# Phonological Opacity and the General Schema FAITH-to-INPUT *

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## 1. Introduction

A species of phonological opacity (Kiparsky 1971, 1973a) is taken care of by the level condition INPUT that destines markedness constraints as a whole to be satisfied at input level (Lee 1996, In prep.). Besides, there are cases in which at first glance it would seem to be plausible to rely on this level condition to tackle the problem of phonological opacity. Naturally, they are considered to give rise to complex and intricate problems not susceptible to a satisfactory solution in Optimality Theory (OT; Prince & Smolensky 1993). In this paper, I will investigate these cases cited from various languages within the framework of OT, specifically, the Correspondence Theory (McCarthy & Prince 1995). Eventually, this study will prove that the instantiations of the following schema play a crucial role in accounting for the complex and intricate data, which constitute another species of phonological opacity:

(1) General Schema FAITH-to-INPUT
  FAITH-to-INPUT ($C_i$)
  Element E in the satisfied domain of constraint $C_i$ has a correspondent K in input.

I need hardly emphasize that an extension of the correspondence relation restricted to faithfulness constraints makes it possible to state this schema.

Each individual instantiation of the schema will be shown to play a decisive role in the following interactions, which incur phonological opacity: in the interaction of epenthetic

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vowels with stress assignment in Mohawk (section 2), in the interaction of *u*-Epenthesis with *u*-Umlaut in Icelandic (section 3), in the interaction of vowel lowering and vowel epenthesis with vowel harmony in the Yawelmani and Wikchamni dialects of Yokuts (section 4), in the interaction of nasal assimilation with consonant deletion in Diola Fogny (section 5), and finally in the self-interaction of vowel gradation and in the interaction of vowel gradation with vowel shortening in Klamath (section 6).

## 2. Mohawk

In Mohawk, a Northern Iroquoian language, epenthetic vowels interact with stress assignment in a most complicated way. In this section, I will show that an instantiation of the schema FAITH-to-INPUT plays an important part in this interaction. The ensuing discussion and data are mainly based on Michelson (1981a, 1981b, 1989; see also Postal 1968, Chafe 1977, Michelson 1983, 1988, Lakoff 1993, Alderete 1995, Pigott 1995).

In Mohawk, stress regularly falls on penultimate syllables in case no epenthetic vowel occurs within the last two syllables of a word:

(2) Canonical Stress

| | | |
|---|---|---|
| katirútha? | /k-atirut-ha?/ | 'I pull it' |
| kkétskwas | /k-ketskw-as/ | 'I raise it' |
| wakashé:tu | /wak-ashet-u/ | 'I have counted it' |
| kakʌ?roké:was | /k-akʌ?rokew-as/ | 'I'm dusting' |
| kríhtha? | /k-riht-ha?/ | 'I cook' |

Assuming the satisfaction of the constraints FTBIN (disyllabic) and FTFORM (trochaic), we may illustrate the canonical stress pattern with ALIGN-R (FT, PRWD) dominant over PARSE-SYLL as in the following tableau. (Foot is enclosed with braces.)

(3) Canonical Stress: ALIGN-R >> PARSE-SYLL

| /k-atirut-ha?/ | ALIGN-R | PARSE-SYLL |
|---|---|---|
| ☞ kati{rútha?} | | ** |
| {kà:ti}{rútha?} | *!* | |
| ka{tí:rut}ha? | *! | ** |
| {ká:ti}rutha? | *!* | ** |

In fact, epenthetic *e* and *a* derange the regular stress pattern enormously. A basic description of epenthesis in Mohawk involves

> the insertion of an epenthetic vowel *e* into certain consonant clusters, except at the boundary between an incorporated noun root and a following verb root, where an epenthetic *a* (the *joiner*) is inserted instead (e.g. Postal 1968, 253; Bonvillain 1973,56; Chafe 1977,171; Mithun 1979a, 179 and 1979b, 345) (Michelson 1989)

I will not go deep into the issue of the process of epenthesis, since the main interest lies in investigating the interaction of the epenthetic vowels with the assignment of stress, which will ultimately lead to invoking an instantiation of the schema FAITH-to-INPUT. Consider now the following examples with epenthetic vowels. (Henceforward, epenthetic vowels are underscored.)

(4) a. Epenthesis in Ultimate Syllable

| | | |
|---|---|---|
| ʌká:rate̲ʔ | /ʌ-k-arat-ʔ/ | 'I lay myself down' |
| waʔkyé:rite̲ʔ | /waʔ-k-yerit-ʔ/ | 'I accomplished it' |
| ʌ́kyaʔke̲ʔ | /ʌ-k-yaʔk-ʔ/ | 'I will cut' |
| ʌkóhkwate̲ʔ | /ʌ-k-ohkwat-ʔ/ | 'I will dig' |
| rokú:tote̲ʔ | /ro-kut-ot-ʔ/ | 'he has a bump on his nose' |

b. Epenthesis in Penultimate Syllable

| | | |
|---|---|---|
| téke̲riks | /te-k-rik-s/ | 'I put them together, next to each other" |
| wakatyáne̲ruʔs[1] | /wak-atyanruʔ-s/ | 'I feel spooky' |
| tkatáwe̲yaʔts | /t-k-atawyaʔt-s/ | 'I enter' |
| otsî:ne̲kwar[2] | /yo-tsiʔnkwar/ | 'yellow' |
| wake̲núhsa̲yʌ | /wak-nuhs-yʌ-∅/ | 'my house' |
| tekanákta̲ke | /te-ka-nakt-ke/ | 'two beds' |

c. Epentheses in Antepenultimate and Ultimate Syllables

| | | |
|---|---|---|
| waʔtkatáte̲nake̲ʔ | /waʔ-t-k-atat-nak-ʔ/ | 'I scratched myself' |
| takatáwe̲yaʔte̲ʔ | /t-a-k-atawyaʔt-ʔ/ | 'I entered' |
| ʌ́ke̲rihte̲ʔ | /ʌ-k-ri-ht-ʔ/ | 'I will cook' |
| waʔke̲wʌ́:na̲rahkwe̲ʔ | /waʔ-k-wʌn-rahkw-ʔ/ | 'I obey' |

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[1] Morpheme-internal epenthesis will be discussed later.

[2] " ^ " denotes both stress and falling tone, to which I will come later. And, according to Michelson (1981), *w* and *y* are deleted word-initially in nouns.

tʌktsî:tsyarike? /t-ʌ-k-tsi?tsy-rik-?/ 'I will put the flowers side by side'

In Lee (1996, In prep.), it is proposed that level conditions be imposed on markedness constraints. The levels at which markedness constraints are destined to be satisfied are input, output and indifferent which comprises both input and output. Thus, making a hurried survey of the above data might persuade us to conclude that FTBIN conditioned by the level condition INPUT is sufficient for forming foot, since epenthetic vowel is not counted in satisfying FTBIN. Among others, however, output forms like *ítenehre?* from /t-ni-ehr-?/[3] 'you (sg.) and I want' in which the underlying penultimate vowel is deleted counter the proposal of $\text{FTBIN}_{\text{INPUT}}$. Hence, the generalization to be drawn is that epenthetic vowel is not counted in satisfying FTBIN. This is accomplished by requiring that the vowels parsed by foot have correspondents in input, even though the structural description (SD) of FTBIN as a whole is not met at the input level, which would induce FTBIN to be constrained by the level condition INPUT. We may thus formulate a process-specific constraint to this effect to constrain FTBIN, which is satisfied at the output level:

(5) FAITH-to-INPUT (FTBIN)
Every vowel in the satisfied domain of the constraint FTBIN has a correspondent in input.

Of course, this is an instantiation of the schema FAITH-to-INPUT. This process-specific constraint successfully excludes epenthetic vowels in forming foot, as is demonstrated in the following summary tableau. (The parenthesized syllables within braces are discontinuous prosodic constituents that constitute foot (this notation is borrowed from Alderete 1995).)

[3]The prothetic ı will be dealt with later

(6) FAITH-to-INPUT (FTBIN) >> FTBIN, ALIGN-R

| | | FAITH-to-INPUT (FTBIN) | FTBIN | ALIGN-R |
|---|---|---|---|---|
| /ʌ-k-arat-ʔ/ | ☞ ʌ{ká:ra}te̲ʔ | | | * |
| | ʌka{ráte̲ʔ} | *! | | |
| | {ʌ́:ka}rate̲ʔ | | | **! |
| /te-k-rik-s/ | ☞ {(té)ke̲(riks)} | | | |
| | te{ké̲:riks} | *! | | |
| | {téke̲}riks | *! | | * |
| /waʔ-t-k-atat-nak-ʔ/ | ☞ waʔtka{(tá)te̲(na)}ke̲ʔ | | | * |
| | waʔtkatate̲{náke̲ʔ} | *! | | |
| | waʔtkata{té̲:na}ke̲ʔ | *! | | * |

FAITH-to-INPUT (FTBIN) must outrank ALIGN-R so as to be able to disregard the word-final syllable which contains epenthetic vowel in forming foot, but no ranking obtains between FTBIN and ALIGN-R. Moreover, even if there is no evidence, in the present case, that FAITH-to-INPUT (FTBIN) dominates FTBIN, the process-specific constraint must dominate the constrained constraint if the former is to be effective: if the process-specific constraint is dominated by the conditioned constraint, the effect of the former is counteracted (cf. Elsewhere Condition of Kiparsky (1973b) and Pāṇini's Theorem on Constraint-ranking of Prince & Smolensky (1993)). The empirical proofs of this ranking will be supplied in the process of discussion.

The vowels that should be invisible to FTBIN are to be further restricted. The epenthetic vowels *e* and *a* in syllables closed by an oral consonant must not be ignored in forming foot (Alderete 1995).[4] Incidentally, this fact compels us to reject definitely the device of hypothetical $\text{FTBIN}_{\text{INPUT}}$.

(7) Epenthetic Vowels in Closed Syllable

| | | |
|---|---|---|
| a. waké̲nyaks | /wak-nyak-s/ | 'I get married' |
| tekahsuté̲rha | /te-k-ahsutr-ha/ | 'I am splicing' |
| ʌké̲theʔte̲ʔ | /ʌ-k-theʔt-ʔ/ | 'I will pound' |

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4 This statement with the qualification "oral" is due to the fact that the epenthetic *e* which breaks up word-final *C*ʔ cluster is disregarded in satisfying FTBIN. Henceforward, the vowels in syllables not closed by oral consonant are referred to as "weightless" According to Michelson (1981), the term "weightless vowels" was first used by Lounsbury (1942) to refer to epenthetic vowels in Oneida.

| | | |
|---|---|---|
| kyʌtâkwas [5] | /k-yʌt-kw-as/ | 'I collect wood' |
| tekahruwânyu | /te-ka-hruw-nyu-∅/ | 'many objects put in your path' |
| b. kenʌ́stak-s | /k-nʌst-k-s/ | 'I eat corn' |
| tekshâ:kets | /te-k-shaʔkt-s/ | shaʔkt 'bend' |

As observed, epenthetic vowels *e* and *a* in syllables closed by an oral consonant behave like underlying vowels in forming foot: not only do they bear stress (a), but they are also counted in forming foot (b). Thus, FAITH-to-INPUT (FTBIN) must be revised in such a way that only "weightless" epenthetic vowels are ignored in forming foot:

(8) FAITH-to-INPUT (FTBIN)

Weightless vowel *e* or *a* in the satisfied domain of the constraint FTBIN has a correspondent in input.

In Alderete (1995), the following constraint is formulated:

(9) CONTIG-SYLL

Each syllable dominated by a prosodic foot $F_x$ must be contiguous with at least one other syllable parsed by $F_x$.

This constraint is absolutely necessary to penalize the foot formed with discontinuous syllables.

Equipped with the constraint FTBIN conditioned by the revised FAITH-to-INPUT (FTBIN) and CONTIG-SYLL, we may construct the following summary tableau:

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[5] The cluster *kw* which occurs intramorphemically preceded by V and followed by isomorphemic V is parsed as onset. For example, in *otsî·nekwar* from /yo-tsiʔnkwar/ in (4b), the cluster *kw* is parsed as onset.

(10) FAITH-to-INPUT (FTBIN) >> FTBIN, ALIGN-R; FAITH-to-INPUT (FTBIN) >> CONTIG-SYLL

| | | FAITH-to-INPUT (FTBIN) | FTBIN | CONTIG-SYLL | ALIGN-R |
|---|---|---|---|---|---|
| a. /wak-nyak-s/ | ☞ wa{ke̲nyaks} | | | | |
| | {(wá)ke̲n(yaks)} | | | *!* | |
| | {wáke̲n}yaks | | | | *! |
| b. /ʌ-k-theʔt-ʔ/ | ☞ ʌ{ke̲theʔ}te̲ʔ | | | | * |
| | ʌke̲t{hê:te̲ʔ} | *! | | | |
| | {(ʌ́)ke̲t(heʔ)}te̲ʔ | | | *!* | * |
| c. /k-nʌst-k-s/ | ☞ ke̲{nʌ́sta̲ks} | | | | |
| | {ké̲:nʌs}ta̲ks | *! | | | * |
| | {(ké̲:)nʌs(ta̲ks)} | *! | | ** | |

CONTIG-SYLL will be shown to be dominated by FAITH-to-INPUT (FTBIN), but there is no ranking among FTBIN, CONTIG-SYLL and ALIGN-R.

