Word construction: tracing an optimal path through the lexicon

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1. Introduction

In this paper we propose a new theory of word formation which blends three components: the "bottom-up" character of lexical-incremental approaches of morphology, the "top-down" or meaning-driven character of inferential-realizational approaches to inflectional morphology, and the competition between word forms that is inherent in Optimality Theory.[1] Optimal Construction Morphology (OCM) is a theory of morphology that selects the optimal combination of lexical constructions to best achieve a target meaning. OCM is an incremental theory, in that words are built one layer at a time. In response to a meaning target, the morphological grammar dips into the lexicon, building and assessing morphological constituents incrementally until the word being built optimally matches the target meaning.

We apply this new theory to a vexing optimization puzzle confronted by all theories of morphology: why is redundancy in morphology rejected as ungrammatical in some situations ("blocking"), but absolutely required in others ("multiple / extended exponence")? We show that the presence or absence of redundant layers of morphology follows naturally within OCM, without requiring external stipulations of a kind that have been necessary in other approaches. Our analysis draws on and further develops two notions of morphological strength that have been proposed in the literature: stem type, on a scale from root (weakest) to word (strongest), and exponence strength, which is related to productivity and parsability.

2. The case study: blocking vs. multiple exponence

Blocking and multiple exponence are inherently contradictory phenomena. Blocking, e.g. *men* blocking **men-s* and **man-s* as the plural of 'man', epitomizes the avoidance of redundancy and unnecessary complexity. Multiple exponence, of which we will see examples below, epitomizes the requirement of apparent redundancy or unnecessary complexity. Many theories of morphology focus on one of these problems or the other. Aronoff (1976) and Anderson (1992) develop principles of blocking for which multiple exponence is a problem. By contrast, Stump (2001) develops a theory in which multiple exponence is easy to describe but blocking requires extra statements. Several theories — Distributed Morphology and, more recently, the Realizational Optimality Theory approach of Xu & Aronoff 2011 — have sought to incorporate offsetting principles that generate both blocking and multiple exponence. Our goal in OCM is to design the basic architecture of the model in such a way that blocking and multiple exponence both emerge, under different conditions, as natural consequences of the model. In OCM, blocking and multiple exponence share a comfortable and natural co-existence, matching their distribution in natural language.

[1] This paper was influenced, directly or indirectly, by valuable discussions with many morphologists, including Teresa McFarland, Anne Pycha, Grev Corbett, Greg Stump, Heidi Harley, and Alice Harris. We are grateful to them for sharpening our understanding, and regret all the ways in which this paper does not reflect their wisdom and knowledge.

3. Examples

To seed the discussion, we introduce brief examples of each phenomenon, both within the same language, Swahili (Bantu G.40, Ashton 1947). This familiar data illustrates that within the same partial verb paradigm, redundant morphology is both prohibited and required. Blocking effects are seen in negative verbs with first person subjects. Throughout the verbal paradigm, and clearly in this present tense fragment, the prefix *ha-* (in boldface) expones the feature [Polarity=Negative]. In the 1st person singular, however, the prefix *si-* (in bold boxes) encodes both [Polarity=Negative] and [Subj=1sg]:

(1) Swahili, fragment of paradigm of *tak-* 'want'

		Affirmative				*Negative*			
future	1sg	ni-	ta-	tak-a	1sg	si-		ta-	tak-a
	2sg	u-	ta-	tak-a	2sg	**ha-**	u-	ta-	tak-a
	3sg	a-	ta-	tak-a	3sg	**ha-**	a-	ta-	tak-a
	1pl	tu-	ta-	tak-a	1pl	**ha-**	tu-	ta-	tak-a
	2pl	m-	ta-	tak-a	2pl	**ha-**	m-	ta-	tak-a
	3pl	wa-	ta-	tak-a	3pl	**ha-**	wa-	ta-	tak-a
present indefinite	1sg	ni-		tak-a		si-			tak-i
	2sg	u-		tak-a		**ha-**	u-		tak-i
	3sg	a-		tak-a		**ha-**	a-		tak-i
	1pl	tu-		tak-a		**ha-**	tu-		tak-i
	2pl	m-		tak-a		**ha-**	m-		tak-i
	3pl	wa-		tak-a		**ha-**	wa-		tak-i

The prefix *si-* blocks not only the ordinary negative *ha-* prefix but also *ni-*, which in affirmative verbs encodes [Subj=1sg]. The following examples show that of three competitor verb forms, each of which would expone the features [Polarity=Negative], [Subj=1sg], only one is grammatical:

(2) Five possible ways of expressing 'I will not want'

a. si-ta-taka
b. *ha-si-ta-taka (*ha-* is redundant, given *si-*, and is blocked)
c. *si-ni-ta-taka (*ni-* is redundant, given *si-*, and is blocked)
d. *ni-si-ta-taka (*ni-* is redundant, given *si-*, and is blocked)
e. *ha-ni-ta-taka (No single prefix is redundant, but *si-ta-taka* is better)

Note that the blocking effect of *si-* is not limited to prohibiting redundant layers of affixation within the same word. Rather, it has a more global, or paradigmatic, effect. Even the hypothetical verb form *ha-ni-ta-taka* (in (2e)), with no single redundant affix, is blocked by the actual form *si-ta-taka*. At a descriptive level, two principles seem to be in effect here, described in (3):

(3) a. Anti-redundancy: redundant layers of affixation are prohibited
b. Economy: a verb with fewer affixes is superior to a synonymous verb with more affixes

Within the same paradigm fragment, however, we see that blocking — or, specifically, the principles in (3) — is not always in effect. In (4), illustrating the simple past tense, we see that two different tense prefixes are used: *li-*, in affirmative past tense verbs, and *ku-,* in negative past tense verbs. On the assumption that *ku-* encodes the information [Polarity=Negative, Tense=Past], the prefix *ha-* is redundant in this paradigm fragment. Nonetheless it is obligatory.[2]

(4) Redundancy in the Swahili past tense paradigm

		Affirmative				*Negative*			
past	1sg	ni-	li-	tak-a	1sg	si-		ku-	tak-a
	2sg	u-	li-	tak-a	2sg	**ha-**	u-	ku-	tak-a
	3sg	a-	li-	tak-a	3sg	**ha-**	a-	ku-	tak-a
	1pl	tu-	li-	tak-a	1pl	**ha-**	tu-	ku-	tak-a
	2pl	m-	li-	tak-a	2pl	**ha-**	m-	ku-	tak-a
	3pl	wa-	li-	tak-a	3pl	**ha-**	wa-	ku-	tak-a

The question for any theory incorporating the seemingly sensible principles in (3) is why the actual form for 'I did not want', namely *si-ku-taka* (5a), is better than the synonymous and equally complex form **ni-ku-taka* (5d), with no redundancy.

