Similarity among Variants: Output-Variant Correspondence
異種間における忠実性

with an abstract in English

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Abstract

This thesis addresses the issues of opacity involved in variant formations, couched within Optimality Theory (Prince and Smolensky 1993; McCarthy and Prince 1993b). In natural languages there are a plethora of cases where one input form can be mapped onto more than one distinct output (e.g., [fæmɪli] and [fæmli] for 'family'). Concentrating on phonological phenomena involved in such context, this thesis argues for the following points.

(1) To descriptively point out that derivational opacity is often found in the context of variant formations.
(2) To argue for the existence of OV-Correspondence (Output-Variant Correspondence) which militates for the identity between a base form and its variant form.
(3) To critically assess multi-stratal OT model.
(4) To propose a model that generates more than one output form from one input without any reranking or multi-strata.
(5) To show that OV-Correspondence approach has a wider empirical coverage than the approach appealing to constraint-conjunction system in terms of opacity in variant forms.

These points are developed in a following way. The first section is a general introduction, which clarifies my overall goals and provides some basic backgrounds.

Section 2 is devoted to achieve (1) and (2) above. I point out that in the context of variant formations, opacity is often found. Concrete data will be taken up from various languages, including Japanese, Sea Dayak, Mwera and so on. Also it will be pointed out that marked syllable structures, which are otherwise absolutely banned from surfacing, are unexpectedly licensed in variant formations. The discussion revolves around the data from English, Japanese and Ganda. One pattern that pertains both of the phenomena above is *the emergence of the marked*: marked structures only emerge in the context of free variation.

Meanwhile I provide a principled account of the problems above. I argue that in natural languages there is fundamental requirement that outputs that share the same input be phonologically identical. Employing Optimality Theory as the analytical device, these demands are articulated in the form of Correspondence (McCarthy and Prince 1995), which is dubbed here OV (Output-Variant)-Correspondence. This proposal is an extension of Benua's Transderivational Correspondence Theory (1997b).

In section 3, I argue that OV-faithfulness approach can be independently applied

to account for other opaque phenomena: compensatory lengthening and vowel lengthening concomitant with vowel coalescence. This section further supports my OV-Correspondence Theory.

Section 4 is devoted to the discussion of theoretical issues. In the first half of this section, as the third goal of this thesis, I critically assess a version of Optimality Theory that incorporates multi strata (Serial OT; see e.g., Kiparsky 1998). Although this model can be used to account for the problems I present, I argue that the monostratal model that employs OV-Correspondence is better both conceptually and empirically. One of the main arguments is that reranking is too powerful, and allowing this system in OT predicts the existence of languages that are not attested.

Meanwhile I present a new model of how variants might arise without recourse to any reranking or Partial Order Theory (e.g., Anttila 2000a). I show that variant formations often involve anti-faithfulness effects (Aldrete 1999), and moreover, variants often exhibit an additional sociological meaning. Based upon these observations, I argue that variant formations are morphologically driven. Variants are generated when they underlyingly have a sociolinguistic morpheme, which is required to be phonologically realized by a morpheme realization constraint (Kurisu 2001). This unifies the OV-Faith approach more closely with general OO-Faith approach (Benua 1997b).

Finally in section 5, I show that although the approach with recourse to local conjunction (Smolensky 1993, 1995, 1997 among others) can account for some of the problems presented in section 2, the OV-Faith approach has wider empirical coverage. Section 6 briefly concludes the paper.

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1.INTRODUCTION

1.1. Introduction and Overview

Opacity has been one of the recalcitrant problems for Optimality Theory (Prince and Smolensky 1993: McCarthy and Prince 1993b). Since opaque forms manifest structures that cannot be motivated by harmony at the surface level, they present a potential problem for surface-oriented OT, which disallows reference to levels other than input and output. A number of proposals have appeared in the literature to account for opacity problems within OT framework[1].

This thesis points out that there is one pattern of opacity, which hitherto has not attracted systematic attention in the past literature; namely, opacity involved in variant formations. In natural languages it is not uncommon that there is more than one output form for one input (e.g., [famıli] and [famli] for 'family), and opacity is often found in such context. I show that there are a plethora of cases in which one realization of a certain input shows opacity, though other realizations of the same input are totally transparent. The following examples from Japanese exemplify the problem[2]:

(1)	a.	/uka(-uka)/	ukkari		absentmindedly
		/biku(-biku)/	bikkuri		surprise
	b.	/zabu(-zabu)/	zamburi	*zabburi	raining heavily
		/nobi(-nobi)/	nombiri	*nobbiri	leisurely

(2)	a. neutral form	b. emphatic forms		Gloss
	[huzakeru]	[huzzakeru]	*[hunzakeru]	'kid, joke (verb)'
	[yabai]	[yabbai]	*[yambai]	'dangerous'
	[mazi(de)]	[mazzi(de)]	*[manzi(de)]	'seriously'

(1) shows the process of gemination in the environment that does not involve variant formations: along with the suffixation of '-ri', internal gemination takes place for adverbs as shown in (1a). As we can see from (1b), however, in cases where gemination would result in a geminate voiced obstruent, nasal insertion instead takes effect (Kuroda 1965; McCawley 1968; Lombardi 1998; Itô and Mester 1999a). In derivational terms, the appearance of a nasal can be accounted for by a rule that changes the first half of a voiced geminate into a nasal (Kuroda 1965; McCawley 1968; Itô and Mester 1986), which is shown below:

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[1] See Kager (1999: 372-400) for an overview and the references cited therein.

[2] Here and throughout, for transcriptions of Japanese I do not strictly follow IPA. The transcription I employ instead is mostly in accordance with *Kunreishiki* romanization.

(3) [-son, +voi] ==> [+nasal] / ___ C

However, in the context of the variant formation shown in (2), gemination that results in a voiced obstruent geminate is unexpectedly tolerated, and, what is more, nasal epenthesis is prohibited. Forms in (2b) are thus opaque in the sense that it is not clear from surface structures alone why a geminate of voiced obstruent is allowed for in these forms ("non-surface-true" in the sense of McCarthy (1999)). This can be conceived of as a clear instance of derivational opacity: with the nasalization rule (3) being ordered before the process of gemination, the nasalization rule fails to apply (i.e., gemination counterfeeds nasal insertion), and hence opacity.

Given OT as an analytical device, however, this opacity cannot be explained by appealing to rule ordering. One of the main purposes of this paper is to show that there are a plethora of cases that are parallel to the one that is described by (2). Further building upon this observation, this paper aims at providing a principled account of this kind of problem. It is argued that there is requirement in natural languages that variants be phonologically similar to each other. So, for example, in (2), emphatic forms are required to be similar to neutral forms, and due to this requirement a voiced geminate is tolerated. This claim is formally articulated in the form of a new correspondence relation, in the sense of Correspondence Theory (Prince and McCarthy 1995).

The basic idea is an extension of Benua's (1995, 1997a,b) Transderivational Correspondence Theory (see also McCarthy (1995); Itô, Kitagawa and Mester (1996); Itô and Mester (1997, 1998); Kenstowicz (1996, 1998) among many others). Benua claims that morphologically related words tend to be similar not just because they share an identical underlying form, but also because they are required to be identical. I will show that similarity among variants is parallel in this respect: it cannot be explained simply by saying that they share the same underlying form. Consider forms in (2) again. Emphatic forms can have a voiced geminate, which is strictly prohibited in other contexts, and this violation of otherwise true generalization is in order to achieve identity among variants. To put it in more general terms, a phonological operation may misapply so that variants are more alike in featural content or in prosodic structures. The phonological process (e.g., nasal insertion as observed in (1b)) can underapply or overapply to increase identity among variants. This paper is an attempt to capture this observation in terms of constraint interaction in the sense developed in Optimality Theory.

The remainder of this introductory section presents some background, upon which the subsequent discussion is based. First some basic relevant notions of

Optimality Theory are presented, which include some basic tenets and conventions that become relevant to the following discussion. This section is followed by a brief sketch of Correspondence Theory, which is the predominant model to represent faithfulness relations. Finally, I will present the basic model of how similarity among variants is achieved.

1.2. Framework

1.2.1. Optimality Theory

1.2.1.1 Some basic Ideas and Conventions

As the analytical framework I adopt Optimality Theory (henceforth OT; Prince and Smolensky 1993; McCarthy and Prince 1993b) and the Correspondence Theory of faithfulness (McCarthy and Prince 1995). I propose a new kind of correspondence, namely correspondence among variants, which is dubbed here ‘Output-Variant Correspondence’ (henceforth OV-correspondence). Before we go into the main analysis, I sketch the basic ideas of Optimality Theory in this section. I do not attempt to describe all of the characteristics of OT, which is neither possible nor necessary here[3]. This section is to introduce basic concepts and conventions which will become relevant in subsequent discussion in this paper.

One of the basic tenets of OT is that a grammar is captured as a set of universal constraints ranked in a certain way. The ranking of constraints is language-particular, and so for instance, Japanese is thought to have a different ranking from that of English or Chamorro. However, constraints themselves are considered to be universal and hence innate, serving as a part of Universal Grammar. OT obviates all the traditional notions of “phonological rewriting rules”, which have been the predominant analytical device since the birth of generative phonology (Chomsky and Halle 1968). All that is involved in an OT grammar is a set of universal constraints.

Another remarkable characteristic of OT is the *violability* of constraints: all constraints can potentially be violated, but the violation incurred by an actual output must be minimal. Hence no constraint is allowed to be violated without a compelling reason. Only when it would avert a violation of a higher-ranked constraint can a constraint be violated. This notion of ‘minimal violation’ is the core of OT, and the output is chosen on the basis of optimality, which can be defined as below (taken from Kager 1999: 13):

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[3] For a more comprehensive introduction to Optimality Theory, see Archangeli and Langendoen (1997), Kager (1999) and McCarthy (in press).

(4) Optimality: an output is considered to be optimal iff it incurs the least serious violations of the given set of constraints, taking into account their hierarchical ranking.

Since each constraint imposes a different goal on output forms, different constraints sometimes conflict with each other: a satisfaction of one constraint often entails a violation of anther constraint. For example, consider two simple constraints: NoCoda and Max. The first constraint militates against a presence of a coda consonant in a syllable. The second one, on the other hand, requires every element in the input to surface. Suppose now that the input is /tak/, if it surfaces as faithfully as possible (i.e., [tak]) then it violates NoCoda but satisfies Max. On the other hand, if we delete the offending consonant and generate [ta], then it incurs the violation of Max but satisfies NoCoda.

(5)

Input /tak/	Max	NoCoda
[tak]	Satisfied	Violated
[ta]	Violated	Satisfied

The crucial observation, upon which OT is based, is that constraints sometimes impose conflicting goals on output forms. As a result, violations of some constraints are by nature inevitable, since satisfaction of one constraint necessitates violation of another. Still violations must be minimal; in other words, the output that satisfies (4) is chosen as the actual surface form.

In the OT literature, to show the process of choosing the optimal candidate given a particular constraint ranking, "a tableau" is often used. One demonstrative example of an OT tableau is provided below:

(6)

/abcd/	Constraint 1	Constraint 2	Constraint 3	Constraint 4
a. [abcd]	*!			
b. [abd]		*!		
c. ☞ [abecd]			*	*
d. [abfcd]			**!	

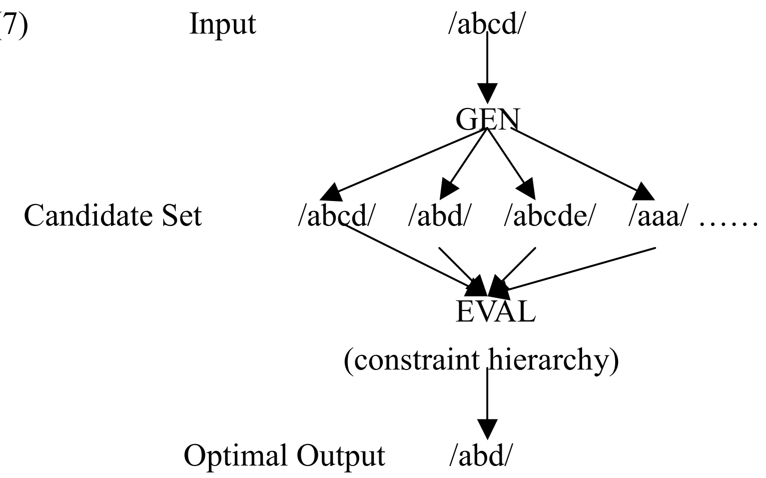
In tableaux constraints are arranged in order of ranking from left to right. A solid line represents the strict domination of one constraint over another. On the other hand, a dotted line indicates that the ranking is yet to be determined. Hence in the above tableau, Constraint 1 and 2 are ranked higher than Constraint 3, but the ranking between Constraint 1 and 2 has not been established yet.

The input appears in the upper left corner, and it is shown by two slashes, following the notational convention of traditional phonology. Output candidates are displayed in the cells below. For the clarity of representation, we usually consider only candidates that have a possibility of winning, despite that a potentially infinite number of candidates could be taken into consideration.

The violation of a constraint is shown by an asterisk, and an exclamation along with an asterisk(s) highlights each fatal violation; i.e., the violation that eliminates the candidate from further consideration. For instance, in (6), the candidate (a) incurs a fatal violation of Constraint 1 since there are other candidates (i.e., (b), (c) and (d)) that better satisfy this constraint. Therefore, (a) is ruled out by this very violation. Similarly, candidate (b) constitutes a fatal violation of Constraint 2 since (c) and (d) satisfy the constraint better than (b). Then the decision is passed onto Constraint 3. Since (c) incurs fewer violations than (d), (c) is considered to be the optimum (the winning candidate). The actual output is expressed by the sign ☞. Shaded parts represent violations that become irrelevant because the candidates are already excluded due to a fatal violation of a higher-ranked constraint. The winner's cells are also shaded when there are no more competitors (see the cell of candidate (c) for Constraint 4 in (6)).

The specific OT model of how to generate an output is illustrated by the diagram shown as (7).

(7)



For an input /abcd/, the GENerator (often referred to as *GEN*) creates a candidate set of potential outputs, and EVALuator (or *EVAL*) selects the optimal output based on (4). This "derivation" (being different from the traditional notion of a serial derivation with intermediate stages) takes place in parallel without intermediate stages: a candidate set is generated and evaluated in a simultaneous fashion. In OT, derivations are conceived as one step mapping from the input onto the output[4]. It becomes important later in this chapter that OT does not recognize "intermediate" stages in derivation. Since opacity arises out of generalizations that apparently need to be stated at some non-surface level of representation (Kiparsky 1973), it raises a fundamental problem to Optimality Theory.

1.2.1.2 Richness of the Base

Another outstanding characteristic of Optimality Theory that sharply distinguishes it from other pre-OT phonological theories is *Richness of the Base Hypothesis*, which concerns us later in this paper. Constraints employed in OT are restrictions on output representation, and as a corollary it is generally assumed that there are no language-specific constraints imposed on the input[5].

In the pre-OT literature the absence of certain segments in a language (e.g., front round vowels in English) is analyzed by imposing conditions on the input; e.g., morpheme structure constraints. However, OT constraints do not impose any restriction on input forms, and this hypothesis is known as Richness of the Base (Prince and Smolensky 1993; Smolensky 1996; Kurisu 2000; McCarthy (in press) among many others). The absence of certain segments is accounted for by the interaction of constraints at the surface level. For instance, in English no front round vowels are attested. OT does not analyze this gap by inflicting constraints on English sound inventory, but rather accounts for the gap by postulating that *{[-back], [+round]} >> Faith, the former being the antagonistic constraint against non-back rounded vowels. Let us assume that the relevant faithfulness constraint is Ident-IO-[back] which militates against the change in backness feature specification. With this ranking, given a high front rounded vowel /y/ as an input, this eventually surfaces as /u/. The tableau below illustrates how this constraint ranking accounts for the absence of front rounded vowels in English:

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[4]There are theories within OT that stipulate several intermediate levels, as proposed by McCarthy and Prince (1993b: Chapter 3), Inkelas and Orgun (1995), Sprouse (1997), Kiparsky (1998), among others. See section 4 for discussion.

[5] Richness of the Base, however, is not an "entailment" of Optimality Theory. It is logically possible to posit language-specific constraints on inputs while retaining the basic architecture of OT. This, however, leads to the duplication problem (Kenstowicz and Kisseberth 1977, 1979; McCarthy (in press); see below).

(8)	/y/	*{[-back], [+round]}	Ident-IO-[back]
	a. [y]	*!	
	b.☞ [u]		*

The sound inventory of a language is thus explained in terms of a constraint interaction in Optimality Theory. As a ramification of this approach, OT avoids duplication problem (Kenstowicz and Kisserbeth 1977, 1979); that is, in pre-OT literature, the similarity between morpheme structure constraints and the surface patterns produced by rules is left unexplained. In OT this problem does not arise since there are no constraints on input in the first place. The surface pattern is captured purely as a result of a constraint interaction.

1.2.3. Correspondence Theory

Departing from the earlier model of Optimality Theory (Prince and Smolensky 1993, McCarthy and Prince 1993b), the predominant model within OT that is employed by many current researchers to represent faithfulness is that of Correspondence Theory (McCarthy and Prince 1995). It is generally considered in the literature that the universal set of constraints is classified into two major types by their nature: markedness constraints and faithfulness constraints. Markedness constraints require output forms to avoid certain marked structures; or in other words, markedness constraints can be captured as the demand that outputs be structurally well formed. Instances of marked structure include: a coda consonant in a syllable; two consecutive stresses; a nasalized vowel; a voiceless consonant after a nasal; and so forth. The targets of markedness constraints encompass segmental structures as well as syllabic or metrical structures.

Faithfulness constraints constitute the other family of constraints. They prohibit the disparity between the outputs and other levels. In Correspondence Theory (McCarthy and Prince 1995), faithfulness constraints are uniformly expressed in the form of correspondence. The definition of correspondence is provided below (McCarthy and Prince 1995:262):

(9) Given two strings S_1 and S_2, correspondence is a relation R from the elements of S_1 to those of S_2. Elements $\alpha \in S_1$ and $\beta \in S_2$ are referred to as correspondents of one another when $\alpha R \beta$.

Given the definition (9), not only is faithfulness correspondence established between the output and the input (IO-faithfulness), but it has been also proposed that there should be a correspondence between a base and a reduplicant (McCarthy and Prince 1995), a base and a truncatum (Benua 1995) or among morphologically related paradigms (Benua 1997a,b) and others. The most significant idea of Correspondence Theory is that these kinds of faithfulness relation are all regulated by the same principle formulated as (9).

The following are three constraints that will play a leading role in our subsequent discussions, all of which relate the string S_1 (input, base…) to the string S_2 (output, reduplicant, truncatum…):

(10) Max: Every segment[6] in S_1 has a correspondent in S_2
Dep: Every segment in S_2 has a correspondent in S_1
Ident (F): Correspondent segments must be identical with respect to feature (F)

The first one requires every segment in S_1 to be present in S_2, and therefore it functions as an antagonistic constraint against deletion. On the other hand, Dep requires every segment in S_2 to have a corresponding segment in S_1 i.e., it prohibits an epenthetic element. Ident (F) demands that corresponding elements share the same feature specification with respect to (F).

My central claim in this paper is that there is requirement in human language that variants be similar to each other, and this claim will be articulated in the form of correspondence. This new correspondence is dubbed here Output-Variant Correspondence or OV-correspondence.

1.3. Model

OV-correspondence is faithfulness relation among variants. I now flesh out some assumptions and definitions which will be employed in the rest of the paper. When there are two forms for one input, one is less faithful to the input than others. In addition, it is usually the case that one is predictable from the other, but not vice versa. For illustration, let us take the variant formation in Japanese generated via vowel coalescence.

(11)

a. neutral forms	b. casual forms	
[ak**ai**]	[ak**e:**]	'red'
[sug**oi**]	[sug**e:**]	'formidable'

Mainly in colloquial speech, Japanese exhibits an active vowel coalescence process where two consecutive vowels are fused into one long vowel. As shown in the data above, for instance, [ai] and [oi] are coalesced into [e:]. The forms after the coalescence

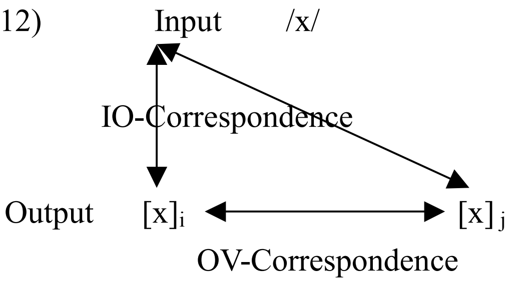
[6] This in fact can be a feature, as argued by Lombardi (1995, 1988). Assuming that /h/ is placeless, for example, the change from /h/ to [p] violates Dep-IO-[lab].

(11b) are predictable from the forms in (11a) because the output of vowel fusion is fully predictable from the input vowels (for a more meticulous description, see section 3). The reverse is not true, however. That is, from [ake:] alone, it is not clear whether it is derived from [akai] or [akoi]. It follows from this observation that [akai] is more faithful to the underlying representation since it contains unpredictable information.

Based on this observation, I distinguish “a base” and “a variant”. “A base” is defined as the form that is most faithful to the underlying representation, and other forms are collectively referred to as ”variants”. Variant forms are usually found in fast or casual speech, and they often have sociolinguistic (as opposed to grammaticalized) meaning such as “rough,” “male” or “condescending” flavor. Base forms, on the other hand, usually lack these kinds of extra meaning.