Next, I will proceed to the forms which have epenthetic vowels in consecutive syllables:

(11) Epenthetic Vowels in Consecutive Syllables

| | | |
|---|---|---|
| a. turé:se̲re̲ʔ | /t-a-w-aresr-ʔ/[6] | 'it boiled, flowed over' |
| tewakahsú:te̲re̲ʔ | /te-wak-ahsutr-ʔ/ | 'I have spliced' |
| yʌ́:ke̲we̲ʔ | /y-ʌ-k-w-ʔ/ | 'I will get there' |
| yó:te̲re̲ʔ | /yo-t-r-ʔ/ | 'it's in the dish or glass' |
| b. tekanaʔka̲rá̲:ke | /te-ka-naʔkr-ke/ | 'two horns' |
| skanyata̲rá̲:ti | /s-ka-nyatr-ti/ | 'one side of the lake' |

Definitely, both of the two epenthetic vowels in the consecutive weightless syllables must not be skipped in forming foot. This can be handled by a constraint equivalent to the local conjunction of PARSE-SYLL, i.e., PARSE-ADJ-SYLL, formulated by Alderete (1995) in accounting for Selayarese stress pattern (for the local conjunction of constraints, see Smolensky 1993, 1995, Alderete 1997, Itô and Mester 1996). The constraint in question is PARSE-SYLL$^2]_{AS}$, which demands that one of the adjacent two weightless syllables containing epenthetic vowels be parsed by foot. This constraint must outrank FAITH-to-

6 The sequence *a* followed by *wa* is reduced to *u*

INPUT (FTBIN) to ensure that one of those vowels is counted in forming foot at the cost of violating the latter. This point is illustrated with the following summary tableau:

(12) PARSE-SYLL$^2$]$_{AS}$ >> FAITH-to-INPUT (FTBIN) >> FTBIN,
FAITH-to-INPUT (FTBIN) >> CONTIG-SYLL

| | | PARSE-SYLL$^2$]$_{AS}$ | FAITH-to-INPUT (FTBIN) | FT-BIN | CONTIG-SYLL |
|---|---|---|---|---|---|
| /t-a-w-aresr-ʔ/ | ☞ tu{ré:se̲}re̲ʔ | | * | | |
| | {tú:re}se̲re̲ʔ | *! | | | |
| | tu{(ré)se̲(re̲ʔ)} | | * | | *!* |
| /te-ka-naʔkr-ke/ | ☞ tekanaʔka̲{rá̲:ke} | | * | | |
| | teka{(nâ:)ka̲ra̲(ke)} | *! | | | ** |
| | tekanaʔ{(ká̲:)ra̲(ke)} | | * | | *!* |

In case weightless syllables containing epentheic *e* and *a* occur consecutively, the latter must be parsed by foot, regardless of the order of occurrence, even at the risk of violating CONTIG-SYLL: in (b) below, weightless epenthetic *a* is parsed in violation of CONTIG-SYLL:

(13) Epenthetic Vowels *e* and *a* in Consecutive Syllables

| | | |
|---|---|---|
| a. tekaʔnukse̲{rá̲:ke} | /te-kaʔ-nuksr-ke/ | 'two onions' |
| wake̲noʔkwitshe̲{rá̲:ku} | /wak-noʔkwitshr-k-u/ | 'I have eaten the cornmush' |
| b. ohne{(ká̲)ke̲(ri)} | /o-hnek-kri-∅/ | 'broth' |
| oru{(tá̲)ke̲(ri)} | /o-rut-kri-∅/ | 'maple syrup' |

In order to guarantee the prior parsing of epenthetic *a* to *e*, we need the following two constraints ranked in the order of the statement:

(14) a. PARSE-*a*
Weightless epenthetic *a* must be parsed by foot.
b. PARSE-*e*
Weightless epenthetic *e* must be parsed by foot.

The ranking PARSE-*a* >> PARSE-*e* is quite natural considering that *a* is universally less marked than *e*. PARSE-*a* must also dominate CONTIG-SYLL to ensure that the syllable with epenthetic *a* out of the two consecutive weightless syllables with epenthetic vowels *e* and *a* is parsed by foot at the risk of violating the latter. This is illustrated in the following tableau:

(15) PARSE-SYLL$^2$]$_{AS}$ >> FAITH-to-INPUT (FTBIN) >> FTBIN;
PARSE-*a* >> PARSE-*e*, CONTIG-SYLL

| | PARSE-SYLL$^2$]$_{AS}$ | FAITH-to-INPUT (FTBIN) | FT-BIN | PARSE-*a* | PARSE-*e* | CONTIG-SYLL |
|---|---|---|---|---|---|---|
| a. /te-kaʔ-nuksr-ke/ | | | | | | |
| ☞ tekaʔnukse{rá:ke} | | * | | | * | |
| tekaʔnuk{(sé:)ra(ke)} | | * | | *! | | ** |
| tekaʔ{(núk)sera(ke)} | *! | | | *! | * | ** |
| b. /o-hnek-kri-∅/ | | | | | | |
| ☞ ohne{(ká)ke(ri)} | | * | | | * | ** |
| ohneka{ké:ri} | | * | | *! | | |
| oh{(né:)kake(ri)} | *! | | | *! | * | ** |

In (b) above, the actual output form is selected since it obeys PARSE-*a* despite its violation of CONTIG-SYLL.

Intramorphemic instances of weightless epenthetic *e* between a consonant and *r* (and between *w* and *y*) behave exactly like the intermorphemic weightless epenthetic *e* with respect to FTBIN. And the same is true of the intramorphemic instances of the weightless epenthetic *a* in the identical environments. But Michelson (1989) claims that there is no evidence that synchronically they are epenthesized because they never alternate with ∅. The intramorphemic occurrence of the sequence *Cr*, however, is qualified to be an abstract one in the sense that this underlying sequence does not appear unchanged anywhere in surface (Kiparsky 1968); hence, on the assumption that this abstract sequence is justified grammar-internally, it is to be broken up by the epenthetic *e* or *a* by means of the independently-motivated constraints responsible for intermorphemic epenthesis (see Lee 1996, 1997 for the treatment of abstract segment and morpheme).[7] (The intramorphemic instances of epenthetic *e* and *a* are underscored and bold-faced.)

[7] If the approach of abstract morpheme were rejected, the constraint FAITH-to-INPUT (FTBIN) would have to be further qualified in order to disregard the intramorphemic occurrences of these vowels in satisfying FTBIN:

(i) FAITH-to-INPUT (FTBIN)
Weightless vowel in the satisfied domain of the constraint FTBIN has a correspondent which does not occur in the intramorphemic environment C ___ r in input.

(16) Intramorphemic Epenthesis

| | | |
|---|---|---|
| a. katoryâ:ne̱ru | /k-atoryaʔnru-∅/ | 'I move fast' |
| wáke̱ras | /w-akra-s/ | 'it smells' |
| tewarése̱rus | /te-w-aresr-us/ | 'it boils, flows over' |
| wakáwe̱ru | /wak-awru-∅/ | 'I'm spilling it' |
| b. oskú:ta̱raʔ | /o-skutr-aʔ/ | 'bark' |
| onyátsta̱raʔ | /o-nyatstr-aʔ/ | 'ribbon' |
| otsiʔnéhta̱raʔ | /o-tsiʔnehtr-aʔ/ | 'bead' |
| okúhkwa̱raʔ | /o-kuhkwr-aʔ/ | 'nipple' |

We have no need to give a tableau for these forms; they can be handled as are done the forms with epenthetic vowels in intermorphemic environments.

There is a form which presents a seemingly perplexing problem: *kathuwâ̱:reks* from /k-at-huw-hrek-s/ 'I go boating'. The epenthetic vowel *â:* in this form is stressed in open syllable, which acts contrary to FAITH-to-INPUT (FTBIN). According to Michelson (1981), a lengthened stressed vowel followed by *ʔ* or *hR* (*R* = resonants *n, r, w* and *y*) bears falling tone, and *ʔ* followed by a consonant and *h* are concurrently deleted:

(17) Forms with Falling Tone

| | | |
|---|---|---|
| a. wâ:ke̱rihte̱ʔ | /waʔ-k-riht-ʔ/ | 'I will cook it' |
| kethê:thaʔ | /k-theʔt-haʔ/ | 'I pound, am pounding' |
| watê̱:skute̱ʔ/ | /w-at-ʔskut-ʔ/ | 'a roast' |
| ohnyʌ̂:tskwire̱ʔ | /o-hnyʌʔtskwir-ʔ/ | 'small branch' |
| cf. ronuhwê:ʔu | /hro-nuhweʔ-u/ | 'he has liked it' |
| b. ʌke̱ʔnekʌ̂:naʔ | /ʌ-k-ʔnekʌ-hna-ʔ/ | 'I will go and beg' |
| tyeyaʔta̱kê:ru | /t-ye-yaʔt-kehru-∅/ | 'bodies are lying over there' |
| kathuwâ̱:reks | /k-at-huw-hrek-s/ | 'I go boating' |
| ranû:weʔs | /hra-nuhweʔs/[8] | 'he likes it' |
| cf. ke̱ríhthaʔ | /k-riht-haʔ/ | 'I cook' |

For the assignment of this falling tone, Michelson gives the following rule: V́: → V̂ / ____{ʔ, hR}. But here I sidestep the complicated and cumbrous formulation of the constraints responsible for creating falling tone and the subsequent deletion of *ʔ* and *h* in closed syllables. In brief, to save the forms which bear falling tone in open syllable with

[8] The segment *h* is lost before a consonant in word-initial position

epenthetic *a* (or *e*) from being forsaken, we must revise FAITH-to-INPUT (FTBIN) in such a way that the weightless epenthetic vowel which bears falling tone is exempted from being subject to that constraint. (It is assumed that the stressed vowel which does not bear falling tone is level-toned.)

(18) FAITH-to-INPUT (FTBIN)

The level-toned weightless vowel *e* or *a* in the satisfied domain of the constraint FTBIN has a correspondent in input.

As a consequence, the output form at issue is appraised to be optimal since it perfectly conforms to the revised FAITH-to-INPUT (FTBIN).

Vowel *i* is inserted word-initially by the process of Prothesis in verb forms which have fewer than two vowels in underlying representations:

(19) *i*-Prothesis

| | | |
|---|---|---|
| a. i̱kyʌs | /k-yʌ-s/ | 'I put it' |
| i̱ktats | /k-tat-s/ | 'I offer it' |
| i̱kkets | /k-ket-s/ | 'I scrape it' |
| b. í̱se̱riht | /s-riht-∅/ | 'Cook!' |
| í̱te̱nehre̱ʔ | /t-ni-ehr-ʔ/ | 'you (sg.) and I want' |
| í̱khne̱rʌks | /k-hnrʌks/ | 'I tie something' |
| c. sé̱rhos (*í̱se̱rhos) | /s-rho-s/ | 'you coat it with something' |

In assigning stress to underlying monosyllabic verb forms, the epenthetic *e* acts in the same way that it does in assigning stress to the forms discussed so far; namely, weightless epenthetic *e* is not counted (b), but the epenthetic *e* in the syllable closed by oral consonant is counted (c). As is obvious from the data given above, FTBIN necessary for those verb forms must be satisfied at the output level as is done FTBIN employed so far. That FTBIN must be constrained by the same process-specific constraint FAITH-to-INPUT as that involved in conditioning the already-established FTBIN. And, toward creating falling tone and lengthening the vowel bearing it, the stressed prothetic *i* behaves in the same manner as does the stressed vowel in non-prothetic forms (e.g., *î:raks* from /hra-k-s/ 'he eats it'[9]). Moreover, the stressed prothetic *i* in such forms as *í̱se̱riht* in (b) which is followed by epenthetic *e* in the next syllable is not lengthened, as is the case with non-prothetic forms.[10]

[9] This example is cited from Postal (1968).

[10] The process of vowel lengthening will be discussed at the end of this section.

The only idiosyncratic characteristic of the weightless epenthetic *i* (the prothetic *i*) is that it is counted in forming foot and bears stress.