(5) Four possible ways of expressing 'I did not want'

a. si-ku-taka (*si-, ku-* both express [Polarity=Negative])
b. *ha-si-ku-taka (*ha-* redundant, given *si-* and *ku-*)
c. *ha-ni-ku-taka (*ha-* redundant, given *ku-*)
d. *ni-ku-taka (no single prefix is redundant)

From a global perspective, in which the overall redundancy of exponence in a given word can be evaluated against all possible competitor words, this type of overlapping exponence does not make sense.

In this paper we will show that the basic architecture of OCM predicts blocking effects as a natural outcome of local competition for exponence and well-formedness. We will also show that there are numerous subtypes of redundant exponence, many if not all of which also follow from the basic architecture of the model. This paper thus addresses two goals: it sorts out a taxonomy of redundant exponence, and it provides a theoretical model that encompasses those effects with minimal stipulation.

4. The basic model

Optimal Construction Morphology is a sign-based model of morphology in which the primitive elements are lexical items and constructions. These combine freely, subject to the basic

[2] Similar effects obtain in the Completive, marked with the prefix *me-* in affirmative verbs and with *ja-* in negative verbs; and with the Present Definite and Present Indefinite, marked with *a-* and *na-*, respectively, in affirmative verbs but by suffixal *-i* in negative verbs. In these three tenses, negative *ha-* is still redundantly present. (See Ashton 1947).

well-formedness principles of unification and inheritance, to generate all and only the well-formed words of a language. Possible words compete with one another in terms of which best realizes a meaning target. Thus well-formedness is not absolute, as in previous lexicalist or constructionist theories, but relative. In this section we outline the crucial aspects of OCM, including the basic principles that this model shares with Construction Morphology.

4.1 Construction Morphology

OCM draws some basic assumptions from Network Morphology (Hippisley 1997) and Construction Morphology (Booij 2010; see also Orgun 1996, Croft 2001, Riehemann 2001, Inkelas & Zoll 2005, and Gurevich 2006, among others). These are lexicalist theories with a rich lexicon or constructicon composed of product/output-oriented schemas that relate form to meaning. These schemas are related in an inheritance hierarchy, capturing generalizations across them. They combine with lexical items through a process of unification, where the semantic specification and variables of an abstract structure are turned into constants (e.g., $[\text{buy}]_V\ \text{er}]_N$, from the schema in (6)) (Booij 2010):

(6) Constructional schema deriving an agent noun
$[[x]_V\ \text{er}]_N$ ↔ 'one who Vs'

Monomorphemic lexical items are one-level constructs, while complex morphological words are built from two-level constructions involving lexical bases plus morphological operations such as suffixation, prefixation, truncation, reduplication, ablaut, zero-derivation, etc.:[3]

(7) Reduplication (plural nouns)
$[[X]_{Ni}\ [X]_{Ni}]_{Nj}$ ↔ 'two or more N' (e.g., Warlpiri *kamina* 'girl', *kamina-kamina* 'girls' (Nash 1986))

Ablaut (past tense)
$[X\ \text{ɪ}\ Y]_{V,\ [\text{-PAST}]}$ ≈ $[X\ \text{æ}\ Y]_{V,\ [\text{+PAST}]}$ (e.g, *sing, sang*)

Zero-derivation (agent noun derivation)
$[[X_{Vj}]_{Ni}]$ ↔ 'one who V's' (e.g., *to cook, cook*)

Binary-branching constructions combine two sister nodes into a single constituent, relating both the meaning (an inflectional feature or derivational category) and the form of the input to that of the output. The following schema (borrowing from Sign-based morphology (Orgun 1996)) depicts this relationship, formalized as form and meaning functions:

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[3] Constructions exist within an 'inheritance hierarchy', an intermediate level of generalization in the hierarchical lexicon between individual words and the most abstract schemas. For instance, Dutch NN compounds have an intermediate schema $[[\text{hoofd}]_N\ [x]_N]_N$ 'main x' (for compounds like hoofd-*ingang* 'main entrance' and *hoofd-gebouw* 'head building') which is partially specified (specifically, that the base is the noun *hoofd*) (Booij 2007:35). More generally, inheritance hierarchies allow to model highly structured relationships in the lexicon, which allows accounting for general types of word formation as well as idiosyncratic properties of morphologically complex words, including idiomatic semantics/syntax and/or idiosyncratic phonological properties (Hippisley 2001).

(8) Mother and daughter nodes in a binary-branching schema

Syntax = V
Semantics = *a*(X)
Phonology = *g*(Y)

Syntax = V
Semantics = X
Phonology = Y

/-er/

Schemas are maximally binary-branching, but they can also be non-branching (as in zero-derivation).[4] The phonology function in constructions, termed "co-phonology" (Orgun 1996; Anttila 1997, 2002; Inkelas 1998; Yu 2000; Orgun and Inkelas 2002; Inkelas and Zoll 2005, 2007), is a fully general mapping of input to output. Co-phonologies can differ in their constraint ranking, or rules can differ in their ordering, from construction to construction, but within a construction the phonological rules and constraints are not morphologically specific.

Each constructional schema imposes restrictions on the properties of the bases with which it may combine. These include part of speech (e.g., a noun-selecting construction cannot combine with a verb) and phonological shape (e.g., a construction selecting disyllabic bases cannot combine with monosyllabic bases). Constructional schemas may also impose restrictions as to the stem type of the base they combine with (i.e., level/stratum ordering) (e.g., in English 'level 1' and 'level 2' affixes select for stems of type '1' and type '2', respectively). Stem type, as a category, includes the affix-specific selectional restrictions noted by Fabb (1988), among others. Stem type will be discussed further in section §6.

In sum, in Construction Morphology, structure is emergent from the (structured) lexicon, and word formation takes place locally and incrementally. In this paper, we assume this general perspective. We add to the framework by incorporating two notions: (1) the kind of syntactic-semantic target assumed by top-down theories of word formation and (2) the competition structure of Optimality Theoretic approaches. We turn to the details of these two aspects of the theory in the next section.

[4] For the purpose of this paper, we make the simplifying assumption that constructions are maximally two-level and maximally binary-branching, but this is not a critical assumption for the OCM model. We also recognize the possibility of multi-level constructions (e.g., proverbs or other constructions involving long-distance dependencies) but we leave these out of our discussion here (but see, e.g. Ackerman & Stump 2004).