As I will show in the subsequent sections, variant forms often exhibit opacity, and I argue that this is the result of OV-correspondence. The following diagram (12) portrays the system of relations between a variant and a base. The subsequent case studies presented in section 2 and 3 are based on this model.

(12)



Suppose that $[x]_i$ is closer to the underlying representation /x/, then $[x]_i$ is considered to be the base and $[x]_j$ is the variant. OV-Correspondence requires that a base and a variant be phonologically identical. This base/variant distinction becomes relevant when we consider the “morphological priority” of a base. If OV-correspondence requires a base and a variant be phonologically identical, the question that immediately arises is: which form is affected in order to achieve the identity? The answer is that, empirically speaking, it is the variant that is affected. This point is taken up in section 2.2.2 by analyzing concrete data.

Although for the sake of simplicity (12) will be employed in the case studies presented in section 2 and 3, another model, which is similar but distinct from (12), is also developed in section 4. Retaining the basic concept of (12), further augmentation will be made, building upon Kurisu’s Realizational Morpheme Theory (2001). This model is developed based on the fact that a variant can often have an additional sociolinguistic meaning. In the vowel coalescence operation above, for example, the variant forms (e.g., [ake:] or [suge:]) have a "rough" and "masculine" flavor. Thus it is plausible that a variant has a sociolinguistic morpheme underlyingly, which causes additional sociolinguistic meaning. The relation between a variant and a base can then be illustrated in the following diagram.

(13) /$Input_i$/ ⟷ /$Input_i$+γ/

$/Input_i/$ ↕ [Output]

$/Input_i+\gamma/$ ↕ [Output]γ

[Output] ⟷ [Output]γ

OV-correspondence

In (13), γ represents the sociolinguistic morpheme. This morpheme is required to be phonologically realized by the constraint Realize Morpheme (Kurisu 2001) and hence a variant manifests a distinct surface representation from its base. This model explains in a natural way why a variant has a different phonological shape from its base and also why a variant shows additional sociolinguistic meaning. This approach provides a more explicit account of how variants can come about, and it unifies the OV-Faith approach more closely with general OO-Faith approach. As the upshot of this model, moreover, the concept of "base" can be more clearly defined: a base form is that which does not have a sociolinguistic meaning underlyingly.

Though (13) is the model that I ultimately argue for, for the sake of simplicity I will employ (12) as the basic model for the discussion in section 2 and 3. This is purely for the sake of simplicity and should make no crucial difference. Both of the models share my fundamental claim: disparity between a variant and its base is prohibited by OV-correspondence.

1.4. Organization of the Paper

The rest of this paper is organized as follows. Section 2 is allotted to case studies of the misapplication of phonological processes due to OV-correspondence. I show first that well-established markedness constraints (*NT, *DD and *HH) in Japanese are unexpectedly disregarded due to the influence of OV-correspondence, which consequently gives rise to opacity. Also an extension to data from other languages will be made. Further, it will be pointed out that generalizations on syllable structure often fail to hold in the context of variant formations, and this tendency can again be elegantly accounted for by the existence of OV-correspondence. Throughout, we will see that all of the data can be generalized into one schema, which I name *the emergence of the marked*.

In section 3, I point out that OV-Correspondence Theory can eliminate a wider range of opaque derivations. Two concrete phenomena are taken up as the realization of OV-correspondence. The first case is vowel coalescence and the other is compensatory lengthening resulting from glide formation. In both of the cases, the output vowel in a variant must invariably be long. I will argue that there should be Max-OV-μ involved, which requires a variant to have a corresponding mora for each mora in the base.

Section 4 is devoted to theoretical discussions where I critically assess the OT model that stipulates several intermediate stages since this kind of theory can be used as an alternative to account for the opacity problems in variant forms. Further, I flesh out the model (13), building upon Realizational Morphology Theory (Kurisu 2001). This model generates more than one output form from one input with absolutely no reranking, or multiple strata. I show that the model has several advantages over OT with serial strata.

Finally in section 5, we will scrutinize yet another approach that could be used to account for the problems presented in section 2; namely, local conjunction (Smolensky 1993, 1995, 1997; Kirchner 1996; Itô and Mester 1998, 1999b; Lubowicz 1998 among others). I show that although this approach can potentially account for some of the problems, it fails to account for some particular patterns. I therefore argue that in order to gain a principled understanding of the opacity problems in variant forms, the approach with recourse to OV-correspondence is necessary.

2. CASE STUDIES

2.1. Introduction

This section presents various case studies of opacity involved in the context of variant formations. We will see that OV-correspondence constraints force a variant to deviate from the canonical surface pattern of the language in order to be phonologically more similar to the base.

One pattern that characterizes all of the data below can be generalized as *the emergence of the marked*, meaning that certain marked structures are tolerated in the context of variant formations, but not in IO-dimensions. This pattern derives from the ranking schema Faith-OV >> Markedness Constraints >> Faith-IO[7]. Given this pattern, a certain structure is neutralized in IO-dimensions (i.e., it does not surface) but tolerated in variant forms.

The rest of this section proceeds as follows. I first present three case studies from Japanese, where we see that three markedness constraints *NT (no nasal followed

[7] As we will see, in an overapplication pattern, Faith-OV does not necessarily dominate the markedness constraint.

by a voiceless obstruent), *DD (no voiced geminates) and *HH (no geminated *h*) are unexpectedly violated. After the analysis of these phenomena, I point out that parallel phenomena are found in other languages. Data from Sea Dayak, Isthmus Nahuat, and Mwera will be taken up: the first two examples instantiate underapplication patterns and the last one an overapplication. Finally we will turn our attention to the syllable structure of three languages, English, Japanese and Ganda while observing that unexpected syllable structures are tolerated only in variant forms.

2.2. Japanese

2.2.1. Preliminary: Japanese Phonological Lexicon

Before we delve into the concrete analysis of some Japanese phonological phenomena, it must be pointed out that the Japanese lexicon exhibits rather clear stratification of vocabulary: Yamato (native), Sino-Japanese (Chinese borrowing), Foreign (recent borrowing mainly from Western countries) and mimetic (see Martin 1952; McCawley 1968; Vance 1987; Shibatani 1990; Itô and Mester 1995ab, 1999a). This organization of the lexicon is not merely a record of etymological history for each lexical item, but it plays a significant role in synchronic grammar. As extensively discussed by Itô and Mester (1995ab, 1999a), each of the strata manifests different degrees of obedience to markedness constraints, and the Yamato-stratum, placed as the core of the lexicon, is pointed out to be the most restricted domain. What will be discussed below is mainly the vocabulary from the Yamato Stratum.

2.2.2. NC Voicing

The first realization of featural OV-correspondence is observed in relation to nasal-obstruent clusters. In Japanese, or more specifically in the Yamato-stratum, the constraint that requires all nasal-obstruent clusters be voiced throughout (henceforth *NT; Pater 1996; Itô and Mester 1999a) is well attested[8]. This constraint is responsible for the regular alternation in the verbal inflection for past tense "-ta" and the gerundive ending "-te" (Davis and Tsujimura 1991 for autosegmental account; see also Itô and Mester 1999a).

[8] See Itô, Mester and Padgett (1995) for an analysis that does not rely on *NT constraint. They analyze the voicing in terms of feature licensing.

(1)

	Stem	Gerundive	Past	Gloss
a.	tabe-	tabe-te	tabe-ta	‘eat’
b.	hasir-	hasit-te	hasit-ta	‘run’
c.	sin-	sin-de	sin-da	‘die’
d.	kam-	kan-de	kan-da	‘bite’

When the stem ends with a non-nasal sound as in (1a) or (1b), the suffixes realize as [-te] and [-ta], respectively, while when the stem ends with a nasal, the suffix-initial consonants are voiced. This postnasal voicing effect is also observed in verbal root compounding, as illustrated in (2) (Itô and Mester 1999a):

(2)

Root	Gloss	Compound		Gloss
kiru	‘cut’	fun-giru	*fun-kiru	‘give up’
sibaru	‘tie’	fun-zibaru	*fun-sibaru	‘immobilize’

As seen, when the first root ends with a nasal sound, the first obstruent of the second member must be voiced. In addition to these productive alternations, lexical items in the Yamato-stratum all obey *NT that disallows a sequence of a nasal followed by a voiceless obstruent, as in *tombo* ‘dragonfly, *riŋgo* ‘apple,’ *kaŋgaeru* ‘think’, and so forth.

However, it is of considerable interest that even in the vocabulary in the Yamato-stratum, there is a case where postnasal voicing effect does not take effect: this is the case of a variant formation. Admittedly, this formation seems sporadic, and the following list covers all the examples that I can come up with. Still it is evident that NC clusters created as a result of syncope systematically fail to satisfy *NT.

(3)

Base	Variant		Gloss
[anata]	[anta][9]	*anda	‘you’
[nanika]	[naŋka]	*nanga	‘something’
[nani+to]	[nanto]	*nando	‘with what’
[anosa:]	[ansa:]	*anza:	address phrase
[anisan]	[ansan]	*anzan	‘(literally) brother’

This failure of postnasal voicing could be regarded as derivational opacity. In terms of a

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[9] Itô and Mester (1999a: 70) treat this syncopated form as belonging to a stratum other than Yamato (but they are vague about exactly where it belongs). Their only rationale behind this treatment is that it fails to undergo postnasal voicing. However, merely treating the failure of voicing as an exception does not explain why syncopated forms shown in (3) are systematically immune to postnasal voicing.

rule-based approach, this apparent underapplication of the voicing effect can be accounted for by postulating that syncope is ordered after the postnasal voicing rule. Then by the time the structure comes to meet the structural description of the postnasal voicing rule, the chance to apply it has already passed. To describe the situation in traditional terms, syncope counterfeeds the postnasal voicing rule.

Within the OT framework, however, we cannot account for this opacity by recourse to rule ordering since the mapping of input to output is one-step. I propose that the failure of postnasal voicing is the consequence of the dominance of an OV-faithfulness constraint over the markedness constraint. It cannot be the case that an IO-faithfulness constraint (i.e., Ident-IO-[voi]) dominates *NT, since in other environments such as past-tense suffixation, voicing does take effect. Rather, it is Ident-OV-[voi] that outranks *NT, inhibiting [t] in [anta] from being voiced. Consider (4) which illustrates OV-correspondence between [anata] and [anta]. Observe that [t] in [anta] has [t] as its correspondence in the base [anata]. Hence Ident-OV-[voi] requires the postnasal [t] in [anta] to be [-voice]. The tableaux (5) and (6) summarize the point (the trigger is encapsulated as Syncope[10])[11]:

(4) OV-Correspondence between [anata] and [anta]

Base	[a	n	a	t	a]
	|	|	|	|	|
Variant	[a	n		t	a]

(5)

/anata/ BASE [anata]	Syncope	Ident-OV-[voi]	*NT	Ident-IO-[voi]
a. [anata]	*!			
b. ☞ [anta]			*	
c. [anda]		*!		*

[10] Ad hoc constraints such as Syncope to trigger the formation of a variant are abandoned later in section 4. I basically argue that syncope is driven by a sociological morpheme underlyingly attached to the base.

[11] Syncope does not take effect for [sinda], presumably because the would-be resulting structure [snda] fatally deviates from the canonical syllable structure of Japanese. That is, *ComplexOnset dominates syncope. For simplicity, however, these constraints are omitted from the tableau (6).

(6)

/sin+te/	Ident-OV-[voi]	*NT	Ident-IO-[voi]
a. [sin+te]	N/A	*!	
b. ☞ [sin+de]	N/A		*

As seen in (5), with Ident-OV-[voi] dominating *NT, it is more important to have the same specification for voicing with its base form than to satisfy the markedness constraint *NT. Therefore, voicing the postnasal [t] is prohibited. Yet when OV-correspondence does not hold as in (6), the voicing does take place under the same ranking.

Some comments are in order. Notice that, in tableau (5), in order for Ident-OV-[voi] to correctly function, the base form [anata] must be taken into account. This entails that the surface form of [anata] must be determined before (5) takes place. Assuming Richness of the Base, OV-correspondence cannot refer to the input of the base since the input can be "rich" (i.e., its exact properties can be undetermined). Rather, OV-correspondence should be the correspondence between two outputs. Hence in order for (5) to be successful, the base form must be given in the form of output.

Another point that must be made clear is the *priority* of base forms. There do not seem to be cases where variant forms affect base forms. Consider the case above again. If the failure of postnasal voicing is caused by Faith-OV, why doesn't this constraint affect the base form? That is, why underapplication in the variant rather than overapplication in the base? This point is significant since the overapplication in the base seems to be more harmonic than the underapplication in the variant. As shown in the tableaux below, the overapplication pattern avoids the violation of Ident-OV-[voi] as well as the violation of the markedness constraint *NT.

(7)

/anata/	Ident-OV-[voi]	*NT	Ident-IO-[voi]
a. [anata]			
b. ☞ [anada]			*

(8)

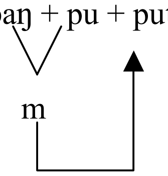
/anata/	Ident-OV-[voi]	*NT	Ident-IO-[voi]
a. [anta]		*	
b. ☞ [anda]			*

Notice that in (5), *NT is violated by the actual output form of the variant. Thus the theory at present predicts that the overapplication in a base form is more harmonic than the forms of the underapplication pattern. However, empirically, base forms can affect variants forms but not vice versa. Stating differently, when disparity between a base and a variant is prohibited, it is the variant, not the base, that is affected.

To avert this problem, we can of course stipulate that OV-Correspondence is one-way: only variant forms are regulated to be identical to its base. However, this stipulation seriously deviates from the fundamental conception of Correspondence Theory. Correspondence regulates identity and thus a faithfulness constraint is violated whenever identity is not achieved (McCarthy and Prince 1995). McCarthy and Prince confirm this point by showing “back-copying” pattern. Tagalog exhibits the pattern where the base of the reduplication copies phonology that is conditioned only in the reduplicant. The prefix /paŋ/ triggers nasal substitution both in the reduplicant and in the base, although the condition of nasal substitution is met only in the reduplicant.

(9) /paŋ+RED+putul/ => [pa-mu-mutul].

(10) paŋ + pu + putul



Nasal substitution, as seen in (9) and (10), is conditioned only between the prefix and the adjacent reduplicant. But the result of nasal substitution in the reduplicant is copied back to the base, as depicted in (10). This data suggests that a reduplicant can affect its base. Also it has been pointed out that there are many cases in which a base affects its reduplicant form via Base-Reduplicant Identity (for concrete data, see McCarthy and Prince 1995). It follows then that correspondence should not be one-way.

Similarly, to the extent that OV-correspondence is one kind of correspondence, the violation of OV-faithfulness should be incurred both by the base and the variant if it is different from its variant. Simply treating OV-correspondence[12] as a mere exception is theoretically undesirable and unmotivated. Then, it remains mystery why a variant form never affects a base via OV-correspondence.

Benua’s *recursive evaluation* solves this problem (1997b: 33-39) while simultaneously providing a solution to the first problem: in order for OV-Faith to function, the base form must be given in the form of output. To recapitulate Benua’s model from our perspective, a base and its variant are evaluated in parallel against a recursive constraint hierarchy. The constraint ranking is duplicated, and the recursions are ordered from the evaluation of a base to the evaluation of a variant. The optimal form of each of the forms is selected by one of the recursions.

To illustrate the system, let us take the generation of [anata] and [anta]. In

[12] In fact, the same problem arises in the case of OO-Correspondence (Benua 1997b).

recursive evaluation mechanism, the selection of each output is achieved in the following way (for simplicity I ignore how syncope takes effect in [anta]; see the discussion in section 4):

(11) Recursion A

/anata/	Ident-OV-[voi]	*NT	Ident-IO-[voi]	>>
a. ☞[anata]				
b. [anada]			*!	

Recursion B

>>		Ident-OV-[voi]	*NT	Ident-IO-[voi]
	a. ☞ [anta]		*	
	b. [anda]	*!		*

In the first recursion, [anata] is selected as the optimum, and next, [anta] is selected in the next evaluation. In this way, at the time of evaluation of [anta], the base form, which is necessary for Ident-OV-[voi], is available. Also, this model accounts in a natural way for the priority of a base form. Since Ident-OV-[voi] does not take effect due to the lack of its correspondent in the first recursion, the base is not subject to Ident-OV-[voi] and hence it is not affected by a variant.

In the rest of this paper, I assume this recursive evaluation mechanism to avoid the problems presented above, but do not explicitly provide recursive tableaux for clarity of presentation.

2.2.3. Voiced Obstruent Geminate

Let us now continue our case study of OV-correspondence. In addition to *NT constraint, it has been pointed out that *DD, the prohibition against a geminate of a voiced obstruent (Itô and Mester 1995ab, 1999, Lombardi 1998 among others), has a fairly notable effect in Japanese. This constraint indeed has such a strong effect on the entire Japanese lexicon that even the foreign stratum is affected (This stratum is known to exhibit the least obedience to markedness constraints). For instance, though there are idiolect variations, some speakers devoice a voiced obstruent geminate in recent borrowings as below[13]:

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13 See Nishimura (2001b) for an attempt to account for this devoicing in terms of constraint conjunction (Smolensky 1993, 1995, 1997, Kirchner 1996; Itô and Mester 1998, 1999b, Lubowicz 1998 and section 5 below). Observing that this devoicing takes effect only when there is a voiced obstruent in the same stem, he argues that *VoiObs

(12)	Devoiced Form	Voiced Form	Gloss
	dokku	doggu	‘dog’
	bakku	baggu	‘bag’
	betto	beddo	‘bed’

Given the core-periphery organization of the lexicon where the core domain tolerates less marked structures, it naturally follows that the core Yamato stratum should manifest the obedience to *DD, and in fact it does. The effect of this constraint can be also seen in some adverbs, which involve internal gemination when ‘-ri’ is suffixed (see Martin 1952: 69-70; Kuroda 1965; 201-228; Itô and Mester 1986: 59, 1999: 67; Lombardi 1998).

(13) Adverbial Gemination

a.	/uka(-uka)/	ukkari		absentmindedly
	/biku(-biku)/	bikkuri		surprise
b	/zabu(-zabu)/	zamburi	*zabburi	raining heavily
	/nobi(-nobi)/	nombiri	*nobbiri	leisurely

In (13a), intensification is expressed by way of internal gemination of a voiceless stop. However, in the parallel examples shown as (13b), a nasal is inserted instead of gemination. This must be related to the fact that Japanese does not allow a voiced obstruent geminate: the only licit geminates are voiceless obstruents or homorganic NC clusters.

The exception to this generalization is again found when we see the formation of variants. There is a process where gemination generates an emphatic variant.

(14)	Base	Variants		Gloss
	[yabai]	[yabbai]	*[yappai] *[yambai]	‘dangerous’
	[mazi(de)]	[mazzi(de)]	*[massi(de)] *[manzi(de)]	‘seriously’
	[huzakeru]	[huzzakeru]	*[hussakeru] *[hunzakeru]	‘joke, kid (V)’
	[ʃoboi]	[ʃobboi]	*[ʃoppoi] *[ʃomboi]	‘puny’

As we see, in this case, voiced obstruent geminates are allowed, and what is more, a devoiced counterpart is totally ungrammatical. Nasal insertion is not allowed either,

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and *DD are conjoined to be ranked higher than Ident-IO-[voi].

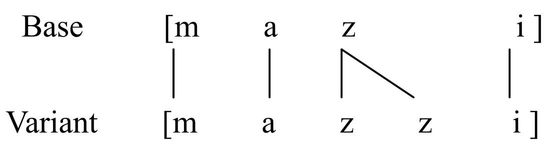
although, sporadically, some emphatic forms with a nasal insertion are attested (e.g., [sugoi] =>[suggoi], [soŋgoi]).

The examples with a voiced geminate are fairly common and thus constitute an empirical problem to the otherwise robust generalizations concerning *DD. These examples are particularly interesting since they show that gemination in different context (i.e., adverbials as in (13) and the variant formation in (14)) react differently to the same markedness constraint *DD. This clearly suggests that faithfulness constraints regulating IO-dimensions and OV-dimensions are different in their ranking.

Similar to the case of NC effect, this is an instance of opacity. In derivational terms, it can be accounted for by rule ordering. One rule is Coda Nasalization (Kuroda 1965; McCawley 1968; Itô and Mester 1986: 59), which changes the first part of a voiced obstruent geminate into a nasal, and the other rule is an insertion of an empty skeletal slot for intensification. While the second rule must feed the first rule in adverbial gemination, in case of variant formations the second rule must follow the first rule so that it counterfeeds the first rule.

In OT framework, the situation is problematic in that rule ordering is unavailable as an analytical device. It is also problematic because of a ranking paradox it entails. In case of adverbial gemination, the alternation suggests that *DD should be ranked higher than Ident-IO-[voi] and Ident-IO-[nas], thereby prohibiting a voiced geminate. On the other hand, in case of variant formations, these faithfulness constraints must dominate *DD, and hence a ranking paradox. However, with appeal to OV-correspondence, this opacity is given a natural account. The OV-Faithfulness constraints are ranked higher than *DD, thereby prohibiting *DD from taking effect. To clarify the point, the correspondence relation between a base and a variant is depicted in (15), taking [mazi] as an example:

(15) Correspondence between [mazi] and [mazzi]



Based upon (15), the tableau below illustrates how voiced geminates survive despite the presence of *DD constraint (the trigger of gemination is encapsulated as GEMINATE; see section 4 for discussion).