At this point, we have to pause to ask why Prothesis should be satisfied in verb forms with a single syllable in underlying representation. The answer is: because Prothesis is none other than a device to meet the requirement of "Minimal Word," i.e., maximally unmarked prosodic word (Prince 1980, Broselow 1982, McCarthy & Prince 1986, 1990, 1991a, 1991b). Maximally unmarked prosodic word, in turn, contains a single foot by virtue of Prosodic Hierarchy (Selkirk 1980a, 1980b). Hence, the facts pointed out in the paragraph above and the requirement of minimal word which entails Prothesis taken together, the separate constraints that would be required for assigning foot to the underlyingly-monosyllabic verb forms are rendered superfluous by taking advantage of the already-employed constraints FAITH-to-INPUT (FTBIN), FTBIN, CONTIG-SYLL and ALIGN-R. But it is needless to say that the constraints responsible for prothesizing *i* are necessary. Furthermore, it is only too natural that the weightless prothetic *i* is not mentioned in the constraint FAITH-to-INPUT (FTBIN). For the prothetic *i* not merely makes the requirement of minimal word satisfied, but also it is the only legitimate penultimate vowel on which stress falls, if the underlying monosyllabic verb forms are to avoid risking extra violation of $\text{DEP}_{IO}$. The following summary tableau where the prothetic *i* is presupposed illustrates the state of affairs:

(20) FAITH-to-INPUT (FTBIN) >> FTBIN, CONTIG-SYLL

| | | FAITH-to-INPUT (FTBIN) | FTBIN | CONTIG -SYLL |
|---|---|---|---|---|
| a. /k-yʌ-s/ | ☞ {í̲kyʌs} | | | |
| | {kyʌ́s} | | *! | |
| b. /s-riht-∅/ | ☞ {(í̲)se̲(riht)} | | | ** |
| | {sé̲:riht} | *! | | |
| c. /k-hnrʌks/ | ☞ {(í̲k)hne̲(rʌks)} | | | ** |
| | kh{né̲:rʌks} | *! | | |
| d. /s-rho-s/ | ☞ {sé̲rhos} | | | |
| | {(í̲)se̲r(hos)} | | | *!* |

Obviously, the forms in (b) and (c) indicate that FAITH-to-INPUT (FTBIN) must dominate CONTIG-SYLL

Finally, I will examine a case that requires a process-specific constraint, which cannot be subsumed under the schema FAITH-to-INPUT. Short vowels in stressed syllables not closed by consonant are lengthened (a) unless they are followed by an epenthetic *e* in the next syllable (b). But the epenthetic *a* after stressed vowel does not interfere with the vowel lengthening at all (c).

| | | |
|---|---|---|
| (21) a. wake̱ruh{yá:kʌ} | /wak-ruhyakʌ-∅/ | 'I suffer' |
| {khní:nus} | /k-hninu-s/ | 'I buy' |
| ʌ{ká:ra}te̱ʔ | /ʌ-k-arat-ʔ/ | 'I lay myself down' |
| ro{kú:to}te̱ʔ | /ro-kut-ot-ʔ/ | 'he has a bump on his nose' |
| cf. {ákska}re̱ʔ | /ak-skar-ʔ/ | 'my girlfriend, boyfriend' |
| b. {(wá)ke̱(ras)} | /w-akra-s/ | 'it smells' |
| {(ʌ́)ke̱(rʌʔ)} | /ʌ-k-r-ʌʔ/ | 'I will put it into a container' |
| waʔtka{(tá)te̱(na)}ke̱ʔ | /waʔ-t-k-atat-nak-ʔ/ | 'I scratched myself' |
| wa{(ká)we̱(ru)} | /wak-awru-∅/ | 'I'm spilling it' |
| ʌ{(né)ke̱(ri)} | /∅-ʌnekri-∅/ | 'hay' |
| c. os{(kú:)ta̱(raʔ)} | /o-skutr-aʔ/ | 'bark' |
| waʔke̱{(wʌ́:)na̱(rah)}kwe̱ʔ | /waʔ-k-wʌn-rahkw-ʔ/ | 'I obey' |
| ka{(ná:)wa̱(ku)} | /ka-naw-ku-∅/ | 'in the swamp' |
| yaʔke̱{(ná:)wa̱(raʔ)}ne̱ʔ | /y-aʔ-k-naw-raʔ-nʔ/ | 'I approached the swamp' |
| wakh{né:ka̱}re̱ʔ | /wak-hnek-r-ʔ/ | 'I've put water into it' |

Nonetheless, the following data show that the epenthetic *e* which is followed by another epenthetic *e* does not hinder the process of vowel lengthening of the preceding stressed vowel:

| | | |
|---|---|---|
| (22) tu{ré:se̱}re̱ʔ (*tu{(ré:)se̱(re̱ʔ)} | /t-a-w-aresr-ʔ/ | 'it boiled, flowed over' |
| {yʌ́:ke̱}we̱ʔ (*{(yʌ́:)ke̱(we̱ʔ)} | /y-ʌ-k-w-ʔ/ | 'I will get there' |
| {yó:te̱}re̱ʔ (*{(yó:)te̱(re̱ʔ)} | /yo-t-r-ʔ/ | 'it's in the dish or glass' |

By the comparison of the forms above with those in (21b), it is evident that the stressed vowel in the syllable not closed by consonant is lengthened provided it is not followed by the epenthetic *e* unparsed by foot in the next syllable. Thus, the process-specific constraint to this effect to constrain vowel lengthening is required. To guarantee the lengthening of the stressed vowel in open syllables, while preventing the lengthening of the stressed vowel in closed syllables, we may have the process pair *[Vμ, +stress] (VL) >> WTIDENT$_{IO}$, which is dominated by the constraint *[μμμ]$_\sigma$, assuming that syllable-final consonant is moraic. Now, the process-specific constraint to condition VL is stated as in the following:

(23) Constraint on VL (C-on-VL)
The vowel *e* in the syllable following the target in the satisfied domain of the constraint VL must be dominated by a prosodic foot F.

With these constraints at our disposal, the phenomenon of vowel lengthening can be illustrated as in the following summary tableau:

(24) C-on-VL >> VL >> WTIDENT$_{IO}$

| | | C-on-VL | VL | WTIDENT$_{IO}$ |
|---|---|---|---|---|
| a. /k-hninu-s/ | ☞ {khní:nus} | | | * |
| | {khnínus} | | *! | |
| b. /w-akra-s/ | ☞ {(wá)ke̱(ras)} | | * | |
| | {(wá:)ke̱(ras)} | *! | | |
| c. /o-skutr-aʔ/ | ☞ os{(kú:)ta̱(raʔ)} | | | * |
| | os{(kú)ta̱(raʔ)} | | *! | |
| d. /t-a-w-aresr-ʔ/ | ☞ tu{ré:se̱}re̱ʔ | | | * |
| | tu{rése̱}re̱ʔ | | *! | |
| | tu{(ré)se̱(re̱ʔ)} | | *! | |
| | tu{(ré:)se̱(re̱ʔ)} | *! | | |

The optimal form in (b) certifies that C-on-VL must dominate VL. This is an empirical proof of the claim brought forward before that the process-specific constraint must outrank the constrained constraint so that the former can be effective.

In this section, an instantiation of the general schema FAITH-to-INPUT has been shown to take an active part in accounting for the interaction of epenthetic vowels with stress assignment. And I have argued that the stress assignment to *i*-prothesized forms is governed by exactly the same constraints as those in charge of assigning stress to non-prothetic forms. Finally, it has been demonstrated that a process-specific constraint that cannot be subsumed under the general schema FAITH-to-INPUT is requisite for explaining the phenomenon of vowel lengthening.

Before closing this section, it seems to be proper to raise the question why the epenthetic vowels are so diversified instead of being reduced to a single vowel, for example, to *e*. The hypothetical single epenthetic *e* would make the statement of the process-specific constraints FAITH-to-INPUT (FTBIN) and C-on-VL extremely complicated. The same would be said of the hypothetical single epenthetic *a* or *i*. Thus, let it be supposed that the diverse epenthetic vowels are indissolubly connected with the simpler statement of the two process-specific constraints. Then, it might be claimed that the functional contrivance reinforces their justification greatly.

## 3. Icelandic

An instantiation of the schema FAITH-to-INPUT introduced in the previous section is not an isolated or even exceptional one; Icelandic, Yawelmani, Diola Fogny and Klamath furnish equivalent cases. In this section, I will discuss the well-known Icelandic *u*-Umlaut phenomenon; its interaction with *u*-Epenthesis process brings about the vital necessity of an instantiation of the schema FAITH-to-INPUT. The ensuing data and discussion are chiefly founded on McCarthy (1994). As a point of departure, consider the following data quoted from McCarthy (1994, originally due to Anderson 1972, 1974; see also Orešnik 1972, 1977, Kiparsky 1993, Lakoff 1993, Kenstowicz 1994):

(25) a. Regular Case

börnum /barn-um/ 'child (dat.pl.)' cf. barn 'child'
svöngu /svang-u/ 'hungry (neut.dat.sg.)' cf. svangt 'hungry (neut.nom.sg.)'
(við) köllum /kall-um/ 'we call' cf. (ég) kalla 'I call'

b. Deleted Input *u* as Trigger

böggli (*baggli) /bagg-ul-e/ 'parcel (dat.sg.)' cf. baggi 'package, parcel'
jökli (*jakli) /jak-ul-e/ 'glacier (dat.sg.)' cf. jaki 'piece of ice'
þöglan (*þaglan) /þag-ul-an/ 'taciturn (m.acc.sg.)' cf. þagga 'to silence'

c. Trigger Available Only in Output

kötlum /katil-um/ 'kettle (dat.pl.)' cf. katli 'kettle (dat.sg.)'
rögnum /ragin-um/ 'gods (dat.pl.)' cf. ragna 'gods (gen.pl.)'
ölnum /alen-um/ 'ell of cloth (dat.pl.)' cf. alin 'ell of cloth'
cf. akkerum (*ökkerum) /akker-um/ 'anchor (dat.pl.)'

d. Reduction of Umlauted Vowel in Unstressed Syllable

dómurum (*dómörum) /domar-um/ 'judge (dat.pl.)' cf. domari 'judge (nom.sg.)'
héruðum (*héröðum) /herað-um/ 'region (dat.pl.)' cf. herað 'region (nom.sg.)'

bökurum (*bökörum) /bakar-um/ 'baker (dat.pl.)' cf. bakari 'baker (neut.sg.)'
fötnuðum (*fötnöðum) /fatnað-um/ 'suit of clothes (dat.pl.)' cf. fatnað 'suit of clothes (nom.sg.)'

e. Epenthetic *u* Not as Trigger
ak<u>u</u>r (*ök<u>u</u>r) /akr/ 'field (nom.sg.)' cf. akri/ökrum 'field (dat.sg.) / (dat.pl.)'
ald<u>u</u>r (*öld<u>u</u>r) /aldr/ 'age (nom.sg.)' cf. aldri/öldrum 'age (dat.sg.) / (dat.pl.)'
fag<u>u</u>r (*fög<u>u</u>r) /fagr/ 'beautiful (m.nom.sg.)' cf. fagran/fögru 'beautiful (m.acc.sg.) / (neut.dat.sg.)'

By *u*-Umlaut, *a* is converted to *ö* when followed by orthographic *u* (phonetic *ü*) with $C_o$ intervening. And the umlauted *ö* is reduced to *u* in unstressed syllable (d). (In Icelandic, the initial syllable bears stress.) However, the serious problem confronting us is that the underlying *u* and the reduced *u* trigger *u*-Umlaut (a-d) but the epenthetic *u* doesn't (e).

The level condition on the constraint *u*-UMLAUT should be INPUT in view of forms like those in (25b) where the SD is met only in input, but it should also be OUTPUT in view of the forms in (25c) where the SD is met only in output. Consequently, the level condition INDIFFERENT, which comprises both INPUT and OUTPUT, is to be imposed on *u*-UMLAUT.[11] But note that the INDIFFERENT *u*-UMLAUT is unable to account for the occurrence of such forms as *ak<u>u</u>r* in which its epenthetic trigger appears, since the umlauted output form **ök<u>u</u>r* impeccably obeys the OUTPUT part of *u*-$\text{UMLAUT}_{\text{INDIFFERENT}}$. Hence, to exclude forms like those in (25e) in which the potential trigger *u* is epenthetic from undergoing *u*-$\text{UMLAUT}_{\text{INDIFFERENT}}$, it appears that there is no alternative but to depend on the constraint FAITH-to-INPUT (*u*-$\text{UMLAUT}_{\text{INDIFFERENT}}$), a specific instantiation of the general schema FAITH-to-INPUT. The process pair for *u*-Umlaut and FAITH-to-INPUT (*u*-$\text{UMLAUT}_{\text{INDIFFERENT}}$) are stated in the following:

(26) a. *$aC_0u_{\text{INDIFFERENT}}$ (*u*-$\text{UMLAUT}_{\text{INDIFFERENT}}$) >> $\text{IDENT}_{\text{IO}}$ (+back, +low, -round)
b. FAITH-to-INPUT (*u*-$\text{UMLAUT}_{\text{INDIFFERENT}}$)
The trigger in the satisfied domain of the constraint *u*-$\text{UMLAUT}_{\text{INDIFFERENT}}$ has a ccorrespondent in input.

McCarthy states the process pairs *[+back, -low] >> IDENT (+back) and *[-stress, -high, -low] >> IDENT (-high) to prohibit non-low back vowels and ustressed mid vowels in the Icelandic vowel system. And he establishes the constraint ranking given below:

[11] No effort, however, will be made to determine the level condition to be imposed upon markedness constraints unless they bear upon the issue under discussion.

(27) Ranking for Icelandic *u*-Umlaut

*[+back, -low], *[-stress, -high, -low], *u*-UMLAUT >> IDENT (-high), IDENT (+back, + low, -round)

By way of summing-up, let us examine the following summary tableau. FAITH-to-INPUT (*u*-UMLAUT$_{INDIFFERENT}$) outranks *u*-UMLAUT$_{INDIFFERENT}$ in accordance with the meta-constraint on constraint ranking that demands that the process-specific constraint outrank the constrained constraint if the former is to be effective. (It is assumed that the vowel deletion and *u*-Epenthesis attested in the forms in (25c) and (25e) respectively are satisfied. And the forms in (25b) in whose derivations the INPUT part of *u*-UMLAUT$_{INDIFFERENT}$ is involved will be dealt with at the end of this section.)

