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Identity Effects in Morphological Truncation*

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1. Introduction

Morphologically truncated words may be phonologically irregular, constituting a class of exceptions to regular surface patterns.[1] In this paper I propose that phonological irregularities in truncated words are *identity effects* forced by constraints demanding identity between truncated forms and their source words. These constraints, which are ranked and violable in the Optimality Theory model (Prince & Smolensky 1993), regulate the *correspondence relation* between the source word base and the truncated form, in the same way that faithfulness constraints require identity of base and copy in reduplicated words (McCarthy & Prince 1993a et seq.). I will show that truncated words mimic derived properties of their sources, and conclude that truncatory correspondence is a relation between two output forms. Building on proposals in McCarthy & Prince (1994b, 1995), this analysis of truncatory identity extends Correspondence Theory beyond base-reduplicant and input-output relations, establishing correspondence between separate words.

To begin, consider some examples of phonologically irregular truncated words. In English, truncated words are exempt from constraints on vowel quality in syllables closed by [r] (Kahn 1976). Ordinarily, the low front vowel [æ] does not appear in English words before an [r] that precedes another consonant or a pause. Orthographic 'a' is realized as [ɑ] before a tautosyllabic [r], as in (1).[2]

(1) English [æ]≈[ɑ] Alternation

a.	map	[mæp]	b.	mar	[mɑr]
	carry	[kæ.ri]		car	[kɑr]
	Harry	[hæ.ri]		hard	[hɑrd]
	Larry	[læ.ri]		lark	[lɑrk]

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1 The exceptional phonology of truncated words is discussed by Anderson 1975, Prince 1975, Aronoff 1976, McCarthy 1979, Kahn 1976, Stevens 1968, Kiparsky 1984, Martin 1988, McCarthy & Prince 1990, Weeda 1992, Hargus 1993, and Odden 1993, among others.

2 The identity effect described here occurs in dialects that maintain the *merry/marry/Mary* distinction. The *[ær] constraint illustrated in (1) holds when [r] is uniquely associated as a coda, that is, when it precedes another consonant or a pause, as in (1b). The intervocalic consonants parsed as onsets in (1a) may be ambisyllabic (Kahn 1976) or undergo resyllabification from onset to coda (Selkirk 1982). Whatever their syllabic affiliation, intervocalic consonants do not prevent the appearance of a preceding [æ].

Truncated words are exceptional; the truncated names in (2) have [æ], not [ɑ], in spite of the fact that these vowels precede a tautosyllabic [r].

(2) English Hypocoristics

Harry	[hæ.ri]	Har	[hær]
Larry	[læ.ri]	Lar	[lær]
Sarah	[sæ.rə]	Sar	[sær]

The constraint against tautosyllabic [ær] sequences apparently does not apply to morphologically truncated words. As a result of this *underapplication*, the truncated forms are identical to the initial string of their source words.[3]

A slightly different example observed by Anderson (1975) comes from Danish. In this language, the stød accent, which is realized as creaky voicing or a glottal stop, may appear on syllables containing long sonorant segments (Basbøll 1985). Stød appears on the nouns in (3a), which are derived from stems that have a long vowel and consonant, respectively. No stød appears on the nouns in (3b) because there are no long segments in their underlying stems.

(3) Danish Stød

a.	/mæ:s/	mæʔs	'toil'	b.	/bæð/	bæð	'bath'
	/spill/	spelʔ	'waste'		/spel/	spel	'play'

The stød accent unexpectedly appears on imperatives related to the stems in (3b). Because these stems have no long segments, it appears that stød insertion has *overapplied* in the imperatives in (4). However, if imperatives are derived by truncation of the related infinitives, in which segments are regularly lengthened preceding the affix [-ə], the appearance of stød in the imperative can be seen as an identity-preserving strategy, faithfully marking length in the infinitive base form.

(4) Danish Imperatives

Stem	Imperative	Infinitive
/bæð/	bæʔð	bæ:ðə
/spel/	spelʔ	spellə

The English and Danish cases suggest that maintaining identity between the truncated word and its source may be more important than conforming to regular phonological patterns. They also show that truncated words are related to the *surface* form of their sources, since the truncated words faithfully reproduce derived surface properties of the source words. In the Danish example, lengthening depends on suffixation of the infinitival marker [-ə], and in the English case, vowel quality depends on syllabification of the source. These properties are reliably present only in the surface form of the source words. To account for the observed identity between the source and the truncated word, the two surface forms must be formally related.

Similar over- and underapplication phenomena in reduplicated words have received some attention in the literature (see Wilbur 1973; Anderson 1975; Aronoff 1976; Marantz 1982; Kiparsky 1986; Mester 1986; McCarthy & Prince 1995). One reduplicative case of overapplication, in which the reduplicant faithfully copies a

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[3] Speakers of the eastern Massachusetts dialect documented in McCarthy (1993) unexpectedly do not drop the final [r] of truncated names in (2). This can also be understood as an identity effect.

derived property of its base stem, comes from Indonesian (Cohn & McCarthy 1994). The data in (5a-b) show that the initial voiceless stops of unaffixed roots coalesce with the final nasal of the prefix /meN-/. When the prefixed roots are reduplicated, the derived nasal segment appears in both copies, even though only one of these is adjacent to the triggering prefix. The underlined reduplicants in (5c) are faithful copies of their output bases, not the non-nasal input roots.[4]

(5) Indonesian Reduplication

a. /Root/	b. /meN-Root/	c. /meN-Root-RED/	
potoŋ	məmotoŋ	məmotoŋ-<u>motoŋ</u>	'cut'
tulis	mənulis	mənulis-<u>nulis</u>	'write'
kira	məŋira	məŋira-<u>ŋira</u>	'guess'

In rule-based theories, this overapplication effect is accounted for by ordering reduplication after the nasal substitution rule applies to the base. In the Optimality Theory (OT) framework, McCarthy & Prince (1995) propose that the unexpected phonological behavior in (5c) is forced by constraints demanding identity of base and copy in the reduplicated form. These identity constraints regulate the *correspondence relation* between the reduplicant and its base. When identity constraints are undominated, base and reduplicant are identical, even if this entails violation of high-ranking phonological constraints. Correspondence Theory and the constraints on correspondent identity are introduced in §2.

Identity effects in truncated words can be given an analogous account. By positing a correspondence relation between truncated words and their sources, the exceptional phonology of truncated words can be forced by identity constraints. The model of truncation based on Correspondence Theory is also introduced in §2.

The rest of the paper is organized as follows. Empirical support for the correspondence proposal is presented in §3. Truncation patterns in three languages are examined to show how identity constraints force phonological irregularities in truncated words. This discussion establishes correspondence between output forms (dubbed output-to-output correspondence) by showing that truncated words may mimic allophonic, surface properties of their sources. Cases in which base and truncated form are not identical are also discussed, demonstrating that the typological predictions of OT constraint-ranking are attested. At the end of §3, the correspondence-based account is compared to rule-based analyses of the same facts, and constraint-ranking is argued to be a better model of the interaction between phonology and truncating morphology.

The role of templates in morphological truncation is taken up in §4. I will argue that, given correspondence between surface forms, prosodic templates are not necessary in truncation, either as mapping targets or as prosodic delimitors. The discussion of circumscriptional effects, recast as prosodic identity effects, suggests that correspondence can account for many problems of Prosodic Morphology, relating not only a base and its truncated form, but also a base and its infixed form or a base and its templatically-derived counterpart in root-and-pattern systems (see McCarthy & Prince 1994b; McCarthy 1995). In §5, output-to-output correspondence is generalized beyond Prosodic Morphology, to an analysis of segmental alternations previously accounted for by the phonological cycle, or level-

[4] In Indonesian reduplication, both copies are stressed prosodic words (Cohn & McCarthy 1994), making it difficult to tell which copy is the original root and which is the reduplicant. Since only one string is adjacent to the prefix, the nasal substitution process mis-applies in (5c) no matter which string is assumed to be the reduplicant. For an OT analysis of Indonesian nasal substitution, see Pater (to appear).

ordering hypotheses. Section 6 discusses the model in general terms, points out some open issues, and concludes the paper.

2. Correspondence Theory

In their study of reduplicative morphology, McCarthy & Prince (1993a et seq.) posit *correspondence* as a relation mapping between strings. Correspondence relates base and copy in reduplicated words.

(6) Correspondence (McCarthy & Prince 1995)
Given two strings S_1 and S_2, correspondence is a relation $\mathcal{R}$ from the elements of S_1 to those of S_2. Segments α (an element of S_1) and β (an element of S_2) are referred to as correspondents of one another when $\alpha\mathcal{R}\beta$.

Correspondent segments are not necessarily identical. Correspondent identity is regulated by faithfulness constraints, including those in (7). MAX and DEP demand complete and exclusive correspondence between strings of segments, penalizing deletion and insertion, respectively. The family of IDENT[F] constraints require featural identity between correspondent segments. Other constraints on faithful correspondence enforce LINEARITY, CONTIGUITY and edge ANCHORing (see McCarthy & Prince 1994ab, 1995).

(7) MAX
Every segment in S_1 has a correspondent in S_2. That is, Domain (f) = S_1.

DEP
Every segment in S_2 has a correspondent in S_1. That is, Range (f) = S_2.

IDENT([F])
Correspondent segments in S_1 and S_2 have identical values for feature [F].

These faithfulness constraints are ranked in the parochial constraint hierarchy. When base-reduplicant (BR) correspondence constraints are dominated, identity of base and reduplicant is sacrificed, as in (8). ONSET forces incomplete copying in vowel-initial roots in Axininca-Campa, in violation of MAX-BR. In Balangao, NOCODA has a similar effect on consonant-final forms. In Makassarese, nasal-stop assimilation leads to imperfect featural identity between base and reduplicant, in violation of IDENT-BR[place]. For discussion of these cases, see McCarthy & Prince (1993a et seq.).

(8)	Axininca Campa	/osampi-RED/	osampi-<u>sampi</u>
	Balangao	/RED-tagtag/	<u>tagta</u>-tagtag
	Makassarese	/RED-bulaŋ/	<u>bulam</u>-bulaŋ

When BR-correspondence constraints are undominated, base and reduplicant are identical. In some cases, maintaining BR-Identity entails violation of phonological constraints, as in the Indonesian example in (5), where IDENT-BR[nasal] forces overapplication of nasal substitution, and in many similar cases discussed by McCarthy & Prince (1995). By positing a set of ranked and violable constraints demanding identity of base and reduplicant, the success of reduplicative identity in (5) and its failure in (8) are given a coherent account.

Observing the similarities between base-reduplicant identity and faithfulness of the output to the input, McCarthy & Prince (1995) propose that input-output relations should also be regulated through correspondence relations. Thus, inputs are related to outputs by an IO-correspondence relation, regulated by identity constraints. One important part this proposal is the characterization of deletion. Unlike the Containment theory of input-output faithfulness in Prince & Smolensky (1993), under which deleted material is present but prosodically unparsed in output representations, Correspondence Theory holds that deleted segments are literally absent from output strings. Phonological deletion violates the faithfulness constraint MAX-IO, which requires every input segment to have a correspondent in the related output form.

Under Correspondence Theory, reduplication involves multiple, simultaneous correspondences, including a relation between the input and the output (IO-correspondence), and a relation between the base and reduplicant (BR-correspondence).[5] Identity of the pairs of corresponding strings is regulated by parrallel but distinct sets of faithfulness constraints (MAX-IO, MAX-BR, DEP-IO, DEP-BR, IDENT-IO[F], IDENT-BR[F], etc.), which I will refer to by the cover terms IO-Faith and BR-Identity. The lines in (9) represent correspondence relations.

(9) Reduplication (McCarthy & Prince 1995)

BR-Identity

Base ----- **R**eduplicant

\ /

IO-Faith \ / *IR-Faith*

Input

As shown in (9), there must also be a link between the reduplicant and the input (IR-correspondence), since reduplicants may be more faithful to the input string than the base is. For example, in the Lushootseed reduplication /RED-pastəd/ ≈ [papstəd], the underlined CV reduplicant copies a vowel that syncopates from the base. Since deleted segments are literally absent, there is no vowel in the base to which the reduplicant's vowel can be related. The vowel of the reduplicant must, therefore, be a correspondent of the input [a]. This requires a correspondence relation between the input and the reduplicant (see McCarthy & Prince 1995).

The relation between the base and the reduplicant (BR-correspondence) is needed to account for over- and underapplication identity effects. The Indonesian overapplication example, in which the reduplicant copies a derived nasal segment in the base, shows that the base of reduplication is an output form. As noted, the faithfulness constraints requiring base-reduplicant identity are ranked among the structural output constraints. If BR-Identity constraints are undominated, base and reduplicant must be identical, even when maintaining identity entails violation of high-ranking structural constraints.

The model of truncation that I propose, given in (10), closely resembles McCarthy & Prince's reduplication theory. This formally captures the intuition that truncation and reduplication are mirror images; reduplication is morphology that

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5 In multiply-reduplicated forms, distinct BR-correspondences, each with an attendant set of faithfulness constraints, holds between each reduplicant and its base (see Urbanczyk 1995). In §3.3, I show that each truncation morpheme in a language with more than one must similarly be associated with distinct correspondence relations.

lengthens words, and truncation is morphology that shortens them. The two phenomena also resemble one another, and differ from other morphological operations, in that neither involves segmental affixation. As shown in (10), I propose that truncation involves two correspondence relations; an input-to-base relation and an output-to-output correspondence between the base and the truncated form. The output-to-output relation will be called BT-correspondence (for **b**ase and **t**runcated form), and the faithfulness constraints that regulate identity of the corresponding outputs will be BT-Identity constraints.

(10) Truncation

BT-Identity
Base ------- **T**runcated Form
|
IO-Faith |
Input

The input is mapped to the base by IO-correspondence, and BT-correspondence relates the base to the truncated form. Because truncated words, like reduplicants, can mimic surface properties of their sources, producing over- and underapplication phenomena, the base of truncation in (10) must be an output. The BT-Identity constraints that compare the two outputs force truncatory identity effects.

There are a number of important differences between the truncation and reduplication models in (9-10). First, there is a critical difference between the two types of output-to-output relations. In reduplication, base and reduplicant are simultaneously produced, but in truncation, the related output strings are separate words. Unlike reduplicative BR-correspondence, truncatory BT-correspondence is a *transderivational* relation. The display in (11) shows this more clearly with a real truncation example. The base and the truncated form are separate, prosodized output forms.

(11)

BT-Identity
[l æ.r i] ------- [l æ r]
|
IO-Faith |
/ l æ r i /

Also, there is no correspondence relation between the input and the truncated output form. This predicts that truncated words will never be more faithful to the underlying stem than the base is. That is, there should be no case in which the base shows epenthesis, deletion, coalescence or other lack of faithfulness to the input that is not also observed in the corresponding truncated word.

A third crucial difference between (9) and (10) is that the input-to-output and output-to-output relations in truncation are not demonstrably simultaneous. In reduplication, base and reduplicant must be generated simultaneously, in parallel (see McCarthy & Prince 1993a, 1995; Urbanczyk 1995). The base of truncation, however, is prior to the truncated version in the same way that an input is prior to the related output. While this is not necessarily inconsistent with full parallelism in (10), there is a lack of evidence that truncated words and their bases are derived at the same time. The parallelism issue, which is closely related to both the transderivational nature of BT-correspondence and the lack of a relation linking the truncated output and the input, is discussed at the end of this paper, in §6, after the BT-correspondence relation itself is motivated.

An obvious difference between truncation and reduplication is that reduplication lengthens words, and truncation shortens them. In (11), for example, one base segment has no correspondent in the truncated form. This incomplete mapping violates MAX-BT, the faithfulness constraint requiring every base segment to have a correspondent in the truncated word. Truncation morphology, by definition, requires MAX-BT violation,[6] and any theory of truncation must account for the loss of base material. In §4, I will sketch out an analysis of templatic Japanese hypocoristic truncation. Adopting McCarthy & Prince's (1994ab) theory of templatic effects in reduplication, I propose that morphological deletion is forced by domination of MAX-BT by general prosodic constraints. This ranking results in the emergence of unmarked prosodic structure in Japanese nicknames, which always consist of exactly one bimoraic foot. This discussion shows that the BT-Identity constraints posited to explain over- and underapplication identity effects can also account for the loss of base material in truncated words.

The next section, §3, supports my central proposal: that the interaction of morphological truncation with phonological processes can be explained by constraint ranking, instead of rule-ordering. Truncation patterns that show under- and overapplication identity effects are analyzed in detail to demonstrate how dominant BT-Identity constraints on the output-to-output correspondence relation force constraint violations in truncated words.

3. Truncatory Identity Effects

Earlier I mentioned two cases in which truncated forms are phonologically irregular, based on the surface patterns observed in their languages. English truncated words were shown to be exempt from a constraint prohibiting tautosyllabic [ær] sequences, and I suggested that this constraint *underapplies* so that truncated words will have the same vowel quality that their sources have. Danish imperatives were also presented, and I proposed that these truncated forms unexpectedly take a stød accent in order to resemble their infinitival bases. Because the truncated imperatives do not condition the accent, stød-insertion appears to *overapply* in this case.

This section examines similar identity effects in detail. Data from three languages are presented. In New York-Philadelphia English (§3.1) and Icelandic (§3.2), truncated words are identical to the corresponding portion of their source words, even though maintaining identity entails violation of high-ranking phonological constraints. I will argue that "irregularities" in the truncated words are compelled by undominated BT-Identity constraints, which demand identity between truncated forms and their bases. This discussion develops the general ranking schema required to analyze all cases of truncatory identity effects.

In Tiberian Hebrew (§3.3), truncated forms are not always identical to their bases. In some truncated words, phonological processes apply *normally,* where they are expected to on the basis of surface patterns, resulting in non-identity of base and truncated form. This result is achieved by ranking BT-Identity constraints below the constraints that drive the phonological processes. Other truncated words in Tiberian Hebrew do preserve identity with the base, showing over- and underapplication identity effects. BT-Identity, cannot, then, be a single constraint demanding wholesale identity between base and truncated form; BT-Identity must

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[6] This is not quite true. In Japanese, monomoraic base names may lengthen to derive a "truncated" hypocoristic (see §4.1 below). Target-based OT can handle this apparent anomaly, since it does not rely on a deletion process. Apart from such minimality cases, however, morphological truncation entails loss of base material, or MAX-BT violation.

be enforced by a full set of constraints, which separately evaluate each aspect of the representation for identity with the corresponding base form. In Tiberian Hebrew, some BT-Identity constraints outrank structural constraints, while other BT-Identity constraints are dominated.

The constraint-ranking analysis is compared with rule-based approaches in §3.4. In a theory of ordered rules, truncatory identity effects are explained by ordering morphological truncation before or after phonological rule applications. However, to model identity effects, rule-based analyses require complicated and otherwise unmotivated ordering stipulations, and may even need special phonological rules for truncated forms. I will argue that the correspondence-based theory, which focuses the identity relation between the base and its truncated counterpart, provides a more explanatory account of truncatory identity phenomena, and that inherently arbitrary OT constraint ranking is a better model of the apparently arbitrary interaction between morphological truncation and phonology.

The truncatory identity effects discussed in this section establish the *output-to-output* correspondence relation by showing that truncated forms may mimic surface properties of their source words. In the New York-Philadelphia English case, truncated words are faithful to a base vowel that participates in a syllabically-conditioned allophonic alternation. The source and the truncated word have the same vowel, but they differ in syllabification, so that the truncated form appears to have the wrong allophone. Since the choice of allophone depends on the output syllabification of the base, and the truncated form always copies the base vowel, the truncated word must be in correspondence with this surface form, where the allophone reliably appears. The BT-Identity constraints enforcing identity must compare the two output forms.

All of the truncated forms presented in this section are shorter than their source words, and are therefore not entirely identical to their bases. This will be left aside until §4, where templatic morphological deletion is discussed. In what follows, my central concern is identity between the truncated form and the corresponding portion of its base.