(16)

/mazi/ BASE [mazi]	Geminate	Ident-OV -[voi]	Ident-OV -[nas]	*DD	Ident-IO-[voi]
a. [mazi]	*!				
b. ☞ [mazzi]				*	
c. [massi]		*!			**
d. [manzi]			*!		

Crucially, two OV-faithfulness constraints must be ranked higher than the *DD constraint. The first one excludes the candidate with a devoiced geminate. The second rules out candidate (d) because of the nasal insertion[14]. The same ranking accounts for the intensified adverb formation shown as (17):

(17)

/zaburi/	Intens	Ident-OV-{[voi],[nas]}	*DD	Ident-IO-[voi]	Ident-IO-[nas]
a. [zaburi]	*!	N/A			
b. [zabburi]		N/A	*!		
c. [zappuri]		N/A		*!	
d.☞ [zamburi]		N/A			*

Since Ident-OV-{[voi],[nas]} are not applicable in this case, *DD takes effect excluding the candidate (b) with a voiced geminate obstruent.

2.2.3 *HH

Not only does the gemination process above create structures that violate *DD, it also generates another kind of otherwise illicit structure. In Japanese, or more specifically in Yamato-Japanese and Sino-Japanese, [p] and [h] behave as though they were allophones. [p] can be found as a part of a geminate (be it partial or total), and [h] as a simplex sound. The data in (18) illustrates the complementary distribution of [h] and [p] (Itô and Mester 1995ab, 1999a, Nishimura 2001a).

(18)	[h] as a simplex sound		[p] as a member of a geminate	
a.	[**h**ayai]	'fast'	[baka**pp**ayai]	'absurdly fast'
b.	[**h**aru]	'attach'	[hi**pp**aru]	'pull'
c.	[kou**h**ai]	'younger students'	[se**mp**ai]	'older students'

[14] I assume that the [nz] cluster corresponds to [z] in the base, as illustrated in (15), and hence the candidate [manzi] violates Ident-OV-[nas]. If we conceive the nasal sound as an epenthetic consonant, then Dep-OV also works.

Take (18a) for instance. When *hayai* 'fast' is concatenated with *baka* 'absurd', gemination takes effect at the morphological boundary. However, the actual result of gemination is not [hh], but [pp]. The most important point that we concern ourselves with here is that a geminate *h* is prohibited in Yamato and Sino-Japanese[15]. Hence *HH, which militates against a gemination of *h* must be ranked higher than some relevant constraints, which are presumably, Dep-IO-[lab][16] and Ident-IO-[cont]. Let us confirm this ranking by looking at the alternation of /hik+haru/ 'pull+attach' into [hipparu]. The constraints that participate in this alternation are laid out below:

(19)

*HH	No geminated *h*
Coda Condition	A coda must be place-linked to the following onset in an adjacent syllable (Itô 1986, 1989)
Dep-IO-[lab]	No epenthetic labial feature
Ident-IO-[cont]	No change in terms of [cont]

Amongst this list of constraints, *HH, CodaCond >>Dep-IO-[lab], Ident-IO-[cont] is motivated, as confirmed by the following tableau[17].

(20)

/hik+haru/	CodaCond	*HH	Dep-IO-[lab]	Ident-IO-[cont]
a. [hik-haru]	*!			
b. [hih-haru]		*!		*
c.☞ [hip-paru]			*	*

The ranking motivated above alone fails to explain the following variant forms, however:

(21)

Base	Variants		Gloss
[ohayoo]	[o**hh**ayoo]	*[oppayoo]	'Good Morning'
[aho]	[a**hh**o]	*[appo]	'idiot'
[ohuro]	[o**hh**uro]	*[oppuro]	'bath'

As seen, geminate [h]s are unexpectedly attested in geminated variant forms. Similar to

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15 The phonetic motivation behind this prohibition is probably the cross-linguistic tendency to avoid geminates of sonorous sounds.

16 Nishimura (2001a) stipulates that Japanese /h/ has an abstract [+lab] feature underlyingly. However, this stipulation goes against Richness of the Base since it imposes a language-specific constraint on input. I thus assume that the emergence of [p] is due to Dep-IO-[lab].

17 For a full analysis of the [p]=[h] allophonic alternation, see Nishimura (2001a).

the case in 2.2.2, this exceptional behavior of [h] can be explained by the dominance of Faith-OV over *HH, as shown below.

(22)

/aho/ BASE [ahho]	Dep-OV-[lab] or Ident-OV-[cont]	*HH	Dep-IO-[lab]	Ident-IO-[cont]
a. [appo]	*!		*	*
b. ☞ [ahho]		*		

2.3. Cross-linguistic data

2.3.1. The emergence of the Marked.

To sum up the discussion so far, we have seen that three markedness constraints (*NT, *DD and *HH) are unexpectedly violated in the production of variants. This is rather surprising because in the Yamato vocabulary these markedness constraints seem to be ranked higher than the relevant faithfulness constraints. I proposed that this is an effect of OV-correspondence, and the intuition behind this proposal is that there is a force requiring variants to be identical to its base form, which overrides the effect of segmental markedness constraints.

We can generalize the ranking schema which pertains to the Japanese cases, which is shown as (23).

(23) *The Emergence of the Marked* Ranking Schema

Ident-OV
|
Markedness constraints
|
Ident-IO

The schema generates the following general situation. When OV-correspondence is irrelevant, markedness constraints take effect, and therefore neutralized outputs surface. On the other hand, in the context of a variant formation, since the faithfulness constraints are ranked higher, marked structures are tolerated. This general ranking schema thus produces the phenomenon which can be called the *emergence of the marked*, mimicking the renowned coinage of the *emergence of the unmarked* by McCarthy and Prince (1994). Marked structures (e.g., a voiced obstruent geminate, a geminated [h] and an NC cluster) emerge in the context of variant formations, while neutralized forms surface in base forms.

If (23) is a general ranking schema, it predicts that the emergence of the marked should be observed in the context of variant formations cross-linguistically. The following subsections are devoted to the examination of cross-linguistic data concerning the emergence of the marked.

2.3.2. Sea Dayak

The first example is from Sea Dayak (Scott 1957, Kenstowicz and Kisseberth 1979). In this language, a nasal consonant induces the nasalization of following vowels up to the first non-glide consonant. Also, this language has the deletion of a voiced stop or affricate after a nasal, which is optional. Some concrete data are given below (based on Kenstowicz and Kisseberth 1979: 298):

(24)
a. mãta ‘an eye’
b. mõã ‘the face’
c. mãjã ‘a season’
d. /naŋga/ => [nãŋga?] or [nãŋa?] ‘straighten’ but not *[nãŋã?]

(24a) through (24c) illustrate nasal harmony. Particularly important to our discussion is (24d) where a variant formation is involved. Consider the variant [nãŋa?] in which the second vowel must be oral despite the fact that it immediately follows a nasal consonant.

This apparent misapplication of the nasalization is an instance of OV-correspondence effect. Let us assume that the trigger of nasal harmony is *NV[oral], which prohibits an oral vowel after a nasal sound (see Walker (1998) for an alignment-based approach). In [nãŋa?], the second vowel obviously violates this constraint since it is oral despite being placed right after a nasal sound. The underapplication of nasal harmony can be explained by Ident-OV-[nas]. Observe that in the base [nãŋga?], the second vowel is non-nasal, and the OV-identity thus requires the same specification for [nãŋa?].

(25)

/naŋga?/ BASE [nãŋga?]	Ident-OV-[nas]	*NV[oral]	Ident-IO-[nas]
a.☞ [nãŋa?]		*	*
b. [nãŋã?]	*!		**
c. [naŋa?]	*!	**	

In (25), the candidate (b) which undergoes normal application of nasal harmony is excluded by Ident-OV-[nas], despite fully satisfing the markedness constraint *NV[oral]. The winning candidate (a) is the one that is most faithful to its base in terms of nasal specification. This is a clear example of the emergence of the marked: the marked structure (i.e., an oral vowel after a nasal in this context) is tolerated only in the context of a variant formation.

2.3.3 Isthmus Nahuat

Another example is provided by the Mecayapan, Veracruz dialect of Isthmus Nahuat (Law 1958; Kenstowicz and Kisseberth 1979; Kager 1999). This dialect deletes a word-final unstressed short vowel when preceded by a vowel-sonorant sequence, but this apocope is an optional operation. The second operation, which interacts with apocope, is the devoicing of a coda approximants[18]. The result of the interaction is as below (Kenstowicz and Kisseberth 1979: 299)

(26)
a. ʃikakíli or ʃikakíl *ʃikakíl̥ ‘put it in it’
b. kítaja or kítaj *kítaj̥ ‘he already sees it’
c. kikówa or kików *kików̥ ‘a season’

As seen, variants generated by way of apocope systematically fail to undergo word final devoicing: it underapplies in the context of variant formations. This phenomenon is also an instance of the OV-faithfulness effect. Variants are required to have the same specification as the base, which overrides the demand to devoice a coda approximant. The illustrative tableau is provided as (27):

(27)

/kitaja / BASE [kitaja]	Ident-OV-[voi]	DEVOICE[19]	Ident-IO-[voi]
a.☞ [kitaj]		*	
b. [kitaj̥]	*!		*

2.3.4. Mwera

The third example is from Mwera, which instantiates overapplication due to OV-faithfulness. This language possesses nasal place assimilation and optional deletion of a postnasal voiced obstruent. When these are operations interact with each other, nasal place assimilation overapplies (Kenstowicz and Kisseberth 1977: 157).

[18] The environment is actually somewhat complicated. [l] is always devoiced when syllabified as a coda. [j] is also devoiced in a coda position unless followed by a voiced consonant. The devoicing of [w] takes effect word-finally, and it is optional.

[19] This constraint is obviously ad hoc. Other conceivable approaches to coda devoicing include the one with recourse to positional-specific faithfulness (see particularly,

(28) a. /N+juci/ => [ñ+juci] or [ñ+uci] but * [Nuci] or *[nuci] ‘bee’
b. /N+gomo/ => [ŋgomo] or [ŋomo] but *[Nomo] or *[nuci] ‘lip’

The plural of a certain noun class is marked by the prefix /N-/, and this nasal must assimilate to the following consonant, as [ñ+juci] and [ŋgomo] show. This language also has optional cluster simplification that deletes a voiced obstruent in a postnasal position. This operation gives rise to simplified variants such as [ñ+uci] and [ŋomo]. The important observation is that the prefixal nasal must assimilate to the underlyingly following obstruent even though the trigger consonant is not present at the surface.

This is clearly opacity. The place assimilation of the nasal cannot be motivated by surface harmony since the trigger is absent from the surface forms. In terms of rule-based approach, this overapplication arises from counterbleeding interactions of two rules. Since simplification rule applies after nasal place assimilation, output forms are opaque.

This opacity is accounted for by the ranking Ident-OV-[place] >> Ident-IO-[place], assuming Richness of the Base, which allows for any place specification for the prefixal nasal. This ranking requires the nasal in a variant to have the same specification as its base, and faithfulness to the input can be disregarded. Also, the fact that underlying pre-consonantal nasal cannot surface as a default form (presumably coronal [n]) despite that it is prevocalic at the surface level indicates that Ident-OV-[place] dominates the Place Markedness Hierarchy (i.e., *Dor, *Lab >> *Cor (Prince and Smolensky 1993)) that determines the default place of articulation. The constraint ranking motivated here can be confirmed by the following tableau (the trigger for nasal place assimilation is encapsulated as NPA; see Padgett (1995) for de-encapsulation):

(29)

/m+gomo / BASE [ŋgomo]	Ident-OV-[place]	NPA	Ident-IO-[place]	*Dor	*Lab	*Cor
a.☞ [ŋomo]		N/A	*	*		
b. [nomo]	*!	N/A	*			*
c. [momo]	*!	N/A			*	

The tableau above shows the evaluation given the input /mgomo/ (recall Richness of the Base allowing any place specification for the nasal in input). Since Ident-OV-[place] dominates Ident-IO-[place], candidate (a) wins. Also, since the OV-faithfulness constraint is ranked higher than Place Markedness Hierarchy, candidate (a) wins over

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Beckman (1998)), or constraint conjunction (see Itô and Mester (1998)).

(b) that best satisfies Place Markedness Hierarchy. The fact that non-default nasals are allowed pre-vocalically in variants suggests that this is another instance of the emergence of the marked. Note that a palato-alveolar nasal in (28a) is a very highly marked nasal.

Witness, however, that for this case, Faith-OV does not necessarily dominate the markedness constraint (encapsulated as NPA). This is because the pattern this language exhibits here is not underapplication, but overapplication[20].

For this case of opacity, other approaches can be also possible. For instance, if the universal set of constraints contain a Max constraint for each feature as extensively argued by Lombardi (1995, 1998), Max-IO-[place] also accounts for the overapplication of nasal place assimilation since the constraint requires the place specification of the deleted consonant to surface in the output. Yet another alternative might be to assume that variant forms, which lack postnasal obstruents, are formed by way of fusion as in the case of Indonesian analyzed by Pater (1996).

There is no crucial evidence to decide which approach is most plausible. However, the overapplication pattern of this language can still be seen as an instance of opacity caused by OV-correspondence. The important point is that the OV-system that I am arguing in this paper predicts such overapplication pattern and it is actually empirically attested.

2.4. OV-Faithfulness in the Context of Syllabification

We have seen so far that misapplication of an otherwise pervasive phonological process is widely attested in the context of variant formations. In addition to misapplication of phonological process, I point out that variant forms tend to tolerate more marked syllable structures in natural languages[21]. Three examples are taken up for illustration: English, Japanese and Ganda. For each of the languages, an analysis appealing to OV-faithfulness will be presented.

2.4.1. English

The past phonological literature has revealed that there are strict conditions on a complex onset in English (Kahn 1976, Selkirk 1982,1984 among other works). Some of the conditions are as below:

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[20] This point becomes important in the subsequent discussion in section 5.

[21] I am grateful to Markus Hiller for bringing this observation to my attention and having an extensive discussion with me.

(30) a. Two obstruents cannot constitute a complex onset except when the first member is /s/ (e.g., *stop, sky* but **ptight, *tky*)

b. only /s/ may appear with /m/ and /n/ (e.g., smite, snare, but **tmite*, **knight*)

c. Two sonorants cannot form a complex onset (*mrite, *lrik).

Assuming Richness of the Base, we do not and in fact must not impose these restrictions on input representations. The absence of such forms as *tky* or **tmite* must be derived from the constraint interaction. That is, the absence can be accounted for by the ranking of the relevant markedness constraint (such as Sonority Sequencing Principle (e.g., Selkirk 1984; Clements 1990)) over the faithfulness constraint. Of course, we do not know how these inputs actually surface since they are hypothetical forms, and thus let us assume that the first member of the complex onsets are deleted, violating Max[22]. Assuming that the markedness constraint is Sonority Sequencing Principle (SSP) that requires enough rise in sonority from the first member to the second, the following tableau illustrates how input such as /tmite/ are prohibited to surface.

(31)

/tmite/	SSP	Max
a.☞ [mite]		*
b. [tmite]	*!	

The generalizations on syllable structure shown in (30) might seem very robust, but they fail to hold once we take variants into account. Consider the data below, which represents some forms generated by syncope (Zwicky 1972; Hammond 1997, 1999):

(32)

	Regular form	Syncopated Form	Remarks
potato	[poteɪto]	[**pt**eɪto]	Violation of (30a)
pachinko	[pətʃɪŋko]	[**ptʃ**ɪŋko]	Violation of (30a)
connect	[konekt]	[**kn**ekt]	Violation of (30b)
tomato	[tomeɪto]	[**tm**eɪto]	Violation of (30b)
Marina	[mərinə]	[**mr**inə]	Violation of (30c)

22 There is in fact some evidence that in such cases indeed Max is violated. Borrowings such as *ptalmi* are pronounced without the first consonant. Similarly, unpronounced letters in orthography (e.g., *k* as in *knight*, *m* as in *mnemonic)* also suggest that illicit complex onsets might actually be adjusted by way of deletion. The second type of evidence might not be so strong since it is diachronic rather than synchronic, however.

As seen, otherwise illicit complex onsets are amply attested in syncopated forms[23]. This phenomenon can be naturally accounted for by Max-OV.

(33)

/konekt/ BASE [konekt]	Syncope	Max-OV	SSP	Max-IO
a. [konekt]	*!		*	
b.☞ [knekt]		*	*	*
c. [nekt]		**!		**

With Max-OV dominating SSP, the desired candidate (b) wins. Note that ranking motivated in (31) alone predicts that candidate (c) would win. It should be evident that Max-OV is indispensable to achieve the correct result. Notice that the ranking is one clear instance of the emergence of the marked where Faith-OV and Faith-IO sandwich a markedness constraint. The situation derived from this ranking also evidently falls into the emergence of the marked pattern since the marked syllable structures are tolerated only in the context of variant formations.

2.4.2. Ganda

A similar example to that of English above is found in Ganda, though this time it concerns the licensing[24] of a syllabic consonant. General characteristic of this language is that syllabic consonants are allowed only word-initially (Cole 1962:14). This generalization, however, has one exception: if optional apocope deletes a word-final vowel, /m/, being placed word-finally, can function as a syllabic consonant. Some concrete data are provided below as (34) (m̥ represents a syllabic nasal):

(34)

Base	Variants	
[ffumu]	[ffum̥]	'spear'
[mudumu]	[mudum̥]	'pitcher'
[ntamu]	[ntam̥]	'clay cooking pot'

The absence of syllabic consonants in this language can be accounted for by ranking *{[+cons], [+syll]} above a faithfulness constraint, say, Max. However, with Max-OV

[23] Pater (p.c.) points out that syncope is prohibited when the resulting structure exhibits such configurations as *tl* or *dl*. It thus seems that OCP dominates Syncope.

[24] This use of terminology does not necessary mean that I am assuming Syllable Licensing Theory (Itô 1986, 1989, Goldsmith 1990, Lombardi 1991, Itô and Mester 1993, 1994). It simply means that a syllabic consonant is "allowed".

dominating the markedness constraint, unexpected licensing of /m/ takes place. Ignoring why only /m/ can be syllabic, the following tableau captures the pattern.

(35)

/mudumu/ BASE [mudumu]	Apocope	Max-OV	*{[+syll,-cons]}	Max-IO
a. [mudumu]	*!		*	
b.☞ [mudum̥]		*	*	*
c. [mudu]		**!		**

2.4.3. Japanese

The final example of unexpected syllable structure in variant forms is from Japanese. It is a fairly well known fact that a geminate (whether it be total as in *katta* 'bought' or partial *kanda* 'bit') is allowed only intersyllabically (see Itô 1986). Consider, however, the following data which is mainly found in colloquial speech.

(36)

	Base	Variants	
	a. [mattaku]	[ttaku]	*expression for disappointment*
	b. [kattarui]	[ttarui]	'dull'
	c. [sonna]	[nna]	'such'

This process deletes the first CV-sequence of certain forms. The environment of this process is very limited and its exact characterization is yet to be explored. The point pertinent to our discussion, however, is that in such contexts non-intersyllabic geminates are unexpectedly allowed. The illustrative tableau that accounts for these observations should be as below (the trigger is encapsulated as Delete and constraint against non-intersyllabic geminates is expressed as *NIG (*Non Intersyllabic Geminate)[25]).

(37)

/mattaku/ BASE [mattaku]	Delete	Max-OV	*NIG	Max-IO
a. [mattaku]	*!			
b.☞ [ttaku]		**	*	**
c. [taku]		***!		***

This example is parallel to the two cases we have seen above in that a certain marked syllable structures only emerges in variant formations.

Let us summarize what we have seen in this subsection. Descriptively, I have

[25] See Itô (1986), Itô and Mester (1994) among others for the analysis of Japanese coda consonants.

shown that certain syllable structures that are prohibited in usual contexts are unexpectedly tolerated in variant forms. The fact that such structures are usually prohibited indicate Markedness >> Faith-IO, assuming Richness of the Base. On the other hand, the unexpected emergence of these otherwise inhibited structures indicate Faith-OV >> Markedness. This pattern exemplifies the emergence of the marked very clearly.

2.5. Summary

This section has dealt with the cases where OV-correspondence takes effect, thereby creating opaque output forms or otherwise unlicensed structures. As notably exemplified by the several misapplications of phonological neutralizations and licensing of marked syllable structures, the general property of this kind of situation can be captured as *the emergence of the marked*, where marked structures are tolerated only in the context of variant formations. The fact that the emergence of the marked pattern is often observed in the context of variant formations strongly motivates the existence of OV-correspondence.

3.EXTENSION: OPAQUE VOWEL LENGTHENING

3.1.Introduction

The last section presented several case studies of the realization of OV-correspondence. In this section I show that the theory with OV-correspondence can be independently applied to account for other opaque phenomena: optional compensatory lengthening and vowel lengthening concomitant with vowel coalescence. These processes exhibit output forms with a prosodic structure that cannot be motivated by surface well formedness.

Primary emphasis is placed on data from Japanese, concentrating on phonological operations that have been recognized as vowel coalescence and compensatory lengthening. In both cases, the total mora count is preserved through variant formation, but this gives rise to opacity in that the length of output forms is unpredictable from the input and the motivation cannot be attributed to surface harmony. I point out that Max-OV-μ is of crucial importance to the opaque lengthening of a vowel.

