts, since in case the word has a long vowel, or a short vowel followed by a consonant cluster, making the final consonant extrametrical will leave the remaining syllable heavy, i.e., at least a CVV or a CVC syllable. But in case the word has a short vowel followed only by a simple consonant, making the last C extrametrical will result in a light, i.e., monomoraic, syllable. The examples relevant to this account are summarized here in (11).

(11)	ra<d>	raa<t>	brät<t>	xraf<t>

Critical to this analysis is that the final segment in *brätt*, a geminate, is treated effectively as two segments. Therefore if the final consonant is made extrametrical the syllable will still have a coda consonant making it a heavy syllable. If the final /t/ is extrametrical in a form like *raat* the result still has a long vowel and the syllable is bimoraic, while in the form *xraft* the result is a heavy CVC syllable. Only in *rad* is the resulting syllable monomoraic.

The situation here is then essentially the same as in Ponapean (Levin 1989, McCarthy 1984). In Ponapean there is an alternation in the length of the vowels of certain ‘short’ nouns. That is, some nouns which show a short vowel in suffixed forms, show a long vowel in the corresponding free form. Examples can be seen in (12).

(12)

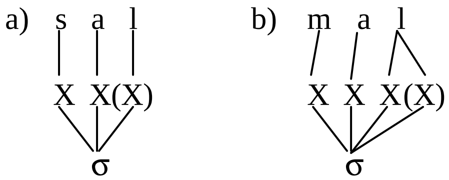
Ponapean

	base	**free form**	**gloss**
a.	sali-	saal	‘rope’
	sap^{w}E-	saap^{w}	‘land’
	p^{w}oNe-	p^{w}ooN	‘night’
b.	(i)nsar-	(i)nsar	‘snare’
	aramas-	aramas	‘person’
c.	Empi-	Emp	‘coconut crab’
	mall-	mall	‘grassy area’

The standard analysis of these cases relies on a general process of final vowel deletion which is operative in Ponapean. If the remaining stem after truncation is of type CVC, the result undergoes lengthening, as can be seen in (12a). Vowels in longer words do not lengthen, as shown in (12b). Note that the /n/ in *nsar* 'snare' is moraic, making the word bimoraic, and arguably even disyllabic, since there is optional epenthesis word initially as well in such cases. Words with final clusters, including geminates, pattern with the latter, as can be seen in (12c). Again this can be analyzed as lengthening of monomoraic nouns after final consonant extrametricality.

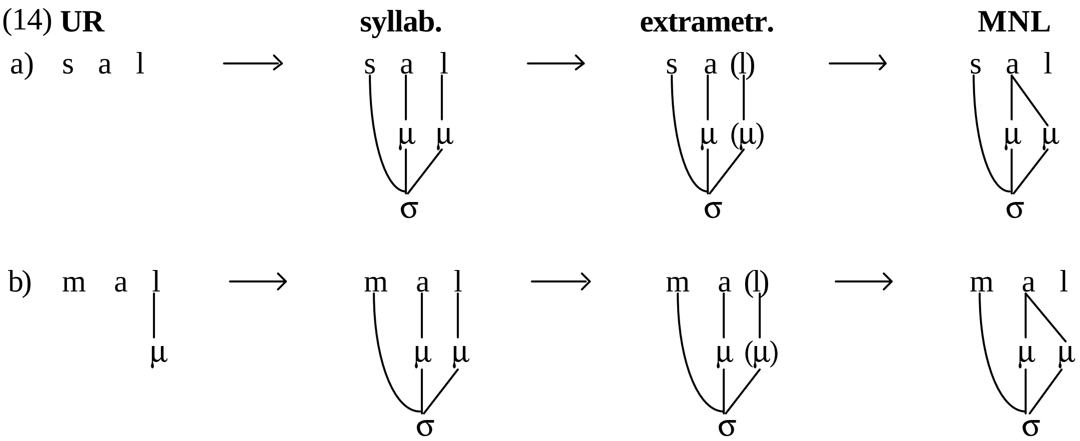
This type of situation seems to favor the bi-skeletal or the two-root-node theory of geminates, since in the moraic theory it is not clear how to make the last segment extrametrical, without obliterating the distinction between moraic, final geminates and non-moraic consonants. This has to do with the fact that extrametricality typically affects segments. Segments have a natural analog in the X-slots, since the X-slots represent timing. The analysis is shown in (13) (taken from Levin 1989).

(13)



In contrast the moraic theory has no direct analog to the segment. Therefore a first question that arises is what exactly is made extrametrical. A second problem has to do with the fact that although the moraic theory marks geminates underlyingly the contrast to non-moraic consonants is obliterated under standard assumptions about syllabification. A sample derivation which illustrates some of the problems encountered is shown in (14) again taken from Levin (1989) (MNL stands for monomoraic noun lengthening).

(14)



As can be seen here the underlying form /sal/ 'rope'correctly results in an output *saal*, while the form with the underlying geminate /mall/ 'grassy area' incorrectly gives the output **maal*. This is due to the fact that syllabifiaction neutralizes the underlying contrast, making the forms indistinguishable to the rule of final consonant extrametricality.

There are a number of ways that one might try to rescue such an analysis, most of which require additional stipulations or redundancies (see Levin 1989 for discussion). I will not pursue this issue further here. Instead I would like to show how a non-derivational account in the framework of Optimality Theory (P&S) avoids these difficulties altogether.

4. An Optimality Analysis

The problems encountered by the moraic conception of geminates in the type of analysis proposed above, are due to two factors. One is that the underlying difference between two forms is neutralized at an intermediate stage of derivation. The second is that the constraint of extrametricality when imposed on the different forms uniformly, produces a desired result in one case, but an undesired result in another.