3.1 New York-Philadelphia English

In English dialects spoken in New York and Philadelphia, the low front vowel [æ] is tensed in closed syllables, with certain provisions described below (see Ferguson 1972; Kahn 1976; Payne 1980; Labov 1981; Dunlap 1987). The tensed allophone, written [E] in (12), is a diphthong that begins with a front vowel higher than [æ] and ends in a centralized glide. Tensing occurs only when the coda consonant is exclusively tautosyllabic, that is, when it precedes another consonant or a pause. In (12), word-internal syllable boundaries are indicated by periods.[7]

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[7] As in the morphophonemic [æ] ≈ [ɑ] alternation in (1), the consonants following the alternating vowel, which are parsed as onsets in (12a), may be considered ambisyllabic (Kahn 1976) or "resyllabified" into coda position (Selkirk 1982). Whatever their status, these intervocalic consonants do not condition æ-tensing.

(12)

	a.		b.	
	manage	[mæ.nəǰ]	man	[mEn]
	Janice	[jæ.nɪs]	plan	[plEn]
	cafeteria	[kæ.fə.ti.ria]	laugh	[lEf]
	mathematics	[mæ.θə.mæ.tɪks]	psychopath	[say.ko.pEθ]
	cannibal	[kæ.nə.bl̥]	mandible	[mEn.dɪ.bl̥]
	planet	[plæ.nɪt]	plan it	[plEn#ɪt]

This æ-tensing process underapplies in truncated words. When truncation reduces the source words in (13) to CVC, the environment for tensing is created. However, the truncated forms, like their sources, have lax [æ] (Ferguson 1972; Kahn 1976; Dunlap 1987).

(13)

Pamela	[pæ.mə.lə]	Pam	[pæm]
Janice	[jæ.nɪs]	Jan	[jæn]
cafeteria	[kæ.fə.ti.ria]	caf	[kæf]
Massachusetts	[mæ.sə.ču.sɛts]	Mass	[mæs]
pathology	[pæ.θɑ.lə.ǰi]	path	[pæθ]

Three of the truncated forms in (13), *caf* [kæf] from *cafeteria*, *Mass* [mæs] from *Massachusetts*, and *path* [pæθ] from *pathology,* minimally contrast with the non-truncated words *calf* [kEf], *mass* [mEs], *path* [pEθ], which obey the tensing rule. These minimal pairs highlight the exceptional status of morphologically truncated words. Apparently, it is more important for the truncated words to resemble their source words than it is to conform to the regular tensing pattern. In the correspondence model, this identity effect is forced by BT-Identity, the set of constraints that require truncated words to be identical to their source word bases. Before I show how BT-Identity constraints produce this identity effect, I need to develop an analysis of the underapplying æ-tensing process.

Not all codas trigger æ-tensing, and the New York and Philadelphia dialects have different sets of conditioning consonants. New York English has the larger set; all consonants inside the box in (14) condition æ-tensing if they are exclusively tautosyllabic codas (Dunlap 1987).

(14) New York English æ-Tensing

	inside box	outside box
vcls stops		p t č k
vcd stops	b d ǰ g	
vcls fricatives	f θ s š	h
vcd fricatives	v z	ð ž
nasals	m n	ŋ
liquids		l r
glides		w y

This chart suggests that the tensing process is sensitive to the sonority of the coda; assuming that it must have some sonority excludes the voiceless stops. The fricatives {h, ð, ž} never appear as codas following [æ] in English words, so it is unclear whether or not these segments are properly excluded from the set of conditioning consonants. This leaves the sonorants {w, y, l, r, ŋ}. Assuming that all of these segments have a [dorsal] component, since all involve raising of the tongue dorsum, the exclusion of these segments from the set of conditioning consonants can be seen as a kind of OCP effect. The [+sonorant] dorsal segments are enough like the [+sonorant] vowel to induce an interaction that prevents the raising and fronting of [æ] adjacent to the dorsal coda. The dorsal obstruent [g], which is unlike the vowel in terms of stricture, does not induce this interaction, and does not block æ-tensing.[8]

In Philadelphia, the set of conditioning consonants is restricted to {m, n, f, θ, s}; that is, voiced obstruents do not trigger tensing in this dialect (*jazz* [jæz], *pad* [pæd], *bag* [bæg]) (Ferguson 1972; Payne 1980). Also, the æ-tensing rule has exceptions: function words (*can* [kæn], *have* [hæv]) and ablauted verbs (*swam* [swæm], *began* [bi.gæn]) do not tense in either dialect, and certain adjectives are exceptional (in New York, the vowel in *sad* is unexpectedly lax, and Philadelphia, the irregular forms are tensed *mad, glad, bad*). The tensing process is also subject to extensive dialect variation around the northeastern U.S. (Labov 1981). I will not address dialect variation or the non-truncated exceptions to æ-tensing; my focus is on truncated words in (13), which do not fit the tensing pattern in either dialect.

New York-Philadelphia æ-tensing is an allophonic alternation, in which the tensed member of the opposition reliably appears in a definable environment. In traditional analyses of allophony, the unmarked member of the pair is posited as the underlying phoneme, and the marked alternant is derived by a context-sensitive phonological rule (see, e.g., Harris 1942; Hockett 1947). Optimality Theory, however, is a theory of output constraints, which cannot require predictable phonological properties to be absent from input forms. In OT, inputs may contain either member of an allophonic pair; the appropriate alternant is selected by the ranking of output constraints. As discussed by McCarthy & Prince (1995), an OT account of allophonic alternation requires two constraints; one favoring the marked member of the pair in a certain context, and another favoring the unmarked alternant. When these constraints dominate faithfulness requirements, the quality of the input vowel is irrelevant, as I will show below.

Because my main concern is the interaction of truncation with the phonology of the language, I will not attempt a detailed characterization of the æ-tensing process. The two constraints in (15) will be used to drive the alternation. The first constraint is the descriptive constraint æ-TENSING, which is formulated as prohibition against lax [æ] in closed syllables. This constraint must be specific to the [æ]≈[E] alternation, and not force tensing of other vowels. Only the sonority condition on the coda consonant is built into this constraint;[9] as noted above, an undominated OCP constraint prohibits tense [E] before dorsal sonorants. The other constraint in (15) is a context-free markedness constraint against tensed low vowels, *TENSE-low.[10]

(15) æ-TENSING $*æC]_\sigma$ where | C | > | [-cont, -vc] |

*TENSE-low "no tense low vowels"

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[8] See Padgett (1991) for a discussion of stricture-sensitive OCP effects.

[9] The sonority condition on the æ-TENSING constraint in (15) is intended to read "where the sonority of the syllable-final consonant is greater than the sonority of a voiceless stop". The notation follows Prince & Smolensky (1993).

[10] In English, the tense vowels {i,e,u,o} are less marked than their lax counterparts {ɪ,ɛ,ʊ,ɔ}. However, with respect to the [æ]≈[E] alternation, the lax [æ] vowel is the less marked segment. The cross-linguistic tendency to avoid tensing low vowels (Archangeli & Pulleyblank 1994) is reflected in the markedness constraint *TENSE-low.

The æ-TENSING constraint forces the appearance of tense [E] in closed syllables, so it must dominate the markedness constraint *TENSE-low. The relevant IO-Faith constraint, here called IDENT-IO[tense], must also rank below æ-TENSING. The tableaux in (16-17) show that this ranking forces the tense vowel to appear in closed syllables, no matter which allophone is assumed to be in the input. In (16), the input has a lax vowel. The faithful candidate (16a) incurs a fatal violation of the dominant æ-TENSING constraint, because it has a lax [æ] in a closed syllable. The optimal form (16b) violates both the markedness constraint *TENSE-low and the IO-Faith requirement.

(16) æ-TENSING >> *TENSE-low, IDENT-IO[tense]

Input: /plæn/	æ-TENSING	*TENSE-low	IDENT-IO [tense]
a. plæn	*!		
b.√ plEn		*	*

In (17), the input is assumed to contain the tense alternant [E]. Again, dominant æ-TENSING requires a tense vowel in the optimal form (17b). Because *TENSE-low and IDENT-IO[tense] are ranked below æ-TENSING, violations of these constraints are irrelevant.

(17) æ-TENSING >> *TENSE-low, IDENT-IO[tense]

Input: /plEn/	æ-TENSING	*TENSE-low	IDENT-IO [tense]
a. plæn	*!		*
b. √ plEn		*	

By looking at a word with [æ] in an open syllable, it can be established that IDENT-IO[tense] is ranked below the markedness constraint *TENSE-low. In words like *Pamela*, high-ranking ONSET ensures that the alternating vowel is in an open syllable in all competitive candidates. Thus, æ-TENSING is vacuously satisfied, and the decision falls to *TENSE-low, which selects the candidate with a lax low vowel. The second tableau in (18), where the input is assumed to be the tense allophone, shows that *TENSE-low dominates the IO-Faith constraint.

(18) æ-TENSING >> *TENSE-low >> IDENT-IO[tense]

Input: /pæmələ/	æ-TENSING	*TENSE-low	IDENT-IO [tense]
a. √ pæ.mə.lə			
b. pE.mə.lə		*!	*

Input: /pEmələ/	æ-TENSING	*TENSE-low	IDENT-IO [tense]
a. √ pæ.mə.lə			*
b. pE.mə.lə		*!	

So far, I have established that IDENT-IO[tense] is ranked below both æ-TENSING and *TENSE-low in the New York-Philadelphia dialects. This ranking enforces the regular pattern, demanding lax [æ] in open syllables, and tense [E] in closed syllables. Truncated words are exceptions to this pattern; truncated forms have lax [æ] in closed syllables, as in (13). As discussed, I propose that this is an *identity effect* required by high-ranking constraints that demand identity between truncated forms and their source words. These are the BT-Identity constraints in the diagram in (19), which repeats the truncation schematic in (10) with an example from these æ-tensing dialects. The truncated word is related by correspondence to the output form of the source word, the base of truncation. BT-Identity constraints regulate the output-to-output correspondence between the base and the truncated form.

(19)

```
                         BT-Identity
            [pæ.mə.lə]   ----------   [pæm]
                 |
  IO-Faith       |
             /pEmələ/
```

In (19), the base and the truncated form have different syllabification; in the base, [m] is intervocalic and parsed as an onset, but in the truncated word, the [m] is word-final, and must be incorporated into the prosodic structure as a coda. Thus, the truncated form and its base crucially differ with respect to the environment of the æ-TENSING constraint; tensing is expected in the truncated form, but not in the base. But truncated words never differ from their bases with respect to vowel quality. Since it is always obeyed, the BT-Identity constraint governing tenseness must be undominated. Moreover, IDENT-BT[tense] must dominate æ-TENSING, since satisfaction of the BT-Identity constraint entails violation of the structural constraint. This is shown in (20). The base of truncation, which is a prosodized output form, is displayed in the top left corner in truncation tableaux.

(20) IDENT-BT[tense] >> æ-TENSING

Base: [pæ.mə.lə]	IDENT-BT [tense]	æ-TENSING
a. √ pæm		*
b. pEm	*!	

In (20), the base has a lax [æ] in an open syllable, as required by the ranking in (18). When the base is truncated to CVC, the [æ] vowel appears in a closed syllable, and æ-TENSING is expected to apply. The failed candidate in (20b) satisfies æ-TENSING, but fatally violates the BT-Identity constraint. The optimal form (20a) obeys BT-Identity by violating æ-TENSING.

This English example demonstrates that the base of truncation is an output form. These truncated words mimic a derived property of their bases; the lax [æ] allophone. Since Optimality Theory's output constraints cannot require the lax allophone to be present in the input string, either allophone may be present in the underlying form. OT relies on constraint ranking to force the appropriate segment to appear in the optimal output. The lax [æ] in the base name *Pamela* is therefore <u>reliably</u> present only in the output form of this word. Because the truncated version is always faithful to this allophone, BT-Identity constraints must compare the two surface strings.

The ranking in (21) governs æ-tensing in the New York-Philadelphia dialects. The BT-Identity constraint governing tenseness is at the top of the hierarchy, dominating the æ-TENSING constraint. The analogous IO-Faith constraint is at the bottom of the ranking, dominated by both phonological constraints, æ-TENSING and *TENSE-low.

(21) IDENT-BT[tns] >> æ-TENSING >> *TENSE-low >> IDENT-IO[tns]

This is one specific instantiation of the ranking that forces identity effects in morphological truncation. This ranking can be stated more generally as in (22).

(22) BT-Identity >> Phono-Constraint >> IO-Faith

With respect to the New York-Philadelphia English case, *Phono-Constraint* designates the two constraints that drive the allophonic alternation, æ-TENSING and *TENSE-low. Because the [æ]≈[E] alternation is observed in the language, both of these constraints must dominate IO-Faith, as shown in (16-18) above. Because these phonological constraints are dominated by a BT-Identity constraint, underapplication of the tensing process is observed in truncated words, as in (20).

Logically, the base and the truncated form must differ with respect to the structural conditions of a phonological process to get over- and underapplication identity effects. In the English example just given, æ-tensing is not expected and does not apply in the base forms, where the [æ] vowel is in an open syllable. In truncated words, the [æ] vowel appears in a closed syllable, and tensing is expected. Tensing does not apply, or *underapplies*, because the Phono-Constraint that forces æ-tensing is dominated by a BT-Identity constraint. In other cases, a process that is not expected to apply to the truncated form applies anyway, or *overapplies*. In these cases, a process that is properly conditioned by the base is copied in the truncated form. Overapplication, like underapplication, is forced by undominated BT-Identity constraints, as shown in the next section's analysis of Icelandic.

3.2 Icelandic

In Icelandic, truncation of the final vowel of infinitival forms derives deverbal action nouns (Orešnik 1978ab; Arnason 1980; Kiparsky 1984).[11]

(23)

Infinitive		Deverbal Action Noun	
klifra	'climb'	klifr	'climbing'
kumra	'bleat'	kumr	'bleating'
grenja	'cry'	grenj	'crying'
söötra	'sip'	söötr	'sipping'
puukra	'conceal'	puukr	'concealment'
kjöökra	'wail'	kjöökr	'wailing'

The truncated deverbal action nouns in (23) are phonologically exceptional in two ways. First, the truncated words end in otherwise impermissible final clusters. This is an underapplication effect; the processes that are expected to eliminate these clusters fail to apply in truncated forms. Second, truncated words may have long vowels in closed syllables. Because long vowels ordinarily appear in Icelandic in stressed open syllables only, it looks as though a vowel lengthening process overapplies in the truncated forms. Each of these will be taken in turn.

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[11] The source stems in (23) are infinitives of ōn verbs (Orešnik 1978a). These are the only verbs that can truncate to produce deverbal action nouns.

3.2.1 Icelandic Final Clusters

All of the truncated nouns in (23) end in consonant clusters, either *Cr* or *Cj*. In the non-truncatory phonology of Icelandic, these final clusters do not surface. Final *Cr* sequences are broken up by epenthesis, as in (24a), and word-final *Cj* clusters are eliminated by a glide-deletion process, shown in (24b).[12]

(24) Icelandic Final Clusters

a. <u>Epenthesis</u>

/tek-/	tek**u**r	'take' (pres.ind.3sg.)	cf. tek	(pres.ind.1sg.)
/hest-/	hest**u**r	'horse' (nom.sg.)	cf. hesti	(dat.sg.)
/akr-/	ak**u**r	'field' (nom.sg.)	cf. agri	(dat.sg.)

b. <u>Deletion</u>

/bylj-/	'snowstorm'	acc.sg/pl	byl	bylji
		acc.sg/pl	byl	bylji
		dat.sg/pl	byl	byljum
		gen.sg/pl	byls/byljar	bylja

For the present discussion, I propose that epenthesis and deletion in (24) are motivated by the syllable structure constraints that govern the sonority contour of complex syllable margins. Icelandic allows complex codas word-finally, as long as the consonant sequence falls in sonority (*björn* 'bear', *folald* 'young foal'). I will assume the standard sonority hierarchy in (25) and abbreviate the syllable sonority conditions as SON-CON, for "sonority contour".[13]

(25) Sonority Hierarchy: | glide | > | liquid | > | nasal | > | fricative | > | stop |

SON-CON "complex onsets rise in sonority and complex codas fall in sonority"

To get the results in (24), the syllable structure constraint SON-CON must dominate the constraints that prohibit epenthesis and deletion in the mapping from input to output, DEP-IO and MAX-IO.

(26) MAX-IO
"every segment in the input has a correspondent in the output"

DEP-IO
"every segment in the output has a correspondent in the input"

MAX-IO penalizes deletion by requiring every input segment to have an output correspondent. Epenthesis violates DEP-IO, which requires every output segment to have a correspondent in the input string.

---

[12] Some details of the underapplying processes will not be addressed. For example, the epenthesis process shown in (24a) happens only before [r], and there is some disagreement about whether it applies only between morphemes (Orešnik 1972; Kiparsky 1984) or also occurs within roots (Itô 1986). Also, the glide-deletion process in (24b) applies to [v] as well as [j] in word-final position.

[13] The sonority constraints on Icelandic syllables are more complicated than this. Word-medially, only clusters consisting of a tense obstruent {p, t, k, s} plus {r, v, j} make complex onsets, as in [voo.kva] 'water', [vii.tja] 'visit', [snuu.pra] 'chide' (Arnason 1980; Kiparsky 1984). All other intervocalic two-consonant clusters are parsed hetero-syllabically, [af.laga] 'out of order', [tem.ja] 'domesticate', even though these sequences may be word-initial onsets, [flas.ka] 'bottle', [rjuu.ka] 'smoke' (see Itô 1986). Thus, the sonority scale needs fine-tuning, to differentiate tense from lax obstruents, and a sharper sonority increase must be required of word-medial complex onsets.

The epenthesis cases in (24a) show that SON-CON and MAX-IO dominate DEP-IO, as in (27). The syllable structure constraint rules out the faithful candidate (27a), and MAX-IO prohibits consonant deletion (27b). Because DEP-IO is ranked below these constraints, the optimal candidate (27c) has an epenthetic vowel.

(27) SON-CON, MAX-IO >> DEP-IO

Input: /dag - r/	SON-CON	MAX-IO	DEP-IO
a. dagr	*!		
b. dag		*!	
c.√ da.gur			*

Not shown in (27) is the role of the Alignment constraint that rules out the candidate [dag.ru], in which the correspondent of the rightmost input segment is not rightmost in the output. This alignment constraint cannot be ranked in (27); it merely settles the tie between the optimal form [da.gur] and the unaligned competitor [dag.ru].

The [j]-deletion cases in (24b) establish a ranking between SON-CON and MAX-IO. Given (27), we expect epenthesis rather than deletion in the optimal surface form generated from an input like /bylj+ø/. However, the high front glide never appears as a coda consonant in Icelandic (Einarsson 1945; Jonsson p.c.). An undominated CODA-COND must rule out the candidate [by.luj]. Two competitive candidates are shown in (28). The faithful candidate (28a) fatally violates SON-CON. The optimal form (28b) satisfies the syllable structure constraint by violating MAX-IO.

(28) SON-CON >> MAX-IO

Input: /bylj + ø/	SON-CON	MAX-IO
a. bylj	*!	
b. √ byl		*

Another candidate output for the input in (28) has to be considered: [byl.ju], which is competitive because it satisfies SON-CON by violating low-ranking DEP-IO. The [byl.ju] candidate violates Alignment, but so does the optimal form [byl]; in both, the rightmost input segment is not rightmost in the output string. The [bylju] candidate must be ruled out by a constraint that prohibits [j] before an epenthetic [u]. Such a constraint is independently required; for example, the nominative form of the stem in (28), generated from the input /bylj + r/, is [bylur], with an epenthetic [u] and no [j]. Kiparsky (1984) and Itô (1986) account for this by ordering [j]-deletion before epenthesis. I will not solve this interesting puzzle, but I will tentatively propose that [j] fails to surface in the nominative form [bylur] (and in the failed candidate for (28), *[byl.ju]) because the OCP prevents the high front glide from appearing adjacent to the front rounded epenthetic vowel. This requires that the epenthetic [u] be distinguished from the phonetically-identical underlying [u], which can take [j] as an onset, as in the dative plural form /bylj + um/ ≈ [byljum]. However, this distinction is independently motivated, since underlying [u] triggers umlaut, and epenthetic [u] does not (Orešnik 1972; Kiparsky 1984). In order to keep on the main point, I will leave these open questions aside and move on to the analysis of truncation identity effects. Whatever constraint rules out the candidate [bylju] is not crucial; what is important is that the optimal form in (28), [byl], satisfies the syllable structure requirement SON-CON by violating MAX-IO.