The rest of the chapter proceeds as follows. First, I introduce empirical data concentrating on two phenomena from Japanese. This is followed by clarification of problem: how the architecture of OT makes the data difficult to handle. Next, analyses with recourse to OV-correspondence are presented. This section is followed by objections to Lee's (1996) proposal to account for compensatory lengthening without appealing to moraic theory. Finally, I present the theoretical implications of the analysis presented, and argue that the prediction is empirically supported from cross-linguistic point of view.

3.2.Phonomena

3.2.1. Overview

In Japanese there are two major cases where the preservation of the mora count in variants holds. Both of the cases are phonological alternations observed in the context of two consecutive vowels. When two distinct vowels are placed next to each other, either vowel coalescence or glide formation takes effect, depending upon the quality of the vowels involved. The alternation is summarized in table (1) below:

(1)

V1 \ V2	[i]	[u]	[e]	[o]	[a]
[i]		[ju:]			[ja:]
[u]	[i:]				
[e]	[e:]	<[o:]>			[ja:]
[o]	[e:]	[o:]			
[a]	[e:]	<[o:]>	([e:])		

Forms in < > are alternations which took place in the history of Japanese, but synchronically they are unattested in Tokyo dialect[26]. The change of [ae] into [e:], which is represented in a parenthesis above, is an unproductive alternation, which might be better viewed as a sporadic formation.

Given the chart above, which alternation (whether vowel coalescence or glide formation) takes effect is in fact predictable: a diphthong undergoes vowel coalescence while two heterosyllabic vowels undergo glide formation. As Vance (1987: 73) notes, when the second vowel is high, two consecutive vowels generally constitute a diphthong in Japanese. This nicely matches to what we observe in (1): when the second vowel is [+high], vowel coalescence is observed in most cases. One apparent exception is [iu], which undergoes glide formation rather than vowel fusion, despite that the second vowel is high. Independent evidence from accent placement, however, suggests

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[26] According to Kubozono (1999: 40), in a dialect of west Japan, this vowel coalescence is in fact observed in the verbal and adjectival paradigms. Some examples are as follows:

(i) [kaute] => [koote] ‘buying’
(ii) [hayaku] => [hayoo] ‘fast’

that this sequence constitutes two independent syllables. When enclitic [ga] ‘but’ is attached to an unaccented form, the accent usually appears on the penultimate mora as in (2a) (see Vance 1987: 74-75 and reference cited there):

(2)	a.	/iku/	[ikú+ga]	‘go’
	b.	/asa+i/	[asái+ga]	‘shallow’
	c.	/iu/	[iú+ga]	‘say’

However, when [ga] is added to an unaccented adjective that ends with [ai] as in (2b), the accent lodges on the antepenultimate mora. This indicates that the sequence of [ai] forms a diphthong, even though a morphological boundary is present ([-i] is a suffix for present tense). In the form (2c), on the other hand, the accent falls on the penultimate mora, which suggests that [iu] is a heterosyllabic sequence. Therefore this does not seem to be an exception for the generalization that when two consecutive vowels constitute a diphthong, these undergo vowel coalescence, whereas a heterosyllabic vowel sequence undergoes glide formation.

Aside from many details, the crucially important point for the purpose of this paper is the fact that resulting vowels as an output are long. In fact, particularly for glide formation, this point is emphasized by Poser, who claims that the lengthening should be conceived as an instance of compensatory lengthening in that it preserves the total mora count (Poser 1986; 1988). In the remainder of this subsection, I will present more concrete data for these phenomena, looking at their characteristics more closely.

3.2.1. Vowel Coalescence

For the case of vowel coalescence, the output form is completely predictable. The interesting generalization that holds for every input is provided below (from Kubozono 1999: 96-104 with a slight modification):

(3) When V_1 and V_2 are fused into one output V_3, the feature specification of V_3 equals to the combination of [α high] feature of V_1 on the one hand, and [β low], [γ back] and [δround] of V_2 on the other.

Though this generalization holds for all of the cases, this phenomenon can be further subdivided into three types in terms of their productivity.

The first one is an extremely productive vowel fusion where the output is identical to the long counterpart of V_1, which takes place when the input vowels share the same specification for backness, and V_1 is a mid vowel and V_2 is a high vowel. That is, more concretely, [ei] becomes [e:], and [ou] becomes [o:].

(4) [ei] => [e:]

a. [eiga] => [e:ga]	'movie'
b. [sensei] => [sense:]	'teacher'
c. [de+iri] => [deeri]	'going in and out' (heteromorphemic)

(5) [ou] => [o:]

a. [you] => [yoo]	'chore'
b. [to+u] => [too]	'ask (stem+ present suffix)'

This alternation is quite productive, being observed word-internally as in (4a) or word-finally as in (4b). In fact, this process is so widespread that one could suspect that the sequence is underlyingly /e:/ or /o:/ already. In careful speech, however, at least for the forms in (4), words ordinarily pronounced with [e:] can be also realized as [ei] (Vance 1987: 13, 59). Moreover, consider (4c) and (5b). They are heteromorphemic and hence they undoubtedly have the underlying sequence of /ei/ and /ou/, respectively, and they can in fact be pronounced that way. These forms strongly support the existence of the alternation.

To the extent that this alternation is in fact operative in Japanese, it is important to note that the length of the output vowel must be strictly bimoraic. The output with a short vowel is completely ungrammatical (e.g., *[ega] 'movie,' *[jo] 'chore').

The second type of vowel fusion mainly takes place at the word-final position of adjectives. This alternation fuses the stem-final vowel of an adjective with the inflectional ending for present tense '-i'. Some examples are provided below:

(6) [oi] => [e:]

a. [omosiroi] => [omosire:]	'great'
b. [sugoi] => [suge:]	'interesting'
c. [kakoi] => *[kake:]	'wall'

(7) [ui] => [i:]

a. [samui] =>[sami:]	'cold'
b. [hikui] =>[hiki:]	'low' '
c. [sui+ei] => *[si:sei]	'swimming'

(8) [ai] => [e:]

a. [akai] => [ake:]	'red'	
b. [mitai] => [mite:]	'want to see'	(Morphologically adjective)
c. [nai] => [ne:]	NEGATION	(Morphologically adjective)
d. [sekai] => *[seke:]	'world'	

This kind of alternation seems to be attested only for adjectives[27] and hence less productive than the case above. In fact, as indicated by (6c), (7c), and (8d) nouns systematically resist this monophthongization[28]. Next, as for the vowel length, the

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[27] In some dialect of Tokyo (edokko-Japanese), alternation (8) can affect some nouns as in [daikoN] 'radish' changing into [de:koN] (Kubozono 1999).

[28] This asymmetrical behaviors between nouns and adjectives might be the result of

situation is a bit complicated: the output with a short vowel (e.g., [ake] 'red') is indeed attested. This kind of form, however, can be used exclusively for exclamation in isolation[29]. It is safe to conclude therefore that these forms lose their function as a modifier. Hence I assume here and throughout that it is the output with a bimoraic vowel that is functionally equivalent to the original form.

The third kind of vowel fusion seems to be sporadic, and attested only in few forms. Some examples are provided below:

(9)[ae] => [e:]
  a. [omae] => [ome:] 'you'
  b. [temae] => [teme:] 'you'

This alternation differs from the two cases presented above in that it affects nouns and it seems to be sporadic. What is crucial to the present discussion is that the vowel lengthening is obligatory in this case too. An output form with a short vowel, for instance [ome] 'you', is simply ungrammatical.

To sum up, we have seen that a diphthong is monophthongized by vowel coalescence in Japanese. Though each of the subcases differs in productivity, overall this type of alternation is quite widespread in casual speech. The significant point is that the resulting output vowel must be bimoraic in all of the cases.

3.2.2. Compensatory Lengthening as a Result of Glide Formation

Another strategy to resolve two consecutive vowels is glide formation, and in Japanese cases[30] this is usually accompanied by the lengthening of V_2, as schematically

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noun-specific faithfulness constraints (Smith 1997, 1999).

[29] Outputs with a short vowel should in fact be conceived as the variants for special use of adjectives. In recent Japanese, the stem of adjectives (i.e., without the inflectional ending '-i') is used in isolation for an exclamation as in *taka* 'how tall!' and variants with a short vowel, e.g., *take*, have exactly the same function. That is, [taka] and [take] share the same function, and so do [takai] and [take:]. This indicates that a variant is required to have the same number of morae as its base to which it is functionally equivalent.

[30] It is reported that the compensatory lengthening concomitant with glide formation is attested in Bantu languages too. See Clements (1986), Katamba (1989) for examples in Luganda; Bickmore (1995) for the examples in Kinyambo and Chilungun and Hayes (1989); for a case in Ilokano, spoken in Philippines in Northern Luzon; see also Odden

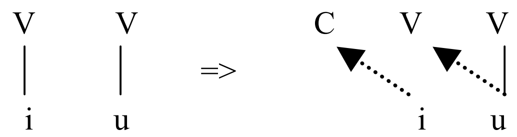
illustrated by (10):

(10) $V_1\ V_2$ ==> $G_1\ V_2$:

There are two major cases for this compensatory lengthening: one is the sequence of [iu] becoming [yuu] (Poser 1986, 1988), and the other is [ea] or [ia] alternating with [yaa] (Miyara 1980; Poser 1986, 1988; Shibatani 1990; Vance 1987). It might be worth mentioning here that V_1 must be a front vowel, and the glide generated by the operation is [y]. The glide formation of [u] or [o] into [w] is entirely unattested, and this is presumably because of the phonotactics restriction of the overall Japanese phonology. That is, the sequence of a consonant followed by [w] is absolutely prohibited (i.e., $*[CwV]_\sigma$), whereas $[CjV]_\sigma$ sequence are ubiquitous.

Now let us move on to the discussion of concrete data. There are four subcases in present Japanese grammar that we can assume to be actual instances of this alternation. The first one is the present tense of the verb [iu], which is often pronounced as [yuu] 'say'. In careful speech, the present form is sometimes pronounced as [iu], but in most cases, this becomes [yuu]. Poser (1986, 1988) argues that this is the result of glide formation followed by compensatory lengthening as depicted in (11):

(11)



The alternation illustrated as (11) can also be seen in the treatment of loan words that end with [-iumu].

(12) bariumu => baryuumu 'barium'
aruminiumu => aruminyuumu 'aluminum'
opiumu => opyuumu 'opium'

In this case too, both forms are attested: in careful speech, the unaltered forms are preferred, whereas in fast speech people are likely to use the other forms. The third case of the alternation [iu] => [yuu] is what Poser calls the formation of hyperpolite adjectives.

(1981).

(13) [o:ki+u] => [o:kyu:] 'big'
[kawai+u] => [kawayu:] 'cute'

This formation is somehow old-fashioned in present day Japanese. Intuitively, however, both of the forms can be used. Again the output with a short vowel is completely ungrammatical.

Finally, this alternation can take place even beyond a compound boundary. Some examples are provided below:

(14) [yomi+uri] => [yomyu:ri] 'reading and selling (the name of newspaper company)'
[sugi+ura] => [sugyu:ra] 'cedar and coast (a surname)'

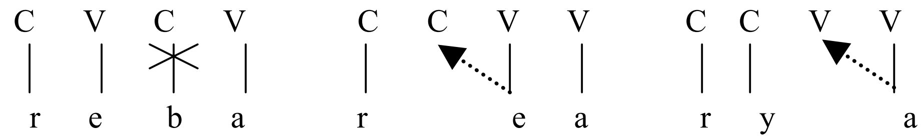
All of the four cases presented so far exemplify the alternation of the [iu] sequence into [yuu]. Again in each of the cases, the lengthening of [u] is obligatory.

There is another environment where glide formation applies with concomitant compensatory lengthening. This is the case of casual speech contractions that reduce the sequence of [C_1VC_2a] into [C_1ya:] where V is a front vowel and C2 is a labial consonant (Miyara 1980; Poser 1986, 1988; Shibatani 1990; Vance 1987). Consider the illustrative examples below:

(15)	a.	[-reba]	=>	[-rya:]	Verbal provisional ending
	b.	[dewa]	=>	[dya:]	'then'
	c.	[kore+wa]	=>	[korya:]	'this+TOPIC'
	d.	[ni+wa]	=>	[nya:]	'DATIVE+TOPIC'
	e.	[uraniwa]	=>	*[uranya:]	'backyard'
	f.	[yane+wa]	=>	*[yanya:]	'roof+TOPIC'

This alternation seems to be morphologically governed. Ordinary nouns do not undergo this change as in (15e). Nor does it apply to a *noun+wa* sequence, as indicated by the ungrammaticality of (15f). It might be instructive to show in derivational terms how this alternation takes place. Below the illustrative derivation of [reba] into [rya:] is given in an autosegmental notation:

(16) a. Labial Delinking b. Glide Formation c. Compensatory Lengthening



Aside from the issue of why a labial consonant is deleted flanked by [e] and [a], this alternation can be seen as an example of hiatus resolution; i.e., [ea] becomes [yaa]. Interestingly enough, in this case, vowel lengthening is not obligatory.

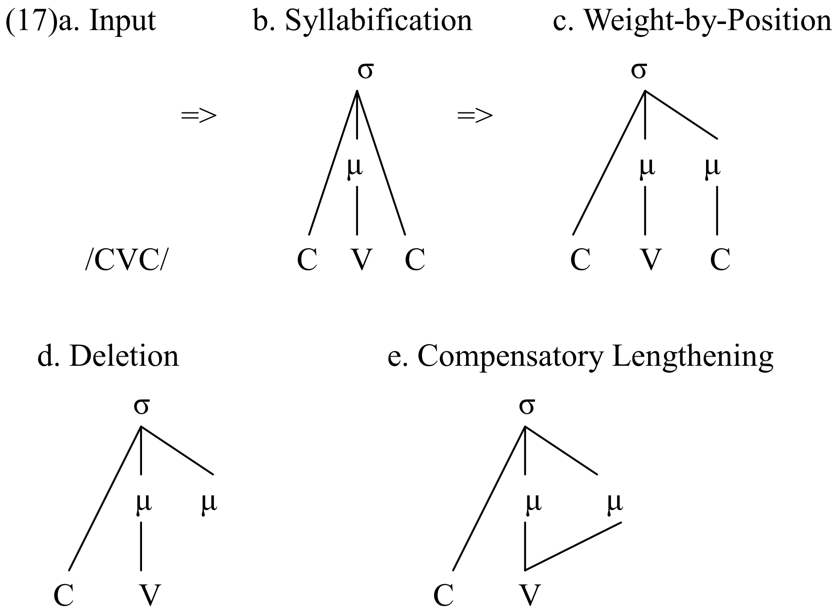
I have shown that almost throughout the data, the output vowel must be bimoraic. An important observation is that variants are opaque while their bases are not. Lengthening of output vowels is opaque, since the lengthening cannot be attributed to surface harmony. The next subsection is devoted to the clarification of the problem. I will show that, assuming Richness of the Base (Prince and Smolensky 1993; Smolensky 1996), it is impossible to account for the lengthening by referring to facts about the number of morae present in input forms

3.3. Problem: Lengthening as Phonological Opacity

The vowel lengthening phenomena we have seen in the last section, and in fact compensatory lengthening in general, are considered to be an instance of phonological opacity (see Sprouse 1997; Kager 1999; Goldrick 2000 among others). The problem of opacity is particularly challenging to a theory that maps the input to the output in one step. Here I will clarify the problem that is entailed by vowel lengthening phenomena. First, we will look at compensatory lengthening invoked by consonant deletion and see how (derivational) moraic theory accounts for its characteristics (Hayes 1989). Then we will go back to vowel lengthening phenomena and see the difficulty in accounting for compensatory lengthening, given OT as an analytical device.

3.3.1. Moraic Theory

One of the most important characteristics of compensatory lengthening is that, though it can be triggered by the deletion of a coda consonant, the deletion of an onset consonant does not generally induce compensatory lengthening (Hyman 1985; McCarthy and Prince 1986). Hayes (1989), building upon this observation, accounts for compensatory lengthening by appealing to moraic theory. The basic idea of this theory is that a coda consonant can be associated with a mora by a so-called Weight-by-Position rule, while onsets are universally non-moraic. Then, compensatory lengthening is given a unified explanation: it is the realization of an effort to preserve the total mora count. In this moraic approach, compensatory lengthening is assumed to arise from derivation with serial operations, which is sketched in (17) (C and V represent a segment, not a skeletal slot):



What is crucial in the derivation above is that the deletion of a segment shown in (d) does not delete its timing unit (or mora) altogether: later in the derivation, this stray mora is reassociated to the following vowel, thereby giving rise to the lengthening of the vowel. This naturally explains why an onset deletion does not induce compensatory lengthening: an onset is universally not mora-bearing and hence no lengthening (for further motivation for moraic theory, see Hayes 1989; Bickmore 1995).

In sum, moraic theory accounts in a natural way for the fact that only the deletion of a coda consonant induces compensatory lengthening[31]. This theory, moreover,

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[31] A further advantage of moraic account for compensatory lengthening is that it utilizes a device (i.e., mora) which is independently motivated by other prosodic phenomena. Not only is this theory successful in dealing with the problem of compensatory lengthening, it simultaneously accounts for the seemingly unrelated phenomenon: the problem of syllable weight. The location of word stress is frequently sensitive to the presence of a coda consonant across languages, while the number of onset segments usually does not affect the stress placement. The theory of stress, i.e., metrical phonology, hypothesizes that the weight of a syllable is determined on the basis of the mora count in a syllable: a monomoraic syllable is light whereas a bimoraic is heavy. This naturally explains why a coda can affect the stress pattern while an onset

simultaneously provides a nice account for the compensatory lengthening that results when an underlying syllabic segment is deleted or is realized as non-syllabic. Under moraic theory, since a vowel is intrinsically associated with a mora, a natural account is given for the fact that the deletion or glide formation of a vowel triggers compensatory lengthening.

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3.3.2. Compensatory Lengthening and Richness of the Base

To the extent that moraic theory is on the right track, it is extremely difficult to incorporate this insight into the framework of OT. Recall that the standard assumption of OT is that the mapping of input onto output is achieved in one step. Given that compensatory lengthening can be best viewed as the effort to preserve that the total mora count, the constraint responsible for the vowel lengthening should be Max-μ, which requires that there be a correspondent mora in output for each mora in input. Then one is forced to assume the exact moraic specification in the input in order to incorporate the moraic theory.

However, as Sprouse (1997) points out, it is not unproblematic to naively assume mora specification in inputs (see also McCarthy 1999). He convincingly argues that the mora that triggers the lengthening cannot be present in the input. For instance, in the case of Oromon (Lloret 1988,1991; Sprouse 1997), compensatory lengthening takes effect only in the context of coda consonant deletion, but it does not occur as a consequence of resyllabification. Compare (18a) and (18b) below (Sprouse 1997:2):

(18)a. /fed+na/ [fee+na] 'we wish'
b. /fed+a/ [feda] *[feeda] 'I wish'

If the coda consonant /d/ is associated with a mora in the input, we would expect the output of (18b) to be [feeda], which is not what we observe in the actual data. These data alone show the difficulty in assuming that coda consonants are underlyingly moraic.

Then how about vowels? If vowels are inherently moraic, one might argue that it is plausible to assume that already in the input vowels bear a mora. Especially, in the case of Japanese, since a short vowel and a long vowel phonemically contrast with each other (cf., *ojisan* 'uncle' and *ojiisan* 'grandfather'), one might propose that the proper mora specification for each input is necessary. One of the basic tenets of OT, Richness of the Base, however, is incompatible with this view.

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does not.

In OT, grammatical generalizations are expressed as the results of interactions of faithfulness constraints and markedness constraints at the level of the output. Yet no specific property can be stated at the level of underlying representations. For our present cases, more specifically, we cannot stipulate the exact number of mora specifications in the input. To put it slightly differently, inputs can contain any kind of prosodification they want or prosodification can even be totally absent, but the constraint interaction must still guarantee an appropriate surface outcome.

Let us be more concrete, concentrating on the case of Japanese vowels. Richness of the Base allows the input vowel to have any number of morae or none. The Evaluator contains a set of constraints (with a proper ranking) that produces the output with a possible moraic specification. Let us take an underlyingly non-moraic and monomoraic vowel for example, and consider the following tableaux:

(19a)

/V/	μ-V(min)	Dep-μ	Max-μ
a. V	*!		
b. ☞ V^{μ}		*	
c. $V^{\mu\mu}$		**!	

(19b)

$/V^{\mu}/$	μ-V(min)	Dep-μ	Max-μ
a. V	*!		*
b. ☞ V^{μ}			
c. $V^{\mu\mu}$		*!	

The constraint μ-V(min) requires a vowel to be at least mono-moraic[32], and with this constraint dominating Dep-μ, for both of the inputs (non-moraic, mono-moraic), the evaluator chooses a mono-moraic output. In other words, given Richness of the Base the constraint hierarchy must work in such a way that it produces a monomoraic vowel as the output even when the input is non-moraic (or monomoraic).

Similarly, for bimoraic output vowels, any input with more than one mora suffices. Given any of these inputs, the evaluator still chooses the right output. So for example, let us take an input with four morae, for which the output will eventually be bimoraic. The tableaux below show how this works:

[32] Since vowels are considered to be moraic universally, it might be the case that μ-V(min) is universally undominated. Another possibility is that GEN does not simply generate candidates which contain moraless vowels.