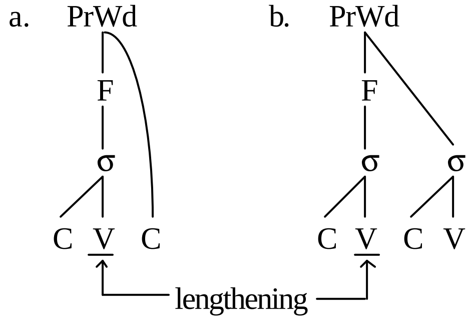
Optimality Theory has an immediate answer to both of these problems. First, since Optimality Theory is non-derivational, there will be no intermediate representations where distinct underlying forms are collapsed. In fact the principle of Containment (P&S, McCarthy & Prince 1993a, 20), which requires that underlying material must be present in the output in some form, guarantees that underlying distinctions are preserved. The solution to the second problem is that in Optimality Theory constraints are violable. A constraint such as extrametricality need not apply to all forms equally, since a higher ranked constraint can preempt it.

What does it mean for extrametricality to be a violable constraint? The intuition behind extrametricality is that material at the edge, typically the right edge, should be exempt from assigned structure. In other words the right edge should be structurally weak. A constraint which relates to this issue and that has been discussed in the OT literature is that of NONFINALITY from P&S, given here as (15).

(15) NONFINALITY (Prince & Smolensky 1993, p.52)
No head of PrWd is final in PrWd

P&S use NONFINALITY to account for the recurring pattern of penultimate stress, a pattern that is standardly analyzed as involving 'final syallable extrametricality.' That NONFINALITY can be used to account for final consonant extrametricality as well can be seen in the diagram in (16a) (Itô, Mester, McCarthy classnotes) Assigning prosodic structure to a word of the shape CVC in the most straightforward manner would lead to a violation of NONFINALITY, since the only foot of the word will be in final position. One way to avoid this is by excluding the final C from the foot, thereby making the head foot non-final in the prosodic word. But then the remaining CV will need to augment, e.g. by lengthening, in order to comply with the requirement of foot binarity. A similar idea has been proposed by Hung (1993) to account for the lengthening of the first syllable in CVCV words in certain languages (16b).

(16)



A nice aspect of this analysis is the fact that no new constraints need to be introduced, since it relies on NONFINALITY, a constraint that is independantly necessary and motivated. It should however be noted that NONFINALITY is essentially the statement of an observation. I will therefore propose a different constraint of more general scope than NONFINALITY, which I will call WEAKEDGE. I will than show how NONFINALITY can be seen to be a special case of WEAKEDGE. In addition I will discuss how WEAKEDGE might ultimately be reduced to other principles and therefore not constitute a separate constraint of its own. In order to be in a position to formulate WEAKEDGE the following definition is necessary:

(17) Def: the Right Periphery of node *n* is the set of all nodes *m* such that *n* dominates *m*, and there is no node *m'* such that *n* dominates *m'*, and *m* precedes *m'*.

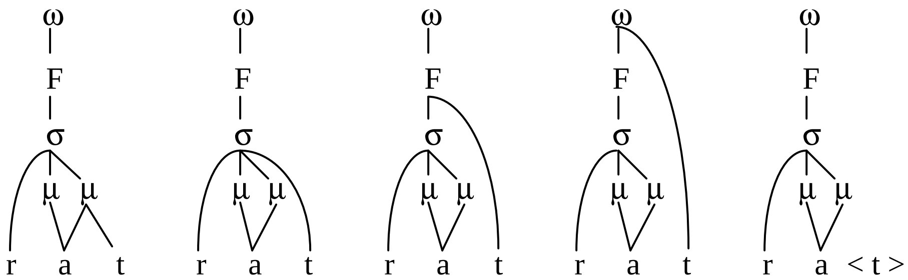
The intuitive force of this definition is that it will yield for any given tree structure the set of nodes that constitute the right edge of the structure. With this notion WEAKEDGE can now simply be stated as in (18).

(18) **WEAKEDGE** (P-CAT)
The right periphery of P-CAT should be empty

The constraint in (18) is a general constraint schema. Specific constraints can be obtained by providing a specific prosodic category for the argument P-CAT. For example if P-CAT is the prosodic word the resulting constraint is WEAKEDGE (PrWd). In the following discussion PrWd will be the only value for P-CAT that I will be considering, and WEAKEDGE (PrWd) will be abbreviated simply as WEAKEDGE.

The effects of WEAKEDGE are best illustrated by looking at an example. In (19) are a few of the possible candidate structures for *raat* ‘councilman’. Indicated immediately below each structure in set braces is the right periphery for that structure.

(19) a. b. c. d. e.



{ω,F,σ,μ,t} {ω,F,σ,t} {ω,F,t} {ω,t} {ω,F,σ,μ,a}

Although (a) and (b) include the segment /t/ in prosodic structure in a way consistent with the Strict Layer Hypothesis (Selkirk 1984, 1986), (c) and (d) will clearly also be among the candidate set produced by GEN. If we compare the four candidates with respect to their right periphery as defined earlier, we note that the right periphery of (d) contains the least amount of structure, and is therefore the most harmonic with respect to WEAKEDGE.

A crucial point is also that WEAKEDGE refers to the *prosodic* structure. Consider for example the candidate (e), where the final /t/ is not parsed. Since the segment /t/ is not included in the prosodic struc ture, it is irrelevant in the determination of the right periphery of candidate (e). In fact, candidate (e) has the right periphery given above, and is therefore considerably less harmonic with respect to WEAKEDGE than candidate (d). From this it should be clear that WEAKEDGE does not in and of itself lead to a preference for underparsing.