Examination of non-truncatory Icelandic phonology establishes the ranking in (29). Two IO-Faith constraints, MAX-IO and DEP-IO, rank below the syllable structure constraint SON-CON.

(29) SON-CON >> MAX-IO >> DEP-IO

In contrast to their IO-Faith counterparts, the BT-Identity constraints MAX-BT and DEP-BT are ranked above SON-CON in Icelandic. This ranking forces the underapplication of epenthesis and deletion in the truncated nouns in (23). Truncated versions of stems with *Cj* clusters, which unexpectedly surface with a word-final glide, show that SON-CON is dominated by MAX-BT, the constraint that demands a full mapping from the base to the truncated form. This ranking dictates that it is better to realize more of the base in the truncated output than it is to avoid final clusters that rise in sonority.[14] The optimal truncated candidate in (30a) incurs a single violation of MAX-BT, as required by the truncation morphology. The failed form in (30b) incurs an extra, fatal violation of MAX-BT.[15]

(30) MAX-BT >> SON-CON

Base: [gren.ja]	MAX-BT	SON-CON
a. √ grenj	*	*
b. gren	**!	

Truncated forms of infinitives with *Cr* clusters, which unexpectedly do not show epenthesis, demonstrate that DEP-BT also outranks SON-CON. Candidate (31b) contains a segment that has no correspondent in the base, and fails on DEP-BT. The optimal candidate in (31a) satisfies DEP-BT, but violates SON-CON.

(31) DEP-BT >> SON-CON

Base: [söö.tra]	DEP-BT	SON-CON
a. √ söötr		*
b. söö.tur	*!	

To summarize, tableau (32) shows that both BT-Identity constraints outrank the syllable structure requirement. MAX-BT and DEP-BT are not crucially ranked, but both identity constraints must dominate SON-CON.

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14 Throughout this discussion, I assume that the truncated deverbal action nouns are mono-syllabic. Word-final [r, j] are devoiced, decreasing their sonority, which suggests that these segments are linked as codas or appendices in the Icelandic truncated words (cf. French *votre* [votʁ̥] 'your'). If the Icelandic truncated forms are in fact disyllabic, the details of the analysis will have to change, but the overall argument will not. If the word-final sonorants of the truncated forms are parsed as either syllable heads or onsets to empty nucleii, this marked syllabification must be forced by undominated BT-Identity constraints (thanks to John Kingston for pointing this out).

15 Because truncated words are by definition shorter than their bases (except in some word-minimality cases - see (88) below), violation of MAX-BT must be morphologically motivated. In Icelandic, loss of a single segment satisfies the morphological requirement. Loss of more base material incurs gratuitous violation of MAX-BT, as shown in (30).

(32) MAX-BT, DEP-BT >> SON-CON

Base: [söö.tra]	MAX-BT	DEP-BT	SON-CON
a. sööt	**!		
b. söö.tur	*	*!	
c. √ söötr	*		*

For some Icelandic speakers, epenthesis may be optional or preferred in *Cr*-final deverbal action nouns, so that *söötur* (32b) is the optimal truncated form, rather than *söötr* (32c) (Kiparsky 1984; Jonnson, p.c.). In (32b), epenthesis applies normally, where its structural conditions are met, before the post-consonantal, word-final [r]. Similar examples of normal application are discussed in more detail in §3.3. For now, note that normal application of epenthesis in (32b) means a loss of BT-Identity. Epenthesis incurs a violation of DEP-BT; the epenthetic vowel has no correspondent in the base form. For speakers who prefer the epenthetic candidate, DEP-BT must rank below SON-CON, as the reader can verify by permuting the two rightmost columns of tableau (32). MAX-BT must still be high-ranking, however, to rule out candidate (32a), **sööt.*

The Icelandic ranking in (33) is another specific instantiation of the general schema BT-Identity >> Phono-Constraint >> IO-Faith that produces truncation identity effects.

(33) MAX-BT, DEP-BT >> SON-CON >> MAX-IO >> DEP-IO

By (33), Icelandic truncated forms are exempt from the constraint against rising-sonority final clusters, SON-CON. This constraint is active in the non-truncatory phonology of Icelandic; it dominates MAX-IO and DEP-IO, requiring deletion and epenthesis to eliminate offending syllable-final clusters. The syllable structure constraint has no effect in truncated words, because it is ranked below BT-Identity requirements. High-ranking MAX-BT demands that all base segments have correspondents in the truncated form, prohibiting deletion of a consonant from the rising-sonority coda cluster. Ranking DEP-BT over SON-CON prevents elimination of the final cluster by epenthesis. As discussed, some speakers rank DEP-BT below SON-CON, producing an epenthetic vowel in [r]-final truncated action nouns.

3.2.2 Icelandic Vowel Length

The other "irregularity" in the truncated deverbal action nouns of Icelandic is that they may have long vowels, even though all other cluster-final words in the language have short vowels. In non-truncated words, vowel length is entirely predictable; long vowels appear always and only in open stressed syllables. Because long vowels appear in a specific environment, traditional analyses propose that Icelandic has a vowel lengthening process which targets stressed open syllables (Arnason 1980; Kiparsky 1984). Because truncated forms do not meet the conditions of this rule (they are not open syllables), it appears that the vowel lengthening process has overapplied in truncated forms like *söötr* 'the act of sipping'. This overapplication effect is forced by undominated BT-Identity constraints.

The Icelandic vowel length pattern is illustrated in (34-35). Leaving aside the irregular truncated nouns, vowel length is predictable in Icelandic; long vowels appear in all stressed open syllables, and nowhere else. The examples in (34) have regular initial stress. As usual, long vowels are written as vowel sequences, and syllables are separated by periods.

(34) a. Stressed Open σ, Long V

höö.fuð	'head'
aa.kur	'field'
faa.ra	'ride'

b. Stressed Closed σ, Short V

har.ður	'hard'
el.ska	'love'
kal.la	'call'

Vowel length is also predictable in monosyllabic words. Vowels are long in words shaped CV or CVC, and short in cluster-final monosyllables. Kiparsky (1984) proposes that word-final consonants are extrametrical, so that final CVC syllables are effectively open, and lengthening in CVC monosyllables (35b) is expected. Because only one consonant can be extrametrical, cluster-final syllables are closed, and vowels in CVCC monosyllables (35c) are short.

(35) Icelandic Monosyllables

a. V-Final, Long V		b. C-Final, Long V		c. CC-Final, Short V	
skoo	'shoe'	haas	'hoarse'	björn	'bear'
buu	'homestead'	ljoos	'light'	haft	'have'
tɛɛ	'tea'	skiip	'ship'	skips	'ship's'

Truncated deverbal action nouns do not conform to the regular vowel length pattern; they may have long vowels in cluster-final monosyllables. Their bases, however, obey the vowel length generalizations. First, consider the regular patterns. In an OT analysis of this predictable alternation, surface vowel length has to be derived from input vowels of any length, and two constraints can do the work. The context-sensitive constraint favoring the marked long alternant is STRESS-to-WEIGHT, which requires stressed syllables to be bimoraic. Because long vowels appear only in open syllables, I assume that coda consonants are moraic in Icelandic, precluding vowel length in closed syllables (Hyman 1985; Zec 1988).[16] The context-free markedness constraint is NO-LONG-V (Rosenthall 1994).

(36) STRESS-to-WEIGHT (S-->W) "if stressed, then heavy"
NO-LONG-V (*VV) "no long vowels"

With these constraints, vowel length in Icelandic can be given an analysis similar to the account of [æ]≈[E] allophony in New York-Philadelphia English. In Icelandic, long vowels always appear in stressed open syllables; this shows that STRESS-to-WEIGHT dominates NO-LONG-V. Ranking IO-Faith below NO-LONG-V ensures that long vowels appear only in stressed open syllables. In (37), two possible inputs are considered for the infinitive *söötra* 'to sip', one with long vowels, and one with short vowels. The ranking derives the correct surface form in both cases. In these tableaux, each pair of correspondent vowels that are not the same length incur one violation of IDENT-IO[v-length].[17] Stress falls on the first syllable in all examples.

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[16] The extrametricality effect in (35b) indicates that final consonants do not project weight-by-position moras.

[17] Moras, like tones, have stability, as shown by compensatory lengthening phenomena, where a vowel usurps a mora previously associated with another segment (Hayes 1989). This suggests that moras and tones should not be treated as featural attributes of correspondent segments, regulated by IDENT constraints.

(37) STRESS-to-WEIGHT >> NO-LONG-V >> IDENT-IO[v-length]

Input: /sötra/	S -->W	*VV	IDENT-IO [v-length]
a. sö.tra	*!		
b. söö.traa		**!	**
c. √ söö.tra		*	*

Input: /söötraa/	S -->W	*VV	IDENT-IO [v-length]
a. sö.tra	*!		**
b. söö.traa		**!	
c. √ söö.tra		*	*

In (37), the medial [tr] cluster is parsed as a complex onset in all competitive candidates (see fn.13). Therefore, the preceding stressed vowel appears in an open syllable and must be long, as required by STRESS-to-WEIGHT, the top-ranked constraint. The markedness constraint NO-LONG-V prevents vowels other than the stressed vowel from surfacing as long, no matter what length they are in the underlying form.

In infinitives like *kum.ra*, *gren.ja* and *lif.ra*, the medial consonant cluster is heterosyllabic. Syllable structure constraints ensure that the initial stressed syllable of these stems has a moraic coda in all relevant candidates. In (38), STRESS-to-WEIGHT is vacuously satisfied, so the decision falls to the markedness constraint NO-LONG-V. The IO-Faith constraint, ranked below NO-LONG-V, is irrelevant.

(38) STRESS-to-WEIGHT >> NO-LONG-V >> IDENT-IO[v-length]

Input: /kuumraa/	S -->W	*VV	IDENT-IO [v-length]
a. √ kum.ra			**
b. kuum.raa		**!	
c. kuum.ra		*!	*

The ranking in (37-38) ensures that infinitives, like all non-truncated words in Icelandic, have long vowels in all stressed open syllables, and only in stressed open syllables. The exceptional truncated deverbal action nouns may have long vowels in closed syllables because they are subject to a distinct set of faithfulness constraints, the BT-Identity constraints on the correspondence with the base form. Truncated candidates that are not faithful to base vowel length are never optimal; if the base has a long vowel, the truncated noun must too. This shows that BT-Identity outranks the markedness constraint NO-LONG-V.

(39) IDENT-BT[v-length] >> NO-LONG-V

Base: [söö.tra]	IDENT-BT [v-length]	*VV
a. √ söötr		*
b. sötr	*!	

No ranking can be established between the BT-Identity constraint and STRESS-to-WEIGHT. Since non-final coda consonants are moraic in Icelandic, both candidates in (39) are bimoraic and satisfy STRESS-to-WEIGHT. The ranking that forces overapplication in Icelandic truncated words must be as in (40).

(40) IDENT-BT[v-lgth], STRESS-to-WEIGHT >> *VV >> IDENT-IO[v-lgth]

The overapplication ranking is stated more generally in (41).

(41) BT-Identity, Phono-Constraint >> IO-Faith

As in the underapplication ranking in (33) above, BT-Identity is undominated in the overapplication hierarchy. The difference is that BT-Identity cannot be ranked with respect to the constraint that drives an overapplying phonological process, since this constraint is vacuously satisfied by the truncated word. Unlike its base, the truncated word in (39) does not condition vowel length; the truncated word does not contain a stressed open syllable. Length in the truncated word is copied from the base, as demanded by undominated identity requirements. The overapplication ranking is therefore simply a less specific instantiation of the underapplication ranking. In all cases, truncatory identity is forced by undominated BT-Identity constraints.

3.2.3 Icelandic Summary

The phonological irregularities in Icelandic truncated words have been analyzed as identity effects forced by faithfulness constraints on the output-to-output or BT-correspondence relation. Icelandic deverbal action nouns mimic properties of their infinitival bases (the base's consonant cluster and vowel length) and as a result, truncated words violate high-ranking phonological constraints. These violations are forced by undominated BT-Identity requirements.

The analysis of Icelandic vowel length clearly shows that the truncated nouns are related to the surface form of their source words. Predictable Icelandic vowel length is traditionally assumed to be absent from underlying forms. Optimality Theory, however, cannot restrict inputs in this way; non-contrastive vowel length may or may not be present in Icelandic input strings. Vowel length is therefore reliably present only in output forms. Because truncated words are always faithful to allophonic vowel length in the base, the BT-Identity constraints that enforce identity must compare two surface strings, as in (42).

(42)

```
                              BT-Identity
                  [söö.tra]   -----------   [söötr]
                      |
      IO-Faith        |
                   /sötra/
```

By positing a distinct set of faithfulness constraints relevant to truncated words, and allowing these BT-Identity constraints to be ranked over constraints that drive phonological processes, the special phonological behavior of truncated forms is given a coherent account.

Underapplication and overapplication in truncation are formally indistinct; both are forced by undominated BT-Identity requirements.[18] The two phenomena differ only in which output (the base or the truncated form) contains the structural environment relevant to the high-ranking Phono-Constraint. In underapplication, the truncated form conditions the relevant process. The process fails to apply in the

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18 In contrast, over- and underapplication in reduplication do require distinct rankings (see McCarthy & Prince 1995, and §6 below).

truncated word, or underapplies, because BT-Identity dominates the constraint that drives the alternation. In overapplication, the base contains the relevant conditioning environment, and undominated BT-Identity constraints force the truncated form to mimic the effect of the relevant phonological constraint. The two types of identity effects are formally the same; both require top-ranked BT-Identity constraints.

The base and the truncated word must differ in the structural environment of a phonological process in order to get identity effects. Also, note that the base of truncation is always regular with respect to the surface patterns of the language. Because the base stands in an IO-correspondence and is subject to IO-Faith constraints, and it is the ranking of IO-Faith constraints with structural or markedness constraints that determines the regular patterns of the language, source words must have regular phonology. Truncated words may be exceptional because they are subject to a distinct set of identity constraints, which enforce faithfulness to the surface form of the source word, the base of truncation.

The truncatory identity effects in English and Icelandic are not unique; similar phenomena have been observed in other languages. In Madurese, vowel tensing and glide insertion overapply in truncated forms (Stevens 1968).[19] In Abkhaz, epenthesis overapplies word-initially adjacent to a truncated prefix /y-/ (Anderson 1975). Several identity effects in Tiberian Hebrew noted by Prince (1975) are discussed below, and further investigation is certain to reveal similar examples in other languages. However, BT-Identity constraints are not universally undominated, as typologically-oriented OT predicts. In some cases, identity of base and truncated form is not achieved. In terms of the truncation model in (42), this means that BT-Identity constraints are violated under domination. Tiberian Hebrew provides some illustrative examples.

3.3 Tiberian Hebrew

Truncated words are not always identical to the corresponding portion of their source word. Phonological requirements may force BT-Identity to be sacrificed. When truncation creates the structural environment of a phonological process, and that process applies normally, where it is properly conditioned, the base and truncated form are not identical. One example of *normal application* was mentioned in the discussion of Icelandic in §3.2. Below tableau (32), I noted that some Icelandic speakers prefer epenthesis in [r]-final truncated nouns. For these speakers, epenthesis applies normally, where it is expected to, between the final two consonants of the truncated word. Normal application entails loss of BT-Identity; the epenthetic vowel in the truncated word has no correspondent in the base. This result is obtained by ranking DEP-BT, the BT-Identity constraint against epenthesis, below SON-CON, the syllable structure constraint that drives vowel insertion in Icelandic. Thus, in normal application, BT-Identity constraints are violated in order to respect a higher-ranking Phono-Constraint.

This section illustrates the non-identity effect of normal application with examples from Tiberian Hebrew (Prince 1975; McCarthy 1979; Aronoff 1976). Two different types of truncation are discussed; truncation of the initial CV of imperfective stems, which produces imperatives, and truncation of the final vowel of imperfective stems, which marks jussives and second person feminine singular (2fs) stems. In both patterns, truncated words are sometimes identical to their bases, and sometimes not. In the descriptive terms adopted here, both Tiberian

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[19] These processes, as well as nasal assimilation, similarly overapply in Madurese reduplication (Stevens 1968; McCarthy & Prince 1995).

Hebrew truncation patterns show normal application of phonological processes as well as over- or underapplication identity effects.

In imperative truncation, BT-Identity is disrupted by normal application of epenthesis and post-vocalic spirantization. These processes apply in truncated forms where they are properly conditioned, resulting in non-identity with the base. Imperatives also show identity-preserving mis-application of various segmental processes, including vowel-glide coalescence, nasal-stop assimilation and a vowel height alternation. To model this variation, BT-Identity cannot be a monolithic requirement; it must be a set of separably-rankable constraints, each governing a specific aspect of the representation. In Tiberian Hebrew imperative truncation, some BT-Identity constraints are dominated by structural constraints, allowing certain phonological processes to apply normally, while other BT-Identity constraints are undominated in the grammar, forcing over- and underapplication identity effects.

Jussives and second person feminine singular (2fs) stems, which are marked by truncation of the base-final vowel, show a somewhat different pattern of variation. In these forms, a single phonological process sometimes applies normally, disrupting BT-Identity, and sometimes underapplies, preserving identity with the base. Truncation of the base-final vowel exposes a consonant cluster to the word-edge. Non-truncated words of Tiberian Hebrew do not have complex codas, and epenthesis is expected to apply. However, epenthesis occurs in the truncated forms only if the base's consonant sequence rises in sonority or if the cluster contains a guttural; otherwise, epenthesis underapplies. Truncated jussives and 2fs stems thus distinguish two types of coda clusters, allowing unmarked coda clusters to surface, but requiring epenthesis to prevent marked coda sequences, while non-truncated words treat all consonant clusters alike. This is an emergent unmarkedness phenomenon, in the sense of McCarthy & Prince (1994a); a markedness distinction which is not visible in the language as a whole emerges in the special morphological domain of jussive/2fs truncation.

The final-V truncation pattern also shows underapplication of spirantization, so that jussive and 2fs stems may have post-vocalic non-spirant stops. This same spirantization process applies *normally* in truncated imperative stems. As I will show below, the relevant BT-Identity constraint on imperative truncation must rank *below* the constraints that force spirantization, allowing normal application of spirantization in imperatives to disrupt identity with the base, while the BT-Identity constraint on final-V truncation must rank *above* the spirantization constraints, forcing underapplication. Following Urbanczyk (1995), I conclude that each truncation morpheme in Tiberian Hebrew is associated with a distinct correspondence relation, governed by distinct BT-Identity constraints. This is taken up in §3.3.2, where jussive/2fs truncation is analyzed. In anticipation of this discussion, subscripting on each BT-Identity constraint presented below identifies the relevant correspondence relation by indicating the morphological category of the truncated word.

3.3.1 Tiberian Hebrew Imperative Truncation

Tiberian Hebrew imperative truncation suppresses the initial CV of the imperfective stem, as in (43). Assuming that imperatives are truncated versions of imperfectives accounts for both the unusual shape of the imperatives (unaffixed stems of this shape do not occur elsewhere in the language) and their vocalism, which always matches the (sometimes unpredictable) vowel of the imperfective verb (Prince 1975). Prince's truncation analysis of imperatives is confirmed by the fact that these stems are systematically irregular with respect to certain segmental processes; these patterns were noted by Prince and are presented in (52-54) below as over- and underapplication identity effects. The imperatives in (43), however, are not phonologically exceptional; in particular, these truncated stems show the expected effects of epenthesis and spirantization. As a result of the normal application of these processes, the imperatives in (43) are not identical to the final string of their imperfective bases. In Hebrew examples, a line under or over an obstruent marks spirantization, and a line over a vowel marks length.