4.2 Optimal Construction Morphology

In Optimal Construction Morphology, competition is modeled via Optimality Theory (McCarthy 2002, Prince & Smolensky 2004). Each tableau operates on a single input, a word in progress which consists of a pairing between meaning and form, and it considers as candidate outputs the result of combining the input with every possible individual construction whose selectional restrictions are compatible with that specific input. In the respect that each tableau evaluates the results of a applying a single morphological step to the input, OCM resembles McCarthy's (2008) Harmonic Serialism, applied to morphological derivations by Wolf (2008). For instance, if the input were the verb *teach*, the candidate outputs in OCM would be *teacher, teaching,* and any other form that is produced by combining the input with a single morphological construction. The output to one tableau can serve as input to another, potentially producing words with multiple layers of morphology. Within any given tableau, selection among these candidates operates on the optimization along two dimensions: (a) faithfulness to the target meaning and (b) well-formedness.

The target meaning (M) is present throughout the derivation and is analogous to the 'property sets' which drive realization approaches (Anderson 1992; Stump 2001) and figure in Noyer's (1993) OT approach to inflection. M includes standard features (e.g., part of speech, person, polarity, number, tense, aspect, mood, diminutive, evidential), valence structures, (including number of arguments and the thematic roles to which they link), as well as the meanings commonly (but not exclusively) associated with 'root' morphemes. Examples of target meanings of specific lexical items are provided in (9):

(9) Target meanings (M) of 'mouse' and 'carry'.
  a. M=[MOUSE, cat=noun, +animate, +plural]
  b. M=[CARRY, cat=verb, +past]

Faithfulness to the target meaning is assessed through FAITH constraints such as the ones exemplified in (10).

(10) Faithfulness to the target meaning (M-FAITH)
  a. M-MAX: The candidate output has all the properties in M
  b. M-DEP: All the properties in M are present in the candidate output

Many factors can come under the term well-formedness, both phonological and morphological, but a crucial and novel aspect of OCM is morphological well-formedness linked to a requirement to achieve wordhood as the ultimate step in the derivation of a complex word. Wordhood in this sense may be represented with the following scale:

(11) Root………………………..Stem(s) ………………………..Word

The substance of the scale in (9) is familiar from works such as Selkirk (1982) and from various implementations of Lexical Morphology and Phonology (LMP; Kiparsky 1982ab, 1984, 1985; Mohanan 1986, Pulleyblank 1986) and Stratal Optimality Theory (Kiparsky 2000, 2008; Bermúdez-Otero & McMahon 2006). Its points refer to standard subconstituents, or levels, within complex words, and it captures the basic assumption that (monomorphemic) roots and (complex) stems and words have a different status in word formation, with words being the units on which the syntax operates on. The relevance of stems in morphological analysis is evidenced by the existence of morphomic stems, namely word subconstituents that are autonomous with respect to syntactic, semantic and phonological principles (see e.g. Aronoff 1994).[5]

Substantive formal scales in phonology and morphology have been proposed in recent years by Kirchner (1996) and Gnanadesikan (1997), to account for phonological chain shifts; by Pycha (2008), to account for the 'weight' of morphemes; and by Mortensen (2006), to account for a variety of scalar vowel height and tonal effects across languages.

The formal implementation we adopt for the scale in (9) is more like that of Mortensen (2006) than like that of Selkirk 1982 or Kiparsky's LMP and Stratal Optimality Theory implementations. The latter models share the same basic insight as X' theory, namely that the constituent types (root, stem, word) exist in a rigid hierarchical order. Translated into X' terms, root might be X^{-2}, Stem might be X^{-1}, and Word would be X^{0}.

But as studies of languages with complex morphology have shown, it is not always the case that words 'advance' through the strata unidirectionally. Rather, a number of languages, e.g. Malayalam (Mohanan 1986), Turkish (Inkelas & Orgun 1995, Inkelas & Orgun 1998), Nimboran (Inkelas 1993), and Totonac (McFarland 2008) have been shown to require scalar recursion and/or the 'skipping' of intermediate points on the scale.

Following Inkelas (1989, 1993), who in turn builds on Selkirk (1982), we adopt a more flexible model of stem type scales which assumes that each construction can specify the scalar type of its daughter(s) and/or mother.[6] Constructions which specify input stem type are limited by that specification as to to what they can combine with. Constructions which specify output stem type determine whether the construction advances, preserves, or loweres stem type. Examples are given in (12) of affixes that raise (a) or lower (b) stem type by one or more increments, that keep stem type constant (c), (d); or that attach to stems of any type but specify the output (e).

(12)	a.	Root → Stem affixation:	$[[\quad]_{Root}$ affix $]_{Stem}$
		Root → Word affixation:	$[[\quad]_{Root}$ affix $]_{Word}$
	b.	Word → Stem affixation:	$[[\quad]_{Stem}$ affix $]_{Word}$
		Stem → Root affixation:	$[[\quad]_{Stem}$ affix $]_{Root}$
	c.	Stem-preserving affixation:	$[[\quad]_{Stem}$ affix]
	d.	Category-preserving afixation:	[[ ] affix]
	e.	Stem-producing affixation:	[[ ] affix $]_{Stem}$

An affix which doesn't specify input type (d, e) can combine with an input of any type; an affix which doesn't specify output type is category-preserving (c, d).[7]

An example of a construction that lowers stem type, as in (12b), can be found in Malayalam (Dravidian; Mohanan 1986). In Malayalam, co-compounds and sub-compounds

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[5] While Stems are not given any role in Distributed Morphology (Embick & Halle 2005), a critical distinction is still maintained between Roots and Words.

[6] For related lexicalist approaches to affixation, see Orgun 1996, Paster 2006, Yu 2007.