A further point that becomes clear from this discussion is that since every candidate has a right periphery, every candidate will also incur some violation of WEAKEDGE. WEAKEDGE can therefore not constistute a constraint that simply judges success or failure, but instead must be seen as a case of Minimal Violation such as EDGEMOST for infixation in Tagalog (Prince & Smolensky 1993), or Alignment in the case of directionality of footing (McCarthy & Prince 1993b). In contrast to these precedents that involve minimal violation of (horizontal) alignment, is that WEAKEDGE is an instance of minimal violation that focuses on the vertical minimization of hierarchical structure. It therefore constitutes a case of *Hierarchical Minimal Violation.*

In addition there are other constraints that interact with WEAKEDGE in order to account for the complete pattern of GT Noun Lengthening. For ease of presentation they can be divided into three groups: the first group consists of those constraints that limit the basic types of permissible structure, the second group enforces the ‘minimal word effect’ and the third group includes the constraints termed ‘faithfulness constraints’ by P&S i.e., those that demand that the output deviate as little from the input as possible.

Turning then to the first group, the constraints that limit the permissible prosodic structures, it was seen that WEAKEDGE by itself will generally prefer as little structure as possible. If zero structure is not the the default situation, then clearly some other constraints must be enforcing some minimal requirements on prosodic structure. These requirements have summarily been called the Prosodic Hierarchy (Selkirk 1978, Nespor & Vogel 1982, McCarthy & Prince 1986, Zec 1988, Inkelas 1991), the standard conception of which is given in (20).

(20)

$$\begin{array}{c} \omega \\ | \\ \mathrm{F} \\ | \\ \sigma \\ | \\ \mu \\ | \\ \text{Seg} \end{array}$$

As it is stated in (20), the Prosodic Hierarchy represents an entire collection of statements, such as the types of nodes that are necessary for a licit prosodic structure, as well as how they are layered. It is unlikely that all of these statements comprise a single constraint, say ProsHier, to be ordered among the other constraints. Instead (20) should probably be the result of a number of different constraints ordered more or less individually. A possible way of conceptualizing this is by breaking (20) up into a number of local hierarchies, i.e. ω domintes F, F dominates σ, and so on. In the form of a constraint schema this can be formalized as in (21).

(21) **Parse-**(P-Cat$_1$)**-in-**(P-Cat$_2$) (cf. Itô & Mester 1992, also Selkirk 1993)
all instances of a prosodic category (P-Cat$_1$) must be dominated by instances of prosodic category (P-Cat$_2$)

Specifically (21) is instantiated as the family of constraints given below. Interestingly this approach, together with the notion of constraint violability, also addresses the issue of strict layering. The Strict Layer Hypothesis (Selkirk 1984, 1986) says that each layer of the Prosodic Hierarchy must be properly included within the next higher one. In OT strict layering is the result of fulfilling all the constraints in (22) maximally. It is an ideal rather than an absolute target. In other words, strict layering is a violable constraint.

(22)

PARSE-F-IN-ω
all F must be dominated by ω

PARSE-σ-IN-F
all σ must be dominated by F

PARSE-μ-IN-σ
all μ must be dominated by σ

PARSE-C-IN-σ
all C must be dominated by σ

PARSE-V-IN-σ
all V must be dominated by σ

Not all the constraints in (22) are obeyed equally. For example PARSE-σ-IN-F is quite commonly violated (cf. Itô & Mester 1992), while others are observed more strictly. This analysis assumes that, in particular, PARSE-μ-IN-σ is ranked fairly high, while PARSE-C-IN-σ is ranked low.

Turning next to the 'minimal word effect', the requirement that a lexical item be minimally bimoraic. P&S (see ch.4, cf. also Mester to appear) show that this can be interpreted as the result of a series of constraints acting together. The constraints included in this group are Foot Binarity (FTBIN) and the requirement that a lexical word must also be a prosodic word (LX ˜ PR) among others. The formulations here are taken from P&S.

(23) **LX ˜ PR** (*MCat*), (Prince & Smolensky 1993, p.43)
A member of the morphological category *MCat* corresponds to a PrWd.

(24) **Foot Binarity** (FTBIN), (Prince & Smolensky 1993, p.47)
Feet are binary at some level of analysis (μ, σ).

These constraints are argued to be at the top of the constraint hierarchy undominated (P&S ch 4). Note that these two conditions, together with the hierarchy in (20), have the effect of requiring that a word be minimally bimoraic.

The final group of constraints necessary for the analysis are the faithfulness constraints (P&S), which generally require that the output be maximally similar to the input. These constraints come in two types: PARSE and FILL (see P&S for discussion). The faithfulness that is at issue here are the underlying prosodic weight specifications. The relevant FILL constraint is one that militates against any moras that are not sponsored by input material. A constraint that serves this function is given in (25) (from McCarthy 1993b, cf. also McCarthy & Prince 1994). Working in the opposite direction is a constraint that restricts underlying weight specifications from being tampered with. A constraint to that effect is *DELINK (cf. Itô, Mester & Padgett 1993).

(25) **M-Mora** (McCarthy 1993b)
Every mora belongs to a morpheme

(26) ***Delink**
Underlying associations must be respected.

A point that needs some clarification is what is meant by ‘belongs to a morpheme’. For the purposes here I will assume this to mean: licensed by underlying material. This can be understood as dividing into two cases: the first is that of a mora which is underlyingly specified. For example a long vowel licenses two moras rather than the usual one, and similarly a geminate consonant licenses a mora as well. The second case is licensing by position. This occurs when a segment is included in a syllable following a nucleus (so called ‘Weight by Position’, Hayes 1989).

The complete ranking of the constraints discussed so far is given in (27). Explications of the particular rankings will be given in conjunction with the relevant tableaux.

(27)

$$\left.\begin{array}{c}\text{FtBin}\\ *\text{Delink}\\ \text{Parse-}\mu\text{-in-}\sigma\end{array}\right\} \;>>\; \text{WeakEdge} \;>>\; \left\{\begin{array}{c}\text{M-Mora}\\ \text{Parse-C-in-}\sigma\end{array}\right.$$

Turning to the analysis of the GT data, we note that the moraic conception of geminates does provide distinct underlying representations for all the crucially distinct forms. Adopting the moraic analysis proposed in Hayes (1989), the underlying forms for the monosyllabic nouns given in (11) are as seen here in (28).