(28) Summary Tableau for Icelandic *u*-Umlaut

| | *[-stress, -high, -low] | FAITH-to-INPUT (*u*-UMLAUT) | *u*-UMLAUT INDIFFERENT | IDENT$_{IO}$ (-high) | IDENT$_{IO}$ (+back, +low, -round) |
|---|---|---|---|---|---|
| a. /barn-um/ | | | | | |
| ☞ börnum | | | | | * |
| barnum | | | *! | | |
| c. /katil-um/ | | | | | |
| ☞ kötlum | | | | | * |
| katlum | | | *! | | |
| d. /bakar-um/ | | | | | |
| ☞ bökurum | | | | * | ** |
| bökörum | *! | | | | ** |
| bakurum | | | *! | * | * |
| bakörum | *! | | | | * |
| e. /akr/ | | | | | |
| ☞ akur | | | * | | |
| ökur | | *! | | | * |

As for the "iterative" satisfaction of this constraint in forms like *bökurum* from /bakar-um/ in (d), the underlying trigger *u* causes the second *a* in the underlying representation to change to *ö*, which reduces to *u* in the unstressed syllable. And this reduced *u*, which has a correspondent in input, causes the preceding *a* to be umlauted.

Nonetheless, the entity of the reduced *u* remains to be identified. In serial derivation, the chain shift $a_i \rightarrow \ddot{o}_i$ (by *u*-UMLAUT$_{\text{INDIFFERENT}}$) $\rightarrow u_i$ (the result of satisfying the constraint *[-stress, -high, -low]) from /baka$_i$r-um/ is unquestionable. But in OT, which recognizes no serial derivation, how do we know that $u_i$ is the product of both *u*-UMLAUT$_{\text{INDIFFERENT}}$ and *[-stress, -high, -low] ? As it happens, the pair theory proposed in Lee (In prep.) holds the key to the solution of this problem. In this theory, the following principle is formulated:

(29) Principle of H-$\pi_n$ Evaluation

In the process pair M,$\pi_n$ >> F$_{IO}$,$\pi_n$, the head H-$\pi_n$ is satisfied iff M,$\pi_n$ is satisfied and F$_{IO}$,$\pi_n$ is violated.

In accordance with the meta-constraint on constraint ranking, the ranking is: M,$\pi_n$ >> H-$\pi_n$ >> F$_{IO}$,$\pi_n$. Let us now consider the following tableau consistent with the pair theory:[12]

(30) Tableau in Terms of the Pair Theory

| /ba$_1$ka$_2$r-um/ | *[-stress, -high, -low],$\pi_i$ | H-$\pi_i$ | *u*-UMLAUT INPUT, $\pi_j$ | H-$\pi_j$ | *u*-UMLAUT OUTPUT, $\pi_k$ | H-$\pi_k$ | IDENT$_{IO}$-V$_2$ (-high),$\pi_i$ | IDENT$_{IO}$-V$_2$ (+back, +low, -round), $\pi_j$ | IDENT$_{IO}$-V$_1$ (+back, +low, -round), $\pi_k$ |
|---|---|---|---|---|---|---|---|---|---|
| ☞ bö$_1$ku$_2$rum | | | | | | | * | * | * |
| bö$_1$kö$_2$rum | *! | * | | | | | | * | * |
| ba$_1$ku$_2$rum | | | | | *! | * | * | * | |
| ba$_1$kö$_2$rum | *! | * | | | | | | * | |

In the tableau above, the vowel $u_2$ in the optimal form *bö$_1$ku$_2$rum* is seen to be derived from underlying /a$_2$/ by satisfying the two process pairs *[-stress, -high, -low] >> IDENT$_{IO}$-V$_2$ (-high) and *u*-UMLAUT$_{\text{INPUT}}$ >> IDENT$_{IO}$-V$_2$ (+back, +low, -round). Feature-wise, *u* is different from *a* in [high], [back], [low] and [round], and, sure enough, this difference is brought about by violating the two faithfulness constraints IDENT$_{IO}$-V$_2$ (-high) and IDENT$_{IO}$-V$_2$ (+back, +low, -round).

[12] The tableau making use of the pair theory will not be presented unless it bears upon the issue under discussion.

Furthermore, let us examine the wrong candidate **bekurum*[13] from /bakar-um/. This form is compared with the optimal form *bőkurum* by constructing a tableau corresponding to the tableau (28) which does not rely on the pair theory:

(31) Tableau for /bakar-um/

| /bakar-um/ | *[-stress, -high, -low] | *u*-UMLAUT INDIFFERENT | $\text{IDENT}_{IO}$ (-high) | $\text{IDENT}_{IO}$ (+back, +low, -round) |
|---|---|---|---|---|
| a. (?) bökurum | | | * | **(+back)<br>**(+low)<br>**(-round) |
| b. bekurum | | | * | **(+back)<br>**(+low)<br>* (-round) |

Unfortunately, the wrong candidate (b) must be evaluated as optimal, since it has a proper subset of the violations of the actual output form (a). This form is thus compared over again with the optimal form in the tableau constructed in conformity with the pair theory:

(32) Tableau in Terms of the Pair Theory

| $/ba_1ka_2r\text{-}um/$ | *[-stress, -high, -low],$\pi_1$ | H-$\pi_1$ | *u*-UMLAUT $_{\text{INPUT}}$, $\pi_j$ | H-$\pi_1$ | *u*-UMLAUT $_{\text{OUTPUT}}$ $\pi_k$ | H-$\pi_k$ | $\text{IDENT}_{IO}$ (-high), $\pi_1$ | $\text{IDENT}_{IO}\text{-}V_2$ (+back, +low, -round), $\pi_1$ | $\text{IDENT}_{IO}\text{-}V_1$ (+back, +low, -round), $\pi_k$ |
|---|---|---|---|---|---|---|---|---|---|
| a $b\ddot{o}_1ku_2rum$ | | | | | | | * | * | *(+back)<br>*(+low)<br>*(-round) |
| b. $be_1ku_2rum$ | | | | | | ? | * | * | *(+back)<br>*(+low)<br>√(-round) |

How to construe this tableau is problematic, since here again the wrong candidate (b) must be evaluated as optimal in terms of the number of asterisks. But note that the vowel *e* in form (b) does not arise as a consequence of satisfying the process pair *u*-$\text{UMLAUT}_{\text{OUTPUT}}$,$\pi_k$ >> $\text{IDENT}_{IO}\text{-}V_1$(+back, +low, -round),$\pi_k$, since the faithfulness constraint is not fully

[13] The vowel *e* is permitted in stressed syllables in Icelandic (Anderson 1972.19)

violated. Hence, the question mark in the tableau above is replaced by asterisk, which makes the actual output form optimal in the strictest sense of the term.[14]

Finally, let us consider the forms in (25b) where the INPUT part of *u*-UMLAUT$_{\text{INDIFFERENT}}$ is concerned. The following tableau demonstrates that the INPUT *u*-UMLAUT is not sufficient to provide us with the expected output forms. (The satisfaction of vowel deletion is assumed.)

(33) Tableau for /bagg-ul-e/

| /bagg-ul-e/ | *u*-UMLAUT$_{\text{INPUT}}$ | IDENT$_{\text{IO}}$ (+back, +low, -round) |
|---|---|---|
| (?) böggli | | * |
| baggli | | |

The wrong candidate **baggli* is evaluated as optimal. Hence, in this case, too, the pair theory is to be crucially relied upon for the survival of the level condition INPUT:

(34) Tableau in Terms of the Pair Theory

| /bagg-ul-e/ | *u*-UMLAUT$_{\text{INPUT}}$,$\pi_i$ | H-$\pi_i$ | IDENT$_{\text{IO}}$ (+back, +low, -round),$\pi_i$ |
|---|---|---|---|
| ☞ böggli | | | * |
| baggli | | *! | |

The incorrect candidate is ruled out because it violates H-$\pi_i$, the head of the process pair *u*-UMLAUT$_{\text{INPUT}}$,$\pi_i$ >> IDENT$_{\text{IO}}$ (+back, +low, -round),$\pi_i$. It is thus proven that the pair theory plays a decisive part in rescuing the level condition INPUT from falling into disuse.

In a brief summary, it has been shown that to give a satisfactory account of Icelandic *u*-Umlaut phenomenon the process-specific constraint FAITH-to-INPUT (*u*-UMLAUT$_{\text{INDIFFERENT}}$), an instantiation of the general schema FAITH-to-INPUT, is necessary. Moreover, it has also been demonstrated that it is essential to mobilize other novel devices, namely, the level condition INDIFFERENT and the pair theory.

## 4. Yawelmani

In this section, I will first investigate the data from the Yawelmani dialect of Yokuts, an American Indian language of California, in search of the instantiations of the general schema FAITH-to-INPUT. And I will later take up the problem of vowel harmony in the

[14] Worse still, the vowel *e* in form (b) is not the product of any other constraint. Thus, this form, having the unidentifiable *e*, is also discarded by the constraint NRC (67) which will be introduced in section 5

Wikchamni dialect of Yokuts in relation to Yawelmani vowel harmony. The interaction of vowel lowering and vowel epenthesis with the phenomenon of vowel harmony will be shown to result in two instantiations of FAITH-to-INPUT to constrain one and the same constraint in charge of vowel harmony. In Yawelmani, a vowel becomes back and rounded after a back rounded vowel of the same height within a word by vowel harmony. The data and discussion are chiefly based on Kenstowicz & Kisseberth (1977, 1979; for the discussion by other writers, see Kuroda 1967, Kisseberth 1969, Archangeli 1985, Cole & Kisseberth 1995; all these writers rely on Newman 1944). Let us begin by considering the following data:

(35) a.

| Nonfuture | Nonfuture Passive | Precative | Dubitative | |
|---|---|---|---|---|
| xat-hin | xat-it | xat-xa | xat-al | 'eat' |
| xil-hin | xil-it | xil-xa | xil-al | 'tangle' |
| bok'-hin | bok'-it | bok'-xo | bok'-ol | 'find' |
| dub-hun | dub-ut | dub-xa | dub-al | 'lead by hand' |

b.

| | |
|---|---|
| max-sit-hin | 'procure' |
| koʔ-sit-hin | 'throw' |
| tul-sut-hun | 'burn' |

The output form *tulsuthun* from /tul-sIt-hIn/ 'burns for' in (b) above shows that the vowels of two suffixes (the indirect /sIt/ and nonfuture /hIn/) harmonize to the root vowel. In other words, it shows that vowel harmony is satisfied across the board within a word. The pattern of vowel harmony observed above can be accounted for nicely in relatively straightforward manner. However, verb roots containing long high vowels in underlying representations constitute a serious obstacle to the seemingly simple analysis of vowel harmony. For the underlying long high vowels *i:* and *u:* lower context-freely to mid vowels *e:* and *o:* respectively:

(36)

| | Nonfuture | Nonfuture Passive | Precative | Dubitative | |
|---|---|---|---|---|---|
| a. /mi:k'/ | mek'-hin | me:k'-it | mek'-xa | me:k'-al | 'swallow' |
| b. /c'u:m/ | c'om-hun | c'o:m-ut | c'om-xa | c'o:m-al | 'destroy" |
| c. /do:s/ | dos-hin | do:s-it | dos-xo | do:s-ol | 'report' |

The surface roots *c'om* and *c'o:m* in (b) behave exactly like a root with a high rounded vowel toward vowel harmony. Thus, the surface low vowels *o:* (or *o*) and *e:* (or *e*) which function as high vowels are derived from the abstract underlying vowels *u:* and *i:* respectively (Kisseberth 1969). (But note that *o* or *o:* in the forms in (c) is a non-high vowel in underlying representations.) The process pair responsible for lowering is: *[Vμμ, +high] (LOWERING) >> $\text{IDENT}_{IO}$ (+high).

Here, I will digress into the subject related to the constraints LOWERING and SHORTENING as a background for the discussion which will follow. On the assumption that syllable-final consonant is moraic, long vowels are shortened by the process pair $*[\mu\mu\mu]_\sigma$ (SHORTENING) >> $\text{WT-IDENT}_{IO}$ (e.g., *doshin* from /do:s-hin/ in (36c) above). SHORTENING bleeds LOWERING, so the level condition INPUT is imposed on the latter, which outranks the former. But this is not all there is to the story, as is demonstrated in the following tableau:

(37) $\text{LOWERING}_{INPUT}$ >> SHORTENING

| /c'u:m-xA/ | $\text{LOWERING}_{INPUT}$ | SHORTENING |
|---|---|---|
| (?) c'omxa | | |
| c'umxa | | |
| c'u:mxa | *! | * |
| c'o:mxa | | *! |

Even the mechanism of the level condition INPUT placed upon LOWERING and the ranking established do not guarantee the expected output form. Therefore, as in the case of Icelandic *u*-UMLAUT, we may have recourse to the pair theory. The tableau (37) above is now restructured in conformity with this theory:

(38) Tableau in Terms of Pair Theory

| /c'u:m-xA/ | $\text{LOWERING}_{INPUT,}$ $\pi_1$ | H-$\pi_1$ | SHORTENING, $\pi_1$ | H-$\pi_1$ | $\text{IDENT}_{IO}$ (+high), $\pi_1$ | WT-$\text{IDENT}_{IO}$, $\pi_1$ |
|---|---|---|---|---|---|---|
| ☞ c'omxa | | | | | * | * |
| c'umxa | | *! | | | | * |
| c'u:mxa | *! | * | * | * | | |
| c'o:mxa | | | *! | * | * | |

The effect of the pair theory is clearly exhibited in this tableau: the incorrect candidate **c'umxa* is discarded because it violates H-$\pi_1$, the head of the process pair $\text{LOWERING}_{INPUT,}\pi_1$ >> $\text{IDENT}_{IO}$ (+high),$\pi_1$.