[7] This analyis mirrors the approach to part of speech specifications in affixal selectional frames in item-based approaches like Lieber 1980. For example, the suffix *-ity,* which combines with adjectives to form nouns, has the selectional frame $[[\quad]_{Adj}$ ity $]_N$. The prefix *en-*, which combines with various parts of speech and forms verbs, has the frame [en [$]]_V$, with an unspecified inner frame. The prefix un- attaches to verbs or adjectives and is category preserving (*un-nerve* (V), *un-happy* (Adj)), with an unspecified outer frame: [un [$]_{V/Adj}$].

belong to two different levels (or strata) which are phonologically discernible through stress and tone assignment properties. In Mohanan's analysis, sub-compounds may be nested inside co-compounds, promoting stratum 2 stems to stratum 3 level (as in (12a)); conversely, co-compounds may also be nested inside sub-compounds, demoting stratum 3 stems to the stratum 2 level (as in (12b)):

(13) a. kaamuki ‘lady love’

b. bhaar̄ya ‘wife’

c. sahood̲ar̄i ‘sister’

d. *Sub-compound inside co-compound*

[[káamukii] [[bháar̄yàa][sahòod̲ar̄i]]$_{\mathbf{STEM\ 2}}$]$_{\mathbf{STEM\ 3}}$ -maarə

L H L H

‘Lady love and wife’s sister’

e. *Co-compound inside sub-compound*

[[[káamukii][bháar̄yàa]]$_{\mathbf{STEM\ 3}}$ [sahóod̲ar̄i]$_{\mathbf{STEM\ 2}}$ -maarə

L H L H L H

‘Sisters of lady love and wife’

For a word to be considered complete and enter into syntactic constructions, it must be of type WORD. Following Mortensen (2006), we assume that advancement on the scale is driven by a markedness constraint referring to the top position in the scale:

(14) BE-WORD

If the language employs a three-point stem type scale, with Root and Stem being the other two points on the scale, then BE-WORD penalizes Roots twice and Stems once. According to BEWORD, any candidate output closer to ‘Word’ than its input is more optimal than a candidate which is at the same (non-‘Word’) point on the scale or shifts it away from ‘Word’, all else being equal.

In sum, in OCM, grammar builds word incrementally. Each step of word construction compares the word-in-progress to the target word. If M-FAITH judges the match to be imperfect, or if BEWORD is not satisfied, the grammar enters another cycle of word-formation, in which the competing candidates are the word-in-progress plus one layer of morphology from the constructicon, the inventory of available constructional schemas. All compatible layers are considered. If a candidate output is more harmonic than the input, it is selected. If no morphological step can improve the word, the derivation ends. The output, even if ‘imperfect’, is handed to the syntax. The following sections illustrate how OCM derives instances of blocking, empty morphology and multiple exponence.

5. OCM in action: Blocking

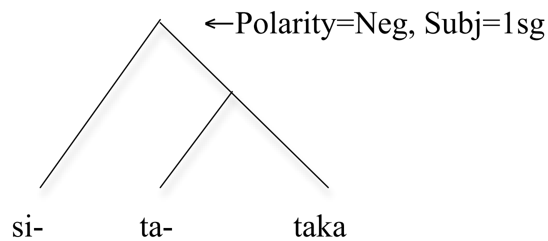
In OCM, portmanteau blocking of the type seen earlier in Swahili results from incremental optimization relative to a target meaning M. In order to illustrate how blocking effects are modeled in OCM, consider again the blocking example from Swahili described in §5. Example (15), below, reproduces example (2):

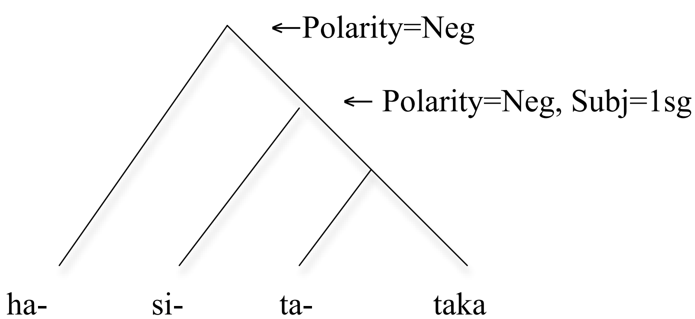
(15) Five possible ways of expressing 'I will not want'

a. si-ta-taka
b. *ha-si-ta-taka (*ha-* is redundant, given *si-*, and is blocked)
c. *si-ni-ta-taka (*ni-* is redundant, given *si-*, and is blocked)
d. *ni-si-ta-taka (*ni-* is redundant, given *si-*, and is blocked)
e. *ha-ni-ta-taka (No single prefix is redundant, but *si-ta-taka* is better)

The contrast between the actual, most economical form, *si-ta-taka* ((15)a), and a form with redundant affixation, *ha-si-ta-taka* ((15)e), is schematized in (16):

(16) Swahili blocking





The schemata in (16) represent the semantic information encoded in each of the cycles of affixation and the order of attachment of each construction in each morphologically complex form. Tableau (17) includes an input with the present form *ta-taka* and a meaning target [WANT, PRESENT, SUBJ=1SG, NEG]. From the constructions available in that cycle of evaluation, the form with prefix *si-* (17)b) encodes all the properties of the meaning target, and is thus selected as the wining form:[8]

[8] For simplicity, we leave out reference to stem type, since it does not play any role in this case.

(17) Swahili example: portmanteau *si-* (SUBJ=1SG, NEG) blocks *ha-* (NEG) and *ni-* (SUBJ=1SG)

	Input =[ta-taka] WANT, PRESENT		M: WANT SUBJ=1SG NEG PRESENT	M-FAITH
a.	*ni-* SUBJ=1SG	[ni-[tataka]]	WANT SUBJ=1SG PRESENT	*!
☞b.	*si-* SUBJ=1SG, NEG	[si-[tataka]]	WANT SUBJ=1SG NEG PRESENT	
c.	*ha-* NEG	[ha-[tataka]	WANT NEG PRESENT	*!*
d.	[IDENTITY FUNCTION]	[tataka]	WANT PRESENT	*!**

The tableau in (17) generates the optimal output for input *ta-taka*, which means [WANT, PRESENT], relative to meaning target M=[WANT, SUBJ=1SG, NEG, PRESENT] The winning output candidate *si-ta-taka* is completely faithful to the meaning target, thus defeating all of the other candidates.

Note that candidate (17)d) is identical to the input. We assume that all tableaux include an identity candidate; its presence is needed to identify the end of the derivation. If a particular tableau chooses the identity candidate as optimal, that means that the lexicon contains no construction which could improve on the input, either in terms of target faithfulness or morphotactic wellformedness (see §7), and therefore that the lexical derivation is complete.[9] That is, of course, not the case in tableau (17).