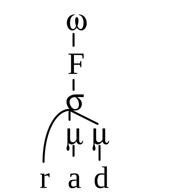
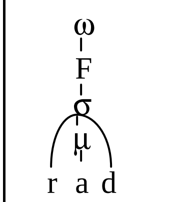
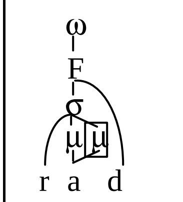
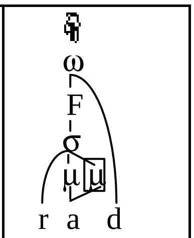
(28) Proposed URs for relevant forms under moraic representation

μ	μ μ	μ μ	μ
r a d	r a t	b r ä t	x r a f t

Following Hayes all vowels are marked underlyingly with a mora. Long vowels, such as in the second example *raat* ‘councilman’, are assigned two moras, while geminates, such as in the third example *brätt* ‘board’, are also assigned a mora. This permits us to make all the necessary distinctions.

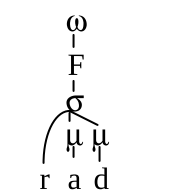
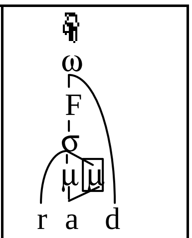
Considering the first case, that of the C_0VC words which undergo lengthening. (29) shows how the relevant candidates for the word *rad* 'wheel' are evaluated by the constraint WEAKEDGE. As was seen earlier, the most harmonic candidate with respect to WEAKEDGE will be the one that links the final /d/ directly to the prosodic word. This is exactly the desired situation since (29d) is in fact the output.

(29)[3]

	a.	b.	c.	d.
				
WEAKEDGE	ω,F!,σ,μ,d	ω,F!,σ,d	ωF!,d	ω,d

The fact that (d) is the winning candidate immediately tells us something about the necessary constraint rankings. Note that (d) contains a mora without morphemic affiliation (boxed in the above representation), thereby violating M-MORA. Also the fact that the final /d/ is directly dominated by the prosodic word, bypassing intermediary constituents leads to a violation of the 'prosodic hierarchy constraints', in particular PARSE-C-IN-σ. At the same time the candidate (a) does not violate either of these constraints. This entire situation can be summarized in a tableau, given here as (30).

(30)

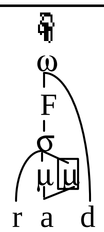
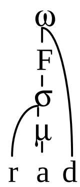
	a.	d.
		
WEAKEDGE	ω,F!,σ,μ,d	ω,d
M-MORA		*
PARSE-C-IN-σ		*

[3]Cautionary note: the following tableaux have the candidates along the horizontal axis and the constraints arranged vertically in contrast to the standard of Prince &Smolensky 1993.

The fact that (d) violates both M-MORA and PARSE-C-IN-σ, while still winning out over candidate (a) tells us that both of these constraints must be ranked below WEAKEDGE.

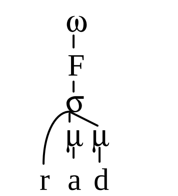
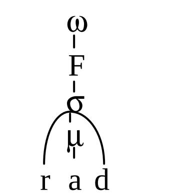
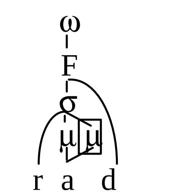
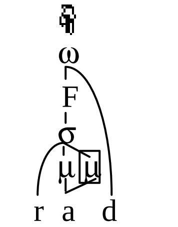
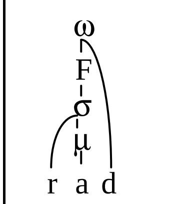
There are of course further candidates which need to be considered as well. Tableau (31) compares (d) with a candidate (e), identical in all respects except that the vowel is not lengthened. Such a candidate will of course have a foot consisting of a light syllable and therefore violate Foot Binarity. From this it can be determined that Foot Binarity must dominate M-MORA at least.

(31)

	d. 	e. 
FTBIN		*!
WEAKEDGE	ω,d	ω,d
M-MORA	*	

A summary of all the candidates discussed so far, and their evaluation on all the relevant constraints, is given in the tableau in (32).

(32)

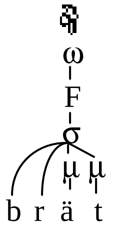
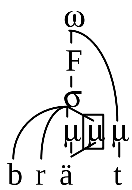
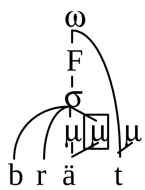
	a.	b.	c.	d.	e.
UR: μ r a d					
FtBin		*!			*!
Parse-μ-in-σ					
*Delink					
WeakEdge	ω,F!,σ,μ,d	ω,F,σ,d	ωF!,d	ω,d	ω,d
M-Mora			*	*	
Parse-C-in-σ			*	*	*

PF: [raad]

Moving on to the form *brätt* 'board', which has a word-final geminate, we can immediately apply the rankings that have been determined so far. In addition some further constraint rankings can be determined.

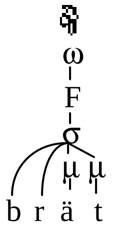
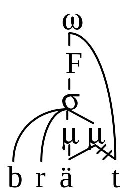
Tableau (33) shows some of the relevant candidates. Here the winning candidate is (a) which includes the final /t/ in the syllable, as opposed to (b) and (c) where the /t/ is directly dominated by the prosodic word. As a result (b) and (c) are both more harmonic with respect to WEAKEDGE. The crucial difference between this case and that of *rad* is that the /t/ is underlyingly moraic. Linking the /t/ to the prosodic word requires that the mora that it comes with go unparsed. As a result both (b) and (c) will violate PARSE-μ-IN-σ. The constraint conflict, and the fact that candidate (a) is the winner, tells us that PARSE-μ-IN-σ must dominate WEAKEDGE.

(33)

	a.	b.	c.
			