To return, high vowel not specified with the features [back] and [round] is epenthesized in the environment C _____ C{C,#}:

| (39) | Nonfuture | Dubitative | |
|---|---|---|---|
| a. /ʔilk/ | ʔilik-hin | ʔilk-al | 'sing' |
| b. /paʔṭ/ | paʔiṭ-hin | paʔṭ-al | 'fight' |
| c. /logw/ | logiw-hin | logw-ol | 'pulverize' |
| d. /ʔugn/ | ʔugun-hun | ʔugn-al | 'drink' |

The output form *ʔugun-hun* in (d) shows that epenthetic high vowel is no different from underlying one with respect to vowel harmony.

With this much preliminary, we are now in a position to call in the alignment constraint (40) (for the formulation of alignment constraints, see McCarthy & Prince 1993, and for the formulation of the constraint responsible for the process of harmony, see Kirchner 1993, Smolensky 1993, Cole & Kisseberth 1995).

(40) ALIGN-R ([+round], PRWD)

The right edge of every [+round] coincides with the right edge of some prosodic word.

This constraint is sufficient to take care of the simplistic case of the vowel harmony phenomenon observable in the data given in (35).

Nevertheless, this constraint falls short of preventing, for example, the derivation of **c'o:mol* from /c'u:m-Al/, as is demonstrated in the following tableau:

(41) $\text{LOWERING}_{\text{INPUT}}$ >> ALIGN-R

| /c'u:m-Al/ | $\text{LOWERING}_{\text{INPUT}}$ | ALIGN-R |
|---|---|---|
| (?) c'o:mal | | *! |
| c'o:mol | | |

Furthermore, the wrong candidate **c'umal* from the same underlying representation in which high long vowel is shortened does not violate $\text{LOWERING}_{\text{INPUT}}$. But this is an instance exactly parallel to the derivation **c'umxa* from /c'u:m-xA/ discussed above. Hence, here again, the pair theory is in readiness to filter it out:

(42) Tableau in Terms of the Pair Theory

| /c'u:m-Al/ | LOWERING$_{INPUT}$, $\pi_1$ | H-$\pi_1$ | IDENT$_{IO}$ (+high), $\pi_1$ | ALIGN-R |
|---|---|---|---|---|
| (?) c'o:mal | | | * | *! |
| c'o:mol | | | * | |
| c'umal | | *! | | * |

The incorrect candidate **c'umal* is ruled out since it violates the higher-ranked H-$\pi_1$, the head of the process pair LOWERING$_{INPUT}$, $\pi_1$ >> IDENT$_{IO}$ (+high), $\pi_1$. Still, the problem remains to be solved of how to discard the wrong candidate *c'o:mol*.

Only such forms as these taken into account, it might be sufficient simply to impose the level condition INPUT on ALIGN-R, but the fact that epenthetic high vowel harmonizes to the root vowel at the output level might also force us to impose the level condition OUTPUT on it. Thus, it might be that the level condition INDIFFERENT is imposed on ALIGN-R. This scheme, however, is thwarted, since the OUTPUT part of ALIGN-R$_{INDIFFERENT}$ would be helpless in preventing the derivation of **c'o:mol*. Consequently, for the prevention of the occurrence of *o* from underlying /A/ harmonizing to the lowered *o:* or *o* of the underlying *u:* of the root, we have the following FAITH-to-INPUT (ALIGN-R)$_1$ to fall back on, which is an instantiation of the general schema FAITH-to-INPUT:

(43) FAITH-to-INPUT (ALIGN-R)$_1$

The only non-epenthetic vowel or the sequence of non-epenthetic vowels in the satisfied domain of the constraint ALIGN-R has a correspondent with monotonic [$\alpha$high] in input.[15]

This constraint also guarantees the occurrence of *u* after the lowered vowel *o:* or *o* of the underlying /u:/. Now, with this constraint in hand, we are enabled to construct the following summary tableau. (The satisfaction of the constraints LOWERING$_{INPUT}$ and SHORTENING is assumed.)

[15] It is assumed that the structural elements in correspondence may include sequence of segments

(44) FAITH-to-INPUT (ALIGN-R)$_1$ >> ALIGN-R

| | | FAITH-to-INPUT (ALIGN-R)$_1$ | ALIGN-R |
|---|---|---|---|
| a. /c'u:m-Al/ | ☞ c'o:mal | | * |
| | c'o:mol | *! | |
| b. /sudu:k-hIn/ 'remove' | ☞ sudokhun | | |
| | sudokhin | | *! |

The fact in (a) indicates very decidedly that FAITH-to-INPUT (ALIGN-R)$_1$ must dominate ALIGN-R. This affords another empirical proof of the claim put forward in section 2 that the process-specific constraint dominates the conditioned constraint if the former is to be effective.

Proceeding to the forms with epenthetic high vowel, let us consider the following tableau:

(45) FAITH-to-INPUT (ALIGN-R)$_1$ >> ALIGN-R

| | | FAITH-to-INPUT (ALIGN-R)$_1$ | ALIGN-R |
|---|---|---|---|
| a. /logw-ʔAs/ | (?) logiwʔas | | ** |
| | loguwʔos | | |
| | loguwʔas | | * |
| b. /ʔugn-hIn/ | ☞ ʔugunhun | | |
| | ʔugunhin | | *! |
| | ʔuginhin | | *!* |

As shown in (a), FAITH-to-INPUT (ALIGN-R)$_1$ is not sufficient to supply us with the correct output form. The reason is that the constraint as stated in (43) has nothing to do with epenthetic vowel. Hence, we need another instantiation of the general schema FAITH-to-INPUT to take care of the forms with epenthetic vowels:

(46) FAITH-to-INPUT (ALIGN-R)$_2$

The feature [+high] of epenthetic vowel in the satisfied domain of the constraint ALIGN-R has a correspondent in root in input.[16]

[16] This constraint is formulated in terms of featural correspondence

This additional constraint to condition ALIGN-R makes it possible to have the following reconstructed tableau:

(47) FAITH-to-INPUT (ALIGN-R)$_1$, FAITH-to-INPUT (ALIGN-R)$_2$ >> ALIGN-R

| | | FAITH-to-INPUT (ALIGN-R)$_1$ | FAITH-to-INPUT (ALIGN-R)$_2$ | ALIGN-R |
|---|---|---|---|---|
| /logw-ʔAs/ | ☞ logiwʔas | | | ** |
| | loguwʔos | | *! | |
| | loguwʔas | | *! | * |
| /ʔugn-hIn/ | ☞ ʔugunhun | | | |
| | ʔugunhin | | | *! |
| | ʔuginhin | | | *!* |

The incorrect candidates **loguwʔos* and **loguwʔas* are ruled out due to their epenthetic vowel being in violation of FAITH-to-INPUT (ALIGN-R)$_2$, though their non-epenthetic rounded vowels are in conformity with FAITH-to-INPUT (ALIGN-R)$_1$.

Finally, we have the problem of how to prevent the choice of the incorrect candidate **logiwʔos* rather than the expected form *logiwʔas* from /logw-ʔAs/. To settle this problem, let us consider the following tableau:

(48) FAITH-to-INPUT (ALIGN-R)$_1$, FAITH-to-INPUT (ALIGN-R)$_2$ >> ALIGN-R

| /logw-ʔAs/ | FAITH-to-INPUT (ALIGN-R)$_1$ | FAITH-to-INPUT (ALIGN-R)$_2$ | ALIGN-R |
|---|---|---|---|
| a. (?) logiwʔas | | | ** |
| b. logiwʔos | | | ** |

The sequence of non-epenthetic vowels in form (b) obeys FAITH-to-INPUT (ALIGN-R)$_1$, since its input correspondent sequence *o* and *A* has monotonic [-high]. But note that the [+round] span is broken in the middle of the word. We may therefore rely on the high-ranking constraint NOGAP (+round) (Kiparsky 1981, Levergood 1989, Archangeli & Pulleyblank 1994) to filter out this form, as is illustrated in the following tableau:

(49) NOGAP (+round) >> FAITH-to-INPUT $(\text{ALIGN-R})_1$, FAITH-to-INPUT $(\text{ALIGN-R})_2$ >> ALIGN-R

| /logw-ʔAs/ | NOGAP (+round) | FAITH-to-INPUT $(\text{ALIGN-R})_1$ | FAITH-to-INPUT $(\text{ALIGN-R})_2$ | ALIGN-R |
|---|---|---|---|---|
| ☞ logiwʔas | | | | ** |
| logiwʔos | *! | | | ** |
| loguwʔos | | | *! | |
| loguwʔas | | | *! | * |

Certainly, the wrong candidate **logiwʔos* is ruled out owing to the high-ranking constraint NOGAP (+round).[17]

The Wikchamni dialect of Yokuts has two front rounded vowels *ü* and *ö*, which Yawelmani lacks.[18] Accordingly, the segmental markedness constraint *[-back, +round] is high-ranked in Yawelmani, while low-ranked in Wikchamni. Taking into consideration the phenomenon of Wikchamni vowel harmony, which differs from Yawelmani vowel harmony only in that it yields two front rounded vowels, ALIGN-R (40) must be revised as stated in (51) after the constraint (50) formulated by Archangeli & Suzuki (1997). This is because ALIGN-R (40) cannot ensure the different occurrences of *u* and *ü* of the respective suffixal vowels of *hutšu* from /hut-šI/ 'knew' and *tüʔüššü* from /tüʔüs-šI/ 'made', namely, the different occurrences from the same underlying /I/.[19]

(50) ALIGNCOLOR: ALIGN (Color (= [round], [back]), Right, Wd, Right)
The right edge of every Color (= [round], [back]) is aligned with the right edge of some word.

(51) ALIGN-R ([αback, +round], PRWD)
The right edge of every [αback, +round] coincides with the right edge of some prosodic word.

Archangeli & Suzuki formulate the following constraint, which may supplant the two instantiations of FAITH-to-INPUT established above:

[17] Alternatively to NOGAP (+round), we may have the high-ranking $\text{DEP}_{\text{IO}}$ (+round) or the high-ranking self-conjoined constraint $*[+\text{round}]^2_{\text{PRWD}}$ which prohibits two occurrences of [+round] within a prosodic word.

[18] The data and discussion concerning Wikchamni are solely based on Archangeli & Suzuki (1997)

[19] This remark holds true even if we assume the fully-specified suffixal vowel /i/ in input.

(52) {ROUND, αHIGH$^{IE}$} (RD/αHI$^{IE}$)[20]

Every path including [round$_i$] includes [αhigh] in the input or, lacking an input, in the output. (Each token of [round] must be linked to vowels of the same height in the input or, lacking an input, in the output.)

The first question we may ask regarding this constraint is whether there are forms in which epenthetic high vowel harmonizes to the lowered trigger *o:* (e.g., *...o:Cu̲CC...* from /...u:CCC.../). Indeed, there are such forms:

| (53)[21] Dubitative | | Gerund | | Imperative | | |
|---|---|---|---|---|---|---|
| wowlal | /wu:wl-Al/ | wo:wu̲ltaw | /wu:wl-tAw/ | wo:wu̲lka | /wu:wl-kA/ | 'stand up' |

And the second question we may ask concerning RD/αHI$^{IE}$ is whether there are forms in which epenthetic high vowel occurs after the raised high vowel in Wikchamni. (Roughly, short /o/ is raised to *u* when followed by *i* (underlying or epenthetic) in Wikchamni.) In that event, it is possible for the raised high vowel to affect the epenthetic high vowel in compliance with vowel harmony (e.g., **...uCu̲CC...* from /...oCCC.../), bringing about the wrong winners. Here again, we find such forms:

| | | | |
|---|---|---|---|
| (54) | t'uyi̲xši (*t'uyu̲xši, *t'uyu̲xšu) | /t'oyx-šI/ | 'doctored' |
| | puṭi̲k'ši (*puṭu̲k' ši, *puṭu̲k' šu) | /poṭk'-šI/ | 'soured' |
| | ʔuṭ'i̲what (*ʔu ṭ'u̲what) | /ʔo ṭ'w-hAt/ | 'hairs' |
| | tuʔi̲ṭ'hat (*tuʔu̲ ṭ'hat) | /toʔṭ'-hAt/ | 'heads' |

On the one hand, RD/αHI$^{IE}$ cannot guarantee the expected output forms *wo:wu̲ltaw* and *wo:wu̲lka* in (53), because they violate its second clause. On the other, it cannot penalize the wrong candidates given in (54), because they are in perfect conformity with its second clause.