OCM predicts blocking to occur at the level of root selection, as well. Consider the example of *broke* in English, which successfully competes with *break-ed.* The competition between *break* and *broke* as the root of the word meaning [BREAK, PAST] is accomplished on the first cycle of evaluation, on which roots are selected. Since roots are one-level constructions in Construction Morphology, the first dip into the expanded lexicon is expected to result in a root. This is true for two reasons: first, because of their rich lexical meaning, roots are likelier to satisfy target faithfulness better than a derivational or inflectional construction could. Secondly, any affixation, compounding, reduplication or other similar construction would be structurally ill-formed on its own, in that its selectional requirements are unsatisfied. This makes a non-root construction a very improbable winner in a first tableau. Therefore, for simplification, we assume

[9] Technically, therefore, the derivation cannot be considered to be complete after producing output ((17)b); ((17)b must defeat all alternatives in a subsequent tableau in order to be crowned as the ultimate winning output for meaning target M=[WANT, SUBJ=1SG, NEG, PRESENT]. That step is not shown here, but can be imagined: any affix that the grammar could add to input /si-ta-taka/ would produce an output which is worse than the identity output, either in form or in meaning.

that the initial tableau in the generation of any word will select and compare only roots as output candidates.

Because of the target faithfulness constraint, OCM predicts that among competing roots, the one encoding the most properties of the target will be selected over one encoding fewer of M's properties, or properties which contradict those in M. In the following table, *broke* blocks *break* if the meaning target M is [BREAK, TENSE=PAST]:

(18) English blocking

	Input = Ø		M: BREAK PAST	M-FAITH
a.	*break-* BREAK	[break]	BREAK	*!
☞b.	*broke* BREAK, PAST	[broke]	BREAK PAST	
c.	[IDENTITY FUNCTION]	Ø	Ø	*!*

In this manner, OCM achieves the blocking by an irregular, portmanteau root like *broke* of the regular root (*break*) with which it is in competition. The tableau in (18) heads off **break-ed* at the pass by rejecting *break* as a root of the word meaning [*break,* PAST].[10]

The point of these three examples is to show that blocking effects, whether they occur between competing affixes, or between competing roots, emerge intrinsically from the architecture of the OCM framework. In this way, OCM differs from other models of word formation, which must stipulate special principles to account for why *break-ed* is blocked by *broke* (and similar examples). A sample list of such constraints is given in (19):

(19) Some principles from the literature that handle blocking effects

a. Stem selection principle ("Lexical insertion" and "lexical stem set"): "In interpreting a given Morphosyntactic Representation M, from among the stems in the lexical set L of a given lexical item, only that stem L_1 which is characterized for the maximal set of features compatible with M may serve as the basis of an inflected form {L, M}" (Anderson 1992:133)

b. Specificity effects: "If a lexical item L appears in a c-structure position P corresponding to an f-structure F, and there is another lexical item L' whose specifications are subsumed by those of L but subsume those of F, then the structure is blocked" (Andrews 1990:507). (See also Hankamer & Mikkelsen 2005 on "Poser-blocking", citing Poser 1992).

c. *FEATURESPLIT: "bans the realization of any morphosyntactic or semantic feature value by more than one exponent" (Xu & Aronof 2011:3)

d. ECONOMY: "Among equally expressive expressions, the simplest is optimal" (Kiparsky 2005:114), "The fewer affixes, the better" (Noyer 1993:17).

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[10] The question of why **broke-d* is not a possible output for target meaning [*break*, PAST] will be addressed in §7. Some languages do generate the equivalent of *broke-d*. While OCM intrinsically rules out **break-ed*, given **broke*, it does not intrinsically rule out **brok-ed*, with multiple exponence. Whether *broke* beats *broked*, which would be determined by the tableau taking as its input the output of (18), is determined not by target meaning faithfulness (both are fully faithful) but by structural well-formedness considerations. In English these conditions are not high-ranked, but in other languages they can be. See §7.

Of these four reasonably similar principle, we choose the straightforward ECONOMY to illustrate here, as a contrast to the OCM approach to blocking. ECONOMY is an inherently global constraint; it assesses complete words to see how many morphemes, or layers of morphology they have. Thus the illustrative tableaux contain whole words, rather than the incrementally constructed stems of OCM tableaux. The tableau in (20) illustrates how an ECONOMY constraint would work to generate the blocking of **break-ed* by the more morph-economical candidate *broke*:

(20) ECONOMY needed to generate blocking effects (English)

	{break,PAST}	M-FAITH	ECONOMY
a.	break	*!	*
☞ b.	broke		*
c.	break-ed		**!

In light of this apparently simple means of modeling blocking, one might ask if it is necessary to introduce yet another method, as we are doing with OCM. We argue that the answer is yes, on several grounds. First, as mentioned above, OCM derives blocking effects through the incremental satisfaction of faithfulness, and does not require an explicit statement of blocking. Secondly, unlike some competitor approaches, OCM has the flexibility to model situations where blocking does not occur. In the next two sections, we will see that OCM can model the distribution of semantically noncontributing layers of morphology, including empty morphs (§6) and redundant morphs (§7), via the same overall architecture used to derive blocking, without using any phenomenon-specific mechanisms. The next sections lay out the details of how this works.

6. OCM in action: Empty morphs

Some morphological layers make no semantic contribution to the word containing them. Their presence is as deserving of explanation as is the presence of redundant morphology. In OCM, semantically vacuous layers of morphology can be optimal if, and only if, they make a contribution to structural well-formedness, e.g. by producing stems that meet phonological requirements or which advance a form along the wordhood scale. As we will see, this is the same explanation offered in OCM for multiple exponence in §7. In this section, however, we focus only on empty morphology.

6.1 Phonologically motiviated empty morphs: phonological stem shape conditions

One well-known type of structural improvement that empty morphology can effect is the repair of phonological stem size conditions. An example is provided by Ndebele (Bantu S.44; Sibanda 2004; Hyman, Inkelas & Sibanda 2009), in which a prefix *si-* serves the simple function of bringing a verb stem up to the minimal disyllabic size that is required by certain TAM prefixes. This augmentation occurs in the Indicative mood, as illustrated in (21). Stems, consisting of root plus Final Vowel (*-a*) are underlined. The bold-faced *si-* prefix in (21)c) augments the disyllabic stem to two syllables:

(21) Ndebele *si-* prefixation

a.	u-s-u-khal-a	'you (sg) are now crying'
	i-s-e-khal-a	's/he is now crying'
	a-s-e-khal-a	'they are now crying'
b.	u-s-u-hlikihl-a	'you are now wiping'
	u-s-e-hlikihl-a	's/he is now wiping'
	a-s-e-hlikihl-a	'they are now wiping'
c.	u-s-u-**si**-dl-a	'you are now eating'
	i-s-e-**si**-dl-a	's/he is now eating'
	i-s-i-**si**-dl-a	'they are now eating'

The prefix *si-* does not contribute a semantic or syntactic feature, nor does it operate on argument structure by changing valence or indexing arguments. Its sole function is to produce a disyllabic stem.[11]