(20a)

/V $^{\mu\mu}$ /	μ-V(max)	Dep-μ	Max-μ
a. V			*!*
b. V $^{\mu}$			*!
c. ☞ V $^{\mu\mu}$			

(20b)

/V $^{\mu\mu\mu\mu}$ /	μ-V(max)	Dep-μ	Max-μ
a. V			***!*
b. V $^{\mu}$			***!
c. ☞V $^{\mu\mu}$			**
d. V $^{\mu\mu\mu}$	*!		*
e. V $^{\mu\mu\mu\mu}$	*!		

μ-V(max) is the constraint that prohibits more than two morae associated with one vowel. Given the right ranking, both a bimoraic input and a quadramoraic input are sufficient to generate a bimoraic output.

To sum up, within the system of OT, the correct output is produced by the interaction of constraints, and therefore no particular constraint (e.g., one that prohibits more than two morae for one vowel) is necessary in the input. In short, an OT grammar is a system that generates appropriate outcomes from unrestricted inputs.

This assumption thus makes it impossible to assume some exact number of morae in the input. Under the lack of the specification, then, the vowel lengthening phenomenon raises a difficult problem. Since the number of morae is not specifically determined in the input, IO-faithfulness cannot handle the lengthening. To illustrate the point more concretely, let us take the case of [takai] 'high' alternating with [take:]. If each of the vowels is associated with strictly one mora in the input, the lengthening of the output vowel naturally follows from the constraint interaction; the tableau (21) below illustrates the evaluation (the trigger constraint is encapsulated as *diphthong):

(21)

/ta $^{\mu}$ ka $^{\mu}$ i $^{\mu}$ /	*diph	Faith-IO-(F)	μ-V-(min)	Max-IO- μ
a. [ta $^{\mu}$ ka $^{\mu}$ i $^{\mu}$]	*!			
b. [ta $^{\mu}$ ke]		*	*!	**
c. [ta $^{\mu}$ke $^{\mu}$]		*		*!
d. ☞[ta $^{\mu}$ke $^{\mu\mu}$]		*		

In (21), the desired candidate (d) wins appropriately. Candidate (b), which has moraless vowel is excluded by μ-V(min) (or Max-IO-μ, depending on the ranking). More importantly, (c) is ruled out by Max-IO-μ since this deletes the input mora for no reason. What (21) shows is that if we assume the exact number of morae in the input, the lengthening phenomenon can be accounted for by Max-IO-μ. Assuming Richness of the Base, however, the same constraint ranking must choose the appropriate candidate given other input. Let us take the case in which the last two vowels are non-moraic.

(22)

/ta $^{\mu}$ kai/	*diph	Faith-IO-(F)	μ-V(min)	Dep-IO- μ
a. [ta$^{\mu}$ ka$^{\mu}$i$^{\mu}$]	*!			
b. [ta$^{\mu}$ke]		*	*!	*
c.☠ [ta$^{\mu}$ke$^{\mu}$]		*		*
d.(☞) [ta$^{\mu}$ke$^{\mu\mu}$]		*		**!

In (22) the desired candidate is shown by (☞) while the wrong winner is shown by ☠. The problem is that this time the desired candidate is harmonically bounded by the wrong winner: the violation incurred by candidate (c) constitutes a proper subset of the violations incurred by (d), and hence under no ranking dose the candidate (d) have a chance to win over (c). The problem is that given the non-moraic vowels as the input, the desired candidate (d) adds an additional mora without improving the requirement of other constraints, the very operation which is prohibited by the fundamentals of OT.

In sum, in this section we have seen that the vowel lengthening phenomena in Japanese raises a problem given the Richness of the Base hypothesis. Tableau (22) above embodies the problem: on the one hand we must allow for the input with moraless vowels, but on the other hand, given non-moraic input, the desired candidate is harmonically bounded due to the additional violation of Dep-IO-μ. Facing with this dilemma there are two possible optionss we can take: either to reject Richness of the Base or find another way to solve the problem. Richness of the Base is one of the central notions in OT, being closely related to the theoretical design of output-oriented OT. It has several theoretical advantages over pre-OT derivational phonology that posits a unique underlying representation (Prince and Smolensky 1993; McCarthy in press), and receives independent empirical supports (Kurisu 2000). Therefore to the extent that we can retain this fundamental hypothesis, we should. The remainder of this section shows that OV-correspondence, independently motivated by cases shown in section 2, can solve the quandary.

3.4. Analysis with recourse to OV-correspondence

3.4.1. Analysis of Vowel Coalescence

As we have seen in the above section, assuming that no language-specific constraints hold in inputs, it is impossible to account for the lengthening by referring to facts about the number of morae present in input forms. I now present an analysis with recourse to OV-correspondence, which does not hinge upon any specific representation in inputs.

Let us take the case of vowel fusion first. Consider (23), which illustrates the generation of a variant [take:] for [takai] 'high'. Recall that [ai] as well as [oi] sequence can become [e:]. Hence [take:] is phonologically predictable from [takai] but not vice versa. Hence by definition [takai] is considered to be the base and [take:] is a variant.

(23) Input /takai/

Base [takai] ◄──► [take:] Variant

OV-correspondence

In (23), OV-Identity requires that the base [takai] and variant [take:] be identical to each other. I argue that this correspondence is responsible for the length of the final vowel in [take:]. More specifically, Max-OV-μ is of particular importance in this context, which demands a correspondent mora in a variant for every mora in the base. Consider now the constraints that are relevant for our discussion, which are summarized as (24):

(24) a. *VV	a sequence of two distinct vowels is prohibited. (i.e., *diphthong + Onset)
b. Dep-IO	Every segment in the output must have a correspondent in the input.
c. Max-IO	Every segment in the input must have a correspondent in the output.
d. Uniformity-IO	No elements in the output may have multiple correspondents in the input (No Fusion).
e. Ident-(F)-IO	The feature specification of the input must be preserved in the output.
f. Max-OV- μ	Every mora in the base should have a correspondent in its variant.

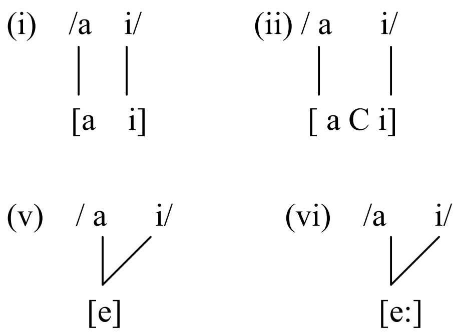
Since the vowel alternation seems to affect both a diphthong (in the case of vowel coalescence) and a hiatus (glide formation), the trigger constraint is encapsulated as (24a) for convenience: this is not to claim the unification of the two constraints *diphthong and Onset. (24b) and (24c) are IO-faithfulness constraints which militate against the insertion and the deletion of a segment, respectively. Fusion of two segments in input violates Uniformity-IO and some Ident-(F)-IO constraints[33]. These faithfulness constraints control IO- correspondence. Max-OV-μ is responsible for the identity in OV-dimension: it requires a variant to have the same number of morae as its base.

Before we delve into the concrete analysis of vowel fusion, it may be instructive

[33] I do not develop a theory of exactly what kind of Ident-(F) constraints are violated in the context of vowel coalescence in this paper.

to clarify the possible reactions to the sequence of two distinct vowels. Below, the various strategies to input /ai/ are illustrated, along with the clarification of which constraint(s) each of the candidate violates.

(25)

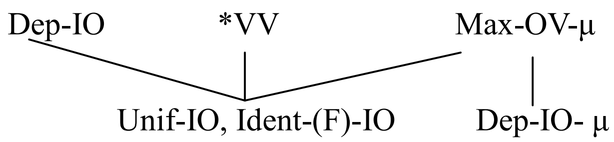


(26)	(i)	(ii)	(iii)	(iv)	(v)	(vi)
*VV	*					
Dep-IO		*				
Max-IO			*	*		
Uniformity					*	*
Max-OV- μ			*	*	*	

(i) is most faithful to the underlying form but violates the markedness constraint *VV. (ii) is a candidate with an epenthetic consonant, and this incurs a violation of Dep since this form has a element that is not present in the input. (iii) and (iv) are results of deletion, which thus violate Max. (v) and (vi) are output candidates that go through fusion at the cost of violating Uniformity. The form in (v) additionally would violate Max-OV-μ since this loses one mora compared to [ai].

Now let us move on to the analysis of a real-life example. Consider the generation of [take:] as the variant of [takai], of which input is considered to be /takai/. In order to correctly produce the variant (which corresponds to (vi) above), the following ranking is crucial:

(27)



The trigger of vowel coalescence (*VV) must dominate Uniformity and Ident-IO-(F), since fusion does takes place in order to satisfy *VV. Next, Dep-IO must be higher than these two constraints, because the language prefers coalescence to epenthesis. Similarly, the fact that the deletion of a vowel does not take place indicates that Max-OV-μ is ranked higher than Uniformity and Ident-IO-(F) [34]. Finally, Max-OV-μ must be ranked higher than Dep-IO-μ since given an input with non-moraic vowels, the output with a short vowel incurs less violation than the output with a long vowel in terms of Dep-IO-μ, as we saw above in (22). The tableau below illustrates how this constraint ranking can choose the right candidate[35]:

(28)

Input /takai/ BASE [ta $^{\mu}$ ka $^{\mu}$ i $^{\mu}$]	*VV	Dep-IO	Max-OV-μ	Max-IO	Unif	Ident-(F)-IO	Dep-IO μ
a. [ta$^{\mu}$ka$^{\mu}$i$^{\mu}$] (=(i))	*!						***
b. [ta$^{\mu}$ka$^{\mu}$ʔi$^{\mu}$] (=(ii))		*!					***
c. [ta$^{\mu}$ka$^{\mu}$] (=(iii))			*!	*			**
d. [ta$^{\mu}$ki$^{\mu}$] (=(iv))			*!	*			**
e. [ta$^{\mu}$ke$^{\mu}$] (=(v))			*!		*	*	**
f. ☞ [ta$^{\mu}$ke$^{\mu\mu}$] (=(vi))					*	*	***

What is crucial in the above tableau is that Max-OV-μ is necessary to get the correct candidate. Observe that without this constraint the desired candidate would be harmonically bounded by (e) since it potentially incurs one additional violation of Dep-IO-μ. Yet with Max-OV-μ being ranked higher than Dep-IO-μ, the desired candidate is successfully considered to be the optimum.

Note that the solution I presented above does not hinge upon the existence of morae in the input since the lengthening takes place as the effect of OV-correspondence. This, admittedly, cannot account for lengthening in the context of the input-output relation, such as those observed in Oromon (see (18) above). However, the analysis with recourse to OV-correspondence relation can eliminate some of the problematic cases: that is, to the extent that the trigger of the lengthening is optional (which means that compensatory lengthening takes place in a variant), the device proposed here can account for the opaque phonological lengthening. The cross-linguistic application of Max-OV-μ is taken up later in this section.

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[34] It could alternatively be Max-IO that dominates Uniformity and Ident-IO-(F) to prevent deletion.

[35] Pater and Selkirk (p.c.) pointed out to me that if a variant is subject to Faith-IO, this alternation raises a problem. Ident-IO-(F) >> *VV is motivated from the absence of vowel coalescence in base forms, and this would prevent a variant from going through vowel coalescence too. This issue is taken up later in 4.3.3.3. below.

3.4.2. Glide Formation with Compensatory Lengthening

Let us now look at one more case for which Max-OV-μ can provide an adequate account. The second case introduced in the last section, compensatory lengthening concomitant with glide formation also necessitates the presence of Max-OV-μ. I use glide formation of [iu] into [yuu] 'say' as a demonstrative example. Underlyingly, the present form of this verb is /iw+u/, and it seems right to conclude that [iu], rather than [yuu], is more close to the underlying form and hence it is the base. Glide formation is invoked by the dominance of *VV over Ident-IO-[cons]. The same ranking we have motivated above in (27) appropriately generates the correct output, as illustrated by the following tableau:

(29)

/iu/ Base [$i^{\mu}u^{\mu}$]	*VV	Dep-IO	Max-OV- μ	Max-IO	Ident-IO -[cons]	Dep-IO-μ
a. [$i^{\mu}u^{\mu}$]	*!					**
b. [i^{μ}?u^{μ}]		*!				**
c. [i^{μ}]			*!	*		*
d. [yu^{μ}]			*!		*	*
e. ☞[$yu^{\mu\mu}$]					*	**

Again, faithfulness identity between the base and the variant necessitates the preservation of total mora count, which excludes candidate (d). The dominance of Max-OV-μ over Dep-IO-μ is crucial: given the opposite ranking, (d) would be the winner. What this ranking suggests is that in Japanese, it is more important or compelling to have the same number of morae with its base than changing the specification of morae between input and output.

3.4.3. Objections to Lee's Proposal

So far I have argued that Max-OV-μ is necessary to account for the lengthening of vowels. There is, however, another account of compensatory lengthening without recourse to moraic theory, proposed by Lee (1996). In the following discussion, I point out that Lee's proposal is based upon improper assumptions and his account makes a wrong prediction for the case of glide formation.

Lee claims that compensatory lengthening falls into a more general category, which can be captured as an endeavor to conserve "the numerical identity of segments of a morpheme". His point is that compensatory lengthening is the result of effort to preserve the number of segment in the input, at the cost of violating lower ranked constraints (i.e., Uniformity and Ident-IO). His analysis is based on compensatory lengthening in Turkish (Sezer 1986), which follows the optional operation to delete the coda [v] being placed immediately before a labial consonant or a vowel (data taken from Sezer 1986: 231-232):

(30)				Gloss
a.	[savmak]	[sa:mak]	*[samak]	‘to get rid of’
b.	[sevmak]	[se:mak]	*[semak]	‘to love’
c.	[ovmak]	[o:mak]	*[omak]	‘to rub’

Lee regards this phenomenon as fusion of the offending consonant [v] with the preceding vowel, proposing that Uniformity is dominated by Max and Dep, which in turn are dominated by the trigger constraint encapsulated as *v{[+lab], V}. His analysis provides a tableau like (31) (1996:5):

(31) *v {[+lab],V} >> Max, Dep >> Uniformity

/savmek/	*v {[+lab], V}	Dep	Max	Unif	Ident
a. ☞ [sa:mek]				*	*
b. [samek]			*!		
c. [savmek]	*!				
d. [savimek]	*!	*			

The tableau above might seem to give an account for the length of the output vowel, but this approach is in fact untenable. There are two crucial mistakes that Lee made in his assumption. One is that candidate like (b) can be generated only by way of deletion (i.e., at cost of violation of Max) as in (32a) below. However, the form like (b) can be generated through fusion too, as depicted in (32b)[36]. Therefore, the ranking Max >> Uniformity alone does not guarantee that the candidate with a long vowel wins.

(32)


Uniformity	Satisfied
Max	Violated

Uniformity	Violated
Max	Satisfied

Moreover, fusion alone does not guarantee the preservation of a numeral identity of

[36] Compare also (v) and (vi) in (25) and (26) above.

segments. In fact there are cases in which fusion results in one (i.e., non-long or non-geminate) sound, instantiated by (33) and (34). The first example is from Indonesian (Halle and Clements 1983; Pater 1996: 2) and (34) is from the German verbal paradigm (Wiese 1996; Kawahara 2001a):

(33) Indonesian *məN*-Prefixation Paradigm

Input	Output	Gloss
/məN+pilih/	[məmilih]	'to choose, to vote'
/məN+tulis/	[mənulis]	'to write'
/məN+kasih/	[məŋasih]	'to give'

(34) Verbal Paradigm of Strong Verbs in German

Input	Output	Gloss
/halt+st/	[hɛl^{t}st]	'to hold' (2nd person, singular, present)
/trɛt+st/	[trɪ^{t}st]	'to step' (2nd person, singular, present)

In (33) the stem-final nasal /N/ is fused with the stem-initial (voiceless) obstruent and importantly, the output sound corresponding to the two sounds is just one segment. (see Pater 1996 for the motivation to treat this phenomenon as fusion). Similarly in (34), the stem-final /t/ is fused with the suffix-initial [s], creating one affricate sound. These two examples should be enough to show that lengthening of a segment is not necessarily guaranteed as the automatic outcome of fusion[37].

There is another crucial problem in Lee's account. His claim is that compensatory lengthening can be seen as one type of endeavor to conserve "the numerical identity of segments of a morpheme". Lee's basic idea is that compensatory lengthening is the outcome of an effort to preserve the number of segments. However, compensatory lengthening which results from glide formation cannot be captured in this manner. In [iu] becoming [yuu] for example, the total number of segments actually increases as a result of compensatory lengthening.

In other to account for glide formation with compensatory lengthening, reference to morae is indispensable. We hence need an independent constraint that militates for the preservation of mora count. With recourse to Max-OV-μ, compensatory lengthening in Turkish is given a straightforward account. Note that the deletion of [v] is optional,

[37] Note, however, that in Root-Fusion in Japanese (Itô and Mester 1996; Kurisu 2000), the outcome of fusion is always a geminate, as in /hat+ken/ => [hakken] 'discovery'. How the result of fusion is determined (i.e., whether it is simplex or geminated) should be explored in the future work of Optimality Theory.

which suggests [o:mek] is a variant for [ovmek]. This variant can be generated in the way the following tableau shows:

(35)

/ovmek/ BASE [o $^{\mu}$ v $^{\mu}$ me $^{\mu}$ k]	*v {[+lab], V}	Max -IO	Dep- IO	Max-OV- μ	Dep-IO- μ
a. ☞ [o $^{\mu}$ $^{\mu}$ me $^{\mu}$ k]		*			***
b. [o $^{\mu}$ me $^{\mu}$ k]		*		*!	**
c. [o $^{\mu}$ v $^{\mu}$me $^{\mu}$ k]	*!				***
d. [o $^{\mu}$ vi $^{\mu}$ me $^{\mu}$ k]	*!		*		***

Again Max-OV- μ must crucially dominate Dep-IO- μ since given the input with non-moraic vowels, the desired candidate constitutes one additional violation of Dep-IO- μ than candidate (b).

3.5. Cross-Linguistic Survey

I have shown in this section that vowel lengthening involved in the creation of a variant can be given a unified account by the constraint Max-OV-μ. My theory thus predicts that compensatory lengthening as a result of an optional operation is not uncommon cross-linguistically. This appears to be empirically supported. The following list provides instances of phenomena that induce opaque lengthening of output vowels in variant formations:

(36) Japanese Glide Formation (Poser 1986, 1988)
Japanese Vowel Coalescence (Kubozono 1999)
Turkish Coda Deletion (Sezer 1986; Lee 1996)
Korean Vowel Deletion (Lee 1996)
Korean Vowel Coalescence (Haas 1988; Lee 1996)
Finnish Vowel Coalescence (Antilla 2000b)
Ancient Greek Vowel Coalescence (Haas 1988)
Luganda Glide Formation (Clements 1986; Katamba 1989; Burnham p.c.[38])
French Inverse Compensatory Lengthening[39] (Rialland 1986; Hayes 1989)

There is yet another type of compensatory lengthening on which OV-correspondence can shed light; namely, compensatory lengthening involved in a

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38 I am grateful to Jerusha Burnham and Alice Burnham for providing me with information about Luganda.

39 This is a kind of compensatory lengthening of a consonant induced by a deletion of a vowel. This is optionally found in fast speech in French.

historical change. In the study of compensatory lengthening, a plethora of examples of historical compensatory lengthening have been pointed out. For instance in Latin, /s/ was deleted before an anterior sonorant, and if the eliminated /s/ was preceded by a vowel, the vowel became long (Ingria 1980; Hayes 1989). A similar example is found in the history of English where a (coda) nasal was deleted before a fricative, which resulted in the lengthening of the preceding vowel (Campbell 1998; see below). In the history of French too, when word-final consonants or preconsonantal /s/ was deleted, the vowel lengthening was observed (Bickkijian 1986). The list of attested historical compensatory lengthening is summarized below:

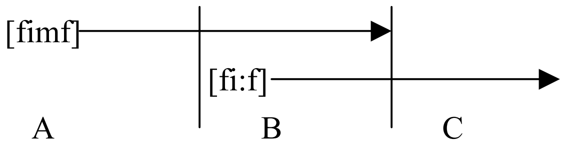
(37) Latin, resulting from */s/-deletion* (Ingiria 1980; Hayes 1989)
Ancient Greek, *Double Flop* (Hayes 1989; Steriade 1982; Wetzels 1986)
Old English, resulting from *coda nasal deletion* (Campbell 1998)
Early Middle English, *double flop* (Minkova 1982; Hayes 1989)
Middle English, *manaerial lengthening* (Hayes 1989 but cf. Chomsky and Halle 1968)
French 16th century, resulting from *word-final consonant deletion* (Bicckijian 1986)
Luganda, *Inverse Compensatory Lengthening* (Clements 1986)
Onondaga, resulting from */r/-loss* (Woodbury 1981)
Proto-West-Finnic > Estonian (Hayes 1989)
Proto-Celtic > Old Irish, *complex coda simplification* (Arlotto 1972; Campbell 1998)
Proto-Scandinavian > Old Norse, *nasal deletion* (Campbell 1998)
Uspenteko, resulting from the deletion of a coda glottal stop (Campbell 1998)

Compensatory lengthening involved in historical change can be regarded as a realization of the OV-correspondence effect based on the assumption that historical change involves creation of variants (Weinreich et al, 1968; Anttila and Cho 1998). Let us take English examples for concrete illustration (data from Campbell 1998: 50 with a slightly different transcription. Note that, following the convention of historical linguistics, I use an asterisk to indicate a reconstructed proto-form.)