In contrast, these recalcitrant forms are taken care of by taking advantage of the two instantiations of FAITH-to-INPUT established above, which take the place of RD/αHI$^{IE}$. (In the following tableau, the satisfaction of LOWERING$_{INPUT}$ and vowel raising is assumed.)

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20 This constraint is claimed to be an instantiation of the following schema.

(ii) Input-Else (IE)
In cases where there is a discrepancy between input and output structures, input structure takes precedence over output structure, otherwise, output structure is opted for.

21 These data are cited from Clements & Halle (1983).

(55) FAITH-to-INPUT (ALIGN-R)$_1$, FAITH-to-INPUT (ALIGN-R)$_2$ >> ALIGN-R

| | | FAITH-to-INPUT (ALIGN-R)$_1$ | FAITH-to-INPUT (ALIGN-R)$_2$ | ALIGN-R |
|---|---|---|---|---|
| /wu:wl-tAw/ | ☞ wo:wultaw | | | * |
| | wo:wiltaw | | | **! |
| /t'oyx-šI/ | ☞ t'uyixši | | | ** |
| | t'uyuxši | | *! | * |
| | t'uyuxšu | *! | *! | |

Finally, I have the following remarks to add. If not for forms like *puk'e:na* from /pok'-I:na/ 'will find' in Wikchamni, and thus if the Wikchamni dialect of Yokuts were left out of consideration, the single constraint FAITH-to-INPUT (ALIGN-R) (56) would be sufficient to constrain ALIGN-R without recourse to the two instantiations of the schema FAITH-to-INPUT established above:

(56) FAITH-to-INPUT (ALIGN-R)[22]

The feature [αhigh] of every vowel in the satisfied domain of the constraint ALIGN-R has a correspondent in root in input.

This constraint is not sufficient to rule out the wrong winner **puk'o:no* from /pok'-I:na/, the product of LOWERING$_{INPUT}$, vowel raising[23] and ALIGN-R, as is illustrated in the following tableau. (It is assumed that LOWERING$_{INPUT}$ and vowel raising are satisfied.)

(57) FAITH-to-INPUT (ALIGN-R (54)) >> ALIGN-R

| /pok'-I:na/ | FAITH-to-INPUT (ALIGN-R (54)) | ALIGN-R |
|---|---|---|
| a. (?) puk'e:na | * | ** |
| b. puk'o:no | * | |
| c. puk'o:na | * | * |

[22] This constraint is based on featural correspondence (see footnote 16).

[23] In view of both this form and the fact that epenthesized *i* triggers vowel raising, the level condition INDIFFERENT is to be placed upon the constraint in charge of this phenomenon. Archangeli & Suzuki (1997), however, propose the following constraint, which is claimed to be another instantiation of the schema given in footnote 20.

(iii) [-HI]. [+HI]$^{IE}$

If a vowel is [-high], then it must not be followed by a vowel that is [+high] *in the input or, lacking an input, in the output.*

The high vowel *u* in all the candidates violates FAITH-to-INPUT (ALIGN-R) (56), but the vowels *o:* and *o* in the candidate (b) satisfy it, since their [-high] has a correspondent in root.

We will now see whether the analysis of Yawelmani vowel harmony within the framework of Optimal Domains Theory (ODT) proposed by Cole & Kisseberth (1995) is tenable. For this purpose, let us examine their tableau given in (59); the constraints employed in this tableau are stated in the following:

(58) a. MAX-H[24]: Every H of the input has a correspondent in the output.
b. LOWERING (LOWER): $V_{\mu\mu} \rightarrow$ [Low]
c. UNIFORMITY (UNIF): The harmony domain must be monotonic: High or Low.
**Faithful (High / Low).**
d. EXPRESSION (EXPR): The feature [F] must be expressed on every element in an F-domain.
e. WIDESCOPE ALIGNMENT (WSA): Align (Rd-domain, R; PrWd, R)

(59) (= their tableau (27)) Evaluation of *ʔo:ṭ'ut* from /ʔu:ṭ'-It/ 'steal'
Notation: { } = Low domain, ( ) = High domain, [ ] = Round domain

| input | u:...I | MAX-H | LOWER | UNIF | EXPR-H | WSA-RT |
|---|---|---|---|---|---|---|
| a. | [(u:)...(u)] | | *! | | | |
| b. | [({u:})...(u)] | | *! | | | |
| ☞ c. | [({o:})...(u)] | | | | * | |
| d. | [{o:}...(u)] | *(!) | | *(!) | | |

In this tableau, the notations { } (low domain) and ( ) (high domain) play a crucial role in making lowered vowels behave in dual character. In (c) above, the lowered ({o:}) functions as [+high] with respect to the constraints MAX-H and UNIF by virtue of the presence of the high domain ( ), but it also functions as [+low] with respect to the constraints LOWER and EXPR-H by virtue of the presence of the low domain { }. In addition, despite the same phonetic realization *o:*, the lowered vowels ({o:}) in (c) and {o:} in (d) behave contrary to each other toward the constraints MAX-H, UNIF and EXPR-H merely because the former has two domains ( ) and { }, while the latter has only one domain { }. Consequently, it appears that without a more plausible and justifiable explanation of the dual behavior of the vowels enclosed with both ( ) and { }, the ODT

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[24] This constraint is also based on featural correspondence (see footnotes 16 and 22).

analysis of Yawelmani vowel harmony which crucially depends upon those notations cannot be insisted upon.

Moreover, Archangeli & Suzuki (1997) remark that

> Cole and Kisseberth (1995) propose a UNIFORMITY constraint which restricts the height requirement to either an input value or, lacking one, an output value (p. 17).

If we take this interpretation of the constraint UNIFORMITY (UNIF) (58c) at its face value, UNIF is proven to be insufficient to cope with those recalcitrant forms discussed above in relation to the constraint $\text{RD}/\alpha\text{HI}^{\text{IE}}$, as has been done the latter constraint, which is modeled after the interpretation of UNIF above.

In this section, I have argued that it is necessary to call in two instantiations of the schema FAITH-to-INPUT for an adequate description of vowel harmony in the Yawelmani and Wikchamni dialects of Yokuts. Also, it has been demonstrated that the level condition INPUT and the pair theory must be exploited in dealing with the interaction between vowel lowering and vowel shortening. In addition, two other OT analyses have been shown to be inadequate to account for the phenomena of vowel harmony in the Yokuts dialects.

## 5. Diola Fogny

In the West African language Diola Fogny, we find the fourth case where an instantiation of the general schema FAITH-to-INPUT is necessary. This process-specific constraint is involved in working out a problem encountered in the interaction of nasal assimilation (NA) with consonant deletion. The following data and discussion mainly rely on Kiparsky (1973b), supplemented with the data from Kenstowicz (1994) (the data are due originally to Sapir 1965).

(60) a. Morpheme-Internal NA

| | | |
|---|---|---|
| bunt | /bunt/ | 'lie' |
| jensu | /jensu/ | 'undershirt' |
| ekumbay | /ekumbay/ | 'pig' |
| famb | /famb/ | 'annoy' |
| mba | /mba/ | 'or' |
| ndaw | /ndaw/ | 'man's name' |

b. NA Before Nasal or Obstruent

| | | |
|---|---|---|
| niŋaŋŋan | /ni-ŋan-RED/ | 'I cried' |

| | | |
|---|---|---|
| na-mi:mmi:n | /na-mi:n-RED/ | 'he cut (with a knife)' |
| | | |
| nigaŋgam | /ni-gam-RED/ | 'I judge' |
| paɲjimaɲj | /pan-ji-maɲj/ | 'you (pl.) will know' |
| kubɔmbɔɲ | /ku-bɔɲ-RED/ | 'they sent' |
| nati:nti:ŋ | /na-ti:ŋ-RED/ | 'he cut (it) through' |
| | | |
| napuŋkuɲilak | /napum#kuɲilak/ | 'he pushed back the children' |
| najuntɔ | /najum#tɔ/ | 'he stopped there' |

c. Nasal Deletion Before Non-Nasal Sonorant Consonant

| | | |
|---|---|---|
| nalalaɲ | /na-laɲ-RED/ | 'he returned' |
| nayɔkɛyɔkɛn | /na-yɔkɛn-RED/ | 'he tires' |
| na-waɲa:waɲ | /na-waɲ-a:m-RED/ | 'he cultivated for me' |

d. Consonant Deletion Before Obstruent

| | | |
|---|---|---|
| ajabuŋar | /a-jaw-bu-ŋar/ | 'voyager' |
| lɛkujaw | /lɛt-ku-jaw/ | 'they won't go' |
| ujuja | /ujuk-ja/ | 'if you see' |
| kɔkɔbɛn | /kɔb-RED-ɛn/ | 'yearn for' |
| | | |
| kutɛsinaŋas | /kutɛb#sinaŋas/ | 'they carried the food' |
| ɛkɛbɔ | /ɛkɛt#bɔ/ | 'death there' |

e. Iterative Consonant Deletion

| | | |
|---|---|---|
| ɛrɛrɛnt | /ɛ-rɛnt-RED/ | 'it is light' |
| namamaɲj (*namammaɲj) | /na-maɲj-RED/ | 'he knows' |

f. Miscellaneous

| | | |
|---|---|---|
| takumbi… | /takun-mbi…/ | 'he must not ...' |
| baɲa (*baɲɲa) | /ban#ɲa/ | 'finish now' |

In Diola Fogny, the constraint CODA-COND limits consonant clusters to homorganic nasal plus consonant, geminate nasals and liquid followed by coronal *t* (e.g., *salte* 'be dirty'). Just for the sake of argument, Kiparsky (1973b) states the rule of nasal assimilation equivalent to that given in (61), which is bound to be simplified by taking advantage of Elsewhere Condition (for this condition, see Kiparsky 1973b, 1982).

(61) Nasal Assimilation

[C, +nas] → [α place] / _____ {[C, +nas, α place], (#) [-son, α place]}

In OT, the constraint responsible for the nasal assimilation may be stated as in the following:

(62) Constraint Responsible for Nasal Assimilation (NA)

*[C, +nas, α place] {[C, +nas, -α place], (#) [-son, -α place]}

The constraint CODA-COND practically amounts to deleting the first consonant of the consonant clusters which are not produced (vacuously or non-vacuously) by the process of nasal assimilation, leaving unscathed the first consonant of the cluster liquid plus coronal *t*. That is, it deletes their first consonant morpheme-internally,[25] across morpheme boundary or across a single word bounday (#).

With the exception of the derivation of *namamaɲj* from /na-maɲj-RED/, the constraints CODA-COND and NA guarantee the expected surface forms. However, it would seem quite natural that **na.mam.maɲj* from /na-maɲj-RED/ is evaluated as the optimal form, since it perfectly obeys CODA-COND and NA as does *nimammaŋ* from /ni-maŋ-RED/. A comparison is made between these two forms in the following tableau:

(63) CODA-COND, NA >> $\text{MAX}_{IO}$

| | | CODA-COND | NA | $\text{MAX}_{IO}$ |
|---|---|---|---|---|
| a. /na-maɲj-RED/ | (?) na.ma.maɲj | | | ** |
| | na.mam.maɲj | | | * |
| | na.maɲ.maɲj | *! | *! | * |
| | na.maɲj.maɲj | *! | | |
| b. /ni-maŋ-RED/ | ☞ ni.mam.maŋ | | | |
| | ni.ma.maŋ | | | *! |
| | ni.maŋ.maŋ | *! | *! | |

Note that *ɲ* in the intermediate form *namaɲmaɲj* from /na-maɲj-RED/ in (a) must be deleted, subsequent to the disobedience to NA. It is due to the fact that the nasal *ɲ* (i.e., the

[25] Their first consonant may be deleted "morpheme-internally" in case input is structured in accordance with the principle of Richness of the Base (for Richness of the Base, see Prince & Smolensky 1993, Smolensky 1996a,b).

potential target of NA) which comes to be located immediately before the first segment *m* of the reduplicant (i.e., the potential trigger of NA) as a result of the deletion of *j*, is not in the root-final position in input, as is the case with the target of NA in all the other optimal output forms. This provides the clue for solving the problem: that the potential target *ɲ* of NA in the intermediate form is not the root-final segment in input is enough to make us invoke an instantiation of the general schema FAITH-to-INPUT:

(64) FAITH-to-INPUT (NA)

The target in the satisfied domain of the constraint NA in intermorphemic environment has a correspondent in the final segment of the root in input.[26]

We may conceive of an alternative to this constraint. It might be to fall back on the level condition INPUT to be placed on the constraint NA. This alternative, however, fails since the trigger of NA is not present in the morpheme RED in input. Even if the morpheme RED is assumed to be prefixed, the alternative also fails, since the target of NA is not present in RED in input, either. With the constraint FAITH-to-INPUT (NA) in hand, we may now have the following tableau:

(65) CODA-COND, FAITH-to-INPUT (NA) >> $\text{MAX}_{IO}$; FAITH-to-INPUT (NA) >> NA

| | | CODA-COND | FAITH-to-INPUT (NA) | NA | $\text{MAX}_{IO}$ |
|---|---|---|---|---|---|
| /na-ma$_1$ɲ$_2$j$_3$-RED/ | ☞ na.ma$_1$.maɲj | | | | ** |
| | na.ma$_1$m$_2$.maɲj | | *! | | * |
| | na.ma$_1$ɲ$_2$.maɲj | *! | | *! | * |
| | na.ma$_1$ɲ$_2$j$_3$.maɲj | *! | | | |
| /ni-ma$_1$ŋ$_2$-RED/ | ☞ ni.ma$_1$m$_2$.maŋ | | | | |
| | ni.ma$_1$.maŋ | | | | *! |
| | ni.ma$_1$ŋ$_2$.maŋ | *! | | *! | |

With FAITH- to-INPUT (NA) dominating $\text{MAX}_{IO}$, we can rule out the incorrect candidate **namammaɲj*. CODA-COND outranks $\text{MAX}_{IO}$ because it is natural that the markedness constraint outranks the faithfulness constraint in a process pair if the former is to be effective. No ranking obtains between CODA-COND and FAITH-to-INPUT (NA), and NA is indifferent to the former and $\text{MAX}_{IO}$.