(43)	Root	Imperfective	Imperative	
	/ktb/	yiḵtōḇ	kəṯōḇ	write
	/ṣḥq/	yiṣḥaq	ṣəḥaq	laugh
	/šmʕ/	yišmaʕ	šəmaʕ	hear
	/lmd/	yilmaḏ	ləmaḏ	learn

The medial consonant clusters in the imperfective bases are initial in the truncated imperative forms. Since Tiberian Hebrew never allows word-initial clusters, schwa epenthesis applies, inserting a vowel with no base correspondent into the truncated word. Post-vocalic spirantization also applies normally, affecting all and only stops that follow vowels, so that a spirantized [ḵ] in the imperfective base [yiḵtōḇ] stands in correspondence with a non-spirant [k] in the truncated word [kəṯōḇ], and so on. Each process that disrupts BT-Identity needs a constraint-interaction analysis.

Epenthesis in word-initial clusters is driven by *COMPLEX (Prince & Smolensky 1993), specifically, by the provision that prohibits complex onsets. In non-truncated words, complex onsets never occur (Prince 1975).

(44) *COMPLEX $*_{\sigma}$[CC "no complex onsets"

Because epenthesis is observed in Tiberian Hebrew, *COMPLEX must dominate DEP-IO, the anti-epenthesis constraint. MAX-IO must also dominate DEP-IO, to prevent consonant deletion. Tableau (45) shows how epenthesis is forced in the noun [gəbūl] 'boundary'.

(45) *COMPLEX ($*_{\sigma}$[CC), MAX-IO >> DEP-IO

Input: /gbūl/	*COMPLEX $*_{\sigma}$[CC	MAX-IO	DEP-IO
a. gbūl	*!		
b. būl		*!	
c. √ gəbūl			*

The faithful candidate (45a) violates the syllable structure constraint. Candidate (45b) satisfies *COMPLEX, but fatally violates MAX-IO by deleting the initial consonant. The optimal form (45c) satisfies *COMPLEX by violating DEP-IO.

The analogous BT-Identity constraint on truncated imperatives, DEP-BT_{imp}, must also rank below *COMPLEX, since epenthetic vowels appear in the imperative stems in (43). The optimal candidate in (46b) has a vowel with no correspondent in the base, satisfying *COMPLEX at the expense of a DEP-BT_{imp} violation. Although it is not shown in (46), MAX-BT_{imp} must also be high-ranking, since epenthesis, rather than consonant deletion, satisfies *COMPLEX.

(46) *COMPLEX (*$_{\sigma}$[CC) >> DEP-BT$_{imp}$

Base: [yiḵ.tōḇ]	*COMPLEX *$_{\sigma}$[CC	DEP-BT$_{imp}$
a. ktōḇ	*!	
b. √ kəṯōḇ		*

Because *COMPLEX dominates DEP-BT$_{imp}$, it is more harmonic to epenthesize a schwa in the truncated imperative to prevent a complex onset than it is to preserve identity with the base.

The other process that disrupts BT-Identity in Tiberian Hebrew imperatives is spirantization of post-vocalic stops. Spirantization affects all post-vocalic non-geminate stops, and does not occur elsewhere in the language (Prince 1975). Tiberian Hebrew spirantization, like New York-Philadelphia æ-tensing and Icelandic vowel lengthening, is a predictable or allophonic alternation. In the familiar way, this alternation can be forced with two constraints, one favoring the marked spirantized allophone in post-vocalic context, and another favoring the unmarked, non-spirant alternant.

(47) *V-STOP *V $C_{[-cont]}$ "no post-vocalic noncontinuants"

*SPIR *[-son, -strident] "no non-strident fricatives"

The *V-STOP constraint prohibits non-continuants post-vocalically. The context-free markedness constraint *SPIR prohibits all non-strident obstruents (and therefore does not penalize [+strident] fricatives). As mentioned, all post-vocalic stops are spirantized, and spirantized stops occur nowhere else in the language. The ranking that drives this predictable alternation is *V-STOP >> *SPIR >> IDENT-IO[continuant]. The top-ranked constraint *V-STOP forces spirantization in post-vocalic context. The markedness constraint *SPIR ensures that spirantization is limited to this environment. Because OT cannot guarantee the absence of spirantized stops in input strings, the IO-Faith constraint must rank below both Phono-Constraints in (47).

The spirantization constraints also dominate IDENT-BT$_{imp}$[cont], allowing base segments and their correspondents in the truncated word to differ with respect to continuancy. This is shown in (48).

(48) *V-STOP >> *SPIR >> IDENT-BT$_{imp}$[cont]

Base: [yiḵ.tōḇ]	*V-STOP	*SPIR	IDENT-BT$_{imp}$ [cont]
a. ḵətōḇ	*!	**	
b. kəṯōb	*!	*	***
c. ḵəṯōḇ		***!	*
d. √ kəṯōḇ		**	**

In candidate (48a), all consonants are identical to their base correspondents with respect to spirantization. Because the [t] is post-vocalic but not spirantized, candidate (48a) fails on the top-ranked constraint *V-STOP. In (48b), all consonants are non-identical to their base correspondents, and this candidate also fails on *V-STOP, since the final [b] is post-vocalic and not spirantized. In (48c), all stops are spirantized, so the *V-STOP constraint is satisfied. However, this candidate incurs fatal violation of the markedness constraint; the initial [k] in (48c) is spirantized, but not post-vocalic. In (48d), the optimal form, all and only post-vocalic stops are spirantized. Candidate (48d) incurs two violations of IDENT-BT_{imp}[cont], since both [k] and [t] are non-identical to their base correspondents, but these violations are irrelevant, due to the low rank of the BT-Identity constraint.

The rankings motivated above are summarized in (49). The constraints that drive epenthesis and spirantization, *COMPLEX and *V-STOP, outrank IO-Faith constraints, ensuring that epenthesis and spirantization occur generally, in non-truncated words of the language. The analogous BT-Identity constraints are also dominated by the epenthesis and spirantization constraints, forcing normal application of these processes in truncated imperative stems.

(49) *COMPLEX ($*_{\sigma}$[CC) >> DEP-BT_{imp}, DEP-IO
*V-STOP >> *SPIR >> IDENT-BT_{imp}[cont], IDENT-IO[cont]

These rankings are specific instantiations of the general schema in (50) that produces normal application of phonological processes in truncated words. When both BT-Identity and IO-Faith are dominated by Phono-Constraints, phonological processes apply normally, wherever their structural conditions are met, in both truncated and non-truncated words.

(50) Phono-Constraint >> BT-Identity, IO-Faith

This Tiberian Hebrew example is not unique; other languages also show disruption of BT-Identity by normal application of a phonological processes. For example, in Hidatsa (Siouan), a regular process that changes the sonorants [r, w] to obstruents [t, p^h] in word-final position applies normally in truncated words (Harris 1942; Robinett 1955; Weeda 1992).

(51)

	Stem	3sg [-c]	Imperative (sg)	
a.	/ca:ki/	cá:kic	cá:k	'wail'
	/puši/	púšic	púš	'push'
	/kipa:taki/	kipá:takic	kipá:tak	'close it!'
b.	/ta:ri/	tá:ric	tá:t	'cross'
	/ki:ri/	kí:ric	kí:t	'look'
	/kiruwi/	kíruwic	kirup^h	'count it'

The [r, w] --> [t, p^h] rule applies normally in the truncated imperatives in (51b), and as a result, the imperatives are not identical to their base forms. The Phono-Constraints that drives word-final hardening in Hidatsa, just like the constraints responsible for epenthesis and spirantization in Tiberian Hebrew, must dominate BT-Identity constraints.[20]

By positing a set of BT-Identity constraints, ranked among structural output constraints, the correspondence model predicts that truncated forms will be identical

[20] Like Hidatsa, Lardil nominative truncation (Prince & Smolensky 1993) suppresses stem-final vowels. Deletion marks a grammatical category in both of these languages, and must therefore be morphological truncation, not phonological apocope. There are, however, no identity effects to confirm this, since truncated words in Hidatsa and Lardil are not faithful to surface properties of their bases.

to (the relevant portion of) their bases in some cases (Icelandic and New York-Philadelphia English), and non-identical to their bases in others (Tiberian Hebrew and Hidatsa). This kind of variation is possible not only between languages, but within a single language, and even among forms in the same morphological category. BT-Identity cannot, then, be a monolithic requirement, demanding overall identity between the truncated word and the (relevant portion of its) base. BT-Identity must be a full set of constraints that separately evaluate every aspect of the representation for identity with the corresponding base form, just as separate IO-Faith requirements govern every dimension of input-output faithfulness. This model of BT-Identity allows some identity constraints to be dominated, so that certain aspects of BT-Identity are sacrificed in order to satisfy a higher-ranking output requirement, while other BT-Identity constraints are undominated, forcing over- and underapplication identity effects. Tiberian Hebrew imperative truncation illustrates this kind of variation. Some BT-Identity constraints (specifically, DEP-BT_{imp} and IDENT-BT_{imp}[cont]) are violated under domination, resulting in non-identity between imperfective bases and truncated imperative forms. However, other BT-Identity constraints on imperative truncation are undominated, and force over- and underapplication identity effects.

The truncated imperatives in (52) show overapplication of vowel-glide coalescence and nasal assimilation. As Prince (1975) notes, these identity effects confirm the analysis of imperatives as truncated versions of the imperfective stems. If imperatives were derived from the underlying root, rather than from the surface imperfective form, disyllabic imperatives like [*yəḏaʕ] and [*nəṯēn] would be expected in (52), instead of the correct monosyllabic forms.

(52)	Root	Imperfective	Imperative	
a.	/ydʕ/	yēdaʕ	daʕ	*yəḏaʕ
	/yšb/	yēšēḇ	šēḇ	*yəšēḇ
b.	/ntn/	yittēn	tēn	*nəṯēn
	/ngš/	yiggaš	gaš	*nəḡaš

Each imperative in (52) mimics a surface property of its base, namely, the absence of the root-initial consonant. The examples in (52a) involve a process that takes the vowel-glide sequence [ay] to [ē] (Prince 1975). The imperfective stem, derived from the prefixed input /ya-ydaʕ/, illustrates this coalescence: the low vowel and high glide merge into a long mid vowel in the surface form [yēḏaʕ]. The imperative stem [daʕ] shows truncation of the initial CV of the imperfective form. The imperative also shows the effect of vowel-glide coalescence; if coalescence did not apply between the prefixal vowel and the root-initial glide, the glide should surface in an imperative form like [*yəḏaʕ], with regular epenthesis in the initial cluster. Even though the imperative does not condition coalescence, since it does not have a prefixal low vowel, coalescence overapplies, and the root-initial glide does not appear in the truncated stem.[21]

The nasal assimilation case in (52b) is similar. Total assimilation of the nasal to the following onset, exhibited in the imperfective base /ya-ntēn/ ≈ [yittēn], overapplies in the truncated form [tēn], forcing loss of the root-initial

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[21] The initial [y] glide of the roots in (52a) is historically [w] (the I-w class). A smaller class of [y]-initial roots that are historically I-y do not undergo coalescence with prefixal low vowels. No imperatives of the I-y roots are attested (McCarthy p.c.).

nasal segment.[22] Again, the truncated form is faithful to a surface property of its base; the root-initial nasal does not surface in the imperfective base, and it also does not appear in the truncated imperative stem. If nasal assimilation is blocked in the imperfective, the root-initial nasal surfaces in a disyllabic imperative. Nasals do not assimilate to gutturals, so assimilation is blocked in the imperfective [yinhāḡ], which is related by truncation to the imperative [nəhāg]. Epenthesis applies normally in this truncated word, as required by the ranking of *COMPLEX over DEP-BT shown in (46) above.

Imperative truncation also shows an underapplication identity effect. This involves a vowel raising rule Prince (1975) calls A-to-I (also known as the Barth-Ginsberg Gesetz), which raises [a] to [i] in initial closed syllables. A-to-I is another general process in Tiberian Hebrew, observed in a number of prefixes before triliteral roots. The imperfective prefix on the triliteral stems in (43), which is underlyingly /ya-/, surfaces as [yi-] by the rule in (53).

(53) A-to-I a --> i / #C__CC

The A-to-I process underapplies in imperatives of the Piʕēl binyan, where doubling of the medial root consonant creates the environment for vowel raising. The forms in (54) show that the A-to-I rule applies in unaffixed perfectives, ensuring that [i], not the underlying /a/, appears in the initial closed syllable. Raising is not conditioned by prefixed imperfectives, where the first vowel of the word is not followed by a consonant cluster. In the truncated imperative forms, A-to-I unexpectedly fails to apply, even though these stems have an [a] in the appropriate environment. This is an underapplication identity effect; the imperative faithfully reproduces the vowel quality of its imperfective base.

(54)	perfective	imperfective	imperative	
	giddēl	yəgaddēl	gaddēl	'magnify'
	limmād	yəlammēd	lammēd	'teach'

Based on the earlier discussions of English and Icelandic, the identity effects in (52) and (54) must be forced by undominated BT-Identity constraints. Undominated IDENT-BT_{imp}[v-height] forces underapplication of A-to-I raising, and an undominated DEP-BT_{imp} constraint against consonantal epenthesis prevents the root-initial consonants in (52) from appearing in the truncated words, since these root-initial segments fail to surface in the imperfective bases. The Phono-Constraints that drive vowel-glide coalescence, nasal assimilation and vowel raising must have equal or lower rank than these BT-Identity requirements, to force mis-application in imperative stems.

Over- and underapplication in imperative truncation will not be analyzed in any detail here; these facts are presented primarily to support the truncation analysis of the imperatives in (43), where BT-Identity is violated by normal application of the phonology. Because the imperatives in (43) are not faithful to any surface properties of their bases, it is not obvious that these imperatives are derived by truncation of the imperfective stem, rather than from the underlying root. The fact that other imperatives do copy surface properties of imperfectives confirms the truncation analysis of imperative morphology.

22 Degemination applies normally, at the word edge, in this imperative stem.

To sum up, I have shown that some phonological processes apply normally, while others under- or overapply in truncated imperative stems, and argued that this effect is achieved by constraint ranking. The BT-Identity constraints DEP-BT$_{imp}$ and IDENT-BT$_{imp}$[cont] are dominated by *COMPLEX and the spirantization constraints, forcing normal application of epenthesis and post-vocalic spirantization in truncated imperative forms. Other BT-Identity constraints are undominated, forcing mis-application of vowel-glide coalescence, nasal assimilation and A-to-I raising in truncated imperative stems.

3.3.2 Jussives and Second Person Feminine Singular (2fs) Stems

Jussives are formed by truncation of the final vowel of the imperfective stem. Only verbs with historically weak third consonants (the III-[w,y] class) have vowel-final imperatives that can undergo jussive truncation (Prince 1975; McCarthy 1979).

(55) Tiberian Hebrew Jussive Truncation

a. Epenthesis applies normally		b. Epenthesis underapplies	
Imperfective	Jussive	Imperfective	Jussive
yiḡlē	yiḡəl	yišbē	yišb
yiḇzē	yiḇəz	yip̄tē	yip̄t
yiḇnē	yiḇən	yēštē	yēšt
yišʕē	yišaʕ	yēḇkē	yēḇk
yimħē	yimaħ	yiśṭē	yēśṭ
not attested	yiħad	yirdē	yērd
		yašqē	yašq

As noted in this display, some truncated jussives show normal application of epenthesis; a vowel with no base correspondent appears in the jussives in (55a).[23] Epenthesis underapplies in (55b), and the base's consonant cluster remains intact in final position in the truncated form. The descriptive generalization is that epenthesis applies if the base's consonant sequence rises in sonority, or if the first consonant of the sequence is a guttural. If the consonant cluster has level or falling sonority, epenthesis does not apply.[24] The last jussive listed in (55a) also shows underapplication of post-vocalic spirantization; the final obstruent follows a vowel, but is not spirantized.

Truncation of the second person feminine singular (2fs) affix shows the same identity effects. When the 2fs affix /tii/ appears word-finally, its vowel is truncated. An epenthetic vowel appears between the root and the truncated suffix only if the root-final consonant is a guttural. Spirantization also underapplies in 2fs stems. When epenthesis applies normally, as in the last two forms in (56), the word-final [t] fails to spirantize.

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[23] The epenthetic vowel, which is otherwise [ə], appears as [a] adjacent to gutturals.

[24] Lebanese Arabic has the same pattern of epenthesis in rising sonority and guttural-obstruent clusters (McCarthy p.c.).

(56) 2fs truncation

/katab - tī/	>	kāṯaḇt	'you (fs) wrote'	cf.	kāṯaḇtī	'I wrote'
/karat - tī/	>	kəratt	'you cut off'	cf.	kārattī	'I cut them off'
/šamaʕ - tī/	>	šāmaʕat	'you (fs) heard'	cf.	šāmaʕtī	'I heard'
/šalaħ - tī/	>	šālaħat		cf.	šālaħtī	

The vowel of the 2fs affix surfaces word-medially (e.g., [kāṯaḇtīm] 'you (fs) wrote to them', [kərattīm] 'you (fs) cut them (m) off'), but it never appears in word-final position. The first person forms given on the right in (56) show that there is no phonological constraint preventing the long high vowel from surfacing word-finally, suggesting that the 2fs stems are morphologically truncated (Prince 1975; McCarthy 1979). This analysis is confirmed by the identity effects in (56); the underapplication of epenthesis in [kāṯaḇt] and the underapplication of post-vocalic spirantization in [šāmaʕat, šālaħat].[25] I will consider the epenthesis patterns first, and then turn to spirantization.

Apart from a few atypical nouns, morphological truncation is the only source of complex codas in Tiberian Hebrew. In non-truncated words, all complex syllable margins are prevented by epenthesis. Tableau (45) above shows that epenthesis in word-initial clusters is forced by ranking *COMPLEX ("no complex onsets") over DEP-IO. The "no complex codas" provision of *COMPLEX also outranks DEP-IO, as demonstrated in (57) with a cluster-final input /sepr/ 'book' (cf. [sīpri] 'my book') (Prince 1975). The faithful candidate (57a) fails on *COMPLEX. Epenthesis in the optimal form (57b) violates DEP-IO, but satisfies the higher-ranked syllable structure constraint.

(57) *COMPLEX (*CC]$_\sigma$) >> DEP-IO

Input: /sepr/	*COMPLEX *CC]$_\sigma$	DEP-IO
a. sēpr	*!	
b. √ sēpər		*

Because the *COMPLEX constraint against complex codas dominates DEP-IO, coda clusters never appear in non-truncated Tiberian Hebrew words.[26]

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[25] In the 2fs stem [kəratt], where a [t]-final root is concatenated with the [-tii] affix, it is unclear (due to orthographic ambiguity) whether the truncated surface form ends in a geminate, as transcribed here, or a non-spirant stop. If this word ends in a non-spirant stop, it simply shows underapplication of spirantization, analogous to the underapplication in the epenthetic forms [šāmaʕat, šalaħat]. However, if the final segment of [kəratt] is in fact a geminate, this word fails to undergo degemination, which is expected to simplify geminates at word-edges (Prince 1975). This means that a BT-Identity constraint regulating consonantal length must dominate the Phono-Constraints that force degemination. As noted earlier (in fn. 22), degemination applies normally in the imperative truncation [tēn] ≈ [yittēn], which indicates that the analogous IDENT-BT[c-length] constraint on imperative truncation ranks below the degemination constraints. Thus, if [kəratt] does end in a geminate, we have more evidence that the BT-Identity constraints on imperative truncation are distinct from the BT-Identity constraints on jussive/2fs truncation.

[26] Note also that it is not possible to satisfy *COMPLEX by appending the final consonant to the Foot or PrWd level (Sherer 1994). An undominated *APPENDIX constraint must prevent this marked configuration.

The jussive/2fs pattern of epenthesis in rising sonority and guttural-obstruent clusters cannot be produced solely by the ranking of *COMPLEX with DEP-BT$_{juss/2fs}$. If the BT-Identity constraint ranks below *COMPLEX, epenthesis should occur in all jussive/2fs forms, and ranking DEP-BT$_{juss/2fs}$ above *COMPLEX predicts that epenthesis will never occur jussive/2fs stems. A more precise characterization of the syllable structure requirements is needed. The SON-CON constraint governing complex syllable margins, introduced in the Icelandic analysis in §3.2, can be utilized here to account for sonority-driven epenthesis. SON-CON (58) is a specific version of the *COMPLEX constraint against coda clusters; that is, SON-CON is violated by a subset of the candidates that violate *COMPLEX.