Another example of empty morphology serving a purely morphophonological need can be found in Bantu languages which, like Ndebele, require the verb stem to end in a vowel. If a semantically contentful inflectional ending such as the subjunctive, imperative or perfective, does not supply this vowel, the dummy suffix *-a* is added instead, satisfying the stem shape constraint. Illustrative data, in (22), are taken from Sibanda (2004:58,118-119). The stems in (22)a), regardless of size or complexity, take the dummy *-a*. (Note that the forms in (22)a) are bare (uninflected) stems, not citation forms; in most cases the actual words containing these stems would also include inflectional prefixes, suppressed here for simplicity.) Dummy *-a* is not used when imperative *-e* (22)b) or perfective *-ile* (22)c) are present:

(22) Ndebele *-a* suffixation

a.	phek-	→	pheka	'cook'
	phek-is-	→	phekisa	'cook-CAUS = cause to cook'
	phek-is-el-	→	phekisela	'cook-CAUS-APPL = cause to cook for'
b.	phek-e			'cook-IMPER = cook!'
c.	phal-ile			'scratch-PERF = scratched'

The competition between semantically contentful affixes and dummy *-a* is illustrated by the following tableaux. In (23), the meaning target contains the feature PERFECTIVE, making perfective *-ile* a better choice than dummy *-a*.

[11] *si-* is not the only augmentative empty prefix in Ndebele. See Downing (2001), Sibanda (2004) and Hyman et al. (2009) for discussion of augmentation of empty *yi-* in imperatives and reduplicants. The question of which augmentative formative is used when is important but beyon the scope of this paper. Note that Ndebele has other, contentful homophonous *si-* prefixes, such as the Class 7 subject and object agreement markers. There is no reason to identify the *si-* in (21)c with Class 7, since the arguments of these verbs do not belong to Class 7.

(23) Perfective target: perfective *-ile* optimal, dummy *-a* not needed

	Input = phek COOK		M: COOK PERF	M-FAITH	STEMSHAPE (ALIGN-R(STEM, V))
a.	*-a*	phek-a	COOK	*!	
b.	*-e* IMPER	phek-e	COOK IMPER	*!	
☞ c.	*-ile* PERF	phek-ile	COOK PERF		
d.	[IDENTITY FUNCTION]	phek	COOK	*!	*

In (24), however, the meaning target does not contain an inflectional feature that a more specific suffix could realize, making dummy *-a* a better choice. Any of the other suffixes would introduce features not in the target, producing a less faithful output candidate. Adding semantically empty *-a* (candidate (24)a) is better than doing nothing (candidate (24)d), since it brings the stem into conformity with the stem shape constraint:

(24) Plain target: perfective *-ile* not optimal, dummy *-a* needed

	Input = phek COOK		M: COOK	M-FAITH	STEMSHAPE
☞ a.	*-a* (Ø)	phek-a	COOK		
b.	*-e* IMPER	phek-e	COOK IMPER	*!	
c.	*-ile* PERF	phek-ile	COOK PERF	*!	
d.	[IDENTITY FUNCTION]	phek	COOK		*!

6.2 Morphotactically motivated empty morphs: progress towards wordhood

Semantically empty morphologically can also be motivated if it produces an output which is closer than the input is to the Word end of the wordhood scale. An example of such semantically empty morphology is found in Latin theme vowels, described in Aronoff (1994:46):

> "The [Latin] theme vowel is ... a marker of the category *verb* only in the sense that it is determined by the category *verb*, just as final devoicing is a marker of the word boundary. In itself, it has no significance. It is empty. Nonetheless, it is not useless. It has a use in the language…it serves to determine the conjugation of the verb stem, or which inflectional affixes will realize the various morphosyntactic properties that the verb bears in a particular instance."

The table, below, illustrates four different derivational verb suffixes and the theme vowels that must be added to each to prepare the stem for future inflection (Aronoff 1994:46):

(25) Latin Derivational Verb Suffixes

Meaning	Derivational Suffix	Theme Vowel	Example	Gloss
desiderative	-ur-	-ī	ēsurīre	‘be hungry’
iterative	-it-	-ā	vīsitāre	‘see often’
inceptive	-sc-	-e	calescere	‘get warm’
intensive	-ess-	-e	capessere	‘seize’

We implement Aronoff’s insight in OCM by characterizing suffixes as combining with stems of various types and producing stems of various types, with the types defined on the following Latin-specific (oversimplified) stem scale:

(26) Stem scale, Latin: Root….D(erivational)Stem….I(nflectional)Stem….Word

Derivational suffixes combine with Roots and produce constituents of type DStem, while theme vowels combine with Roots or DStems and produce IStems. Inflectional suffixes attach to IStems. Examples of lexical entries are given below:

(27) Derivational suffix (e.g. iterative): [[ ]$_{\text{ROOT}}$ it]$_{\text{DSTEM}}$
Theme vowel (e.g. -ā-) [[ ]$_{\text{ROOT/DSTEM}}$ ā]$_{\text{ISTEM}}$
Inflectional suffix (e.g. 1st conjugation 1st person) [[ ]$_{\text{ISTEM}}$ ō]$_{\text{WORD}}$

The structural contribution of the Latin theme vowels is thus to form a stem that is further along the scale to Wordhood and able to take inflection, since in most cases inflectional layers of morphology cannot be added directly to bare roots.

(28) Addition of theme vowel advances Dstem towards wordhood:

	Input = vīs-it]$_{\text{DSTEM}}$ SEE, ITERATIVE		M: SEE ITERATIVE	M-FAITH	BEWORD
☞ a.	-ā SEE, ITERATIVE	vīs-it-ā]$_{\text{ISTEM}}$	see ITERATIVE		*
b.	[IDENTITY FUNCTION]	vīs-it-]$_{\text{DSTEM}}$	see ITERATIVE		**!

Semantically empty morphs can also serve the paradigmatic function of marking all units of its type in the same way, achieving a degree of paradigm uniformity. Aronoff (1994) attributes this function to the Latin theme vowels (p. 46). Paradigm uniformity and Wordhood can both be classified under the general rubric of ‘stem shape” constraints; they act as the markedness constraints that in OT are in tension with faithfulness.

In sum, we find that empty morphology may serve phonological or morphological functions. Example (29) summarizes these functions:

(29) Stem shape improving functions of semantically empty morphs

Type of function	*Example*
Stem size (phonological)	Ndebele *si-,* final -*a*
Stem type (morphological)	Latin theme vowels

The examples discussed in this section illustrate how OCM picks out the optimal path through the hierarchical lexicon, with the guiding purpose of building a well-formed word that matches the target syntactic and semantic description. In OCM, a word has only the morphological layers that it needs. Need is assessed locally, at each incremental step, rather than globally. We have seen how OCM generates blocking effects and empty morphology. The next section shows how this model of word formation can also generate Multiple Exponence, under just the right lexical conditions.