[26]Even if the morpheme RED is assumed to be prefixed, this constraint fully serves its purpose

By way of summary, let us consider the following summary tableau where diverse forms are evaluated:

(66) Summary Tableau for Consonant Deletion in Diola Fogny

| | | CODA-COND | FAITH-to-INPUT (NA) | NA | $MAX_{IO}$ |
|---|---|---|---|---|---|
| a. /ni-gam-RED/ | ☞ nigaŋgam | | | | |
| | nigamgam | *! | | *! | |
| | nigagam | | | | *! |
| b. /na-laɲ-RED/ | ☞ nalalaɲ | | | | * |
| | nalaɲlaɲ | *! | | | |
| c. /lɛt-ku-jaw/ | ☞ lɛkujaw | | | | * |
| | lɛtkujaw | *! | | | |
| d. /ɛ-rɛnt-RED/ | ☞ ɛrɛrɛnt | | | | ** |
| | ɛrɛntrɛnt | *! | | | |
| | ɛrɛnrɛnt | *! | | | * |
| e. /ban#ɲa/ | (?) ba#ɲa | | | | * |
| | baɲ#ɲa | | | | |

The constraints employed in this tableau are not sufficient to allow the choice of the expected *baɲa*, as is seen in (e). But there is a proper step to take. In Lee (1996, 1997), the following constraint is proposed:

(67) No Restructuring Constraint (NRC)

$F_{IO}$ may be violated only by the satisfaction of a markedness constraint in non-intramorphemic environment.

It is obvious that the sequence *ɲ#ɲ* in **baɲ#ɲa* is not the product of NA as stated in (62); put differently, the change of the root-final *n* to *ɲ* is not accomplished by the satisfaction of any constraint whatsoever. Hence, the root-final occurrence of *ɲ* in the wrong candidate violates the high-ranking NRC.[27]

To conclude, Diola Fogny supplies the fourth case of invoking an instantiation of the schema FAITH-to-INPUT. That is, the interaction of nasal assimilation with consonant deletion in Diola Fogny well evidences the vital necessity of placing reliance upon it.

[27] Instead of having recourse to NRC, it might be possible to complicate the statement of CODA-COND to meet this situation.

## 6. Klamath

Lastly, I will examine the problems of vowel gradation and vowel shortening in Klamath, an American Indian language of Oregon. They bear upon the process-specific constraint schema FAITH-to-INPUT. The self-interaction of vowel gradation ultimately leads to invoking an instantiation of this schema; besides, the interaction of vowel gradation with vowel shortening also leads to the same result. The subsequent data and discussion are chiefly founded on Clements & Keyser (1983:115-181; see also Barker 1963, 1964, Kean 1973, Kisseberth 1973a, 1973b, Thomas 1974; for a fuller treatment of these problems and the accompanying issues in the phonology of Klamath, see Lee In prep.).

First, I will clarify the phenomena of vowel gradation which comprises vowel truncation, vowel reduction and vowel deletion. In the first place, the forms in (a) below illustrate that the short initial vowel of a prefix or root is truncated provided it is preceded by at least one syllable in a word. Secondly, the forms in (b) show that the short first vowel of a prefix or root is reduced to schwa provided it is preceded by at least one syllable and followed by C{C,#} in a word. Finally, the forms in (c) demonstrate that the short first vowel of a prefix or root is deleted provided it is preceded by at least one syllable and followed by CV in a word.

(68) a. Vowel Truncation

| | | |
|---|---|---|
| ʔiwa | /ʔi-ew-a/ | 'puts plural objects into water' |
| hiwwa | /hiw-ew-a/ | 'spreads out a blanket in water' |
| n'iqwa | /n'iq-ew-a/ | 'puts a hand into water' |
| cf. wewa | /w-ew-a/ | 'strikes a long instrument in the water' |
| sgeʔəmbli[28] | /sgeʔn-ebli/ | 'buys back' |
| tweqa | /twe-eqn-a/[29] | 'bore through' |
| teto:qa | /DIST-twe-eqn-a/[30] | 'bore through' (distr.) |

b. Vowel Reduction

| | | |
|---|---|---|
| sisəpca | /DIST-sipc-a/ | 'put out a fire' (distr.) |
| cf. sipca | /sipc-a/ | 'puts out a fire' |
| GaGəttk'a | /DIST-Gatdk'-a/ | 'are cold' (distr.) |

---

[28] Schwa is epenthesized when the stem-final sonorant consonant preceded by a consonant is word-final or followed by a consonant.

[29] The consonant *n* is deleted by the constraint *Cna#

[30] Distributive prefix is formed by reduplicating the sequence of the initial $C_1$ plus the short version of the base (see McCarthy & Prince 1995, Alderete et al 1996 for the treatment of reduplication within the framework of OT)

| | | |
|---|---|---|
| cf. Gəttk'a[31] | /Gatdk'-a/ | 'is cold' |
| pipəkcaʔa:k | /DIST-pikca-'a:k'/ | 'little picture' (distr.) |
| cf. pikca | /pikca/ | 'picture' |
| hoscənwa | /hVs-conw-a/[32] | 'makes vomit' |
| cf.conwa | /conw-a/ | 'vomits' |

c. Vowel Deletion

| | | |
|---|---|---|
| soltq'a | /sV-lt'oq'-a/[33] | 'thumps oneself with finger and thumb' |
| cf. lt'oq'a | /lt'oq'-a/ | 'thumps' |
| solp'o:k'a | /sV-lo-p'o:k'-a/ | 'puts warpaint on oneself' |
| cf. lop'o:k'a | /lo-p'o:k'-a/ | 'puts warpaint on someone' |
| coqpq'a | /coq-p'eq'-a/ | 'puts the buttocks in someone's face' |
| cf. wp'eq'a | /w-p'eq'-a/ | 'hits in the face with a long instrument' |
| popli:k'a | /DIST-poli:-k'a/ | 'little policemen' (distr.) |
| cf. poli:s | /poli:-s/ | 'police' |

As has been observed, the three processes that affect short vowels have common property: they affect the short first vowel of a prefix or root in input in case it is preceded by at least one syllable. Particularly, the vowel to be affected by vowel reduction and vowel deletion occupies the same position in a word, the only difference being the right environment. As a rough approximation, the constraints in charge of the three processes may be stated as in the following:

(69) a. Initial Vowel Truncation (VT): $*VC_0\,[[V, \text{-long}]_i$
b. Vowel Reduction (VR): $*VC_1\,[V, \text{-long}]_j\,C\{C,\#\}$
c. Vowel Deletion (VD): $*VC_1[V, \text{-long}]_i\,CV$

And the faithfulness constraints dominated by these constraints are as follows:

(70) $\text{MAX}_{IO}$ ([V, -long]$_i$ ), $\text{MAX}_{IO}$-[V, -long]$_j$ (F)[34]

---

[31] The vowel *a* in closed syllable is reduced to schwa

[32] The vowel V of the causative / transitive prefix /hVs/ reduplicates the first vowel of the base.

[33] The vowel V of the reflexive / reciprocal prefix /sV/ reduplicates the first vowel of the base.

[34] It is assumed that schwa has only root node without any feature; hence, the violation of $\text{MAX}_{IO}$-[ V, -long]$_j$ (F) results in schwa, deleting every feature in input. Of course, this constraint is formulated on the basis of featural correspondence.

However, the data that will be given in (77b) make it necessary to refine the environment to the right of $V_i$ of the constraint VD: another right environment should be G (= glide). The reason is that to provide the environment for the vocalization of the underlying glide the preceding short vowel must be deleted. For example, in the derivation of *pnipno:pc'a* from /DIST-pniw-abc'-a/, the deletion of the short vowel *i* preceding the glide *w* provides the environment for vocalization of the latter. Hence, VD is revised as $*VC_1[V, -long]_i\{CV,G\}$. To reiterate, the deletion of the vowel before G by the revised VD provides the environment for the satisfaction of the constraint responsible for vocalization (i.e., G sandwiched in between two C's or in between C and #). Moreover, the identical left environment $V\{C_o, C_1\}$ of the constraints given in (69) can be removed by positing a process-specific constraint to constrain these three constraints contextually.[35] Consequently, these three constraints which may be dubbed Vowel Gradation (VG) as a whole are restated in (71) and the contextual constraint on VG is stated in (72), which dominates the latter.

(71) Vowel Gradation (VG)

a. VT: $*[[V, -long]_i$

b. VR: $*C_1[V, -long]_i C\{C, \#\}$

c. VD: $*C_1[V, -long]_i \{CV,G\}$

(72) Constraint on VG (C-on-VG)

The target in the satisfied domain of the constraint VG must be preceded by at least one vowel in another morpheme.

To prevent VG from affecting the second vowel (underlying or vocalized) of a morpheme, it is necessary to invoke an instantiation of the general schema FAITH-to-INPUT to constrain it. For the second vowel of the first morpheme of a word must not undergo VG. And the underlying second vowel of the second morpheme in a word may become its first vowel eligible for the potential target of VG as a consequence of the deletion of its underlying first vowel by the satisfaction of VD. The latter case is a self-feeding one; namely, VG interacts with itself. Thus, the necessity of a specific instantiation of the schema FAITH-to-INPUT to constrain VG is certified by the following data:

| | | |
|---|---|---|
| (73) sninklilk'a (*sninklǝlk'a) | /sni-nkililk'-a/ | 'makes dusty' |
| cf. nkililk'a (*nkilǝlk'a) | /nkililk'-a/ | 'is dusty' |
| sm'osmq'itk (*sm'osmq'ǝtk) | /DIST-sm'oq'y-dk/ | 'having a mouthful' (distr.) |

[35] Alternatively, we might think of the constraint $FAITH_{IO}$ (V-$\sigma_1$) (Beckman 1995), which militates against the vowel gradation of the vowel in the first syllable of a word

| | | |
|---|---|---|
| cf. sm'oq'ya | /sm'oq'y-a/ | 'has a mouthful' |
| mbompditk (*mbompdətk) | /DIST-mbody'-dk/ | 'wrinkled up' |
| snəcw'iga (*snəcwga) (*snəco:ga) | /sna-c'aw'ig-a/ | 'drives someone crazy' |
| cf. c'aw'iga (*c'aw'əga) | /c'aw'ig-a/ | 'is crazy' |

Now, the constraint in question is stated below:

(74) FAITH-to-INPUT (VG)

The vowel $V_i$ or $V_j$ in the satisfied domain of the constraint VG has a correspondent in the first vowel of a prefix or root in input.

Eventually, the constraints C-on-VG and FAITH-to-INPUT (VG) allow us to have the following summary tableau. There is no ranking between the two constraints, but they dominate VG.

(75) Summary Tableau for Vowel Gradation in Klamath

| | | C-on-VG | FAITH-to-INPUT (VG) | VG |
|---|---|---|---|---|
| /sni-nkililk'-a/ | ☞ sninklilk'a | | | *** |
| | sninklәlk'a | | *! | |
| | sninkililk'a | | | ****! |
| /nkililk'-a/ | ☞ nkililk'a | | | *** |
| | nkilәlk'a | | *! | ** |
| /DIST-mbody'-dk/ | ☞ mbompditk | | | ** |
| | mbompdәtk | | *! | * |
| /sna-c'aw'$_1$i$_2$g$_3$-a/ | ☞ snәcw'$_1$i$_2$g$_3$a | * | | ** |
| | snәcw$_1$g$_3$a | * | *! | * |
| | snәco:$_1$g$_3$a | * | *! | * |
| /c'aw'ig-a/ | ☞ c'aw'iga | | | *** |
| | c'aw'әga | | *! | ** |
| | cw'iga | *! | | ** |

We might conceive of an alternative to FAITH-to-INPUT (VG); it might be to impose the level condition INPUT on the constraint VG. But it fails because the hypothetical $VG_{INPUT}$

could not delete, for example, the root-initial vowel in the underlying representation /DIST-mbody'-dk/ until the underlying glide /y'/ is vocalized.[36]

Next, I will turn to the problem of vowel shortening. The constraint SHORTENING demands that a long vowel be shortened in the environments V:$C_0$ ____ and CC ____ {CC, $C_0$ #}. But the puzzling problem is that not all the long vowels are shortened in these environments and that the surface long vowels *i:* and *o:* have three sources. They originate from underlying long vowels (e.g., *ʔowi:cn'a* from /ʔo-owi:-cn'-a/ '(long objects) go along in a row'), from glides preceded by a vowel in the underlying representations (e.g., *saʔi:si* from /sa-ʔaysi/ 'keeps something to oneself') and from underlying postconsonantal glides (e.g., *delo:ga* from /delwg-a/ 'attacks'). I will sidestep the knotty problem of formulating explicitly the process pair responsible for vocalizing glides *y* and *w* (plain or glottalized) as long vowels *i:* and *o:* in the environment C ___{C,#} respectively.