(38)

Proto-Germanic	Old English	Gloss
*fimf	fi:f	five
*grinst	gi:st	goose
*munθ	mu:θ	mouth

The important point is that the change from, for instance, [fimf] into [fi:f] did not take place instantaneously. It makes sense to assume that there is a period of time when both forms co-exist. The phonological change of [fimf] into [fi:f] is depicted below:

(39) 

In fact a recent theory of variations, 'variationalist sociolinguistics,' (Weinreich et al., 1968: 188) holds that historical change in progress is manifested as synchronic variation. In this research tradition, it has been pointed out that diachronic changes always involve synchronic variations.

Then historical compensatory lengthening can be captured as the generation of an opaque variant at the period of B in (39). Since this opacity is in the context of variant formations, this type of compensatory lengthening is given a principled account under OV-correspondence theory. Of course, after base forms are completely replaced by variant forms (the period C in (39)), the variant forms are lexicalized and hence not opaque any longer.

3.6. Summary and Some Implications

In this section I have shown that OV-correspondence, independently motivated by the cases presented in section 2, can be applied to account for opaque vowel lengthening phenomena. This further supports the validity of OV-Faith approach.

The fact that compensatory lengthening often involves variant formations might suggest that the compensatory lengthening processes start out from variant formations. That is, in other words, there is no compensatory lengthening that takes place purely in an IO-dimension. This might be too strong a hypothesis; yet considering the number of cases summarized in (36) and (37), it should not be too implausible. It seems very difficult to actually proves this idea, but it is a worthy topic for further investigation.

4. THEORETICAL ISSUES: Serial OT and Reranking

4.1.Introduction

Thus far I have argued for the existence of OV-correspondence and surveyed opaque phenomena involved in variant formations. In this section, I address theoretical issues, comparing my analysis with another approach that can be used to solve problems of opacity in the context of variant formations.

First I compare my theory with a serial OT model that assumes intermediate levels (McCarthy and Prince 1993b; Inkelas and Orgun 1995; Sprouse 1997; Kiparsky 1998). I argue that a multi-stratal model can be obviated in favor of OV-correspondence, though this model is not incompatible with an OV-approach. The argument against multi-stratal OT includes conceptual advantages as well as its theoretical restrictedness. We will also look at the relation between serial OT and the Richness of the Base Hypothesis, pointing out that serial OT faces an odd situation.

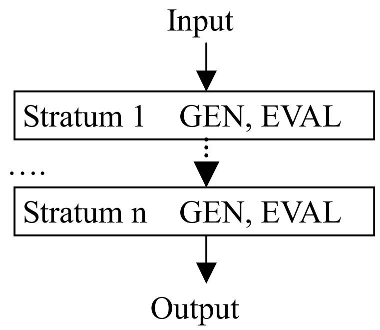
In the following section, I present a theory of free variation that does not require any reranking, based on Kurisu's (2001) Realizational Morphology Theory. This section includes additional counterarguments to the multi-stratal model: Kurisu's theory obviates ad hoc constraints such as SYNCOPE or GEMINATE while in a multi-stratal model we must stipulate constraints like those. Further, Kurisu's theory explains in a natural way why a variant usually has an additional "sociolinguistic" meaning while serial OT requires an extra stipulation to account for this point.

4.2. The Multi-Stratal Model

4.2.1 Basic Idea

One different approach to opacity is to incorporate intermediate levels between input and output, aborting the standard OT assumption of direct mapping. The central idea of this approach, as assumed or proposed by McCarthy and Prince (1993b), Inkelas and Orgun (1995), Sprouse (1997), Kiparsky (1998) among others, is that a grammar is internally structured as serially ordered strata. Its basic system can be illustrated as (40). The output of a previous stratum serves as the input to the next stratum, except that inputs to the first stratum are identical to the lexical representations.

(40)Multi-Stratal Model



Each stratum contains its own GEN and EVAL, and the constraint ranking for each stratum can be different from each other. Also, importantly, Richness of the Base only holds at the level of lexical representations (see below 4.3.2.3). That is, when output forms of Stratum 1 are fed into Stratum 2 as its inputs, no Richness of the Base holds.

4.2.2 Lexical and Post-Lexical Strata

Let us take a more specific model. In order to account for the cases we have seen, a simple model that assumes a two-level serial evaluation suffices[40]. The first level serves as lexical phonology and the second as post-lexical phonology, the latter being responsible for optional operations. The multi-stratal model has its origin in derivational Lexical Phonology (Kiparsky 1982, Mohaman 1982), which hypothesized that phonological rules appear at two distinct points in the grammar, namely, in the lexicon and in the post-syntactic (or post-lexical) component. In models like these, the generation of variants is accounted for by variable reranking at Stratum 2. In other words, reranking from Stratum 1 to Stratum 2 is optional, and if reranking takes place, a variant is generated. For example, given input /anata/, Stratum 1 produces [anata] as its output. If reranking does not take effect at Stratum 2, [anata] surfaces as the optimal output. On the other hand, if reranking does occur, [anta] is chosen as the ultimate output.

Now let us be more concrete and follow the generation of two outputs from /anata/. I will concentrate on how the opaque output [anta] arises. The opacity of this form (i.e., under application of *NT) is accounted for in the way depicted by (41). For a comparison, the derivation for a transparent case, /sin+ta/ => [sinda], is provided along with the derivation for /anata/ =>[anta].

(41)Underapplication of *NT

Stratum 1:	Input 1	/anata/	/sin+ta/	Max>>SYNCOPE
		↓	↓	*NT >> Ident-IO-[voi]
	Output 1	[anata]	[sinda]	↑
		⋮ ↓	⋮ ↓	Different Rankings
Stratum 2:	Input 2	/anata/	[sinda]	↓
		↓	↓	SYNCOPE >> Max
	Output 2	[anta]	[sinda]	Ident-IO-[voi] >> *NT

In Stratum 1, which serves as lexical phonology, *NT must dominate Ident-IO-[voi]

40 Further refinements of serial OT can be imagined to account for other data (Benua 1997b 3.5.4; Sprouse 1997; Kiparsky 1998). Serial OT, however, faces many of the same questions that Lexical Phonology did: it has to decide how many levels can co-exist in one grammar; to what extent they can differ from each other; which operation (in addition to the distinction between lexical and post-lexical, distinct levels might be necessary for morphological operations (e.g., suffixation)) are relevant to which level; to what extent the number of strata is universal; and so forth.

since voicing does take effect with /sin+ta/. For the /anata/=>[anata] mapping, no featural change is required since the nasal and the obstruent are not adjacent to each other. Next, note that syncope is assumed not to take place because it is an optional post-lexical operation. This suggests that the constraint that militates for syncope, encapsulated as SYNCOPE, is ranked lower than Max. The tableaux (42) and (43) show the evaluations at the lexical stratum.

(42)

/anata/	Max-IO	Syncope	*NT	Ident-IO-[voi]
a.☞ [anata]		*		
b. [anada]		*		*!
c. [anta]	*!		*	
d. [anda]	*!			*

(43)

/sin+ta/	Max-IO	Syncope	*NT	Ident-IO-[voi]
a.☞ [sinda]		*		*
b. [sinta]		*	*!	
c. [snta]	*!		*	
d. [snda]	*!			*

As shown, the ranking Max-IO >> SYNCOPE prevents syncope at this level[41]. Next, since the markedness constraint *NT dominates the relevant faithfulness constraint Ident-IO-[voi], postnasal [t] in (43) must be voiced.

The outputs of Stratum 1 are then fed into Stratum 2 as input. Here, first of all, the constraint that triggers syncope is reranked higher than Max-IO. However, syncopating a vowel in a closed syllable is prohibited since the resulting structure strongly deviates from the canonical prosodic shape of Japanese phonology (i.e., fatal violation of *Complex Onset). Secondly, the constraint ranking between *NT and Ident-IO-[voi] is reversed, thereby blocking the voicing of postnasal [t]. The evaluations at Stratum 2 are illustrated as (44) and (45).

(44)

/anata/	Syncope	Max-IO	Ident-IO-[voi]	*NT
a.☞ [anta]		*		*
b. [anda]		*	*!	
c. [anata]	*!			
d. [anada]	*!		*	

41 Candidate (43c) and (43d) are perhaps ruled out by undominated constraints on syllable structure; see below

(45)

/sinda/	NoComplex	Syncope	Max-IO	Ident-IO-[voi]	*NT
a. [sinta]		*		*!	*
b. ☞ [sinda]		*			
c. [snta]	*!		*		*
d. [snda]	*!		*		

Crucially, the trigger constraint SYNCOPE and Ident-IO-[voi] are reranked higher than Max-IO and *NT, respectively. In this manner, postnasal voicing at Stratum 2 is prevented, and also syncope only takes place at Stratum 2. As a result, [anta] and [sinda] are appropriately chosen as the ultimate outputs. As is clear from the discussion so far, reranking plays a pivotal role in this model. I point out in the following subsection that this reranking is undesirable both theoretically and empirically.

4.2.3.Against the Multi-Stratal Model

4.2.3.1 A Conceptual Advantage

Though this serial model provides an explanation for the opacity problem, I argue that this additional machinery can be dispensed with in favor of the OV-correspondence model. As a conceptual advantage, first of all, I point out that the OV-analysis goes straight to the heart of the matter, by focusing on the identity of variants to their base. There is nothing epiphenomenal about this identity as it is enforced by a principle of a grammar. The multi-stratal model, on the other hand, does not require the faithfulness identity between a variant and a base per se (see Benua 1997b: 83-86 for similar criticism), and therefore opacity involved in variant formations is considered as an accidental product. Recall that in the multi-stratal approach, the underapplication of *NT results from the (accidental) reranking of *NT and the faithfulness constraint. However, it is nothing more than an ad hoc stipulation: it does not say anything about why this should be the case. The underapplication effect is captured essentially as an accidental phenomenon: the result of promotion of faithfulness constraints. That is, in other words, why are relevant faithfulness constraints reranked above the markedness constraints in Stratum 2? No convincing answer can be given to this question.

On the other hand, within the framework of OV-correspondence, the cause of *NT failing to affect a variant can be attributed to the dominance of Faith-OV over *NT. The motivation behind Faith-OV is clear: it militates for the similarity among variants. This seems to be well-grounded in human perception. If variants are different from each other, it is difficult to perceive that their meaning is the same.

4.2.3.2. Serial OT and Richness of the Base

Secondly, as Benua (1997b: 87-89) points out, treating the misapplication of markedness constraints as the result of promotion of faithfulness constraints is problematic in that this theory cannot maintain the Richness of the Base Hypothesis. This problem becomes clear when one must distinguish strata for different affixations. Consider the following data from Sundanese (Langendoen 1964: 318, 1968: 100-101; Benua 1997b: chapter 3):

(46) Sundanese Nasal Harmony

a. ɲĩãr	'seek'	b. ɲãtur	'arrange'
ŋãũr	'say'	ŋĩsər	'displace'

(47) Overapplication of Nasal Harmony

Singular	Plural	
a. ɲĩãr	b. ɲ-ãl-ĩãr	'seek'
ŋãũr	ŋ-ãl-ãũr	'say'

In Sundanese, vowels do not contrast in nasality. As exemplified in (46), the nasality of a nasal consonant spreads onto the following vowels until oral stops (or glides) block it[42]. However, this nasal harmony overapplies in plural-forms: the spreading fails to be blocked by the presence of an oral consonant in the infix, as shown in (47b).

Let us now consider a simple serial model which consists of two strata to account for this overapplication problem. The first stratum is responsible for morphologically simplex words, and Stratum 2 is responsible for complex words. The canonical nasal harmony pattern is generated by the ranking *NV[oral] >> *V[nas] >> Ident-IO-[nas] at the first Stratum, as confirmed by the tableaux in (49). Also, at this level Richness of the Base holds: since nasality is a non-contrastive feature for vowels, inputs with any nasal-oral specification (e.g., /ɲiar/, /ɲĩãr/, /ɲiãr/ and /ɲĩar/ for [ɲĩãr]) all converge on the right output [ɲĩãr].

42 The laryngeal sounds ([h] and [ʔ]) are transparent to nasal harmony as in [ñĩʔĩs] 'relax in a cool place' and [bɨŋhãr] 'to be rich.'

(48) a.*NV[oral]: An oral vowel after a nasal sound is prohibited.
b.*V[nas]: A vowel must be oral.

(49)a

/ɲiar/	*NV[oral]	*V[nas]	Ident-IO-[nas]
a. ☞ [ɲĩãr]		**	**
b. [ɲĩar]	*!	*	*
c. [ɲiãr]	*!	*	*
d. [ɲiar]	*!		

(49b)

/ɲatũr/	*NV[oral]	*V[nas]	Ident-IO-[nas]
a. ☞ [ɲãtur]		*	**
b. [ɲatur]	*!		*
c. [ɲatũr]	*!	*	
d. [ɲãtũr]		**!	*

The optimal candidates of (49) are then concatenated with an infix 'al,' and these are fed into the next Stratum as the inputs. Here the ranking between Ident-IO-[nas] and *Vnas must be reversed. A tableau is given below to show that the reranking is necessary.

(50)

[ɲ+al+ĩãr]	*NV[oral]	Ident-IO-[nas]	*V[nas]
a.☞ [ɲ+ãl+ĩãr]		*	***
b. [ɲ+ãl+iar]		**!*	*

In this approach, the overapplication of nasal harmony is captured as the retention of nasal spreading that takes place at Stratum 1. In order to retain the nasality attained at Stratum 1, Ident-IO-[nas] must dominate *V[nas] at Stratum 2, since it otherwise cancels out the effect of nasal harmony.

Thus far this approach seems to provide a nice account for the overapplication of nasal harmony. However, there is a crucial problem: since the faithfulness constraint is promoted at Stratum 2, Richness of the Base must be abandoned at this level for some forms. Some problematic forms are laid out below:

(51)

Base		Derived	
dɤhɤs	'approach'	d-um-ɤ̃hɤ̃s	'approach superior'
gəde	'big'	g-um-ə̃de	'be conceited'

It must be stipulated that the infixal vowel in '-um' is underlyingly oral, contra the Richness of the Base. The following tableaux show that when the vowel in '-um' is underlyingly specified as [+nasal] a wrong candidate is considered as the optimum:

(52)

/d-ũm-ɤhɤs/	*NV[oral]	Ident-IO-[nas]	*V[nas]
a. ☠ [d-ũm-ɤ̃hɤ̃s]		**	***
b.(☞) [d-um-ɤ̃hɤ̃s]		***!	**

As shown, the ranking produces a wrong candidate, given the input with a nasal vowel. The point is that Richness of the Base holds at Stratum 1, but affixes concatenated at Stratum 2 must have fixed specifications for non-contrastive features. Serial OT must answer why affixes belonging to Stratum 1 can be left unspecified for non-contrastive features while this does not hold for affixes at Stratum 2.

On the other hand, Benua's approach (Benua 1997b), which is fundamentally similar to the OV-approach we have taken, does not fall into this quandary. Her basic idea is that the overapplication of nasal spreading is the effect of the ranking Ident-OO-[nas] >> *V[nas], where the former constraint requires the identity between an base and its affixed form in their nasality. Further, maintaining the Richness of the Base Hypothesis, *V[nas] >> Ident-IO-[nas] is established so that even when a vowel is underlyingly nasal, it surfaces as an oral vowel. Finally, when a vowel is preceded by a nasal consonant, it must be nasalized, and hence *NV[oral] >> *V[nas] is motivated. Then summary ranking and tableau are given below:

(53) *NV[oral] >> *V[nas] >>Ident-IO-[nas]
Ident-OO-[nas]

(54)

/ɲ+al+iar/ BASE [ɲĩãr]	*NV[oral]	Ident-OO-[nas]	*V[nas]	Ident-IO-[nas]
a. ☞[ɲ+ãl+ĩãr]			***	***
b. [ɲ+ãl+iar]		*!*	*	*

Under the constraint ranking (53), since the infixal vowel in [dɤhɤs] => [d-um-ɤ̃hɤ̃s] does not have a correspondent to which it must be faithful, it is immune to Ident-OO-[nas]. Also *NV[oral] is irrelevant since it is not preceded by a nasal sound. Therefore, given the ranking *V[nas] >> Ident-IO-[nas], whether it be underlyingly oral or nasal, it surfaces as an oral sound. The point is shown by the following tableaux[43].

[43] I ignore the candidate with an oral vowel following a nasal consonant. As such a candidate never wins, *NV[oral] must dominate Ident-OO-[nas] in this language.

(55a)

/d-ũm-ɤhɤs/ BASE [dɤhɤs]	*NV[oral]	Ident-OO-[nas]	*V[nas]	Ident-IO-[nas]
a. [d-ũm-ɤ̃hɤ̃s]		**	***!	**
b. ☞ [d-um-ɤ̃hɤ̃s]		**	**	***

(55b)

/d-um-ɤhɤs/ BASE [dɤhɤs]	*NV[oral]	Ident-OO-[nas]	*V[nas]	Ident-IO-[nas]
a. [d-ũm-ɤ̃hɤ̃s]		**	***!	***
b. ☞ [d-um-ɤ̃hɤ̃s]		**	**	**

(55a) shows the evaluation when the infixal vowel is nasal, and (55b) shows the case when the vowel is oral. As shown, in both cases the correct output is obtained, given the judicious ranking. Hence the OO-correspondence approach, which does not hinge upon reranking, need not make an additional stipulation about Richness of the Base.

The point is, in short, serial OT requires an additional stipulation about Richness of the Base while monostratal grammar such as Benua's OO-approach or OV-approach can retain Richness of the Base and no stipulation is required.

4.1.3.2. Theoretical Restrictedness and Prediction

Another important point that should be made against serial OT is its prediction about possible natural languages. As extensively discussed by Benua (1997b, especially, 89-95), allowing the reranking of markedness constraints would predict the existence of empirically unattested languages. If reranking from one stratum to another is possible, then it implies that stratal rankings can be radically different from one stratum to another i.e., each strata can be as different as a different language from one another.

It is important to note that OV-correspondence and serial OT crucially differ in their prediction since OV-correspondence only enhances identity but never promotes disparity[44]. On the other hand, since in serial OT reranking is allowed at the post-lexical stratum, a variant can be drastically different from its base. That is, for example, serial OT predicts that variants can be strikingly different from their base. Nothing prevents a language from having English-like vocabulary as its variants and Japanese-like vocabulary as their base. As I have shown in section 2 and 3, this prediction seems to be empirically unsupported.

[44] I argue that the disparity between a base and its variant is advanced by a morphological factor. See 4.3. below.

Serial OT can restrict its theoretical power by, for example, stipulating that markedness constraints are fixed in ranking. In its empirical predictions, it then resembles the OV-correspondence approach.

(56) OV-Approach — Serial OT Reranking Approach

OV-Approach	Serial OT Reranking Approach		
Faith-OV			Faith-IO
|			|
Markedness	Markedness	=>	Markedness
|	|		
Faith-IO	Faith-IO		

Most of the phenomena that are presented in this paper entail one general problem: a ranking paradox. In one situation, a faithfulness constraint must dominate a markedness constraint[45], but in other situation the opposite must hold. The OV-approach posits Faith-OV above a markedness constraint to solve this problem. On the other hand, serial OT appeals to reranking. These two approaches thus can achieve the same result. However, the point of significance is that reranking is too powerful: not only can it enhance identity between a variant and its base, but also it can promote disparity.

Serial OT thus must stipulate further that markedness constraints are fixed in a grammar. On the other hand, the uniform ranking of markedness constraints follows from the architecture in OV-correspondence approach since OV-correspondence is by its nature faithfulness. No stipulation is required to inhibit markedness reversals.

4.3. Variation without Reranking

I argued in the last section that theories that do not assume more than one level or reranking are superior theoretically as well as empirically. However, one question immediately arises: if we do not allow reranking at all in our theory, then how can we account for the fact that there are variations in the first place? Since the output should be that which is optimal in the given constraint ranking, it is a difficult question how the grammar can generate two "optimal" outputs.

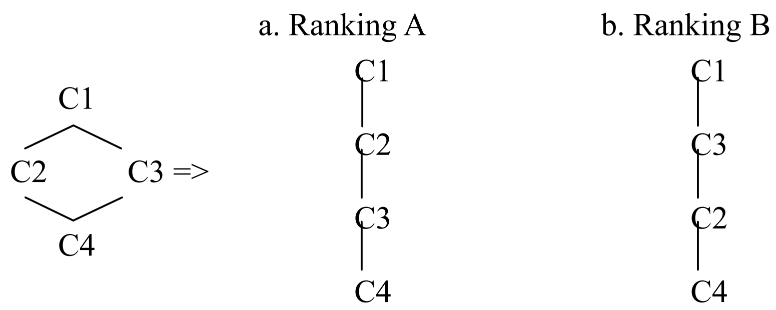
An answer that the multi-stratal OT approach provides is that reranking at post-lexical evaluation is optional. Then there can be two optimal outputs: if reranking takes place, then the ultimate output can be different from what is generated without

[45] In overapplication pattern, as we have seen, the faithfulness constraint does not dominate the markedness constraint.

reranking.