(58) SON-CON "no rising sonority coda clusters"

In jussives and 2fs stems, SON-CON prevents rising sonority coda clusters by dominating DEP-BT$_{juss/2fs}$, as shown in (59). Candidate (59a) is faithful to the base. Because it contains no segment that lacks a base correspondent, this form satisfies DEP-BT$_{juss/2fs}$. However, the rising sonority [gl] coda cluster in (59a) fatally violates dominant SON-CON. The optimal form (59b) satisfies SON-CON by epenthesis, incurring an irrelevant violation of low-ranking DEP-BT$_{juss/2fs}$.

(59) SON-CON >> DEP-BT$_{juss/2fs}$

Base: [yiḡlē]	SON-CON	DEP-BT$_{juss/2fs}$
a. yiḡl	*!	
b. √ yiḡəl		*

Ranking DEP-BT$_{juss/2fs}$ below SON-CON forces epenthesis in jussives and 2fs stems only if the base's consonant sequence rises in sonority. Ranking DEP-BT$_{juss/2fs}$ above the general constraint against coda clusters, *COMPLEX, ensures that epenthesis will not occur unless the rising sonority condition is met. In (60), the base's consonant sequence does not rise in sonority, and no epenthesis is observed in the optimal jussive stem.

(60) SON-CON >> DEP-BT$_{juss/2fs}$ >> *COMPLEX (*CC]$_\sigma$)

Base: [yip̄tē]	SON-CON	DEP-BT$_{juss/2fs}$	*COMPLEX *CC]$_\sigma$
a. √ yip̄t			*
b. yip̄ət		*!	

The consonant cluster in (60) does not rise in sonority; the voiceless obstruents are equally sonorous.[27] Both candidates therefore satisfy the top-ranked SON-CON constraint. Candidate (60a), which contains no segments that lack base correspondents, is selected as optimal by the BT-Identity constraint DEP-BT$_{juss/2fs}$. The optimal form's violation of the lower-ranked general constraint, *COMPLEX, is irrelevant.

[27] Allophonic spirantization has no apparent effect on the sonority of the labial stop in (60).

The ranking in (61) forces epenthesis in jussive/2fs stems just in case the base's consonant sequence rises in sonority. Through domination of DEP-$BT_{juss/2fs}$, SON-CON requires epenthesis to prevent highly-marked (rising sonority) coda clusters. Less-marked (level or falling sonority) coda clusters may surface, however, because DEP-$BT_{juss/2fs}$ dominates the general constraint against coda clusters, *COMPLEX. Remember that the general *COMPLEX constraint dominates DEP-IO, so that non-truncated words of the language never have any coda clusters at all.

(61) SON-CON >> DEP-$BT_{juss/2fs}$ >> *COMPLEX (*CC]$_{\sigma}$) >> DEP-IO

Epenthesis also occurs in final guttural-obstruent sequences in jussive and 2fs stems. In the jussive [yiħad], the guttural glide is more sonorous than the following stop, satisfying SON-CON, but epenthesis nonetheless occurs, violating DEP-$BT_{juss/2fs}$. In this case, epenthesis is compelled by the CODA-COND in (62), which prohibits pharyngeal consonants in codas (McCarthy & Prince 1993b).

(62) CODA-COND *[pharyngeal])$_{\sigma}$ "no gutturals in codas"

McCarthy & Prince show that this CODA-COND is active in Tiberian Hebrew phonology; it dominates DEP-IO and forces epenthesis of the underlined vowels in (63) (McCarthy & Prince 1993b:42).

(63) ye.ʔe̲.sōp 'he will gather'
ya.ʕa̲.mōd 'he will stand'
ye.ħe̲.zaq 'he is strong'

Tableau (64) shows that CODA-COND dominates DEP-IO, ensuring that it is more harmonic to epenthesize a vowel and parse a guttural as its onset than to syllabify a guttural as a coda.

(64) CODA-COND >> DEP-IO

Input: /ya+ʔsōp/	CODA-COND	DEP-IO
a. yaʔ.sōp	*!	
b. √ ya.ʔa.sōp		*

CODA-COND is not, however, an undominated constraint in Tiberian Hebrew; gutturals do appear as codas word-finally, and stem-finally before consonant-initial suffixes. This is shown in (65), with both non-truncated (65a) and truncated (65b) words. In the affixed forms, a vertical line '|' marks the right edge of the stem.

(65) a. rēʕ 'companion'
yədaʕ|.tem 'you knew'
šālaħ|.tī 'I sent'
b. šəmaʕ 'hear!' (imperative)
šāmaʕ 'he heard' (jussive)

McCarthy & Prince propose that the CODA-COND violations in (65) are compelled by a constraint requiring stems to be right-aligned with a syllable. This ALIGN-R constraint is given in (66).

(66) ALIGN-R "every stem is aligned at its right edge with
Align (Stem, R, syllable, R) the right edge of some syllable"

Parsing gutturals as codas in (65) allows the stems to be properly aligned. Thus, the ALIGN-R constraint must dominate CODA-COND, as in (67). In candidate (67a), the guttural is an onset to an epenthetic vowel, satisfying CODA-COND. However, the stem boundary (marked '|') falls in the middle of a syllable in (67a), fatally violating ALIGN-R. The optimal form (67b) satisfies dominant ALIGN-R by parsing the guttural as a coda, incurring an irrelevant violation of CODA-COND.

(67) ALIGN-R (Stem, syllable) >> CODA-COND

Input: /šālaħ + t̄ī/	ALIGN-R	CODA-COND
a. šā.la.ħ|a.t̄ī	*!	
b. √ šā.laħ|.t̄ī		*

MAX-IO must also be high-ranking, to prevent satisfaction of CODA-COND by deletion of the guttural. This is shown in (68), with monomorphemic [rēʔ] 'companion'. In candidate (68a), CODA-COND is satisfied by deletion of the guttural, but this fatally violates higher-ranking MAX-IO. Parsing the guttural as an onset to an epenthetic vowel (68b) also satisfies CODA-COND, but is fatally mis-aligning. The optimal candidate (68c) satisfies both high-ranking constraints by violating CODA-COND.

(68) MAX-IO, ALIGN-R (Stem, syllable) >> CODA-COND >> DEP-IO

Input: /rēʔ/	MAX-IO	ALIGN-R	CODA-COND	DEP-IO
a. rē	*!			
b. rē.ʔ|a		*!		*
c. √ rēʔ			*	

By the ranking in (68), gutturals can appear as codas in stem-final position only. If the guttural cannot be both stem-final and syllable-final, epenthesis applies, and the guttural is parsed as an onset.

Truncated words pattern with non-truncated words with respect to guttural codas; both imperatives and jussive/2fs stems allow guttural codas finally, but not medially. The MAX-BT and DEP-BT constraints governing each truncation pattern must, then, have the same ranking relevant to ALIGN-R >> CODA-COND as the IO-Faith constraints in (68). That is, the ranking MAX-BT, ALIGN-R >> CODA-COND >> DEP-BT forces epenthetic vowels to appear after gutturals in truncated words, unless syllabifying the guttural as a coda satisfies ALIGN-R.

This same ranking forces epenthesis in guttural-obstruent clusters in jussive and 2fs stems. This is shown in (69), with the 2fs stem [šā.ma.ʕat] 'you heard'.

(69) MAX-$BT_{juss/2fs}$, ALIGN-R >> CODA-COND >> DEP-$BT_{juss/2fs}$

Base: [šā.maʕ|.tī]	MAX-$BT_{juss/2fs}$	ALIGN-R	CODA-COND	DEP-$BT_{juss/2fs}$
a. šā.maʕ|.	**!		*	
b. šā.maʕ|t.	*	*	*!	
c. √ šā.ma.ʕ|at.	*	*		*

The base in (69) is the first person stem [šāmaʕtī] 'I heard', in which the stem /šāmaʕ/ is properly right-aligned with a syllable, at the cost of a CODA-COND violation. The 2fs candidate (69a) is also properly aligned, but this form incurs gratuitous MAX-BT violation; loss of a single base segment satisfies the morphological deletion requirement, but this truncated candidate fails to realize two base segments. The remaining candidates (69b-c) minimally violate MAX-BT. These candidates both violate ALIGN-R, so the decision falls to CODA-COND, which selects (69c), where the guttural is parsed as an onset to an epenthetic vowel.

In candidate (69b), there is no epenthesis, and the guttural-obstruent sequence is syllabified as a complex coda, fatally violating CODA-COND. However, another non-epenthesizing candidate has to be considered: this is [šā.maʕ.t], in which the affixal [t] is not in a syllable coda, but is adjoined as an appendix to the Foot or PrWd. This candidate violates CODA-COND, but it satisfies higher-ranked ALIGN-R, since the stem-final guttural is properly aligned with the right edge of a syllable. Because the optimal form violates ALIGN-R, a dominant constraint against appendices must rule out the competitive form, shown as candidate (70a).

(70) *APPENDIX >> ALIGN-R (Stem, syllable)

Base: [šā.maʕ|.tī]	*APPENDIX	ALIGN-R
a. šā.maʕ|.t	*!	
b. √ šā.ma.ʕ|at.		*

With appendices prohibited by undominated *APPENDIX, and loss of the obstruent prevented by high-ranking MAX-BT, no competitive 2fs candidate satisfies ALIGN-R. Among the unaligned candidates (69b-c), optimal 2fs stems are selected by the ranking of CODA-COND over the anti-epenthesis constraint DEP-$BT_{juss/2fs}$. I noted earlier (in fn. 26) that *APPENDIX is also visibly active in non-truncated words; together with *COMPLEX, it dominates DEP-IO and forces epenthesis in all word-final consonant sequences. The DEP-$BT_{juss/2fs}$ constraint, however, ranks above *COMPLEX, allowing complex codas to surface, as long as they do not violate higher-ranked CODA-COND. The ranking that prohibits guttural-obstruent codas in jussive/2fs stems is summarized in (71).

(71) MAX-$BT_{juss/2fs}$, *APPENDIX >> ALIGN-R >>
CODA-COND >> DEP-$BT_{juss/2fs}$ >> *COMPLEX ($*CC]_{\sigma}$)

Recall that DEP-$BT_{juss/2fs}$ is also dominated by SON-CON, the constraint against rising sonority coda clusters, as shown in (72).

(72) SON-CON, CODA-COND >> DEP-$BT_{juss/2fs}$ >> *COMPLEX (*CC]$_\sigma$)

The two top-ranked constraints in (72) prohibit the most marked coda clusters; those with rising sonority and guttural-obstruent sequences. Unmarked coda clusters, on the other hand, may surface in jussive and 2fs stems, because DEP-BT outranks the general *COMPLEX constraint. This markedness distinction, which is not recognized in the non-truncatory phonology of Tiberian Hebrew, emerges in jussive/2fs stems. While non-truncated words prohibit all complex codas by *COMPLEX >> DEP-IO, truncated jussive/2fs stems allow coda clusters, but only the least marked coda clusters. The ranking (72) forces an emergent unmarkedness phenomenon (McCarthy & Prince 1994a); a markedness distinction not exhibited in the language as a whole is revealed in a limited morphological domain.

The final identity effect in Tiberian Hebrew discussed here is the underapplication of post-vocalic spirantization in truncated jussive and 2fs stems. When the base consonant cluster is broken up by epenthesis, as in the 2fs stems in (73), the stop following the epenthetic vowel fails to show spirantization.

(73)	/šamaʕ - tī/	>	šāmaʕat	'you (fs) heard'
	/šalaħ - tī/	>	šālaħat	

As discussed earlier, spirantization in Tiberian Hebrew is predictable; it affects all and only post-vocalic stops. Truncated forms like those in (73) are the only source of non-spirant post-vocalic stops; the spirantization process is otherwise pervasive, applying even across word boundaries (McCarthy 1979). The spirantization constraints are repeated in (74). *V-STOP prohibits non-spirant stops post-vocalically, and the markedness constraint *SPIR penalizes spirantization.

(74)	*V-STOP	*V $C_{[-cont]}$	"no post-vocalic noncontinuants"
	*SPIR	*[-son, -strident]	"no non-strident fricatives"

These constraints, ranked above IDENT-IO[continuant], drive the regular allophonic alternation. Normal application of spirantization in imperatives, discussed in §3.3.1, shows that the analogous BT_{imp}-Identity constraint is also dominated by the spirantization constraints (see (48) above). The IDENT-BT[cont] constraint on imperative truncation cannot, then, be relevant to truncated jussive/2fs stems, since spirantization underapplies in (73). To force this underapplication effect, the IDENT-$BT_{juss/2fs}$[cont] constraint on final-V truncation has to dominate *V-STOP. Both candidates in (75) satisfy CODA-COND and violate DEP-$BT_{juss/2fs}$ by epenthesizing a vowel between the guttural and the final stop. They differ only in spirantization of the final [t].

(75) IDENT-BT[cont] >> *V-STOP

Base: [šā.maʕ.tī]	IDENT-$BT_{juss/2fs}$ [cont]	*V-STOP
a. šāmaʕaṯ	*!	
b. √ šāmaʕat		*

Spirantization is not expected, and is not observed, on the [t] in the base, since this segment is not post-vocalic. However, correspondents of this [t] are post-vocalic in competitive truncated forms, by the ranking in (69). Spirantization of [t] in candidate (75a) satisfies the *V-STOP constraint, but fatally violates higher-ranking IDENT-BT[cont]. The optimal form (75b) satisfies the BT-Identity constraint by failing to spirantize the word-final stop.

Because they must be ranked differently with respect to the same Phono-Constraint, IDENT-$BT_{juss/2fs}$ and IDENT-BT_{imp} must be distinct. Following Urbanczyk (1995), I assume that each truncation morpheme in Tiberian Hebrew is associated with its own set of identity constraints, just as each reduplicative morpheme in a language with more than one has a distinct set of BR-Identity requirements. Because distinct correspondence constraints can be ranked differently in the parochial hierarchy of Phono-Constraints, imperatives and jussive/2fs stems may show different patterns of spirantization.

To summarize, the full ranking governing spirantization in Tiberian Hebrew is given in (76). Spirantization underapplies in jussive and 2fs stems, due to the ranking of IDENT-$BT_{juss/2fs}$[cont] >> *V-STOP. Domination of IDENT-BT_{imp}[cont] by the spirantization constraints forces normal application of spirantization in truncated imperative stems. Low-ranking IDENT-IO[cont] ensures that the spirantization alternation is observed in non-truncated words of the language.

(76) IDENT-$BT_{juss/2fs}$[cont] >> *V-STOP >> *SPIR >> IDENT-BT_{imp}[cont],
IDENT-IO[cont]

3.3.3 Tiberian Hebrew Summary

I have analyzed two patterns of truncation in Tiberian Hebrew, both of which show normal application of phonological processes as well as under- or overapplication identity effects. In imperatives, which are marked by truncation of the initial CV of the imperfective, epenthesis into complex syllable margins and post-vocalic spirantization apply normally, where they are properly conditioned, disrupting identity between base and truncated form. As shown, normal application occurs when BT-Identity constraints are ranked below phonological constraints. Imperative truncation also exhibits under- and overapplication of segmental processes, including vowel-glide coalescence, nasal assimilation, and the A-to-I vowel raising rule. The relevant BT-Identity constraints on imperative truncation must outrank the constraints that drive these processes.

Jussives and 2fs stems are also sometimes identical to their bases, and sometimes not, but in the final-V truncation pattern, a single phonological process both applies normally and underapplies. Epenthesis applies normally only in the most marked coda clusters, those that rise in sonority or contain a guttural. Ranking the anti-epenthesis constraint DEP-$BT_{juss/2fs}$ below specific constraints that prohibit marked codas, and above the general constraint that penalizes all coda clusters, epenthesis is forced only in rising sonority and guttural obstruent sequences. This an emergent unmarkedness patterm, in which a markedness distinction not observed in the phonology of the language as a whole emerges in a special morphological domain.

The discussion also showed that each truncation process in Tiberian Hebrew is regulated by parallel but distinct BT-Identity constraints. Because spirantization applies normally in imperative forms, and underapplies in jussive and 2fs stems, and identity-disrupting normal application is forced by domination of BT-Identity by a Phono-Constraint while identity-preserving underapplication requires the opposite ranking, each truncation pattern in Tiberian Hebrew must be associated with distinct BT-Identity requirements.

Positing a set of BT-Identity constraints, and allowing these constraints to be ranked among structural output constraints, the BT-correspondence model predicts the observed range of variation in (non)identity between truncated words and their sources. When BT-Identity constraints are undominated, truncated forms are identical to the corresponding portion of the base. When BT-Identity constraints are dominated, BT-Identity is sacrificed. As shown above, this model allows for variation in (non)identity across languages, as well as within a single language, even among forms in the same morphological paradigm. In the next section, I consider alternative accounts of truncatory (non)identity that rely on rule ordering theory.

3.4 Rule Ordering

In theory of ordered rules, under- and overapplication identity effects are explained by ordering morphological truncation after the relevant phonological rules. For example, in New York-Philadelphia English, truncation takes place after syllabification of the base and the subsequent selection of the tense or lax allophone [æ ≈ E]. The allophonic rule has to apply before truncation does, and not be allowed to re-apply after truncation creates a different syllabic environment for the alternating vowel.

(77) New York-Philadelphia English Truncation, Serially

	'Pamela'	'mandible'
input	/pæmələ/	/mændɪbl̥/
syllabification	pæ.mə.lə	mæn.dɪ.bl̥
æ-tensing	n/a	mEn.dɪ.bl̥
truncation	pæm	n/a

In the left-hand column in (77), the closed-syllable æ-tensing rule is not conditioned by the base name *Pamela* before it undergoes truncation to CVC. When truncation derives the closed syllable environment, it is too late for the æ-tensing rule to apply.

When truncated words mimic derived phonological properties of their bases, morphological truncation has to follow phonological rules. Truncatory identity effects thus pose a challenge to the traditional hypothesis that morphology precedes phonology; this is the position taken in *SPE* (Chomsky & Halle 1968) and defended more recently by Halle & Vergnaud (1987) and Odden (1993). Odden argues for a non-interactive model of grammar, in which morphology and phonology are distinct components, and all morphological rules precede all phonological rules. To account for truncatory identity effects in Danish, which show overapplication of lengthening (see (3-4) above), Odden proposes that truncation is a phonological rule (albeit one restricted to a morphological category), rather than a rule of the morphological component.[28]

More commonly, linguists have argued that phonology and morphology interact. Two "interactionist" positions can be distinguished.[29] Anderson (1975)

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[28] Carrier-Duncan (1984) makes similar a proposal regarding the copying rule of reduplication.

[29] I take this term from Hargus (1993), who gives a concise review of the "interactionist" and "non-interactionist" positions, and presents an array of data supporting the former.

looks at under- and overapplication identity effects in truncation and reduplication and concludes that morphology and phonology are not distinct grammatical components. He notes that "loss of transparency of one rule [i.e., the phonological rule effecting the under- or overapplying process, which is not transparent due to its mis-application - LB] is compensated for by a gain in transparency for another [the morphological rule of truncation, which is transparent when the truncated form resembles the base - LB]" (1975:58). For Anderson, no special ordering relations are entailed by the typological distinction between morphological and phonological rules.

Contra Anderson, Aronoff (1976) proposes that the interaction of morphological and phonological rules is serially constrained. Morphological processes may be ordered at any of three points in the derivation: before the phonology, after the phonology, and between the cyclic and post-cyclic phonological rules. Lexical Phonology (Kiparsky 1982; Mohanan 1982, 1986) develops this proposal, modelling the interaction between morphological and phonological rules. Although various models have been proposed, the leading idea of Lexical Phonology is that morphology and phonology are interleaved, so that phonological rules can interact with morphological operations in a serially-ordered derivation. This interaction is constrained by dividing the grammar into two major components, the lexical and the post-lexical levels, and allowing morphology and phonology to interact only at the lexical level. The lexical component may be further divided up into levels or strata, which may or may not by cyclic; rules assigned to a cyclic stratum apply after each pass through the morphology.[30] At the post-lexical or post-cyclic level, automatic or allophonic rules apply. Post-lexical phonology is also sensitive to syntactic information, allowing post-lexical rules to apply between words in a phrase.