Let us now consider the following data in an effort toward settling the problem of vowel shortening. The underlined short vowels of the forms in (c) are derived from the long vowels originating from underlying postconsonantal glides:

| | | | |
|---|---|---|---|
| (76) i. | a. mboty'a | /mbody'-a/ | 'wrinkles' |
| | b. mbodi:tk | /mbody'-dk/ | 'wrinkled up' |
| | c. mbompditk | /DIST-mbody'-dk/[37] | 'wrinkled up' (distr.) |
| ii. | a. sm'oq'ya | / sm'oq'y-a/ | 'has a mouthful' |
| | b. sm'oq'i:tk | /sm'oq'y-dk/ | 'having a mouthful' |
| | c. sm'osmq'itk | /DIST-sm'oq'y-dk/ | 'having a mouthful' (distr.) |
| iii. | a. lək'wa | /la-ak'w-a/ | 'puts a round object across' |
| | b. ʔak'o:c'a | /ʔa-ak'w-c'n-a/ | 'just put a long object across and went on' |
| | c. sasəlk'obli | /DIST-sa-la-ak'w-ebli/ | 'puts round objects back across oneself' (distr.) |
| iv. | a. giwk | /gi-wk/ | 'because of being, doing' |
| | b. woNo:k | /woN-wk/ | 'because of finishing' |
| | c. sʔawi:gok | /sʔawi:g-wk/ | 'because of being angry' |
| | loyk'ok | /loyk'-wk/ | 'because of picking berries' |
| v. | a. keys | /ken-y-s/[38] | 'snow' |

[36] If VT were viewed apart from the conflated VG, the level condition INPUT placed upon it would perhaps suffice.

[37] This form and those in (iic, iiic) observe I-R faithfulness (McCarthy & Prince 1995 359-360).

| | | | |
|---|---|---|---|
| | b. sGoc'i:s | /sGoc'-y-s/ | 'breastbone' |
| | c. ce:lis | /ce:l-y-s/ | 'porcupine' |
| | soyn'is | /soyn'-y-s/ | 'race' |
| vi. | a. tawyi:ya | /tawy-i:y-a/ | 'curses for someone' |
| | b. tawi: | /tawy/ | 'curses' |
| | c. tatwi | /DIST-tawy/ | 'curse' (distr.) |

In contrast, the long vowels in the following forms are not shortened in the aforementioned environments. The reason is that they arise from other sources, namely, from underlying long vowels (a) and from the glides preceded by a short vowel in underlying representations (b):

| | | | |
|---|---|---|---|
| (77) | a. yəydi:s | /DIST-yadi:-s/ | 'spirit stones' (distr.) |
| | bonwo:ts | /bonw-o:t-s/ | 'something to drink with |
| | sc'iwa:go:la | /sc'iwa:g-o:l-a/ | 'takes off a skirt' |
| | sʔawi:kWi:ya | /sʔawi:g-Wi:y-a/ | 'almost became angry' |
| | pecl'əqWi:s | /pec-el'G-Wi:y-s/ | 'footprint' |
| | solwo:lgi | /so-lo-o:lgi/ | 'gathers a round object' |
| | b. sdəsdi:nk'a | /DIST-sdayn-k'a/ | 'little heart' (distr.) |
| | pnipno:pc'a | /DIST-pniw-abc'-a/ | 'blow out' (distr.) |
| | njonji:lga | /DIST-njoy-el'g-a/ | 'are numb' (distr.) |
| | snikso:lGa | /sni-ksiw-elG-a/ | 'makes someone dance' |

At the outset, we must devise some means to spare the forms in (a) which contain non-derived potential target from being subject to the constraint SHORTENING. Fortunately, there is a means ready to serve our purpose: we may rely on an instantiation of the process-specific constraint schema NONFAITH proposed in Lee (1997):

(78) NONFAITH (SHORTENING)

The target in the satisfied domain of the constraint SHORTENING is not faithful to the correspondent in input.

---

[38] Roughly, *n* is deleted in the environment __-y-s#.

In this constraint, “A is not faithful to B” denotes that $F_{IO}$ is not observed between A and B. For example, the target *o:* in *bonwo:ts* from /bonw-o:t-s/ in (77a) is *faithful* to its input correspondent, because in every respect $F_{IO}$ is strictly observed between the target *o:* and the correspondent /o:/ in input. On the other hand, the shortened *i* in *mbompditk* from /DIST-mbody’-dk/ in (76ic) is *not faithful* to its input correspondent /y’/ since $F_{IO}$ in the feature [+voc] is not observed between the target *i* and the correspondent /y’/ in input. Note, however, that this constraint is incapable of preventing the forms in (77b) from obeying the constraint SHORTENING. For *o:* in *pnipno:pc'a* from /DIST-pniw-abc’-a/, for example, is *not faithful* to its input correspondent *w*.

Following Kisseberth’s (1973) suggestion that the alternations in vowel length could not be described without recourse to a global condition, Clements & Keyser state the following global rule of vowel shortening simply for the sake of argument, which they reject as extremely powerful:

(79) A long vowel is shortened in the following environments, provided it is derived from an underlying postconsonantal glide:

a. V:$C_o$ ____
b. CC ____ CC
c. CC ____ $C_o$#

Utilizing the insight underlying this global rule within the framework of OT, we may invoke another process-specific constraint FAITH-to-INPUT (SHORTENING), an instantiation of the schema FAITH-to-INPUT:

(80) FAITH-to-INPUT (SHORTENING)
The sequence CV in the satisfied domain of the constraint SHORTENING has a correspondent in input.[39]

In view of forms like *spospni* from /DIST-spon-oy/ ‘give a person’ (distr.) and *wa:miki·na* from /wa:m-oyki:n-a/ ‘extends out of water in a line’ in which the respective sequences *ni* and *mi* have no correspondents in input, the phrase “the sequence CV” in this constraint must be further qualified by the term “intramorphemic” as stated in the following:

[39] It is assumed that the structural elements in correspondence may include sequences of segments like CV (see footnote 16)

(81) FAITH-to-INPUT (SHORTENING)

The intramorphemic sequence CV in the satisfied domain of the constraint SHORTENING has a correspondent in input.

For example, the intramorphemic sequence CV, i.e., the sequence $n_1o{:}_3$ in *pnipn*$_1$*o:*$_3$*pc'a* from /DIST-$pn_1i_2w_3$-abc'-a/ has no correspondent sequence in input, while the intramorphemic sequence CV, i.e., the sequence $d_1i_2$ in *mbompd*$_1$*i*$_2$*tk* from /DIST-mbod$_1$y'$_2$-dk/ has the correspondent sequence /d$_1$y'$_2$/ in input. Here again, we might think of an alternative to the process-specific constraint given above. It might also be to impose the level condition INPUT on the constraint SHORTENING. But it fails, too, merely because it affects the long vowels vocalized from underlying glides.

Armed with the two process-specific constraints NONFAITH (SHORTENING) and FAITH-to-INPUT (SHORTENING), which must dominate SHORTENING, we may clear up the intricate problem of vowel shortening in Klamath, as is demonstrated in the following summary tableau. (In this tableau, the satisfaction of the constraint in charge of vocalization and VG is assumed.)

(82) Summary Tableau for Vowel Shortening in Klamath

| | | NONFAITH (SHORTEN-ING) | FAITH-to-INPUT (SHORTENING) | SHORTEN-ING |
|---|---|---|---|---|
| a. /DIST-mbod$_1$y'$_2$-dk/ | ☞ mbompd$_1$i$_2$tk | | | |
| | mbompd$_1$i:$_2$tk | | | *! |
| b. /DIST-spon$_1$-o$_2$y$_3$/ | ☞ spospn$_1$i$_3$ | | | |
| | spospn$_1$i:$_3$ | | | *! |
| c. /bonw$_1$-o:$_2$t-s/ | ☞ bonw$_1$o:$_2$ts | | | * |
| | bonw$_1$o$_2$ts | *! | | |
| d. /DIST-sd$_1$a$_2$y$_3$n-k'a/ | ☞ sdasd$_1$i:$_3$nk'a | | | * |
| | sdasd$_1$i$_3$nk'a | | *! | |

Even though the wrong candidates **bonw*$_1$*o*$_2$*ts* in (c) and **sdasd*$_1$*i*$_3$*nk'a* in (d) obey SHORTENING perfectly, they are in violation of the higher-ranking NONFAITH (SHORTENING) and FAITH-to-INPUT (SHORTENING) respectively.

There is something unsatisfactory about the treatment of the constraint SHORTENING. Thus, an alternative is suggested to SHORTENING that has been taken as a matter of course. Recall that its environments are those given in (79a-c). The constraint in charge of shortening can be split into two parts: the part responsible for shortening after a long vowel and that responsible for shortening after CC:

(83) Constraints for Shortening

*Vμμ (SHORTENING$_1$), *[μμ{μ}$_\sigma$,#} (SHORTENING$_2$)

The second constraint is founded on the assumption that coda consonant is moraic. Now, we are in need of a constraint to constrain these constraints contextually:

(84) Constraint on SHORTENINGs (C-on-SHORTENINGs)

The targets of the constraints SHORTENING$_1$ and SHORTENING$_2$ are immediately preceded by [...Vμμ...]$_\sigma$ and [... Vμ Cμ]$_\sigma$ respectively.

It is to be noted that the two SHORTENING constraints must occupy the same position in the ranking, since they are constrained by the same instantiations of the schemata NONFAITH and FAITH-to-INPUT, which are assumed to be revised in accordance with the alternative constraints. In brief, how matters stand in the alternative proposed here may be epitomized in the following summary tableau:

(85) Summary Tableau for Vowel Shortening in Klamath

| | | C-on-SHORTEN-INGs | NONFAITH (SHORTEN-INGs) | FAITH-to-INPUT (SHORTEN-INGs) | SHORTEN-INGs |
|---|---|---|---|---|---|
| /wa:m$_1$-o$_2$y$_3$ki: n-a/ | ☞ wa:m$_1$i$_3$ki: na | | | | |
| | wa:m$_1$i:$_3$ki: na | | | | *! |
| /sc'iwa:g$_1$-o:$_2$l-a/ | ☞ sc'iwa:g$_1$o:$_2$la | | | | * |
| | sc'iwa:g$_1$o$_2$la | | *! | | |
| /DIST-mbod$_1$y'$_2$-dk/ | ☞ mbompd$_1$i$_2$tk | | | | |
| | mbompd$_1$i:$_2$tk | | | | *! |
| /bonw$_1$-o:$_2$t-s/ | ☞ bonw$_1$o:$_2$ts | | | | * |
| | bonw$_1$o$_2$ts | | *! | | |
| /DIST-sd$_1$a$_2$y$_3$n-k'a/ | ☞ sdasd$_1$i:$_3$nk'a | | | | * |
| | sdasd$_1$i$_3$nk'a | | | *! | |

To sum up, it has been demonstrated that we must rely on two instantiations of the schema FAITH-to-INPUT, one instantiation of the schema NONFAITH and a process-specific constraint to restrict markedness constraints contextually for a satisfactory account of the processes of vowel gradation and vowel shortening in Klamath. Moreover, it has been shown that three process-specific constraints are involved in constraining the two constraints responsible for shortening which are suggested to take the place of SHORTENING established before.

## 7. Conclusion

In this paper, I have attempted to give an account of the cases in which at first sight it would seem plausible to have recourse to the imposition of the level condition INPUT upon markedness constraints as a whole to settle the problem of phonological opacity. In reality, the investigation of the cases cited from various languages has shown that the complex and intricate data, which incur a species of phonological opacity, can be accounted for by the crucial role of the instantiations of the general schema FAITH-to-INPUT as presented at the outset. To recap, the level condition INPUT may be imposed upon some markedness constraints at large to take care of a certain species of phonological opacity. It has been argued that, apart from this, the process-specific constraints are absolutely necessary that make reference to input to cope with the problem of another species of phonological opacity. Conclusively, it is thus claimed that every process-specific constraint of this property can be subsumed under the general schema FAITH-to-INPUT.

I have this to say in addition: in the course of discussion I have been driven to depend upon novel devices other than the instantiations of the schema FAITH-to-INPUT, namely, the level conditions placed upon markedness constraints, a specific instantiation of the general schema NONFAITH, NRC and the pair theory.

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