7. OCM in action: Multiple Exponence

Multiple, or extended, exponence (ME) may be defined in an incremental framework like OCM as the occurrence of a seemingly superfluous morphological construction, or morphological layer, in a given word. ME has been extensively discussed in the literature; some well-known references include Matthews 1974; Stump 1991, 2001; Anderson 2001; Blevins 2003; Harris, in press; Bobaljik 2000, 2005). ME was exemplified above in Swahili simple past tense marking (§5). Another example of ME is given, below, from Turkana, in which gender agreement marking involves a dedicated gender agreement prefix *ŋa-* which is superfluous given a suffix that marks both gender and number (e.g. (18)). Thus, two independent markers, each of which is clearly by itself an unambiguous encoder of gender agreement, co-occur in feminine nouns.

(30) ME of gender agreement in Turkana (Nilotic; Dimmendaal 1983: 233)
ŋa-pɔɔ-**ɪ**‘
F-hare-**PL.F**
‘hares’

A parallel case involving passive and (ir)realis morphology occurs in Nanti (Michael 2008). In Nanti, all verbs are obligatorily marked as either realis or irrealis. The following example shows the realis/irrealis distinction for portmanteau affixes of the passive (passive realis *-agani* (31)a and passive irrealis *-eNkani* (31)b). The irrealis passive verb also contains an outer irrealis prefix *N-*, which is redundant given the passive irrealis marker *-eNkani*, and thus seems superfluous.

(31) Realis/irrealis marking in Nanti (Arawakan; Michael 2008:276)
a. o=oog-agani
3nmS=consume-PASS.REAL
'It is eaten'

b. tera 　　　　 i=**N**-p-**eNkani**
NEG.IRREAL 　 3mS=**IRREAL**-give-**PASS.IRREAL**
'He was not given anything'

As discussed in §5, the various principles that have been invoked in the literature to derive blocking, some of which were listed in (19), effectively rule out the appearance of this kind of redundancy in morphological marking. For example, the ECONOMY constraint of Noyer (1993) and Kiparsky 2005), which would be needed to choose the correct realization of 'I don't want' in Swahili (32), would choose the wrong output for 'he was not given anything' in Nanti (33). Noyer and Kiparsky employ ECONOMY as a global constraint, which compares complete words to see how many morphemes, or layers of morphology each has. Thus the illustrative tableaux in (32) and (33) contain whole words, rather than the incrementally constructed stems of OCM tableaux:[12]

(32) ECONOMY needed to generate blocking effects (Swahili)

	{want,SUBJ=1SG,NEG,PRESENT}	M-FAITH	ECONOMY
a.	ha-si-ni-ta-taka		***!**
b.	ha-ni-ta-taka		***!*
c.	si-ni-ta-taka		***!
d.	ha-si-ta-taka		***!
☞ e.	si-ta-taka		**

(33) ECONOMY violated by superfluous morphology (Nanti)

	M: GIVE 3MS IRREAL PASS	M-FAITH	?	ECONOMY
a.	[i=**N**-p-**eNkani]** 3mS=**IRREAL**-give-**PASS.IRREAL**	✓		****!
💣 b.	[i=p-**eNkan]** 3mS-give-**PASS.IRREAL**	✓		***

If ECONOMY were the driving force behind blocking, then an offsetting ME-specific mechanism would have to to be introduced to derive cases like Turkana and Nanti. This has happened, in various models. For example, work in Distributed Morphology has appealed to enrichment rules (Müller 2006) or to the distinction between primary and secondary features in Distributed Morphology (Noyer 1992; see also Peterson 1993) to offset the blocking principles that would incorrectly prevent ME from occurring.

In their Realizational Optimality account, Xu & Aronoff (2011) accomplish affixation through the satisfaction of exponence constraints requiring that specific phonological exponents be present when the input contains specific morphological features. ME occurs when two or

[12] Kiparsky (2005) and Noyer (2003) do not discuss Swahili or Nanti per se, though they discuss cases which are comparable to the Swahili example. Kiparsky uses a constraint 'EXPRESSIVENESS' which is comparable to our M-FAITH.

more such constraints are triggered by the same feature, e.g. by SUBJ=1SG in Swahili or by IRREALIS in Nanti. ME is inhibited by the constraint *FEATURE-SPLIT, which penalizes words which satisfy more than one such constraint. Our characterization of the Swahili and Nanti examples, above, in Xu & Aronoff's account are given below:[13]

(34) *FEATURE SPLIT rules out ME, generates blocking effects (Swahili)

	{want, SUBJ=1SG, NEG, PRESENT}	*FEATURESPLIT	{1SGS.NEG}: *si-*	{NEG}: *ha-*	{1SGS}: *ni-*	{PRES}: *ta-*
a.	ha-si-ni-ta-taka	*!* (NEG,1SG.S)				
b.	si-ni-ta-taka	*! (1SG.S)		*		
c.	ha-ni-ta-taka		*!			
d.	ha-si-ta-taka	*!(NEG)			*	
☞ e.	si-ta-taka			*	*	

(35) Low-ranked *FEATURESPLIT (Xu & Aronoff 2011) would permit ME in Nanti

	{GIVE,3MS,IRREAL,PASS}	{3MS}: *i=*	{PASS.IRREAL}: *-eNkani*	{IRREAL}: *N-*	*FEATURESPLIT
☞ a.	[i=**N**-p-**eNkani**] 3mS=**IRREAL**-give-**PASS.IRREAL**				* (IRREAL)
b.	[i=p-**eNkani**] 3mS-give-**PASS.IRREAL**			*!	

In sum, both the ECONOMY and the *FEATURESPLIT approaches generate blocking by fiat. The *FEATURESPLIT approach has the descriptive advantage of being able to describe ME when it occurs.

OCM seeks to improve on this situation approach by treating ME and blocking effects as emergent, generating both and stipulating neither. We have already seen how OCM generates blocking without relying on a principle like ECONOMY or *FEATURESPLIT. How can OCM generate ME? The answer is that OCM generates ME, just like it generates semantically empty morphological layers, if and only if the redundant exponence serves to improve faithfulness or structural well-formedness of the word. Just as there is no single constraint specifically requiring blocking, there is no constraint specifically requiring ME. Both blocking and ME emerge through the interaction of faithfulness and wellformedness constraints. We illustrate how different types of ME fall from the architecture of OCM in the following sections.