Another account of the existence of free variation is to allow "unranked constraints" (Anttila and Cho 1998, Antilla: 2000a). This theory basically asserts that some constraints can remain unranked allowing a language's constraint ranking to be a partial order rather than a total order. Given a partial order ranking, depending upon social context (and other possible factors) one particular ranking is fixed. This approach can be visually illustrated in the following way (C is an abbreviation for 'constraint.')

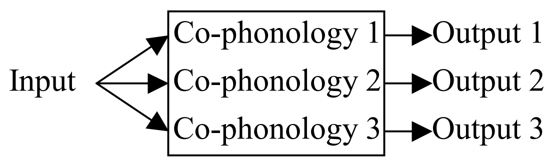
(57)



The state of a partial order ranking is depicted in the leftmost diagram, where C2 and C3 are non-ranked. However, depending upon a sociological context, C2 and C3 are fixed in ranking. In this way, we get two sets of rankings, and hence the grammar generates two outputs.

Another approach to the problem of "more than one output from one input" is to stipulate co-phonologies. This approach splits up a grammar into multiple constraint rankings, each of which selects its own optimal output (Orgun 1996; Inkelas 1998, 1999)

(58)



I present an alternative account for the problem of free variation, based on the "Realizational Morphology Theory" (RMT) developed by Kurisu (2001). Incorporating this theory, I propose a model that can generate variants without any reranking or assuming crucially non-ranked constraints. The basic idea is that a variant results from the addition to the input of a sociolinguistic "null" morpheme. This null morpheme is required to be phonologically realized by the constraint Realize Morpheme (RM). This approach provides a more explicit account of how variants can come about, and it unifies the OV-Faith approach more closely with general OO-Faith approach. In the remainder of this section, I first provide a brief sketch of Kurisu's RMT, and present a mechanism that can generate variants without reranking. I also critically compare this model with the two other models, the multi-stratal approach and Anttlia's approach.

4.3.1 Realizational Morphology Theory

Kurisu (2001)'s RMT, couched within the framework of OT, aims at providing a unified and principled understanding of how non-additive morphology (e.g., subtractive morphology, morphological metathesis, suppletion among others) arise in natural languages. He observes that the common property that characterizes these non-additive morphological processes is that they all exhibit "anti-faithfulness" effects (Alderete 1999). This concept of "anti-faithfulness" requires some explanation. Faithfulness violations themselves are frequently observed in natural phonology, but it is important to notice that there are crucially two kinds of faithfulness violations. One is a result of the dominance of markedness constraints over faithfulness constraints, which should be clearly distinguished from faithfulness violations involved in non-concatenative morphology.

The first kind of faithfulness violation is purely phonological. This is exemplified by the well known coda devoicing in German (Wiese 1996; Itô and Mester 1998, 1999b).

(59)	Devoiced Form	Gloss	Voiced Form	Gloss
	[tʀi:p]	'drive'	[tʀi:be]	'drives'
	[ty:p]	'type'	[ty:bən]	'types'
	[ve:k]	'way'	[ve:gə]	'ways'

Descriptively speaking, all the obstruents are devoiced in a coda position. The crucial point is that the devoicing is phonologically governed in the sense that all that matters is the phonologically defined position occupied by the relevant obstruent. Kurisu calls this kind of faithfulness violation "non-faithfulness".

Anti-faithfulness effects are different from alternations that are motivated by purely phonological considerations. As an illustrative example, consider the following data from Icelandic, which derives deverbal nouns from infinitives by deleting the final vowel (Arnason 1980; Oresnik 1972, 1978ab; Benua 1995; Kurisu 2001):

(60)	Infinitive	Gloss	Deverbal Noun	Gloss
	klifra	climb	klifr	‘climbing’
	kumra	blear	kumr	‘bleating’
	grenja	cry	grenj	‘crying’

To account for this final-vowel deletion, one might postulate a constraint such as Final-C that militates against the presence of a word-final vowel (Prince and Smolensky 1993). However, if this constraint is active in Icelandic phonology in general, it is not at all clear why infinitives end with a vowel. It is also noteworthy that a complex onset is attested only in this morphosyntactic category. We hence should not treat the clipping of word-final vowels as a purely phonological matter. Rather, the reason why faithfulness constraints are violated is morphological: to express the morphosyntactic category, phonological deformation takes place. This kind of faithfulness violations is named “anti-faithfulness”. The crucial observation is that the clipping exemplified in (60) cannot be captured by Markedness >> Faithfulness or Faithfulness >> Markedness. Observe the fact that the clipping results in a more marked structure, and hence this cannot be explained by Markedness >> Faithfulness. Also derived forms have a lower faithfulness value compared with a perfectly faithful candidate, and hence Faithfulness >> Markedness cannot explain this clipping.

Thus the problem is this: what is the driving force of the clipping in Icelandic? Alderete (1999) proposes that there is a set of “anti-faithfulness” constraints that militates for anti-faithfulness effects. These constraints are one kind of OO-correspondence that requires forms in one category to be different from another category. Arguing against Alderete’s theory, Kurisu proposes that the driving force in non-additive morphologies is Realize Morpheme (RM), whose definition is given below:

(61) RM: Let α be a morphological form, β be a morphosyntactic category, and F(α) be the phonological form from which F(α + β) is derived to express β. Then RM is satisfied with respect to β iff F(α + β) is not equivalent to F(α) phonologically.

To put it at its simplest, RM requires every morpheme to receive some phonological exponence. The “phonological exponence” need not be additive; that is, so long as the phonological form before the morphological operation and the phonological shape after the operation are different from each other, RM is satisfied.

Now let us take the case of Icelandic to see how this constraint interacts with other constraints. Recall that in this language, deverbal nouns are derived from infinitives by way of clipping the final vowel, and hence this constitutes a violation of

Max. Kurisu proposes that this is a result of RM dominating Max: in order to realize the morphological operation phonologically, Max must be violated. Of course, among other faithfulness constraints, Max must be the lowest, since otherwise no candidate that violates Max would be optimal. The following tableau shows how truncation of the final vowel is attained within the framework of RMT:

(62)

/klifra/$_{\text{deverbal noun}}$	RM	Dep	Linearity	Integrity	Max
a. [klifra]	*!				
b.☞ [klifr]					*
c. [klifra?]		*!			
d. [klirfa]			*!		
e. [kli-klifra]				*!	

Further, building upon the observation that phonological deformation takes place only in derived morphosyntactic categories (e.g., deverbal noun in (60)) but not in base categories (e.g., infinitive in (60)), Kurisu divides faithfulness constraints into more concrete constraints which refer to specific morphosyntactic categories[46] (e.g.,

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46 For the motivation to relativize faithfulness constraints rather than markedness constraints or RM, see Kurisu (2001: 93-94). Many other researchers suggest that morpheme-specific phonological behavior should be accounted for by morpheme-specific faithfulness relations; see McCarthy and Prince (1995); Urbanczyk (1995, 1996) for the discussion of two different reduplicants in Lushootseed; Beuna (1997b) and Pater (2000) for English stress assignment.

In addition, Honma Takeru (p.c) points out that there are some morphophonological operations that are specific to certain kinds morpheme classes. One of the examples is the famous alternation known as *Rendaku* (or Sequential Voicing) in Japanese (Martin 1952; McCawley 1968; Otsu 1980; Itô and Mester 1986; Shibatani 1990: 174-175; Vance 1972, 1987 among many others). This operation voices initial obstruents in second members of compounds:

(i)	a. /ori+kami/	[origami]		'folding paper'
	/hosi+sora/	[hosizora]		'starry sky'
	b. /nise+kiN/	[nisekin]	*[nise+gin]	'fake gold'
	/gai+koku/	[gaikoku]	*[gaigoku]	'foreign countries'
	c. /yobi+kurasu/	[yobikurasu]	*[yobi+gurasu]	'ancillary class'
	/huransu+paN/	[huransupaN]	*[furansuban]	'French roll'

Max-noun, Max-infinitive etc.). That is, the fact that there is no phonological deformation for infinitive forms indicates that the relevant faithfulness constraints are ranked higher than RM. In sum, Max-$_{infinitive}$ >> RM >> Max- $_{noun}$ is motivated to account for the subtractive morphology in Icelandic. The ranking is confirmed by the following tableaux:

(63)

/klifra/$_{noun}$	Max-$_{infinitive}$	RM	Max- $_{deverbal\ noun}$
a. [klifra]	N/A	*!	
b.☞ [klifr]	N/A		*

(64)

/klifra/$_{infinitive}$	Max-$_{infinitive}$	RM	Max- $_{deverbal\ noun}$
a. [klifr]	*!		N/A
b.☞ [klifra]		*	N/A

The emergence of non-concatenative morphology can be generalized into the following ranking schema, which is shown below:

(65) Faith α >> RM >> Faith β

α and β represent morphosyntactic categories. More specifically, β represents a category that is subject to nonconcatenative morphology, and α represents all categories but β. Given this ranking schema, phonological deformation takes place for forms that bear morphological category β but not for α. Each instance of non-additive morphology follows from the replacement of Faith by a concrete faithfulness constraint (e.g., Max for subtractive morphology, Ident for umlaut and so forth).

The voicing, however, only takes place when the second element of the compound is the Yamato vocabulary as in (ia). Sino-Japanese (ib) and recent borrowings resist in sequential voicing (for exceptions, see Vance 1980). Therefore, the idea that constraints are relativised according to morphological categories is independently motivated.

One potential problem might be that the postulation of lexically relativized faithfulness constraints predicts that there should be cases where different lexical items react differently to purely phonological phenomena such as coda devoicing or palatilization. There does not seem to exist such cases. It rather seems that relativized faithfulness constraints are relevant only in the context of reduplication (Urbanczyk (1995, 1996), Stress Assignment (Benua 1997b; Pater 2000) or Morpheme Realization (Kurisu 2001). This systematic difference should be explained in the future work of OT.

4.3.2. Extension of RMT

Building upon RMT, I now propose an analysis that generates variants without reranking (see also Kurisu 2001: Chapter 3, especially 3.3). Consider the following model (γ represents a sociolinguistic morpheme), which is repeated from Introduction:

(66) $/\text{Input}_i/$ $\qquad$ $/\text{Input}_i+\gamma/$

$\updownarrow$ $\qquad$ $\updownarrow$

[Output] ⟷ [Output]γ

OV-correspondence

In this model, a variant and a base are not derived from the identical input in a strict sense: a variant shares the same input with the base, but in addition it has a "sociolinguistic" morpheme attached to the base. The fundamental idea is that a variant has a different phonological shape from the base because of the effect of RM. When a sociolinguistic morpheme γ does not have underlying phonological substance, some phonological deformation takes place as a strategy to express the presence of the morpheme γ on the surface[47].

A variant often has an extra meaning or connotation compared to its base[48]. For instance, the variants created by gemination in Japanese have an emphatic connotation. Therefore it makes sense to stipulate that variants have an additional morpheme attached to their base, assuming that every meaning is conveyed by the presence of a morpheme.

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[47] This is not to claim that all sociolinguistic morphemes lack phonological substance underlyingly. For instance, in Japanese there is a verbal suffix '-yagaru,' which does not effect any core meaning of the base but yet adds a sociolinguistic effect to the base:

(i) Mary-wa	Taro-wo	nagut-ta	'Mary hit Taro'
Mary-TOP	Taro-ACC	hit-PAST	
(ii) Mary-wa	Taro-wo	naguri-yagat-ta	'Mary hit Taro'
Mary-TOP	Taro-ACC	hit-suffix-PAST	

Compared to (i), (ii) has a "casual" or "rough" flavor. However, the suffix '-yagaru' does not change the core meaning of the verb (at least, truth conditionally the two sentences above are equivalent): nor does it change its morphosyntactic category.

[48] To exactly define what constitutes "sociolinguistic" meaning is not an easy task. I leave this issue for further research.

Given the new model, the correspondence we have been calling OV-correspondence can be reduced to one specific kind of OO-correspondence (Benua 1995, 1997ab) since a base and a variant do not derive from the input in a strict sense in this model, but rather they are morphologically related in that they share the same input. I will keep referring to the correspondence as OV-correspondence for clarity's sake, however. As the upshot of this model, now we can define the notion of 'base' more clearly: the base is the output whose input does not have a sociolinguistic morpheme. A variant, on the other hand, is the realization of a sociolinguistic morpheme attached to its base. OV-correspondence, finally, is one type of OO-correspondence that is specific to the faithfulness relation that is established between a base and a variant, being related by virtue of sharing the same input.

4.3.3.Examples

4.3.3.1 Gemination

Now I present a case study to explicate how this model works. First I take a variant formation by way of gemination, discussed above in 2.2.3. Some relevant examples are repeated below:

(67)		Base	Variants	Gloss
	a.	[sugoi]	[suggoi]	'great'
		[yabai]	[yabbai]	'dangerous'
		[maji(de)]	[majji(de)]	'seriously'
		[uzai]	[uzzai]	'annoying'
		[ʃoboi]	[ʃobboi]	'puny'
	b.	[akai]	[akkai]	'red'
		[nemui]	[nemmui]	'sleepy'

As seen, a new variant can be formed by way of internal gemination. This process is not confined to the cases that result in a voiced obstruent geminate. Gemination can target a voiced obstruent as well as a voiceless obstruent or a nasal as in (67b). These variants with internal gemination usually have an emphatic flavor. Assuming that a sociolinguistic morpheme, which is responsible for this emphatic meaning, is underlyingly attached for a variant form, we can represent the formulation of this variant formation in the following model, which is depicted as (68):

(68) /uzai/ /uzai+γ/

↕ ↕

[uzai] α ⟷ [uzzai]γ

The fact that gemination takes place in order to realize the sociolinguistic morpheme γ indicates that, among other faithfulness constraints, Dep-μ-γ is dominated by RM. Also since gemination does not take place for the form without underlying γ, Dep-μ-α overranks RM (α represents other category than γ). The following tableaux show these rankings:

(69)

/uzai+γ/	Dep-μ-α	RM	Dep-μ-γ
a. [uzai]	N/A	*!	
b.☞ [uzzai]	N/A		*

(70)

/uzai/ α	Dep-μ-α	RM	Dep-μ-γ
a.☞ [uzai]		*	
b. [uzzai]	*!		

As shown in the tableaux above, the reason why gemination takes place for a variant is explained by assuming that RM dominates Dep-μ-γ. The absence of gemination in other cases follows from Dep-μ-α >> RM.

4.3.3.2. Syncope

Variants generated by way of syncope can be accounted for in an essentially similar way. Since variants as a result of syncope have different a connotation from the ones with gemination, it makes sense to assume that they have a different sociolinguistic morpheme underlyingly, and let us call this morpheme δ. In this case, then, RM dominates Max-IO-δ. As a consequence, in order to satisfy RM, Max can be violated, exactly the same situation as Icelandic deverbal noun formation.

(71)a.	[anata]	[anta]	'you'
	[nanika]	[naŋka]	'something'
	[nani+to]	[nanto]	'with what'
	[anosa:]	[ansa:]	address phrase
	[anisan]	[ansan]	'(literally) brother'

The location of the vowel that is subject to deletion is inseparably connected with the restrictions on overall Japanese prosodic structures. In predominant cases, this type of syncope targets (C)VNVCV, removing the second (or postnasal) vowel. Deleting the first vowel would result in a word-initial syllable CNV, which is prohibited due to undominated *Complex that militates against a complex onset. Deleting the final vowel would generate a non-place linked word-final consonant, which is absolutely prohibited in Japanese (i.e., Coda Condition; see Itô 1986, 1989; for OT analysis, see Itô and Mester 1994; see also Beckman 1998 for a different analysis). To summarize, [anta] is generated in the way following tableau illustrates:

(72)

/anata+δ/	RM	*Complex	CodaCond	Max-μ-γ
a. [anata]	*!			
b. ☞ [anta]				*
c. [nta]		*!		
d. [anat]			*!	

4.3.3.3. Vowel Coalescence

The idea that faithfulness constraints are specific to morphological categories and that a variant has an underlying sociolinguistic morpheme allows us to account for vowel coalescence without reranking too. The basic line of thought is the same for the case of gemination: a variant has a different morphosyntactic category due to the presence of a sociolinguistic category and hence is subject to distinct faithfulness constraints from its base. The ranking schema that is responsible for vowel coalescence is summarized below:

(73) Ident-(F)- α (α represents categories other than δ)
|
*diphthong
|
Ident-(F)-δ (δ is a sociolinguistic category)
|
(RM)

The model of generation for [takai] and [take:] is illustrated in (74)

(74) /takai/ /takai+δ/
↕ ↕
[takai] α ↔ [take:] δ

The fact that there is no fusion taking place for base forms indicates that Ident-(F)-α dominates *Diphthong. This markedness constraint in turn dominates Ident-(F)-δ. When a sociolinguistic morpheme δ is attached to the base, this becomes subject to Ident-(F)-δ. The dominance of Ident-(F)-δ over RM is motivated by the fact that a long vowel is not changed even in the variant formation (e.g., [atarasii] not *[atarasuu] or *[atarasee] 'new'). If the ranking were reverse, some featural change would take place in order to satisfy RM, contrary to fact. As a result of this constraint ranking, vowel coalescence takes effect iff a sociolinguistic morpheme is attached to a base with a diphthong, as illustrated by the following tableaux:

(75)

/takai+δ/	Ident-(F)-α	*diphthong	Ident-(F)-δ	RM
a. [takai]	N/A	*!		*
b.☞ [take:]	N/A		*	

(76)

/takai/ $_{\alpha}$	Ident-(F)- α	*diphthong	Ident-(F)-δ	RM
a.☞ [takai]		*	N/A	*
b. [take:]	*!		N/A	

Though the role of RM is obscured in this case since it is dominated by relevant faithfulness constraints, the idea that a variant derives from the morphological attachment of a sociolinguistic morpheme allows us to explain the emergence of variants in a principled way. Not only does this model obviate reranking, it puts a variant formation on the same footing as other morphological operations.

4.3.4. Comparison

4.3.4.1. Serial OT

The model advocated here has several advantages over other models such as serial OT or Partial Order Theory. Let us first consider the multi-stratal model. This model has difficulty in accounting for the fact that a variant often has a different sociolinguistic meaning, compared to the meaning of the base. The multi-stratal model cannot capture this intuition because variant are considered as forms that are generated when reranking takes place at a post-lexical stratum. This approach requires a stipulation that the operation in additional stratum adds sociolinguistic meaning to output. But this is merely an ad hoc stipulation.

Furthermore, with recourse to reranking, it is very difficult to account for variant formation by way of gemination since this is both an anti-faithfulness and "anti-markedness" operation. Gemination cannot result from the promotion of markedness constraints since gemination would produce more marked structure (e.g., a voiced obstruent geminate). Yet we cannot blame a faithfulness constraint either, since gemination is anti-faithful to its base or its input. Therefore, without stipulating a constraint like GEMINATE, an approach with appeal to reranking does not explain why gemination takes place. A constraint like GEMINATE, however, is not only ad hoc, but also theoretically very unfavorable from the perspective of Optimality Theory. Admitting this kind of constraint is tantamount to claiming that there is a family of "anti-markedness" constraints that militate for marked structures. Such imperatives for promoting marked structure are unusual, to say the least, in the context of Optimality Theory, which places a heavy emphasis on constraints against marked structure. Thus introducing a family of "anti-markedness" constraints would go against one of the basic tenets of OT. Furthermore, naively suggesting the existence of "anti-markedness" constraints fail to recognize the fact that gemination takes place for a morphological reason.

On the other hand, the account with recourse to Realizational Morphology Theory can explain this fact rather elegantly. Gemination is the result of constraint ranking RM >> Dep-μ. Not only need we not make up an ad hoc constraint, our strategy allows us to treat variant formations on the same footing as other non-concatenative morphology.

4.3.4.2. Partial Order Theory

The fact that no reranking can explain the gemination effect is also an argument against Partial Order theory or an account with recourse to co-phonology. Without stipulating constraints like GEMINATE, these approaches cannot properly account for anti-faithful variant formations either.

There is, moreover, one empirical argument against Partial Order Theory. Recall the discussion of English syllable structure from section 2, where I showed that syllabifications that are otherwise strictly prohibited are exceptionally allowed in fast speech context.

(77)

	Regular form	Syncopated Form
potato	[poteɪto]	[**pt**eɪto]
pachinko	[pətʃɪŋko]	[**ptʃ**ɪŋko]
connect	[konekt]	[**kn**ekt]
tomato	[tomeɪto]	[**tm**eɪto]
Marina	[mərinə]	[**mr**inə]

In Partial Order Theory, the licensing of these unexpected syllable structures is accounted for in the following way. First, Max and the Sonority Sequencing Principle (SSP) are crucially unranked. In normal contexts, SSP dominates Max because sequences in a complex onset such as [pt],[kn] and [tm] are unattested. In fast speech contexts, however, the reverse ranking is attained in order to account for the data in (77). Assuming Richness of the Base, this ranking predicts that lexical items that have these complex onsets surface in the same context, contrary to fact. Partial Order Theory thus fails in its prediction.

4.3.5. Remaining Issues

I have argued that the model for variant formations based on Realizational Morpheme Theory has several advantages. It obviates ad hoc constraints, and it can treat variant formations in an essentially similar way to other morphological operations. The model, furthermore, captures the point that a variant often has an additional sociolinguistic meaning.