In a Lexical Phonology derivation, truncation in New York-Philadelphia English must be ordered after the post-lexical phonology, since it follows the allophonic [æ ≈ E] rule. It appears, then, that a level of post-lexical morphology is required, ordered after the post-lexical phonology. The Icelandic truncation pattern is similar. Recall that Icelandic truncation exhibits both under- and overapplication identity effects; epenthesis and [j]-deletion underapply in truncated words, and stress-conditioned vowel lengthening overapplies. Truncation must be ordered after all of these rules have had their chance at the derivation, as shown in (78). According to Kiparsky (1984), vowel lengthening in Icelandic is a post-lexical rule, and epenthesis and [j]-deletion apply at both the lexical and post-lexical levels. Morphological truncation must be ordered after the post-lexical phonology of Icelandic, following all applications of the over- and underapplying rules.

(78) Icelandic Truncation, Serially (Kiparsky 1984)

	Input	/sötra/	/grenja/
Lexical Rules	syllabification	sö.tra	gren.ja
	initial stress	sö.tra	grén.ja
	epenthesis, j-deletion	n/a	n/a
Post-Lexical Rules			
	epenthesis, j-deletion	n/a	n/a
	v-lengthening	söö.tra	n/a
Morphology	**truncation**	söötr	grenj
	Output	söötr	grenj
		'sipping'	'crying'

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30 "Interstratal cyclicity" may also be required, so that the same phonological rule will apply at more than one lexical level.

As noted earlier, epenthesis applies normally in [r]-final truncated action nouns for some Icelandic speakers, so that the optimal form of 'sipping' is *söötu**r***, not *söötr*. This was accounted for in §3.2 by ranking the BT-Identity constraint against epenthesis below the syllable structure constraint that drives vowel insertion. In rule-ordering theory, the epenthetic alternant forms are generated by ordering morphological truncation before application of the epenthesis rule. Kiparsky (1984) proposes that for these Icelandic speakers, truncation precedes the post-lexical component. This allows epenthesis to affect the [r]-final forms.

Simply ordering truncation before the post-lexical phonology of Icelandic does not, however, get the correct results. First, if truncation precedes the post-lexical phonology, epenthesis must crucially precede vowel lengthening at the post-lexical level, since epenthesis feeds lengthening in stressed open syllables. This is a natural ordering relation, likely to be required in other cases. However, ordering truncation between the lexical and post-lexical components derives the wrong form **gren* as the truncated version of *grenja* 'to cry'. If truncation precedes all post-lexical phonology, the post-lexical glide deletion rule should remove the glide, as shown in (79).

(79) Icelandic Truncation, Epenthetic Alternants

	Input	/sötra/	/grenja/
Lexical Rules	syllabification	sö.tra	gren.ja
	epenthesis, j-deletion	n/a	n/a
Morphology	**truncation**	sötr	grenj
Post-Lexical Rules	epenthesis, j-deletion	sötur	gren
	v-lengthening	söö.tur	n/a
	output	söötur	*gren
		'sipping'	'crying'

To get the correct surface form in both stems, morphological truncation must be ordered between post-lexical phonological rules. Truncation has to apply after the post-lexical application of [j]-deletion, so that this rule will underapply in *grenj*, and before the post-lexical application of epenthesis, so that this rule can apply normally in *söötur*. This is shown in (80).

(80) Icelandic Truncation, Epenthetic Alternants, revised

	Input	/sötra/	/grenja/
	syllabification	sö.tra	gren.ja
Post-Lexical Rules	j-deletion		n/a
Morphology	**truncation**	sötr	grenj
More Post-Lexical Rules	epenthesis	sötur	
	v-lengthening	söö.tur	
	output	söötur	grenj
		'sipping'	'crying'

These Icelandic facts are problematic for the Lexical Phonology model. Post-lexical rules should not be interleaved with morphological processes; the lexical form /grenja/ should not be able to avoid post-lexical [j]-deletion, be passed to the morphology for truncation and then re-enter the phonology (along with truncated forms like /sötr/) to undergo epenthesis and vowel lengthening. The arbitrary ordering of truncation in Icelandic, which follows the post-lexical phonology for some speakers and occurs between post-lexical rules for others, is not a good result for the Lexical Phonology model (see Kiparsky 1984).

The Tiberian Hebrew facts pose even more difficult challenges for rule-ordering theories. In Tiberian Hebrew, two truncation processes must be ordered among the phonological rules. Initial-CV imperative truncation follows a number of over- and underapplying rules, including vowel-glide coalescence, nasal assimilation and the rule raising [a] to [i] in initial closed syllables. Imperative truncation also precedes epenthesis, spirantization and degemination rules, which apply normally in imperative stems.

(81) Tiberian Hebrew Imperative Truncation, Serially

Input	/ya-ydaʕ/	/ya-gaddēl/	/ya-ntēn/	/ya-ktōb/
A-to-I		n/a	yittēn	
n-assimilation			yittēn	
VG-coalescence	yēdaʕ			
Imperative truncation	daʕ	gaddēl	ttēn	ktōb
degemination			tēn	
epenthesis				kətōb
spirantization				kəṯōḇ
Output	daʕ	gaddēl	tēn	kəṯōḇ

In the derivation in the first column in (81), vowel-glide coalescence applies before imperative truncation, resulting in the loss of the root-initial glide in the truncated form; this is an overapplication identity effect. In the second column, the A-to-I rule fails to apply to the base before truncation of the prefix, resulting in an underapplication identity effect. In the third derivation, nasal-assimilation applies before truncation, assimilating the nasal to the following stop. Truncation of the initial CV creates the environment for the degemination rule, which applies normally to eliminate the word-initial geminate. The last column shows normal application of schwa epenthesis and post-vocalic spirantization. Because morphological deletion produces the environments that condition these rules, epenthesis and spirantization must follow imperative truncation.

The final-V truncation that marks jussives and second feminine singular (2fs) stems must take place at a later point in the derivation, as shown in (82). Final-V truncation follows the spirantization rule, which underapplies in jussive and 2fs forms ([yiħad], [šāmaʕat]), and the degemination rule, which underapplies in the 2fs stem [kəratt].[31] The general epenthesis rule, which inserts a vowel into all complex syllable margins, must also precede final-V truncation, to prevent epenthesis in the final clusters of the jussive and 2fs stems like [yip̄t], [kāṯaḇt]. To account for the normal application of epenthesis in rising sonority and guttural-obstruent clusters, two specific epenthesis rules are required. These special rules, which target obstruent-sonorant and guttural-obstruent syllable margins, follow final-V truncation.

[31] As discussed in fn. 25, it is unclear whether this stem ends in a geminate or a non-spirant stop.

(82) Tiberian Hebrew Jussive/2fs Truncation, Serially

Input	/yiptē/	/yiglē/	/karat-tī/	/šāmaʕ-tī/
degemination			n/a	
general epenthesis				
spirantization	yip̄tē	yiḡlē		
Jussive/2fs Truncation	yip̄t	yiḡl	kəratt	šāmaʕt
C - [son] epenthesis		yiḡəl		
[gutt] - C epenthesis				šāmaʕat
Output	yip̄t	yiḡəl	kəratt	šāmaʕat

All of the derivations in (82) illustrate underapplication of the general epenthesis rule. Because this rule precedes final-V truncation, it does not apply in any jussive or 2fs forms. In the first column, general epenthesis does not apply before truncation, and the specific epenthesis rules do not apply to the [pt] cluster after truncation of the final vowel, so this jussive surfaces with a coda cluster. In the second derivation, general epenthesis similarly underapplies. However, after truncation of the final vowel, one of the specific epenthesis rules is conditioned, and no cluster surfaces in this form. The third derivation shows underapplication of degemination; because this rule precedes truncation, it cannot affect the geminate-final 2fs stem. The last column shows underapplication of post-vocalic spirantization. After truncation of the base-final V, one of the special epenthesis rules applies, but it is too late for spirantization to affect the word-final stop.

(81) and (82) overlap; the degemination, general epenthesis and spirantization rules that follow imperative truncation in (81) are the same rules that precede jussive/2fs truncation in (82). While this set of ordered rules can correctly generate all of the Tiberian Hebrew truncated forms, the analysis has some significant problems. First, the spirantization rule in Tiberian Hebrew should be a late or post-lexical phonological rule, since it is predictable or allophonic (the only exceptions being truncated jussive/2fs forms), and it applies across word-boundaries (McCarthy 1979). But in (82), spirantization is followed by not only a morphological truncation rule, but also by the special epenthesis rules. These special epenthesis rules are a second problem. These rules apply only in jussive and 2fs stems. Because non-truncated words (and truncated imperatives) prohibit all complex codas, the specific epenthesis rules are irrelevant to all but jussive and 2fs forms. Positing special rules that cannot be generalized to other areas of Tiberian Hebrew phonology is clearly undesirable.

Also, notice that the special epenthesis rules target the most marked complex codas, those that rise in sonority or have guttural-obstruent clusters. In ordered-rule theories, it is simply accidental that the clusters cleaned up after truncation are highly-marked. Constraint-ranking, on the other hand, explains this; the most marked clusters are those penalized by the highest-ranked constraints. As shown in §3.3.2, ranking the BT-Identity constraint against epenthesis below specific constraints against rising sonority and guttural codas and above the general constraint against all coda clusters rules out only the most marked complex codas, the correct result. Unlike constraint-ranking, rule-ordering can describe, but not explain this fact.

More generally, arbitrariness of the ordering between morphological truncation and phonological rules is problematic for rule-ordering theories, which strive to establish natural precedence relations between rules. In contrast, the constraint-based approach is inherently arbitrary. Truncatory identity constraints should be ranked differently with respect to different phonological constraints across languages, or speakers, or within or among morphological paradigms. Moreover, there is no expectation that under- and overapplying phonological processes should be morphophonemic, rather than allophonic alternations; unlike Lexical Phonology, the constraint-based OT approach does not need to constrain arbitrary orderings by typological distinctions between lexical and post-lexical rules. Arbitrariness in the morphology-phonology interface is an expected result under the constraint-based OT model, given arbitrary constraint ranking.

One of the most significant differences between the two theories of truncation is the place given to the notion of identity. In rule-ordering accounts, identity of base and truncated form is guaranteed only at the moment when the deletion operation takes place; further derivation may obscure the identity relation. The resemblance between the two surface forms is not directly linked to the morphological truncation itself; if base and truncated version have the same allophone, this is an arbitrary result of ordering the allophonic alternation before deletion, and has little to do with the morphological relation between the words. In the correspondence model, identity plays a more central role: constraints demand perfect identity between base and truncated form. Through domination of BT-Identity constraints, less-than-perfect identity may be achieved, but the relation between the words is always evident at the surface. In the constraint-based model, identity of base and truncated form, formalized through correspondence, is a defining feature of truncatory morphology.

While rule-ordering adequately captures the facts,[32] the constraint-based approach is a clear improvement over processual accounts of truncatory identity effects. Positing an identity relation between base and truncated form is obviously a more explanatory approach to the under- and overapplication phenomena analyzed here. The constraint-ranking model predicts that truncated words will be identical to their bases in some cases, and non-identical in others. In rule-based theories, this variation is modelled by stipulative ordering relations between morphological and phonological rules, and in some cases, by positing special rules that are otherwise unmotivated in the grammar. While arbitrary orderings are problematic for rule-based theories, inherently arbitrary constraint-ranking predicts the observed range of results.

Finally, note that the correspondence model allows truncated words to be generated by parallel, one-step mappings between strings. Assuming correspondence between output forms, truncatory over- and underapplication identity effects, which have been thought to require serial derivation, are given a non-procedural OT account. Parallelism is discussed more fully in the last section of this paper, in the context of a general comparison of identity effects in truncatory and reduplicative morphology. The next section, §4, discusses other ways that BT-Identity constraints play a role in selecting optimal truncated forms.

4. Templatic Deletion

This section turns away from featural identity effects to consider the prosodic organization of truncated words. I argue that given a correspondence relation between the truncated word and its base, prosodic templates can be eliminated from the theory of morphological truncation. Three hypocoristic patterns

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32 In contrast, rule-ordering theories of reduplication encounter ordering paradoxes (see McCarthy & Prince 1995). A brief comparison or truncatory and reduplicative mis-application is undertaken in §6 below. Based on that discussion, the lack of rule-ordering paradoxes in truncation can be linked to the transderivational nature of the BT-correspondence relation.

in Japanese analyzed by Poser (1990) and Mester (1990) are discussed. In each pattern, base names are reduced to minimal (bimoraic) word size. In §4.1, truncation to a minimal word is analyzed as the emergence of unmarked prosodic structure. Following McCarthy & Prince (1994a), I show that templatic truncation results from domination of BT-Identity (specifically, of MAX-BT, the faithfulness constraint requiring a *complete* mapping from base to truncated form) by general prosodic constraints. This analysis accounts for both the deletion of base material and the consistent shape of the hypocoristic forms, without invoking a morphological template for truncated words.[33] Prosodic Circumscription (McCarthy & Prince 1990) in truncation and elsewhere is discussed in §4.2. Following McCarthy (1995), circumscriptional phenomena are analyzed as prosodic identity effects forced by high-ranking BT-correspondence constraints. If output-to-output correspondence is posited, both "mapping target" templates and "prosodic delimitor" templates are superfluous.

4.1 Templatic Deletion in Japanese: The Emergence of the Unmarked

In each of the three Japanese hypocoristic patterns shown in (83-85), base names are truncated to a bimoraic foot (Poser 1990; Mester 1990; Itô 1990). The first pattern is the ordinary hypocoristic paradigm (83). These truncated stems are suffixed with the diminutive [-čan].

(83) Japanese Hypocoristics

Midori	Mido-čan, Mii-čan
Yooko	Yoko-čan, Yoo-čan
Akira	Aki-čan
Hiromi	Hiro-čan, Romi-čan
Mariko	Mari-čan, Mako-čan
JuNko	JuN-čan
Hanako	Hana-čan, Haa-čan, Hač-čan
Kazuhiko	Kazu-čan

The variation in (83) is typical of nickname formation.[34] The truncated stems are always exactly bimoraic, but they may be one syllable or two, as long as the undominated Japanese CODA-COND is obeyed (JuN-čan, Hač-čan, but *Han-čan).[35] Vowels in the base name may lengthen or shorten (<u>Mi</u>dori ≈ <u>Mii</u>-čan; <u>Yuu</u>ko ≈ <u>Yu</u>ko-čan). Also, in some rare cases, the "no skipping" provision of CONTIGUITY may be violated, so that non-contiguous base segments may be contiguous in the truncated form (<u>Ma</u>ri<u>ko</u> ≈ <u>Mako</u>-čan). In every case, however, the truncated stem is a single bimoraic foot.

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33 The analysis in §4.1 deals only with so-called *templatic* truncation, in which the truncated output is a consistent prosodic unit, unsually a minimal word (a foot). Another, less common type of truncation deletes a consistent unit (usually a syllable or a mora) from the base, so that truncated outputs vary in size. This *subtractive* pattern of truncation is not discussed here.

34 Variation in nicknames may be motivated by pragmatic factors such as the need to distinguish people with the same name, or levels of intimacy with the nickname bearer. In Japanese, nickname formation may also be influenced by orthographic considerations (see Poser 1990).

35 Only placeless nasals (written [N]), geminates and nasals homorganic to a following stop may appear in codas in Japanese (see Itô 1986; Itô & Mester 1994).

In the second truncation pattern, the Geisha House Discretionary Client Names in (84), source words are similarly reduced to a bimoraic foot. These forms are subject to the additional restriction that they be monosyllabic. Again, the CODA-COND is always respected. Because these truncated stems must be monosyllabic, less variation is possible in this pattern. The Geisha House Names take the honorific affixes [o-] and [-saN].

(84) Japanese Geisha House Discretionary Client Names

Tanaka	o-Taa-saN, *o-Tana-saN
Koono	o-Koo-saN
HoNda	o-Hoo-saN, o-HoN-saN
Saiki	o-Saa-saN, o-Sai-saN

In the third pattern, the Rustic Girls' Names in (85), the truncated form contains all of the material associated with the first two moras of the base name. No variation at all is possible in this pattern; the truncated stems is always identical to the initial bimoraic foot of the base. These truncated nicknames also take a prefixal [o-].

(85) Japanese Rustic Girls' Names

Midori	o-Mido, *o-Mii, *o-Dori
Yuuko	o-Yuu, *o-Yuko
Kaede	o-Kae
Takie	o-Taki
Hanako	o-Hana, *o-Haa, *o-Han

All of the stems in (83-85) consist of a single bimoraic foot. Poser (1990) and Mester (1990) propose that Japanese truncation involves mapping to a bimoraic foot template. In the correspondence model, *mapping* is understood as a correspondence relation between base and truncated form, fully analogous to the mapping from input to output. I will argue that there is no target template in Japanese. Truncation to a bimoraic foot is the emergence of unmarked prosodic structure.

Following McCarthy & Prince (1994a), I propose that truncation to a foot in Japanese is a case of "the emergence of the unmarked"; the Japanese truncated forms are minimal or unmarked prosodic words (PrWds). In their analysis of Diyari reduplication, McCarthy & Prince develop a constraint-based analysis of minimal word (MinWd) reduplicative templates. MinWds are maximally unmarked PrWds. A PrWd is unmarked when it dominates a binary foot that is aligned at the edge of the PrWd, and when all syllables in the PrWd are footed. Word minimality is enforced by domination of faithfulness constraints by the "PrWd restrictor" constraints, FTBIN, ALIGN-Ft-L and PARSE-SYLL, given in (86). If these constraints are satisfied, a single binary foot stands at the left edge of the PrWd; additional feet and unfooted syllables are not tolerated.

(86) FTBIN "feet are binary on a syllabic or moraic analysis"

ALIGN-Ft-L "every foot is initial in the PrWd"
Align(Ft, L, PrWd, L)

PARSE-SYLL "all syllables are parsed into feet"

In languages like Diyari, where reduplicants are disyllables or single feet, reduplicant size results from domination of MAX-BR (which demands complete copying of base material in the reduplicant) by the PrWd restrictor constraints. When the PrWd restrictors dominate MAX-BR, reduplicants copy only enough base material to support a minimal or unmarked PrWd. McCarthy & Prince (1994a) thus eliminate mapping target templates in reduplication, obviating templatic constraints like RED=PrWd or RED=Ft assumed in earlier OT work.[36]

From a more general perspective, McCarthy & Prince's analysis of Diyari reduplication reduces "minimal word" to a descriptive category. MinWds are simply PrWds that obey the PrWd restrictor constraints. This analysis can be applied directly to Japanese MinWd truncation. If FTBIN, ALIGN-FT-L and PARSE-SYLL dominate MAX-BT, source words must be truncated down to a single foot. This is shown in (87), where candidates that fully satisfy MAX-BT are compared with the optimal truncated form. Hereinafter, parentheses delimit feet, and periods separate syllables within feet. The syllables surrounded by curly braces in the base and in candidate (87c) are unfooted and adjoined to the PrWd.[37]

(87) FTBIN, PARSE-SYLL, ALIGN-Ft-L >> MAX-BT

Base: (mi.do){ri}	FTBIN	PARSE-SYLL	ALIGN-Ft-L	MAX-BT
a. (mi.do.ri)	*!			
b. (mi.do)(ri)	*!		*	
c. (mi.do){ri}		*!		
d. √ (mi.do)				**

In candidates (87a-c), all base segments are realized, incurring fatal violation of high-ranking constraints. In (87a), all base syllables are parsed into a single foot, in violation of FTBIN. Parsing the final syllable into its own monomoraic foot in (87b) violates both FTBIN and ALIGN-Ft-L. Leaving the last syllable unfooted in (87c) fatally violates PARSE-SYLL. The optimal form satisfies all of the higher-ranked constraints by violating MAX-BT; two base segments have no correspondents in the optimal truncated output. Because MAX-BT is low-ranking, the shortened form (87d) is optimal.[38]

Strikingly, Japanese base names may also lengthen to satisfy the dominant prosodic constraints. Poser (1990) reports that the one monomoraic name he has come across lengthens in the derived hypocoristic. In processual theories, this fact is anomalous, since lengthening rather than shortening produces a "truncated" nickname. In the constraint-based approach, lengthening of a truncated word is not problematic; hypocoristics are expected to obey all constraints that dominate BT-Identity, including FTBIN. The base name [Ti] becomes [Tii-čan] in its hypocoristic form, in order to satisfy the FTBIN requirement. The BT-Identity constraint governing correspondent vowel length must therefore be dominated by FTBIN.