PARSE-μ-IN-σ		*!	*!
WEAKEDGE	ωF,σ,μ,t	$\omega\mu$,t	ω,t

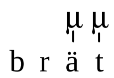
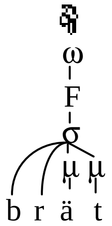
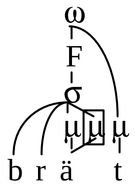
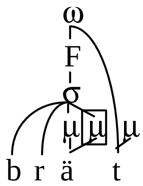
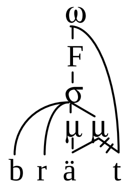
A further important candidate pair to consider is that given in (34). Candidate (d) preserves the mora through a process of compensatory lengthening. The mora that is underlyingly associated with the consonant is delinked and transferred to the preceding vowel. Since such a form disrespects the underlying moraicity, it will violate at least *DELINK (cf. Itô, Mester & Padgett 1993). The fact that (a) wins out over (d) indicates that *DELINK is ranked higher than WEAKEDGE.

(34)

	a.	d.
		
*DELINK		*!
WEAKEDGE	ωF,σ,μ,t	$\omega\mu$,t

Again the candidates discussed are all summarized in the tableau in (35).

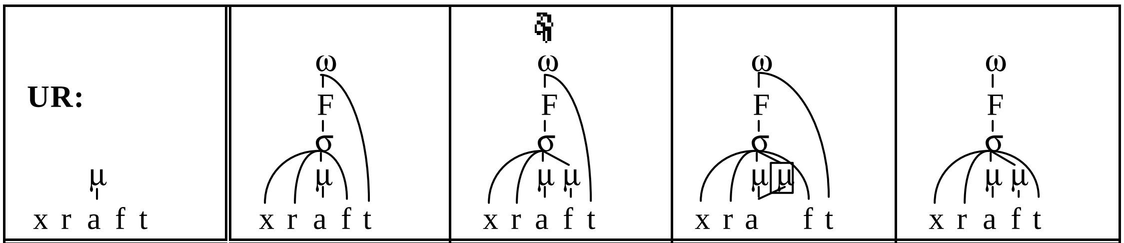
(35)

UR: 	a. ☞ 	b. 	c. 	d. 
FtBin				
Parse-μ-in-σ		*!	*!	
Delink				*!
WeakEdge	ωF,σ,μ,t	ωμ,t	ω,t	ω,t
M-Mora		*	*	
Parse-C-in-σ		*	*	*

PF: [brätt]

Finally in (36) is the set of relevant candidates for the example *xraft* ‘strength’, which has a final consonant cluster. Here the ranking of the constraints that was determined to account for the two previous cases, is completely sufficient and correctly predicts (b) to be the winning candidate.

(36)



	a.	b.	c.	d.
FtBin	*!			
Parse-μ-in-σ				
*Delink				
WeakEdge	ω,t	ω,t	ω,t	ωF!,σ,t
M-Mora			*!	
Parse-C-in-σ	*	*	*	

PF: [xraft]

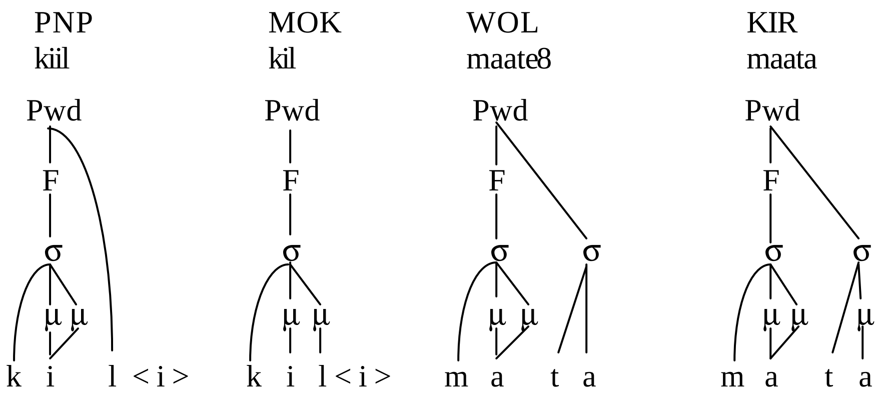
This case brings out another interesting aspect of Optimality Theory, the fact that what counts as optimal is decided relative to a set of candidates of the same form. This is demonstrated by the fact that, in contrast to this set, in the case of *rad*, the candidate that underwent vowel lenghtening was the optimal one.

4. Further cases: the Micronesian languages

Having considered the GT case in detail it is interesting to take another look at Ponapean and some closely related Micronesian languages. As was noted earlier Ponapean exhibits the same type of lengthening pattern as does GT, modulo the further complication of final vowel deletion. In fact other closely related Micronesian languages display similar patterns. Notably Woleaian and Kiribati also show lengthening, while Mokilese exhibits final vowel deletion. An excellent discussion of the cross-linguistic variation is found in Rehg (1984).

The interesting case for comparison between the four languages is the different realization of underlying CVCV words. In Ponapean (PNP) the first vowel is lengthened, while the final vowel is deleted. In Mokilese (MOK) there is final vowel deletion without the lenghtening. Both Woleaian (WOL) and Kiribati (KIR) have lengthening without deletion, but in Woleaian the final vowel is voiceless. The analysis that derives these forms from underlying CVCV items mirrors to a certain extent the historical development. For each of the four languages this has however been argued independantly to constitute the synchronic analysis as well (see Rehg 1981 for PNP, Harrison 1976 for MOK, Sohn 1975 for WOL). The combined pattern of lengthening and deletion in PNP leads one at first to assume that this is a case of compensatory lengthening. But as Rehg (1984) points out the lack of deletion in WOL and KIR calls into question the idea that the lengthening is in any way compensatory. (37) illustrates the different structures for CVCV words in the four languages.