However, it does not seem to be the case that all variants have a sociolinguistic meaning. Consider the fast speech syncope in English again. There does not seem to be a clear "sociolinguistic" meaning that is added to syncopated forms. It seems, moreover, that this variant formation is not totally morphologically driven; that is, some phonological factors are undoubtedly involved. Consider the following data (parentheses show a foot structure):

(78)	Slow	Fast
a	parade	(pra.de)
	Toronto	(Tron.to)
	opera	(o.pra)
	general	(gen.ral)
b.	(o.pe)(ra.tic)	*o.(pra.tic)
	(ge.ne)(ra.lity)	*gen.(ra.lity)

As Hammond (1997, 1999) points out, this syncope seems to be triggered only when deleting a vowel results in improved foot structure. In (78a), the syncopated forms are disyllabic and hence all of the syllables are parsed into one foot. This claim is supported by the fact that, when base forms are exhaustively parsed into feet as in (78b), syncope fails to apply (i.e., syncope cannot aggravate foot structures). Thus syncope seems to be regulated by phonological factors.

Therefore, the RMT model alone might not be able to provide the best account for this kind of variant formation. It thus might be also the case that other theories can provide a better account of cases such as English fast speech syncope. However, the other theories of free variation and RMT are not incompatible with each other, and so there is a possibility that they co-exist in the grammar. It is likely that there are several ways in which variants are produced in a grammar: ones that are morphologically driven and ones that are phonologically governed, for instance.

For present, to what extent RMT can cover variant formations is not clear, and I leave this issue for further research. Hence it follows that to what extent OV-correspondence can be reduced to OO-correspondence is not entirely clear at the present time. What is clear, however, is that where variants show anti-faithfulness effects, RMT provides a better account than other theories in that it dispenses with ad hoc (and undesirable) constraints such as GEMINATE.

5. LOCAL CONJUNCTION

5.1. Introduction

In the previous section, I have argued against a serial OT model in favor of the OV-Correspondence approach. There is in fact another approach that might potentially be used to account for the problems in variant formation; namely, local conjunction (Smolensky 1993, 1995, 1997; Kirchner 1996; Itô and Mester 1998, 1999b; Lubowicz 1998 among others). This section is devoted to a critical assessment of this approach. I will show that although this approach is capable of accounting for some of the problems presented in section 2 above, it cannot deal with all of the problems. More concretely, the local conjunction approach is unable to provide an account for (i) an overapplication pattern (ii) a "partial" underapplication pattern and (iii) opaque vowel lengthening (see section 3).

The remainder of this section is structured as follows. First I lay out some basic concepts of local conjunction. Next, we will see how this approach sheds light on the problems we have seen above. Finally, I compare the local conjunction approach with the OV-Faith approach, and argue that the OV-Faith Approach can give an explanation for wider range of opaque phenomena involved in variant formations.

5.1.1. Local Conjunction

The local conjunction system is proposed to account for a particular type of constraint interaction which cannot be obtained in a theory that precludes any ranking system other than *strict domination* (Prince and Smolensky 1993). To illustrate, let us take three constraints C_1, C_2 and C_3 and suppose that C_1 is ranked higher than both C_2 and C_3 (i.e., C_1>> C_2, C_3). Under a theory that exclusively employs strict domination, a candidate that violates both C_2 and C_3 is still more harmonic than a candidate that violates C_1:

(79)

	C_1	C_2	C_3
a.☞ Candidate α		*	*
b. Candidate β	*!		

Under strict domination, even though candidate α incurs two violations while candidate β incurs just one, the former is more harmonic. The point is that in this theory no matter how many violations of lower-ranking constraints are incurred, they cannot add up to be more important than a single violation of the higher ranked constraint.

However, it has been pointed out by many researchers that there are various phenomena that cannot be accounted for under strict domination (Smolensky 1993, 1995, 1997; Kirchner 1996; Itô and Mester 1998, 1999b; Lubowicz 1998 among others). That is, there are cases where, even though $C_1 >> C_2$ and $C_1 >> C_3$ are independently motivated, simultaneous violations of C_2 and C_3 within a certain domain appear to be more fatal than a violation of C_1.

Itô and Mester (1998) provide an illustrative example. The Yamato vocabulary in Japanese allows voiced obstruents in general. Interestingly, however, words that contain more than one obstruent are systematically missing[49]. That is, both *fuda* 'tag' and *buta* 'pig' are attested, but there is no such word as *buda*. The fact that single obstruent is allowed to surface indicates Ident-IO-[voi] >> *VoiObs. This ranking, however, fails to account for the systematic gap of words containing two voiced obstruents. Itô and Mester argue that this is the result of local conjunction: the self conjunction of the markedness constraint *VoiObs is ranked higher than Ident-IO-[voi]. The ranking summary is given as (80) and the illustrative tableaux are as (81).

(80) $\{$*VoiObs & *VoiObs$\}_{wd}$ >> Ident-IO-[voi] >>

(81a)

/fuda/	$\{$*VoiObs & *VoiObs$\}_{wd}$	Ident-IO-[voi]	*VoiObs
a. ☞ [fuda]			*
b. [futa]		*!	

(81b)

/buda/	$\{$*VoiObs & *VoiObs$\}_{wd}$	Ident-IO-[voi]	*VoiObs
a. [buda]	*!		**
b.☞ [buta]		*	*

[49] This gap was hitherto treated as an effect of the OCP, since the work of Itô and Mester (1986).

Other than the work by Ito and Mester, a number of phonological phenomena are accounted for by local conjunction. Smolensky explains coda condition (1993), Sonority Hierarchy (1995) and typology of vowel harmony (1997) from local conjunction. Lubowicz (1998) argues that the Derived Environment Effect can be obtained through local conjunction. Kirchner (1996), as we will see shortly, accounts for synchronic chain shift by utilizing local conjunction.

5.1.2. Conjunction of Faithfulness Constraints

The Japanese example above is the (self) conjunction of a markedness constraint. The conjunction of faithfulness constraints is also argued for by Kirchner (1996), who proposed that the local conjunction system provides a nice account of synchronic chain shift. He analyzes data from Western Basque, in which underlying /a/ and /e/ become [e] and [i], respectively, in a prevocalic position.

(82)		indefinite	definite	gross
	/a/ => [e]	alab**a** bat	alab**e**a	‘daughter’
		nesk**a** bat	nesk**e**a	‘girl’
	/e/ => [i]	sem**e** bat	sem**i**e	‘son’
		at**e** bat	at**i**e	‘door’

The important observation here is that underlying /a/ does not become [i]. This interaction of two raising phenomena is opaque because surface [e]s are attested despite the presence of raising operation which is supposed to raises /e/ into [i]. In derivational terms two raising rules must be stipulated, as below:

(83)	Raising Rule α	/a/ => [e]
	Raising Rule β	/e/ => [i]

Given these two rules, raising rule α must be ordered after the rule β, or in other words, the first rule must counterfeed the latter. This ordering of two rules gives rise to derivational opacity.

However, Kirchner (1996) critically points out that rule-based approach must fundamentally treat two raising phenomena (α and β in (83)) as unrelated. He also points out that in rule-based approach it is not also clear why the counterfeeding relationship must be established. Building upon these counter arguments against rule-based approach, he instead proposes an optimality theoretic account by appealing to the local conjunction of faithfulness constraints. The followings are the relevant constraints that are involved in the chain shift in this language:

(84)

	Hiatus Raising	In V_1V_2, the height of V_1 must be maximized.
	Ident-IO-[low]	Do not change the specification in terms of lowness.
	Ident-IO-[high]	Do not change the specification in terms of highness.

The first constraint is the markedness constraint which functions as the trigger for the raising: it requires the first vowel in hiatus to be as high as possible, i.e., [i] in this case. The violation of this markedness constraint is assessed gradiently; i.e., surface [e] incurs one violation of the constraint since it is one-step lower than the desired [i], and [a] incurs two violations. The two other constraints are faithfulness constraints which are antagonistic against the raising required by Hiatus Raising.

Given this set of constraints, since one-step raising does occur, the ranking Hiatus Raising >> Ident-IO-[low], Ident-IO-[high] must hold; otherwise, raising cannot take place in the first place. This ranking alone, however, mistakenly predicts that /a/ is raised up to [i], as the tableau below shows:

(85)

/alaba+a/	Hiatus Raising	Ident-IO-[low]	Ident-IO-[high]
a. [alabaa]	**!		
b.(☞) [alabea]	*!	*	
c. ☠ [alabia]		*	*

As shown, if the markedness constraint dominates the relevant faithfulness constraints, then there is no way to prohibit two-step raising under the strict domination principle. To avert this problem, Kirchner proposed that the conjunction of the two faithfulness constraints is ranked above the markedness constraints, and as a result, two-step raising becomes illicit. The illustrative tableaux are as follows:

(86)

/seme+a/	{Ident-IO-[low] & Ident-IO-[high]}	Hiatus Raising	Ident-IO-[low]	Ident-IO-[high]
a. [semea]		*!		
b.☞ [semia]				*

(87)

/alaba+a/	{Ident-IO-[low] & Ident-IO-[high]}	Hiatus Raising	Ident-IO-[low]	Ident-IO-[high]
a. [alabaa]		**!		
b.☞ [alabea]		*	*	
c. [alabia]	*!		*	*

As shown in (86), Hiatus Raising >> Ident-IO-[high] induces raising of /a/ into [e]. But since the conjoined faithfulness constraint {Ident-IO-[low] & Ident-IO-[low]} dominates Hiatus Raising, two-step raising is prohibited.

To recapitulate the point relevant for our subsequent discussions, the key to understand the synchronic chain shift is the local conjunction of faithfulness constraints {F_{12} & F_2} ranked higher than a markedness constraint, which in turn dominates each of the faithfulness constraints.

(88) {F_1 & F_2} >> M >> F_1, F_2

Under this ranking schema, one violation of the faithfulness constraints is tolerated, but simultaneous violation of both constraints is banned, in which case the markedness constraint is disregarded (at least partially) instead. We will see below that this pattern might account for the opacity problems in variant forms.

5.2. Accounting for Opacity in Variants.

This idea of local conjunction of faithfulness constraints could be used to account for opacity problems found in variants. The analysis builds upon a rather trivial observation; a variant is phonologically different from its base form. This very nature of a variant form necessitates the variant incur one or more violation of a faithfulness constraint. Recall now that otherwise general phonological operations often fail to apply in variant forms, as we have seen in section 2.

Local conjunction can stipulate that since a variant form already incurs one violation of a faithfulness constraint, an additional violation of faithfulness constraint is prohibited, and as a result, a markedness constraint is disregarded. This is a similar situation to that of synchronic chain shift introduced above: only one violation of a faithfulness constraint is tolerated, but not two simultaneous violations.

Let us take the data from Isthmus Nahuat for concrete illustration. (Law 1958; Kenstowicz and Kisserberth 1979; Kager 1999). Recall that this dialect optionally deletes a word-final unstressed short vowel when preceded by a vowel-sonorant sequence. The second operation, which interacts with apocope, is the devoicing of a coda approximant. This devoicing is very general except for the fact that variants generated by way of apocope systematically resist word final devoicing: it underapplies in the context of variant formations, as shown below:

(89) a. ʃikakíli or ʃikakíl *ʃikakíl̥ ‘put it in it’
b. kítaja or kítaj *kítaj̥ ‘he already sees it’
c. kikówa or kików *kików̥ ‘a season’

The failure of coda devoicing is given an explanation with recourse to local conjunction in the following way. Since devoicing does take effect in normal contexts, the markedness constraint DEVOICE must dominate Ident-IO-[voi]. Variants, however, by their nature already incur one violation of Max-IO. Therefore, by stipulating that Max-IO and Ident-IO-[voi] are conjoined over DEVOICE, the failure of devoicing in variants is accounted for. The tableau below summarizes the point:

(90)

/ʃikakili/	{Max-IO & Ident-IO-[high]}	APOCOPE[50]	DEVOICE	Max-IO	Ident-IO-[voi]
a. [ʃikakíli]		*!			
b. ☞ [ʃikakíl]			*	*	
c. [ʃikakíl̥]	*!			*	*

The important competition is between candidate (b) and candidate (c). Although the markedness constraint DEVOICE is ranked higher than Ident-IO-[voi], thereby making coda consonants [-voi] in normal contexts, since the conjunction of {Max-IO & Ident-IO-[high]} dominates DEVOICE, the markedness constraint fails to neutralize the structure in variants.

To generalize the point, the ranking schema that produces a situation is the one like below:

[50] In order to simplify the tableau, I use an ad hoc trigger constraint for variant formations in this section. This does not mean that I abandon Realizational Morphology Theory (Kurisu 2001), developed in section 4.

(91)

```
                                          {Faith 1, Faith 2}
                                           |
Markedness 1 (Variant Trigger)            Markedness 2 (Process Trigger)
   |                                       |   e.g., DEVOICE
   |                                       |
Faith 1                                   Faith 2
   e.g., Max                                  e.g., Ident-IO-[voi]
```

In (91), Markedness 1 represents the trigger constraint for variant formation[51], and Faith 1 is the faithfulness constraint violated in the generation of the variant. Markedness 2 is the constraint that induces some phonological process (i.e., coda devoicing above), and Faith 2 is the constraint of which violation is forced due to Markedness 2. Given that Markedness 2 is ranked higher than Faith 1, this constraint takes effect in normal contexts. However, since the conjunction of Faith 1 and Faith 2 is ranked higher than Markedness 2, in variant forms the phonological process does not take place.

5.3. Comparison with the OV-Approach

As shown above, the approach utilizing local conjunction seems to provide an account for the problems laid out in section 2. Still, I will show that OV-Faith approach covers a wider range of problems. To be more concrete, the approach with local conjunction cannot account for the three cases; (i) an overapplication pattern, (ii) a "partial" underapplication pattern and (iii) opaque vowel lengthening, while OV-approach covers all of these problems. Below we will look at each of the cases one by one.

5.3.1. Overapplication

First of all, the local conjunction approach cannot provide an account for an overapplication pattern. Consider again the data from Mwera, repeated below from section 2.

(92) a. /N+juci/ => [ñ+juci] or [ñ+uci] but * [Nuci] or *[nuci] 'bee'
b. /N+gomo/ => [ŋgomo] or [ŋomo] but *[Nomo] or *[nuci] 'lip'

The plural marker in this language is the prefix /N-/, and this nasal must assimilate to

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[51] To the extent that the discussion in section 4 is on the right track, this should be Realize Morpheme (in at least some of the cases).

the following consonant, as in [ñ+juci] and [ŋgomo]. This language also has optional cluster simplification that deletes a voiced obstruent in a postnasal position. This operation gives rise to simplified variants such as [ñ+uci] and [ŋomo]. What is at issue here is the overapplication of nasal place assimilation: the prefixal nasal must assimilate to the underlyingly following nasal even though the trigger consonant is not present at the surface.

Notice that overapplication cannot be accounted for by the conjunction of faithfulness constraints dominating the markedness constraint. This is because it is not that the process induced by the markedness constraint is prohibited in variants (or the process underapplies). Rather, the process applies when it is not properly conditioned, as the term overapplication suggests. Overapplication therefore cannot simply be captured by the dominance of a faithfulness constraint over the markedness constraint.

Overapplication is induced by the faithfulness constraint that militates for parity between the output and another level (e.g., the base form in the OV-approach). Recall that in the OV-faith approach the trigger of the overapplication of nasal place assimilation is Ident-OV-[place] that militates for identity between a variant and its base. Therefore, a local conjunction system that exclusively refers to IO-dimensions cannot account for this pattern. Faith-OV, on the other hand, successfully generates the overapplication pattern by referring to the surface form of the corresponding base forms.

The point becomes clearer by looking at the ranking schema of overapplication and underapplication.

(93) a. Underapplication

Faith
|
Markedness
|
Faith

b. Overapplication

Faith(-OV)   Markedness
|_____________/
Faith(-IO)

In the underapplication pattern, some kind of faithfulness constraint, whether it be the conjoined faithfulness constraint or faith-OV, must dominate the markedness constraint which in turn dominates a faithfulness constraint. In the overapplication pattern, this does not hold. Hence since local conjunction that exclusively refers to IO-dimensions only generates (93a), it fails to account for the pattern generated by (93b).

5.3.2. Partial Underapplication

The second pattern that local conjunction fails to account for is a “partial” underapplication pattern. This is the case where a general process partially fails to apply in variant forms. This is instantiated by the data from Sea Dayak (Scott 1957, Kenstowcz and . As we saw in section 2, in this language, a nasal consonant induces nasalization of following vowels up to the first non-glide consonant. Also, this language optionally deletes of a voiced stop or affricate in a postnasal position. Some concrete data are repeated below:

(94) a. mãta ‘an eye’
b. mõã ‘the face’
c. mãjã ‘a season’
d. /naŋga/ => [nãŋga?] or [nãŋa?] ‘straighten’ but not *[nãŋã?] * [nãŋa?]

(24a) through (24c) illustrate nasal harmony: nasality spreads rightward up to the first non-glide consonant. Particularly important to our discussion is (24d) where a variant formation is involved. Consider a variant [nãŋa?] in which the second vowel must be oral despite the fact that it immediately follows a nasal consonant. In this form, nasal harmony does apply, but partially. In other words, the first vowel is still subject to nasal harmony. Therefore, the desired candidate incurs one violation of Ident-IO-[nas].

If we follow the local conjunction approach, however, it predicts that nasal harmony should be prohibited in all of the vowels, as the tableau below illustrates:

(95)

/ naŋga?/	{Ident-IO-[nas] & Max-IO}	*NV[oral]	Ident-IO-[nas]	Max-IO
a. ☠ [naŋa?]		**		*
b. [nãŋã?]	*!		**	*
c.(☞) [nãŋa?]	*!	*	*	*

The crucial point is this: if two faithfulness constraints are conjoined over the process inducing markedness constraint, this would ban the process altogether. However, the desired candidate, shown by (☞) above, is the one that partially undergoes the process. The approach with local conjunction thus fails to account for this kind of pattern.

5.3.3. Opaque Vowel Lengthening

Yet another problematic case for the local conjunction approach is opaque vowel lengthening. As we have seen extensively in section 3, in natural language, vowel lengthening concomitant with vowel coalescence and compensatory lengthening are plentifully found in the context of variant formations.

(96)	a. neutral forms	b. casual forms	
	[ak**ai**]	[ak**e:**]	'red'
	[sug**oi**]	[sug**e:**]	'formidable'

There is no way for local conjunction to account for this opaque lengthening, however. Variant forms do violate some faithfulness constraints (several Ident-IO constraints and Uniformity). Yet forms with a short vowel (e.g., [ake] or [suge]) do not constitute an additional violation of another faithfulness constraint. Thus local conjunction approach alone is untenable to account for the opaque lengthening.

Similar to the overapplication pattern, lengthening is induced by the constraint that requires identity between a variant form and other forms (i.e., the corresponding base form in OV-approach). Yet local conjunction cannot produce such a constraint, if it exclusively refers to input-output mapping. In other words, reference to other levels than input-outputs is necessary, and hence local conjunction alone cannot account for this pattern.

5.4. Summary

In this section, I have shown that an approach with recourse to local conjunction could account for some of the problems presented in section 2, but it is unable to provide an account of three cases: overapplication, partial underapplication and opaque vowel lengthening. On the other hand, as discussed in section 2 and 3, the OV-approach can account all of the problems in a systematic fashion.

It is important to notice that local conjunction and OV-approach are not incompatible with each other, and furthermore, the necessity of local conjunction is motivated in other contexts (Smolensky 1993, 1995, 1997; Kirchner 1996; Itô and Mester 1998, 1999b; Lubowicz 1998; Nishimura 2001b among others). Still, to solve the opacity in the context of variant formations, the OV-approach is superior in that it covers wider range of phenomena in a principled way.

6. SUMMARY AND CONCLUDING REMARKS

Based upon the observation that variants often exhibit the opaque structures, I have argued for the existence of OV-correspondence throughout this paper. Structures of variants sometimes cannot be motivated by surface harmony as in the case of vowel lengthening. Also some markedness constraints are violated only in the context of variant formations (the emergence of the marked pattern). These behaviors of variants are results of OV-correspondence which regulates the identity between base forms and variant forms.

As a theoretical consequence, I have also argued that the multi-stratal model can be obviated in favor of OV-correspondence approach. Though these two models are not incompatible with each other, I argued that one level suffices in order to account for opacity problems in the context of variant formations. The OV-correspondent model is theoretically more restrictive and its empirical prediction seems better supported. OV-correspondence militates for identity between a variant and a base, but never promotes disparity. Serialism, on the other hand, can create a situation where a variant can be radically different from its base.

I have also pointed out the possibility of reducing OV-correspondence into one specific type of OO-correspondence, proposing a model that does not require any reranking at all. This eliminates ad hoc constraints such as SYNCOPE or GEMINATE, and therefore has an advantage over other theories of variation. To which extent the RMT model can cover variant formations is yet to be explored. This requires further research.

Finally, in section 5, I point out that the approach which utilizes local conjunction cannot provide a systematic account of the problems presented in this paper. Though the two approaches, local conjunction and OV-approach, are not incompatible with each other, the latter is superior in that it can provide a systematic and principled understanding for opacity in variant formations.

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