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[36] In Generalized Template theory (McCarthy & Prince 1994b), the PrWd-hood of the Diyari reduplicant follows from the fact that the reduplicant is a stem, not an affix. Morphological marking, which is independently required in inputs, determines the prosodic shape of the reduplicant. Reduplicative morphemes marked as stems surface as PrWds, while affixal reduplicants comprise a syllable or less (see McCarthy & Prince 1994b, Urbanczyk in prep.).

[37] This is the Weak Layering hypothesis of Itô & Mester (1992) (see (90) below).

[38] The candidate that incurs lesser violation of MAX-BT, **Midor*, fatally violates the undominated Japanese CODACOND.

(88) FTBIN >> IDENT-BT[v-length]

Base: (ti)	FTBIN	IDENT-BT [v-length]
a. (ti)	*!	
b. √ (tii)		*

Domination of BT-Identity constraints by FTBIN, ALIGN-Ft-L and PARSE-SYLL ensures that all hypocoristic forms are exactly bimoraic. There is no need for a templatic constraint (like TRUNC-WD = PrWd) to specify the size of the truncated form; this follows from domination of BT-Identity by independently motivated and very general constraints.

As Itô (1990) points out, only "derived" Japanese words are required to be minimally and maximally bimoraic.[39] Tokyo Japanese has many monomoraic words (*su* 'vinegar', *ya* 'arrow' *ki* 'tree'), so FTBIN is not always satisfied. Japanese also has words longer than two moras, so ALIGN-Ft-L and PARSE-SYLL cannot always be satisfied either. Violations of these constraints are forced by high-ranking IO-Faith constraints. For example, given a monomoraic input, dominant IO-Faith prevents augmentation strategies like vowel lengthening or consonantal epenthesis, forcing violation of FTBIN, as shown in (89). The FTBIN violation is compelled by Lex≈PrWd (Prince & Smolensky 1993).

(89) DEP-IO, IDENT-IO[v-length] >> FTBIN

Input: /ki/	IDENT-IO [v-length]	DEP-IO	FTBIN
a. (kii)	*!		
b. (kiy)		*!	
c. √ (ki)			*

The vowel lengthening candidate (89a) incurs a violation of IO-Faith with respect to length. The glide-epenthesizing candidate (89b) violates DEP-IO, since not all output segments have input correspondents. The optimal form is faithful to the input, but it foots a single light syllable and violates FTBIN.

Following Itô (1990) and Itô & Mester (1992, 1993), I assume that FTBIN is violated only in monomoraic Japanese words, by the force of Lex≈PrWd. In longer forms, monomoraic feet are not optimal; instead, unfootable syllables are adjoined to the PrWd in a "weak layering" configuration, shown in (90).

(90)
PrWd
Ft
σ σ σ
mi. do. ri = $[(mi.do)\{ri\}]_{PrWd}$

---

[39] Only Tokyo Japanese allows monomoraic words; the Kansai dialect spoken in Osaka obeys a bimoraic word minimum. Itô remarks that both hypocoristic truncation and loan-word abbreviation must conform to the FTBIN constraint, but "underived" Tokyo Japanese words are not necessarily bimoraic. BT-correspondence provides a formal characterization of the derived/underived distinction Itô discusses: derived forms are those related to another output by correspondence.

The foot in (90) is aligned with the left-edge of the PrWd (Itô 1990; Itô, Kitagawa & Mester 1992).[40] Because feet are maximally and minimally bimoraic, the final light syllable cannot be incorporated into the initial foot, or be footed on its own. This syllable must be incorporated into the prosodic structure, so it adjoins to the PrWd. This shows that MAX-IO dominates PARSE-SYLL; it is better to realize all input segments in *Midori* than it is to fully foot the output string. This is shown in (91). Again, parentheses surround feet, and curly braces mark unfooted syllables.

(91) MAX-IO >> PARSE-SYLL

Input: /midori/	MAX-IO	PARSE-SYLL
a. (mi.do)	**!	
b. √ (mi.do){ri}		*

The failed candidate in (91a) manages to satisfy PARSE-SYLL by failing to provide correspondents for the last two segments of the input string. In the optimal form (91b), all input segments have output correspondents, satisfying MAX-IO, but one syllable is unfooted in the output form.

Longer input-output pairs show that MAX-IO also dominates ALIGN-Ft-L. The input in (92) is organized into two bimoraic feet in the optimal output (92b). Because the second foot is not aligned at the left edge of the PrWd, this candidate violates ALIGN-Ft-L. The failed candidate (92a) satisfies ALIGN-Ft-L by fatally violating MAX-IO.

(92) MAX-IO >> ALIGN-Ft-L

Input: /kazuhiko/	MAX-IO	ALIGN-Ft-L
a. (ka.zu)	****!	
b. √ (ka.zu)(hi.ko)		*

I have established that MAX-IO dominates both PARSE-SYLL and ALIGN-Ft-L, and that FTBIN is dominated by other IO-Faith constraints (DEP-IO and IDENT-IO[v-length]). These rankings ensure that words longer and shorter than a bimoraic foot can surface in Japanese. I have also shown that each of these output constraints dominates MAX-BT, forcing truncation of base names down to MinWd size. To summarize, the motivated rankings are given in (93). Because MAX-BT is dominated by FTBIN, ALIGN-Ft-L and PARSE-SYLL, truncated words always consist of exactly one bimoraic foot. There is, then, no need for a MinWd mapping template in Japanese truncation.

(93) DEP-IO, IDENT-IO[v-length] >> FTBIN >> IDENT-BT[v-length]
FTBIN, MAX-IO >> PARSE-SYLL, ALIGN-Ft-L >> MAX-BT

In more general terms, the Japanese ranking is as in (94). This is the emergent unmarkedness ranking discussed by McCarthy & Prince (1994a).

(94) IO-Faith >> Phono-Constraint >> BT-Identity

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[40] Following Itô & Mester (1993) and Itô, Kitagawa & Mester (1992), I assume that left-edge foot alignment in Japanese is enforced by a violable constraint. In their study of the jazz musician language *Zuuja-go*, Itô et.al. demonstrate that an ALIGN-Ft-L constraint is active (high-ranking) in Japanese. A word composed of three light syllables will therefore be footed as shown in (90).

Because IO-Faith dominates Phono-Constraint, the phonological constraint is not enforced in non-truncated words of the language. But since the Phono-Constraint dominates BT-Identity, truncated forms must obey the phonological constraint, even though this entails non-identity of base and truncated form. The ranking in (94) ensures that truncated words obey constraints that may be violated by non-truncated words of the language. This results in the emergence of unmarked prosodic structure in morphologically truncated forms.

The emergent unmarkedness analysis of Japanese suggests that truncated outputs do not stand in correspondence with the input string, as encoded in the schematic model in (95).

(95)

		BT-Identity	
	[mi.do.ri]	------------	[mi.do]
	|		
IO-Faith	|		
	/midori/		

The truncated output [mi.do] is linked only to its base [mi.do.ri]; there is no correspondence relation between the truncated output and the input string /midori/. Because the truncated output is not in an IO-correspondence relation, it is not subject to IO-Faith constraints. This could not be demonstrated earlier, in §3, since in the languages discussed there, IO-Faith is low-ranking. However, the analysis of Japanese just given suggests that this is correct. If the truncated forms were subject to the high-ranking IO-Faith constraints that govern non-truncated words of Japanese, truncated and non-truncated words would be expected to have the same phonology. For instance, truncated words would be expected to violate FTBIN, because non-truncated words are not subject to this constraint, due to dominant IO-Faith. Since truncated words always respect FTBIN and the other PrWd restrictor constraints, I propose that truncated forms do not stand in a correspondence relation with the input.[41]

I have shown that deletion of base material from truncated forms is forced by domination of BT-Identity by prosodic output constraints. Following McCarthy & Prince (1994a), I argued that templatic truncation to a minimal PrWd in Japanese is the emergence of unmarked prosodic structure, forced by domination of MAX-BT by the PrWd restrictor constraints FTBIN, ALIGN-Ft-L and PARSE-SYLL. This analysis accounts for both deletion of base material and the templatic shape of the truncated form, without invoking a mapping target template. Next, I argue that the other familiar use for templates, as prosodic delimitors, is similarly made obsolete by Correspondence Theory.

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41 Unmarked structure emerges in reduplicants even though reduplicants are related to the input by IO-correspondence (see (9) above, and McCarthy & Prince 1994a, 1995). However, in reduplication, two types of IO-Faith constraints can be distinguished: faithfulness constraints on roots or stems (ROOT-FAITH) and faithfulness constraints on affixes (AFFIX-FAITH), ranked as ROOT-FAITH >> AFFIX-FAITH (see McCarthy & Prince 1994ab, 1995, Urbanczyk in prep.). Reduplicants, which are affixed to their bases, are subject to lower-ranked AFFIX-FAITH constraints. Thus, in cases of emergent unmarkedness in reduplication, a Phono-Constraint intervenes between the two types of IO-Faith requirements. Truncated forms, in contrast, are not affixed to the base. Because both the base and the truncated form are stems or roots, it is unclear how to properly divide the IO-Faith constraints, in order to allow a Phono-Constraint to intervene and force emergent unmarkedness in truncated words. As laid out above, I assume that there simply is no correspondence between the input and the truncated form, so that truncated words are not subject to any IO-Faith constraints.

4.2 Prosodic Identity Effects

In many languages, the form of a truncated word depends on the prosodic organization of the base. For example, English hypocoristics are often formed from the stressed foot of the source, as in *[Bén]jamin ≈ Bén* (McCarthy & Prince 1986), and the same is true of Spanish nicknames, as in *Fer[nándo] ≈ Nándo* (Weeda 1992). Focusing on the Japanese Rustic Girls Names pattern of truncation, in which the intial foot of the base is reproduced in the truncated form, this section looks at the BT-Identity constraints that force prosodic identity effects.

Truncated words that mimic the prosodic organization of their bases provide strong support for the output-to-output correspondence proposal. This is especially clear in languages where prosodic organization is entirely predictable (although it is no less true in languages with lexical or inherent stress). Traditionally, predictable prosody is assumed to be absent from underlying representations. In OT, prosodic organization is regulated by output constraints. Prosodic structure (syllables, feet, etc.) therefore may or may not be present in input strings, and is reliable only in output representations. In languages with contrastive stress, lexical prosodic structure is posited, but the surface prosody of the word must still be determined by the interaction of faithfulness constraints with metrical output constraints. Since output constraints can take precedence over faithfulness to lexical structure, prosody is reliable only in output forms.

The Japanese Rustic Girls Name truncation pattern, repeated in (96), is a clear case of prosodic identity. In these truncated forms, the initial foot of the base name is reproduced exactly.

(96) Japanese Rustic Girls' Names

Midori	o-Mido, *o-Mii, *o-Dori
Yuuko	o-Yuu, *o-Yuko
Kaede	o-Kae
Takie	o-Taki
Hanako	o-Hana, *o-Haa, *o-Han

Mester (1990) proposes that this truncation pattern involves a circumscriptional template, which delimits the base material that maps to the truncated form. Mester's analysis draws on the theory of Prosodic Circumscription developed by McCarthy & Prince (1990).[42] Circumscription theory holds that prosodic constituents may be parsed out of the base before morphological operations like affixation or deletion apply, either to the circumscribed constituent or to the residue of the base. In (96), the initial foot is circumscribed and mapped to the target template.[43] Prosodic Circumscription theory has similarly inspired other analyses of truncation.[44]

Prosodic Circumscription theory is, however, inherently procedural, requiring first a prosodic parse and then a morphological operation. The output-to-output correspondence proposal provides a way to analyze circumscriptional effects in non-procedural Optimality Theory. Following McCarthy (1995), I propose that circumscriptional effects are forced by constraints requiring prosodic identity between corresponding output strings.

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[42] McCarthy & Prince (1990) establish output-to-output relations by demonstrating that the Arabic broken plural is derived from the surface form of the singular stem, not the underlying root.

[43] Alternatively, it might be assumed that the initial foot of the base is circumscribed and the residue of the base is deleted.

[44] Weeda (1992) applies circumscription-plus-mapping theory to truncation patterns in many languages, and Lombardi & McCarthy (1991) propose a circumscription and deprosodization analysis of truncation in the Muskogean language Koasati.

McCarthy (1995) posits prosodic identity requirements as output-to-output correspondence constraints, requiring correspondent segments to be identical with respect to their prosodic affiliation. Prosodic identity constraints target prosodic heads or prosodic edges. In his study of the Rotuman phase alternation, McCarthy proposes a high-ranking constraint on identity of prosodic heads, which forces corresponding outputs to have the same stressed vowel. The English and Spanish hypocoristics mentioned earlier, which mimic the stressed foot of the base name, are similarly faithful to the prosodic head of the base. In the Japanese truncation pattern in (96), the relevant constraints regulate the edges of prosodic constituents. Adapting ANCHOR constraints, which were originally proposed in McCarthy & Prince (1993a) to regulate directionality effects in reduplication, McCarthy (1995) proposes constraints that require correspondents of peripheral segments to be similarly peripheral in some prosodic constituent. The ANCHOR-L-(Ft) constraint in (97) is an example.

(97) ANCHOR-L(Ft)
"every correspondent of a foot-initial segment is foot-initial"

ANCHOR-L(Ft) requires correspondents of foot-initial segments to be similarly foot-initial. This constraint, which refers to the prosodic affiliation of both correspondents, is an identity constraint over an output-to-output relation.

McCarthy (1995) shows that constraints like ANCHOR-L(Ft) allow a non-procedural OT account of all kinds of circumscriptional phenomena. Here, I will briefly demonstrate that ANCHOR constraints are relevant to morphological truncation. To account for the circumscriptional effect in the Japanese Rustic Girls' Names pattern, where nicknames are always perfectly faithful to the initial bimoraic foot of the base name, I will rely on the ANCHOR-L(Ft) constraint in (97) along with its right-edge counterpart, given in (98).

(98) ANCHOR-R(Ft)
"every correspondent of a foot-final segment is foot-final"

The table in (99) shows that candidate Rustic Girls' Names which violate either ANCHOR-L(Ft) or ANCHOR-R(Ft) are not optimal. The optimal truncated candidate (99d) obeys both constraints. As mentioned earlier, I assume that a bimoraic foot is aligned at the left edge of a trisyllabic base name like *Midori*. In (99), the base is displayed to the left of each truncated candidate, with double-underlining marking correspondent segments. Every candidate in (99) satisfies FTBIN, ALIGN-Ft-L and PARSE-SYLL, the PrWd restrictor constraints that drive truncation in Japanese. The candidates differ only in satisfaction of the ANCHOR constraints.

(99) Japanese Rustic Girls' Names

Base	Candidates	ANCHOR-L(Ft)	ANCHOR-R(Ft)
(mi.<u>do</u>){<u>ri</u>}	a. [<u>do.ri</u>]	*!	*!
(<u>mi</u>.do){ri}	b. [<u>mii</u>]		*!
(mi.<u>do</u>){ri}	c. [<u>doo</u>]	*!	
(<u>mi.do</u>){ri}	d. √ (<u>mi.do</u>)		

In candidate (99a), neither edge of the base foot respected. Segments at the edge of the foot in the base name do not have correspondents at foot-edges in the truncated form. In (99b), the correspondent of the segment at the left edge of the base's foot is similarly foot-initial, but the segment at the right edge of the base foot does not have a correspondent at the right foot-edge in the truncated form. Candidate (99c) respects the right foot-edge, but not the left foot-edge of the base. In the optimal form (99d), both ANCHOR-L(Ft) and ANCHOR-R(Ft) are satisfied.[45]

With relations between words formalized in terms of correspondence, static constraints on prosodic identity can produce circumscriptional effects in a one-step mapping between output strings, obviating the procedural prosodic delimitation account. Because OT output constraints cannot require or prohibit prosodic organization in inputs, so that elements of prosodic organization may be underlyingly present or not, prosodic structure can be relied upon only in output representations. Therefore, circumscriptional phenomena, which make crucial reference to the prosodic organization of the base, require a relation between output forms.

In introducing Correspondence Theory, McCarthy & Prince (1994b) propose that correspondence allows a unified account of many problems of Prosodic Morphology:

> To capture the connections and still leave room for the differences, we need a way to generalize over identity relations - base/reduplicant, input/output, stem/stem (in root-and-pattern, circumscriptional and truncatory morphology). (McCarthy & Prince 1994b: Part II)

My study of truncatory identity effects follows up on McCarthy & Prince's suggestion. As they note, and McCarthy (1995) demonstrates in some detail, correspondence can also govern other morphological relations between surface forms, relating a base and an infixed form, as in Ulwa possessive infixation [siwának] ≈ [siwá-ka-nak], where the affix attaches to the stressed foot of the base, or a base and a templatically-derived counterpart, and in the Rotuman phase alternation [pure] ≈ [puer] or the Arabic broken plural [nafs] ≈ [nufuus]. In each of these cases, correspondence relates two output forms, and identity effects may be forced by constraint interaction. In the next section, I propose that output-to-output correspondence can be generalized beyond Prosodic Morphology to ordinary concatenative processes, to account for segmental alternations previously attributed to the cyclic application of phonological rules.

5. "Cyclic" Effects

The output-to-output correspondence proposal can be extended very naturally to an analysis of phonological patterns that are often explained with level-ordering or cyclic rule application.[46] This section focuses on one case, which is representative of a large number of examples, in which a class of affixes appears to

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[45] In the ordinary hypocoristic pattern in (83), the base name [Midori] may be truncated to a monosyllable [Mii-čan]. This shows that ANCHOR-R(Ft) is not high-ranking. As noted earlier, each truncation morpheme must be associated with a distinct set of BT-Identity requirements, including distinct ANCHOR requirements. Unlike ANCHOR-R(Ft), ANCHOR-L(Ft) is highly-ranked in all Japanese hypocoristic truncations. Mester (1990) reports one hypocoristic example in which ANCHOR-L(Ft) is violated, [Hiromi] ≈ [Romi-čan]. However, according to a small informal sample of Japanese speakers, this nickname is either dispreferred or entirely unacceptable. The candidate that obeys ANCHOR-L(Ft), [Hiro-čan], is the preferred hypocoristic form.

[46] The examples discussed in this section involve segmental or featural alternations that have been attributed to cyclic rule application. Burzio (1994), working in a different framework, develops an analysis of English stress patterns which similarly relies on transderivational relations.

be attached outside of the word. From a different perspective, these are cases in which a stem inside an affixed word behaves phonologically as if it were unaffixed. In some languages, preserving the word-like properties of the affixed stem induces identity effects. The New York-Philadelphia dialects discussed earlier provide an example: as shown in (100), the æ-tensing process is sensitive to the distinction between "class 1" and "class 2" morphology. The root vowel is tense in unaffixed forms, lax before suffixes like {-ic, -ive}, and tense before the {-ing, -able} class of affixes (Dunlap 1987; Borowsky 1993; Ferguson 1972).

(100) New York-Philadelphia æ-Tensing, Level-Sensitivity

Unaffixed		Class 1 Affix		Class 2 Affix	
class	[klEs]	classic	[klæ.sik]	classy	[klE.si]
mass	[mEs]	massive	[mæ.siv]	massable	[mE.sə.bl̥]
pass	[pEs]	passive	[pæ.siv]	passing	[pE.siŋ]

In all of the affixed words, the root-final consonant is parsed as an onset to the vowel-initial suffix. Because the alternating vowel is in an open syllable, tensing is not expected. Forms with class 1 affixes meet this expectation, surfacing with lax [æ]. Tensing unexpectedly applies, or overapplies, in words with class 2 affixes.

This overapplication effect suggests an analysis based on correspondence.[47] Suppose that words with class 1 affixation like *passive* are derived in the familiar way, through input-output mapping, so that the optimal form will have an open initial syllable and a lax vowel, as expected. Class 2 affixation, in contrast, can be derived through an output-to-output correspondence with the unaffixed word. If *passing* [pE.siN] corresponds to the output form of *pass* [pEs], the tense vowel in the affixed form can be required by identity constraints.