(37) URs: /kili/ ‘skin, bark’ /mata/ ‘eye’



Although (37) represents crosslinguistic variation, the free generability of output candidates for any input in OT will mean that (37) also constitutes part of the candidate set for a CVCV word in any one of the four languages. In other words, each one of the four languages will have among its set of potential output candidates for an underlying CVCV form, all four of the above structures, after substituting the appropriate segmental material. Which one is chosen among the four will be the result of the language particular constraint ranking.

A further point that follows directly from the architecture of OT is that, since the constraints that make up the rankings are universal, the constraints that account for the success of a particular candidate in one language, must also be the constraints responsible for the outcome in the other languages, but in a permuted order.

This is also demonstrably the case in the Micronesian family. The constraints that account for the situation are WEAKEDGE, M-MORA, and PARSE-SEG. The first two are already familiar from the discussion of GT. PARSE-SEG is a constraint that militates against any loss of segmental material. With three constraints there will be a total of six possible rankings. Since M-MORA and PARSE-SEG do not conflict, they are not directly rankable and therefore only four of the rankings are distinct. These constraint rankings and the languages that illustrate them are given in (38).

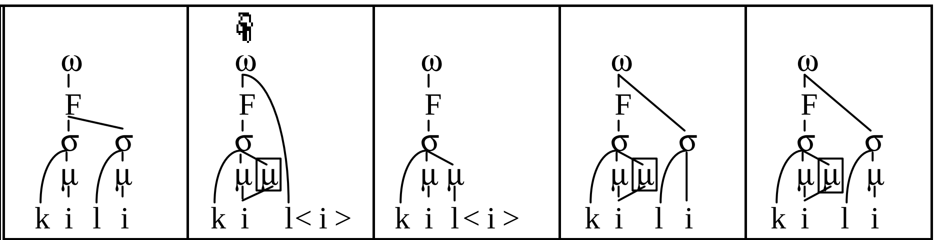
(38)

a.	WEAKEDGE >> M-MORA , PARSE-SEG	Ponapean
b.	M-MORA >> WEAKEDGE >> PARSE-SEG	Mokilese
c.	PARSE-SEG >> WEAKEDGE >> M-MORA	Woleaian and Kirbati
d.	M-MORA , PARSE-SEG >> WEAKEDGE	

The four languages exemplify three of the four patterns as will be demonstrated below. The fourth pattern will be shown to be the default pattern, since it results in a language where a CVCV input is realized as a CVCV output.

How these constraint rankings account for the language variation can be shown with the help of the following tableaux. The first case to consider is that of Ponapean. In Ponapean WEAKEDGE is ranked highest. The other two constraints do not interact and are therefore not crucially ranked.

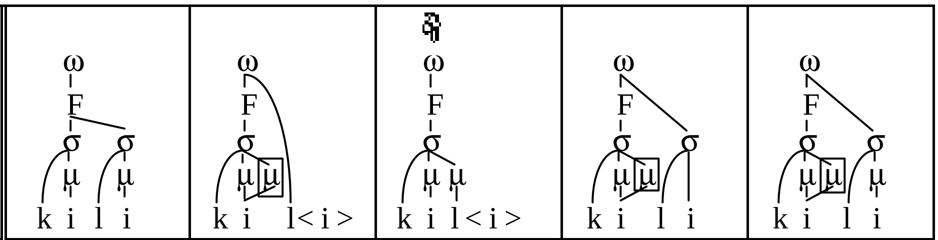
(39) PNP



	a.	b. ☞	c.	d.	e.
WEAKEDGE	ω,F!,σ,μ,i	ω,l	ω,F!,σ,μ,l	ωσ!,i	ωσ!,μ,i
M-MORA		*		*	*
PARSE-SEG		*	*		

Since WEAKEDGE is the highest ranked of the relevant constraints the optimal candidate will be the one that is most harmonic with respect to it. This means that the candidate with the least structure in its right periphery will be chosen, even if this requires underparsing of segmental material or lengthening of a vowel. In fact the winning candidate (b) requires both. Competing candidates (d) and (e) which parse the final vowel are less harmonic with respect to WEAKEDGE, since a final vowel will necessarily form a syllable nucleus, thereby leading to more structure in the periphery.

The case of Mokilese is illustrated with tableau (40). The important difference to Ponapean is that M-MORA, the constraint against unlicensed morae, is ranked highest. This means that increasing the harmony of the periphery will only be possible as long as it doesn't require lenghtening an underlying short vowel. This eliminates candidates (b), (d) and (e).

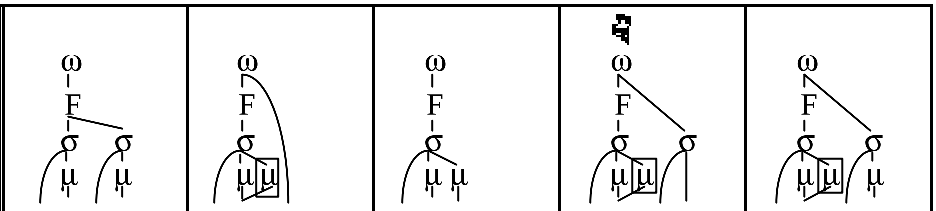


(40) MOK	a.	b.	c.	d.	e.
M-MORA		*!		*!	*!
WEAKEDGE	ω,F,σ,μ,i!	ω,l	ω,F,σ,μ,l	ωσ,i	ωσ,μ,i
PARSE-SEG		*	*		

Among the candidates that do not violate M-MORA, the one that is most harmonic with respect to WEAKEDGE will be the optimal candidate. This makes (c) which has a final consonant the preferred candidate over (a) which has a final vowel. The reason for preferring final consonants over final vowels is that a vowel is a syllable head in contrast to a coda consonant. If the notion 'head of' is a structural one than the final vowel, the syllable head, will contribute more structure to the periphery of the prosodic word than a coda consonant.

In Woleaian final short vowels are voiceless. The representation that I will assume for voiceless vowels is that of non-moraic vowels. The occurance of non-moraic vowels in the periphery is another effect of the constraint WEAKEDGE. The tableau in (41) shows the situation for Woleaian.

(41) WOL

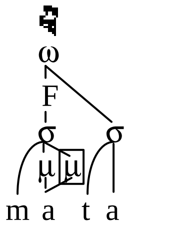
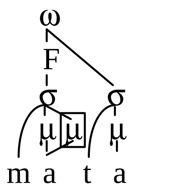


	a.	b.	c.	d.	e.
	m a t a	m a t< a >	m a t< a >	m a t a	m a t a
PARSE-SEG		*!	*!		
WEAKEDGE	ω,F!,σ,μ,a	ω,t	ω,F,σ,μ,t	ωσ,a	ω,σ,μ!,a
M-MORA		*		*	*

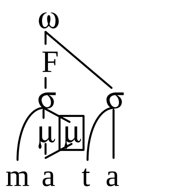
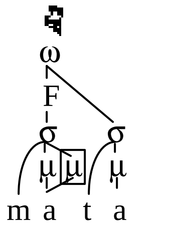
In this case the constraint PARSE-SEG is ranked above WEAKEDGE. This means that underparsing in order to improve the harmony of the right periphery is not an option. The winning candidate will therefore be chosen among the candidates that have the underlying final vowel preserved, that is candidates (a), (d), and (e). Among these the winner is determined by the next ranking constraint, in this case WEAKEDGE. The optimal form is therefore either (d) or (e) depending on whether (d) is a legitimate structure in the language. Since Woleaian permits voiceless vowels, structures such as (d) are acceptable, making (d) the winning candidate.

The tableau for Kiribati would be essentially identical to that of Woleaian. The different choice of winning candidate is simply a matter of (d) being disallowed as a structure in Kiribati. This would be achieved by having a constraint against non-moraic vowels ranked above WeakEdge.

(42) WOL

	d.	e.
		
WeakEdge	ωσ,a	ωσ,μ!,a
Nec V_μ	*	

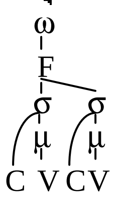
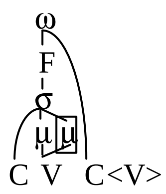
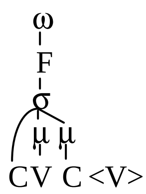
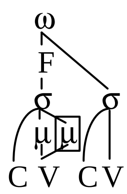
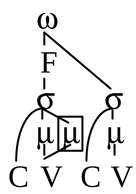
(43) KIR

	d.	e.
		
Nec V_μ	*!	
WeakEdge	ωσ,a	ωσ,μ,a

As shown by the tableaux in (42) and (43), the relative ranking between WeakEdge and a potential constraint that requires syllable peaks to be moraic (Nec V_μ) explains the contrast between Woleaian and Kiribati. Ranking WeakEdge over Nec V_μ results in final vowels being non-moraic and therefore voiceless as can be seen in (42) for Woleaian.

These four languges illustrate three of the four possible constraint rankings listed in (38). The remaining ranking to be considered has WEAKEDGE ranked lowest. In this case the winning candidate is the one most faithful to the input. The tableau for this situation is shown in (44).

(44)

	a.	b.	c.	d.	e.
	☞ 				
PARSE-SEG		*!	*!		
M-MORA		*		*!	*!
WEAKEDGE	ω,F,σ,μ,a	ω,t	ω,F,σ,μ,t	ωσ,a	ωσ,μ,a

In summary the present discussion shows that the use of WEAKEDGE permits a straightforward account of the language variation in Micronesian. It constitutes an excellent example of the factorial typology of OT, all the possible constraint rankings correspond to actually attested languages. The analysis directly relates the final vowel loss and devoicing to the lengthening in the penult, while at the same time preserving their independance. This explains how it is possible to have lengthening without final vowel loss (KIR), as well as final vowel loss without lengthening (MOK).

5. What are geminates?

Returning to questions raised earlier with respect to the different possible conceptions of geminates (bi-skeletal, two-root-node, moraic), it was noted that in the vast majority of languages that have geminates in their inventory, geminates are restricted to the inter-syllabic position. Typical examples of this kind are Japanese, Italian, Finnish, etc. Much more marginally geminates are permissible word finally. Only in very rare cases are geminates permissible in the onset, and, in the cases that I am aware of, they seem to arise due to morphological processes (typically prefixation). This is the case in GT, where word-initial geminates are restricted to the past participle form of the verb. Examples of this can be seen in (45)

(45) Word-initial geminates in GT (cf. Winteler 1876)

infinitive	**past participle**	**gloss**
buu´	**pp**uu´	'build'
plaag´	**pp**laag´t	'torment'
trääge	**tt**räêt	'carry'
gêê	**kk**êê	'give'
alt´	**kk**alt´t	'age'
aan´	**kk**aant	'suspect'
äämde	**kk**äämdet	'cut the second hay'
laxxe	**kk**laxxet	'laugh'
Sêmpfe	**kk**SUmpfe	'scold'
nêê	**kk**nUU	'take'

As the vowel initital verbs show the formation of the past participle involves the prefixation of a 'geminate' /k/. In the cases where the prefix comes before a stop an assimilation process results in geminates of differing quality.

A point that is worth clarifying is that the examples in (45) do indeed constitute examples of onset geminates. This is because certain sources refer to such sounds as 'fortis' (cf. Streiff 1915). The fact that the initial segments in (45) include velars shows that they are geminates, and not just fortis stops. In general GT has a three way distinction between lenis, fortis and geminates (geminated fortis). This paradigm is defective in the case of velars, which only contrast lenis and geminates. This can be shown by the following distribution facts. Labials and coronals contrast lenis and fortis in both onset and final positions, as demonstrated by the facts in (46).