First, recall the analysis of New York-Philadelphia æ-tensing developed earlier. This allophonic alternation is driven by interaction of three constraints: the æ-TENSING constraint that prohibits the lax alternant in closed syllables, the markedness constraint against tense low vowels, and the IO-Faith constraint governing vowel tenseness. The allophony ranking of æ-TENSING >> *TENSE-low >> IDENT-IO[tense] ensures that the tense allophone regularly appears in closed syllables only. No matter what vowel is present in the input string, the top-ranked æ-TENSING constraint forces the tense alternant to appear in the closed syllable *pass*, as shown in (101).

(101) æ-TENSING >> *TENSE-low >> IDENT-IO[tense]

Input: /pEs/	æ-TENSING *æC]$_\sigma$	*TENSE-low	IDENT-IO [tense]
a. pæs	*!		*
b. √ pEs		*	

Tableau (102) shows the derivation of the class 1 affixed form *passive*, achieved by an input-output mapping. High-ranking ONSET forces syllabification of the root-final [s] as an onset in all competitive candidates. Because the æ-TENSING constraint is vacuously satisfied when [æ] is in an open syllable, the ranking of *TENSE-low over IO-Faith ensures that the vowel in *passive* is lax [æ], even if the tense allophone is posited in the input form.

[47] This analysis was suggested by John McCarthy.

(102) æ-TENSING >> *TENSE-low >> IDENT-IO[tense]

Input: /pEs-iv/	æ-TENSING $*æC]_{\sigma}$	*TENSE-low	IDENT-IO [tense]
a. √ pæ.siv			*
b. pE.siv		*!	

Words with class 2 affixes are derived by correspondence with the unaffixed surface form. More precisely, I assume that class 2 affixes trigger a correspondence relation with the surface form of the unaffixed base. Abstracting away from the status of the class 2 affix, (103) shows this schematically.[48] The output-to-output correspondence relation here is BA-correspondence, between the **b**ase and the **a**ffixed form.

(103)

BA-Identity

[pEs] --------------- [pE.siŋ]

IO-Faith |

/ pæs /

The base and the affixed form differ in syllabification, but they have the same tense vowel. The ranking in (100) forces the tense allophone to appear in the unaffixed base [pEs]. The affixed form, where the alternating vowel is in an open syllable, does not condition tensing; the tense vowel is forced in [pE.siN] by faithfulness constraints on the output-to-output BA-correspondence.

In §3, I established that IDENT-BT[tense] is undominated in the New York-Philadelphia dialects, forcing underapplication of æ-tensing in truncated nicknames. The analogous BA-Identity constraint, similarly undominated, can force overapplication of æ-tensing in words with class 2 affixes. The affixed form *passing* must have a tense vowel because its base *pass* has a tense vowel. As shown in (104), satisfaction of BA-IDENT[tense] forces violation of the markedness constraint *TENSE-low.

(104) BA-IDENT[tense] >> *TENSE-low

Base: [pEs] - iŋ	BA-IDENT [tense]	*TENSE-low
a. pæ.siŋ	*!	
b. √ pE.siŋ		*

No ranking can be established in (104) between BA-IDENT[tense] and æ-TENSING, the constraint that drives the tensing alternation. Since ONSET forces syllabification of the [s] in *passing* as an onset in all competitive candidates, the æ-TENSING constraint is vacuously satisfied. The undominated output-to-output correspondence constraint ensures that the tense vowel, which appears regularly in the base's closed syllable, is copied in the related output, even though tensing is not conditioned in the affixed word.

[48] Obviously, some set of faithfulness constraints is relevant to the phonology of the affix itself; otherwise all class 2 affixes would surface as minimally marked [ba]. I assume that the affix is in an IO-correspondence relation with its lexical form.

Phonological contrasts between class 1 and class 2 affixation in English are well-known. Unlike class 2 suffixes, class 1 suffixes affect stress (*périod-periódic*), and trigger rules like trisyllabic shortening (*divine-divinity*) and lenition (*critic-criticize-critical*; *permit-permission-permitting*) Siegel (1974) explains these contrasts by assuming that the {-ive, -ity} class attaches at an earlier level of derivation than the {-ing, -able} class of affixes. In her analysis of the overapplication effect in (100), Dunlap (1987) proposes that the New York-Philadelphia æ-tensing rule applies after level 1 affixation and syllabification of the root-final consonant as an onset to the suffix, but before level 2 affixation similarly captures the root-final consonant into the second syllable. Since the rule applies before affixation in *passing*, the vowel is tensed by the closed-syllable tensing rule.

(105) Class 2 Overapplication, Serially (Dunlap 1987)

input 'pass'	/pæs/	/pæs/
level 1 affixation of '-ive'	pæs-iv	
syllabification	pæ.siv	pæs
æ-tensing	n/a	pEs
level 2 affixation of '-ing'		pEs-iŋ
re-syllabification		pE.siŋ
output	[pæ.siv]	[pE.siŋ]

By dividing the derivation into two levels, the æ-tensing rule is made regular, affecting vowels in closed syllables only.

Borowsky (1993) extends this level-ordering model to a number of similar cases. For Borowsky, the two levels are the "stem-level" and the "word-level"; the æ-tensing rule applies at the word-level, before the morphology affixes morphemes like {-ing, -able}. Borowsky's terminology echoes earlier proposals. Selkirk (1984) proposes that concatenation of the root and affix in *passive* derives another root, while concatenation in *passing* yields a morphological word. In *SPE* (Chomsky & Halle 1968), class 1 affixes attach at a "+" stem boundary, while class 2 affixes follow a "#" word boundary. The phenomenon is apparently quite robust: some affixes attach to a fully-formed word. The correspondence proposal captures this straightforwardly, by proposing that class 2 affixes essentially concatenate with a word; more specifically, with a fully-formed output word.

The semantic contrast between class 1 and class 2 affixation in English can also be linked to output-to-output correspondence. In general, words with class 2 affixes are compositionally related to their unaffixed counterparts, but words with Level I affixes are not. Class 1 words like *classic, passive*, etc., are formed by lexical concatenation (that is, by concatenation of morphemes in the input, with an IO-mapping to the surface form), and are expected to show semantic drift away from the meaning of the unaffixed nouns *class, pass,* etc., given that semantic shifts are commonly associated with "lexicalization" of a polymorphemic words. In contrast, *classable* and *passing*, which stand in a correspondence relation with an unaffixed word, should be more transparently related in meaning to their bases.

Like the level-ordering account, the output-to-output correspondence proposal allows the æ-tensing alternation to be "regular". Tensing is driven by a ranking of æ-TENSING >> *TENSE-low >> IDENT-IO[tense]. This ranking is constant; it does not change. BA-Identity constraints, ranked at the top of the hierarchy, force the apparent irregularities in forms with class 2 suffixes, just as BT-Identity constraints force æ-tensing irregularities in truncated words. Rather than dividing the phonological component into two levels, the contrasts between *passive* and *passing* are explained by distinguishing two sets of faithfulness constraints.

Not all so-called "cyclic effects" require an output-to-output correspondence relation. Many of these phenomena can be accounted for with a simple input-to-output mapping.[49] However, the large class of level-sensitivity effects similar to the case discussed here do not seem tractable without a relation between output forms. While this discussion has only sketched out the core idea, without considering a great number of implications, it's clear that the correspondence proposal can recapitulate the effects of level-ordering in non-procedural Optimality Theory. In the correspondence model, all words are derived by a one-step mapping between strings, with evaluation of infinite candidate sets by a language-particular constraint hierarchy, as is familiar in standard OT.

The output-to-output correspondence proposal does, however, suggest a restricted sort of serialism, in that the mapping from the input to the base is evidently prior to the mapping to the related output form. The base essentially functions as an input to truncation/affixation, in that the truncated/affixed word is required to be faithful to the base in the same way that an ordinary output is required to be faithful to its lexical input. What this means for the OT model of grammar, particularly what it means for the principle of parallelism, is discussed in the following, final section of the paper.

6. Concluding Remarks: Word-Word Relations

Truncated words are related to their source words by correspondence, and through this relation, ranked constraints require truncated words to be identical to their source word bases. In the examples of over- and underapplication identity effects examined here, truncated words mimic surface properties of their source words, even though this entails violation of high-ranking structural constraints. Because truncated words may faithfully reproduce allophonic properties, which are reliably present only in the surface form of the base, the BT-Identity constraints must regulate a transderivational relation between two separate outputs.

(106)

```
                          BT-Identity
                  Base   ----------   Truncated Form
                   |
      IO-Faith     |
                  Input
```

By positing a distinct set of faithfulness constraints on truncated words, and ranking these identity requirements in the independently-established parochial constraint hierarchy, the special phonological behavior of morphologically truncated words can be given a principled account.

Over- and underapplication in truncation are formally non-distinct; both are forced by top-ranked BT-Identity constraints. The overapplication ranking is simply a less-articulated version of the underapplication hierarchy; in both, BT-Identity constraints are undominated. Constraints demanding BT-Identity may also be violated under domination, resulting in surface non-identity of base and

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[49] Reference to morphological information may restrict the 'domain of application' of a phonological process. For example, constraints demanding alignment of morphological and prosodic categories, or the split between ROOT-FAITH and AFFIX-FAITH, could play a role in limiting the force of a phonological constraint.

truncated form. When both BT-Identity and IO-Faith constraints are dominated by a Phono-Constraint, the effects of the structural constraint will be felt in both truncated and non-truncated forms; this is the ranking called normal application. If BT-Identity is dominated by a Phono-Constraint, but IO-Faith constraints outrank the structural requirement, the effects of the constraint will be felt only in truncated words, resulting in "the emergence of the unmarked" in the special morphological domain. The four general ranking schema are repeated in (107).

(107) Truncation Ranking Schema

Overapplication	BT-Identity, Phono-Constraint >> IO-Faith
Underapplication	BT-Identity >> Phono-Constraint >> IO-Faith
Normal application	Phono-Constraint >> BT-Identity, IO-Faith
Emergent Unmarkedness	IO-Faith >> Phono-Constraint >> BT-Identity

Because BT-Identity constraints are ranked and violable, the correspondence model (106) predicts that truncated words will be sometimes identical, and sometimes non-identical to their bases. This was shown to be true both cross-linguistically and within a single language. Moreover, because BT-Identity is a set of constraints that separately governing all of the parameters along which phonological representations vary, the BT-correspondence model allows variation within a single morphological paradigm. The arbitrariness of constraint-ranking appropriately models the arbitrariness of the morphology-phonology interface.

Output-to-output correspondence was also argued to be active in other areas of Prosodic Morphology. Following McCarthy (1995), some of the output-to-output correspondence constraints responsible for prosodic identity effects in circumscriptional and root-and-pattern morphology were briefly discussed. I also suggested that correspondence between words is relevant to certain phonological patterns that are often attributed to cyclic or level-ordering effects. This proposal, which is merely sketched out in this paper, generalizes the principles of non-concatenative truncation to more commonplace concatenative morphology.

More generally, I have shown that the segmental content and/or prosodic shape of a truncated or affixed word may depend on surface properties of its base. This suggests that the base has some sort of priority over the related output, in that the form of the base has to be known before the form of the truncated/affixed version can be determined. In rule-based theories, the priority of the base is interpreted literally; the base exists (and may undergo phonology) before the truncated form is produced at some intermediate stage of the derivation. The correspondence model can also model the priority of the base temporally, by assuming that the base is derived first by an IO-mapping, and then the truncated word is derived by an output-to-output BT-correspondence relation. The epistemological priority of the base does not necessarily entail serial ordering; it is possible that the related outputs are generated simultaneously, in a fully parallel derivation of the truncated word. There is, however, no compelling empirical evidence of parallelism.

In reduplication, the base and the reduplicant must be generated simultaneously, by parallel IO- and BR-mappings. This is shown by examples in which the base of reduplication appears to anticipate the needs of the reduplicant. In Chumash, a complex segment derived by assimilation of the reduplicant-initial segment to a prefix is *copied by the base* in the reduplicated form, as in /k-<u>RED</u>-ʔaniš/ ≈ [<u>k'an</u>-k'aniš], [*<u>k'an</u>-ʔaniš]. BR-correspondence is apparently a "two-way" relation; the reduplicant can copy the base, and the base can copy the reduplicant. This interaction suggests that the base of reduplication has no temporal priority over the reduplicant; base and reduplicant are generated simultaneously. In the correspondence model of reduplication, the IO and BR relations are established in parallel (see McCarthy & Prince 1995).

In contrast, the base of truncation cannot copy properties of its truncated version. BT-correspondence is a "one-way" function from the base to the truncated form. For example, the truncated word *Lar* [lær] violates a constraint of English that prohibits tautosyllabic [ær] sequences. Nevertheless, it is not possible to pronounce the base name *Larry* [læ.ri] as [*lɑ.ri] in order to allow both satisfaction of the *ær]$_\sigma$ constraint and preservation of BT-Identity in the truncated counterpart *Lar* [*lɑr]. The base of truncation, unlike the base of reduplication, always conforms to the regular surface patterns of the language.

Intuitively, it's clear that the truncated word cannot influence the phonology of the base because the base and the truncated form are separate words. More formally, IO-Faith and BT-Identity constraints never come into conflict; each set of faithfulness constraints regulates a distinct class of words. This is unlike the situation in reduplication, where IO-Faith and BR-Identity constraints are relevant to a single form, the reduplicated word. Reduplicative BR-Identity constraints can force phonological irregularities in the base, as in the Chumash example. BT-Identity constraints, on the other hand, cannot affect the phonology of the base.

The conflict between BR-Identity and IO-Faith, and the lack of conflict between BT-Identity and IO-Faith, can be seen in comparison of the rankings required to produce over-, under- and normal application effects in the two morphological domains. The truncation rankings established in §3 are summarized in (107), and the reduplication rankings motivated by McCarthy & Prince (1995) are given in (108).

(108) Reduplication Ranking Schema

Overapplication	BR-Identity, Phono-Constraint >> IO-Faith
Underapplication	ℂ, BR-Identity >> Phono-Constraint >> IO-Faith
Normal application	Phono-Constraint >> IO-Faith >> BR-Identity
Emergent Unmarkedness	IO-Faith >> Phono-Constraint >> BR-Identity

Except in Emergent Unmarkedness, we are concerned with the behavior of a phonological process which is observed in the language as a whole. This requires Phono-Constraint >> IO-Faith; without this ranking, the effects of the Phono-Constraint would not be observed in ordinary (non-truncatory, non-reduplicative) phonology. With respect to the overapplication of a phonological process, truncation and reduplication have entirely parallel rankings: the base and its related string are identical in output form, as required by undominated BT- or BR-Identity, and the Phono-Constraint is also satisfied, at the expense of IO-Faith.

Truncation and reduplication differ with respect to the rankings required to produce under- and normal application. Because BR-Identity and IO-Faith constraints pertain to the same (reduplicated) word, they can conflict and must be ranked. Normal application of phonological processes in reduplicated words requires subordination of BR-Identity to IO-Faith; this rules out overapplication, and results in non-identity of base and reduplicant in the surface form. In truncation, on the other hand, BT-Identity and IO-Faith do not conflict; each set of faithfulness constraints is relevant to a distinct class of words, so they cannot be ranked with respect to one another.

In reduplication, over- and underapplication identity effects require distinct constraint rankings. McCarthy & Prince (1995) show that underapplication in reduplication is possible only if overapplication is ruled out by some undominated constraint, designated ℂ in (108). This constraint prevents the phonological process from affecting the reduplicant; in conjunction with undominated BR-Identity, the Phono-Constraint is prevented from affecting the base, producing an underapplication identity effect. Because BR-Identity and IO-Faith pertain to the same output form, no ranking of faithfulness requirements with a single Phono-Constraint can produce underapplication in reduplication; some other constraint must come into play. In truncation, however, the two sets of faithfulness constraints regulate separate, non-intersecting classes of words. Underapplication identity effects can therefore be derived by simple domination of BT-Identity over a Phono-Constraint.

Because they govern the same (reduplicated) word, IO-Faith and BR-Identity interact, and BR-Identity constraints can force phonological irregularities in the base of reduplication. In truncation, BT-Identity does not conflict with IO-Faith, since each pertains to a separate class of words. This lack of interaction accounts for the "one-way" character of BT-correspondence, in contrast to the "two-way" interaction exhibited in reduplicated forms. It does not, however, appear to definitively rule out parallelism in truncation. The two relations in (106) could be established simultaneously, with the lack of a "two-way" interaction attributed to the transderivational nature of BT-correspondence, rather than to serial ordering in the derivation.

It might be possible to demonstrate that the two correspondence relations in (106) are simultaneous by showing that truncated words stand in correspondence with the underlying stem. If there is a case in which the truncated word is more faithful to the underlying form than the base is, a relation between the input and the truncated form (IT-correspondence) is required. Again, we have examples like this in reduplication; in the Lushootseed case mentioned earlier, /RED-pastəd/ ≈ [papstəd], the reduplicant copies a vowel that syncopates from the base. Because the syncopated vowel is literally absent from the base, the reduplicant's vowel must correspond with the input's vowel.[50] A similar example in truncation would make the case for IT-correspondence. Logically, if the truncated word stands in two correspondence relations, one with the base and another with the input, the base and the truncated form would have to be generated simultaneously, with the base as an (unspoken) element of the representation of the truncated form.

Without a case in which the truncated form is more faithful to the underlying stem than its base is, there is no evidence for a correspondence relation between the input and the truncated form. In fact, the emergent unmarkedness analysis of templatic deletion in Japanese suggests that truncated words are not in an IO-correspondence relation. I argued earlier that the lack of a correspondence with the input allows truncated stems to be exempt from high-ranking IO-Faith constraints, resulting in the emergence of unmarked prosodic structure in truncated words. Appeal to correspondence between the truncated form and the input to establish simultaneity of the IO- and BT-mappings is not supported.

While nothing appears to rule out parallel correspondences in the truncation model (106), no empirical evidence supports it either. What would it mean for the model of gammar to serially order the IO- and BT-correspondence relations? If the

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[50] See Urbanczyk (in prep.) for further discussion of the Lushootseed example, and McCarthy & Prince (1995) for other evidence of the IR relation.

base, an output, serves as the literal input to truncation, the derivation of the truncated form entails two ordered steps. Note, however, that the core of OT parallelism is maintained, in that each correspondence relation governs a parallel mapping. Optimal forms are chosen by the constraint hierarchy from an infinite set of fully-formed candidates. There are no intermediate stages of derivation in any relevant sense; the base of truncation is a pronounceable output. In keeping with parallelism, only fully-formed candidates are relevant.

Also, note that the two correspondence relations in (106) are not phonological cycles in the traditional sense; they are part of a single grammar. There are no "mini-grammars" in this model. Every language has a single, immutable ranking of structural output constraints, interspersed with faithfulness constraints. This distinguishes the correspondence-based proposal from other serialist theories advanced in OT, including McCarthy & Prince's (1993a) division between lexical and post-lexical phonologies, characterized by different rankings of constraints, and Inkelas' (1994) model of serially-ordered "co-phonologies", which similarly involves constraint re-ranking. If distinct faithfulness constraints are recognized, constraint re-ranking is unnecessary. In this model of grammar, then, there are three classes of words; those derived by IO-correspondence, those produced by BT-correspondence, and reduplicated words, which invoke both IO- and BR-correspondence relations.

These ideas are only sketched broadly here; further investigation is clearly needed. One open question, which is obviously relevant to the parallelism issue, is the characterization of the truncation morpheme. If there is a lexically-stored subtractive morpheme, what is it, and how is it concatenated with the base? The discussion of the segmentally-specified class 2 affixes raises a similar question; do these morphemes attach to a lexical form or can they somehow concatenate with an output word? A more fully developed theory of word-word relations will answer these questions, and will be better able to address the broader issues.

In this paper I have shown that by positing a correspondence relation between two separate output forms, truncatory identity effects, prosodic circumscription and level-sensitivity, three disparate phenomena which have each been taken to motivate process-based phonological derivations, can be brought into the purview of non-procedural Optimality Theory.

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