(46)

lenis	**fortis**	
drüü	trüü	‘three’ vs. ‘faithful’
dU´	tU´	‘then’ vs. ‘do’
blaase	plaage	‘blow’ vs. ‘torment’
baxx	paxxt	‘river’ vs. ‘
raad	raat	‘wheel’ vs. ‘counsel’
xalb	alp	‘calf’ vs. ‘alp’

The distribution facts of stops for GT are that lenis stops of all kinds are found in all postions, onset, final, and intervocalic. Fortis stops, on the other hand, are limited to labials and coronals in onset and final position. In intervocalic position fortis stops are always geminated. As was noted in (3) above geminated fortis are possible in final position as well. Unlike for plain fortis, velar geminated fortis are not restricted. This situation is summarized in (47).

(47) distribution of stops in GT

	lenis			fortis			geminates		
	b	d	g	p	t	k	pp	tt	kk
onset						*	?	?	?
intervocalic				*	*	*			
final						*			

As is clear from the above summary, if the segments in (45) above are classified as fortis stops, then GT would be in the peculiar situation of having segments (velar fortis stops) which are restricted to onset position in certain morphologically derived contexts. On the other hand adopting the assumption that the past participle prefix is indeed a ‘geminated’ (moraic) velar, permits us to maintain the generalization that velars are never fortis. Presumably velars are incompatible with the feature (either voicing or glottalization) that marks fortis stops. Some further supporting evidence comes from foreign loanwords. Borrowed /k/ aways surfaces as affricate /kx/, never as /k/ or /kk/. So for example *kxättS@´p* ‘ketchup’, *kxeerIxt* ‘trash’ (from German *kehricht*).

Returning to the analysis of the past participle prefix, in GT there are further morphological contexts that also give rise to onset geminates, for example the plural and the feminine singular definite articles.

(48)

noun	**article+noun**	**gloss**
bÜ´x´r	**pp**Ü´x´r	‘(the) books’
palm´	**pp**alm´	‘(the) palmtrees’
tass´	**tt**ass´	‘(the) cup’
gäd´	**kk**äd´	‘(the) barns’

(49) past participle prefix — definite article (fem + pl)

$$\begin{array}{c} \mu \\ | \\ \text{k} \end{array} \qquad\qquad \begin{array}{c} \mu \\ | \\ \text{t} \end{array}$$

Under the view of geminates advanced here, these prefixes should be considered moraic segments as seen in (49). Prefixation of the morphemes represented in (49) gives exactly the desired result with minimal effort. Note that if a prefix consisting of a geminate with two X-slots or two root nodes had been the proposed the resulting forms would invariably be left with an extra element to be deleted. With the present analysis simply prefixing the morphemes in (49), will already give exactly the desired result. Subsequent delinking of the place feature of the prefix in case the onset of the stem has the same value of [+cont] provides the resulting assimilation.

In Kabardian and Berber word-initial geminates are also the result of a prefixation process.

If the distribution of geminates is skewed in this fashion, then it seems reasonable that a proper conception of geminates should also provide an explanation of these facts. The moraic theory of geminates together with Optimality Theory provides such an explanation. First of all, the mere fact that geminates are moraic consonants limits their general occurrence to the coda position. This explains the rarity of onset geminates directly. Further, in cases where the condition against moraic consonants is ranked relatively high, this will require the geminate to be linked to an onset as well in order to be acceptable, thereby resulting in limiting the geminates to inter-syllabic position. A detailed description of how this type of system can explain the distribution in Japanese is given in Itô and Mester (1993).

In languages where the Path Condition AVOID C_{μ} is ranked fairly low, moraic consonants not linked to an onset position become possible, potentially permiting word-final geminates. The actual availability of final geminates will depend on the relevant ranking of other constraints, such as WEAKEDGE.

6. Conclusion

The main proposal of this paper is the universal constraint WEAKEDGE. This constraint requires the structure of the right edge of a prosodic constituent to be minimal. As a result it accounts for the 'extrametrical' behavior of final consonants in Glarnertüütsch, a Swiss German dialect. The language particular constraint ranking and the violable nature of constraints in OT explain the fact that this behavior is found only in non-moraic consonants, but never in moraic ones.

The languages of the Micronesian family illustrate the wide array of effects attributable to WEAKEDGE. They also provide an example of the factorial typology of languages; each possible ranking of a set of constraints leads to an attested language.

In Woleaian and Kiribati the vowel in the penultimate syllable of certain disyllabic words is lengthened in order to avoid a word final head foot. This follows from WEAKEDGE, since a word final foot would mean more structure in the right periphery of the prosodic word. Constraints on foot form induce the lengthening. WEAKEDGE was also shown to be responsible for the devoicing of word final vowels in Woleaian, assuming that voiceless vowels are nuclei of syllables that lack a mora.

The case of Mokilese shows how WEAKEDGE causes deletion of final short vowels. Vowels are syllable nuclei and therefore syllable heads. Since heads are structurally more salient than non-heads, WEAKEDGE will militate against heads in peripheral position. As a result, consonants are the preferred peripheral elements. Constraints to this effect that have been proposed are FINAL-C (McCarthy 1993a, McCarthy & Prince 1993a) and FREE-V (Prince & Smolensky 1993). Mokilese is a language that has such a condition, and deletes final vowels.

The analysis of Ponapean is interesting in that it relates both the vowel deletion and the vowel lenthening to the same cause without making the lengthening 'compensatory'. This is as should be, since the Woleaian, Kiribati, and Mokilese data show that the two processes are in principle independant.

Speculating about some further possible effects of WEAKEDGE in the segmental domain. If we assume that voice is a privative feature, then segments containing [voi] will be dispreferred. This gives an account of final devoicing. Similarly various types of Coda Conditions might be the result of WEAKEDGE (σ).

The broad range of effects covered by WEAKEDGE might make it preferable to view it as a family of constraints rather than a single entity. Another question for further research is whether WEAKEDGE can be reduced to the general constraint *STRUC (cf. P&S, p.25).

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