[13] *FEATURESPLIT, by itself, does not rule out candidate ((34)c) *ha-ni-ta-taka*, in which *ha-ni-* each individually express one of the two features that *si-*, by itself, would expone. This candidate would be directly ruled out by ECONOMY, which is not a constraint that Xu & Aronoff (2011) use. Instead, Xu and Aronoff (2011:9) assume a Paninian principle whereby that any constraint realizing multiple features must outrank any constraint realizing a proper subset of those features; hence the *si-* constraint ranks higher than both the *ha-* and *ni-* constraints, ruling out candidate ((34)c).

7.1 A typology of Multiple Exponence

ME is a frequent pattern in language (Caballero & Harris 2010), found across many semantic and syntactic contexts (Caballero & Harris 2010). It has sometimes been suggested in the literature that ME is infrequently attested cross-linguistically, in some sense a 'marked' phenomenon in comparison to its counterpart, blocking (Anderson 1992; Halle & Marantz 1993; Noyer 1993). In OCM, however, there is nothing aberrant or marked about ME. The growing number of documented cases of ME in the literature suggest that the expectation of the OCM approach matches natural language more closely than do theories that ban ME outright with principles like those in (19).

It is useful in formalizing ME to discuss two logical subtypes, defined in terms of the nature of the redundancy that is involved:

(36) Two sub-types of ME

a. Overlapping ME: A given feature is contributed by more than one morpheme (morphological layer), but each such morpheme (layer) also contributes a feature that no other morpheme (layer) does

b. Superfluous ME: the featural contribution of a particular morpheme (morphological layer) is completely superfluous, given the featural contributions of the other morphemes (morphological layers) in the word.

Of the two subtypes, Superfluous ME poses the more obvious challenge for incremental theories. Thus, after providing an illustrative example of Overlapping ME, we focus in the remainder of the discussion on Superfluous ME.

A compelling case of Overlapping ME occurs in Filomeno Mata Totonac (Totonacan, Mexico; McFarland 2008). Example (37)a illustrates the basic pattern. All four morphemes in the word contribute some unique and essential semantic information. However, three of them also expone second person subject agreement. Second person is encoded in the root, through root allomorphy. The root for 'come' is *tan* when the subject is second person, and *min* otherwise (e.g. in (37)b). Progressive aspect is marked by the suffix *-paa* when the subject is second person (37)a, by *-maa* when the subject is third person (e.g. (37)b), and by *-maana* otherwise (McFarland 2008:121). The suffix *-t̥i* encodes that the subject is second person and singular; it is used when the aspect is progressive and perfective. In other aspects, the suffix *-l̥i* is used instead (McFarland 2008:44).

(37) Filomeno Mata Totonac overlapping ME

a. /tan-paa-ti/
come.**2SUBJ**-PROG.**2.SUBJ**-**2.SUBJ**.SG
'you (sg) are coming'

b. /min-maa/
come-PROG
'he is coming'

c. */min-maa-ti/
come-PROG-2SUBJ.SG
'you (sg) are coming'

Both the root 'come' and the progressive aspect suffix have suppletive 'elsewhere' allomorphs which are not specific to a specific subject person. However, it would be ungrammatical to use these in a verb whose subject is 2nd person, as illustrated in (37)c. The pattern of overlapping ME of second person is obligatory in Filomeno Mata Totonac.

As mentioned, our focus in this paper is Superfluous ME, exemplified in the Turkana and Nanti examples above. In Superfluous ME, a morpheme makes no unique semantic or syntactic contribution to the word. The prefix ŋa- in the Turkana example in (30), and the prefix n- in the Nanti example in (35), do not contribute any unique properties to the meaning target M.

The essential question for any model seeking to derive Superfluous ME is what function it serves. OCM provides at least two local sources of ME: i) ME that brings a stem closer to wordhood and ii) ME that strengthens weak exponence. In both cases, redundant layers of morphology can make the output more structurally harmonic than the input.

7.2 ME that advances a stem to Wordhood

Recall from section §4 the Wordhood scale, introduced in (11) and invoked in (26) to motivate empty morphology in Latin. Insofar as redundant morphology can advance a stem in the direction of Wordhood, it serves a structurally improving function and can be optimal. This analysis is appropriate to cases like Archi, in which an inner suffix seems to be semantically superfluous.

Archi (North Caucasian; Müller 2006, citing Kibrik 1991) exhibits ME of number. In the examples in (38), an inner suffix (highlighted in boldface) which encodes plurality appears to be superfluous, given the existence of an outer suffix which encodes both number and case (in (38)c and (38)d).

(38) Archi plural nouns

	Singular		Plural
a.	gel-li cup.SG-ERG.SG	c.	gel-**um**-čaj cup-**PL**-ERG.PL
b.	qIonn-i bridge.SG-ERG.SG	d.	qIinn-**or**-čaj bridge-**PL**-ERG.PL

The OCM analysis that we develop for Archi is similar to that developed for semantically empty morphs in Latin in §6. The apparently superfluous inner plural suffix in Archi performs a function equivalent to that of a Latin theme vowel: in Archi, it converts a root into a stem-level constituent that is then able to combine with case endings. We assume that Archi case suffixes combine with constituents of type Stem, and that noun roots are of type Root. Roots can be converted to Stems in either of two ways: through combination with a plural suffix (the inner one), or via a semantically empty construction that shifts type from Root to Stem:

(39)

Pl suffixes: take Root to Stem	$[[\ \ ]_{\text{ROOT}}$ -um $]_{\text{STEM}}$
Zero construction: takes Root to Stem	$[[\ \ ]_{\text{ROOT}}\ \ ]_{\text{STEM}}$
Case suffixes: take Stem to Word	$[[\ \ ]_{\text{STEM}}$ -čaj $]_{\text{WORD}}$

Looking at a case-marked plural Archi noun from the top down, it might seem that either the Plural or the semantically empty Root-to-Stem construction would be sufficient to enable the plural case ending to attach. From the bottom up, however, as an Archi word is constructed with the semantic target always in view, it is clear that for a word whose meaning target is plural, the plural Stem-forming construction will always be preferable to the semantically null Stem-forming construction. On the cycle to which the root is input, an output candidate of type Stem which encodes plural number is more faithful to the meaning target, and hence preferred over, a candidate which only shifts to type Stem. This is illustrated below in the tableau generating the optimal stem for an input root meaning 'cup', for a target meaning of 'cup (ERGATIVE, PLURAL)':

(40) First round of affixation: Input = Root

	Input =[gel]$_{\text{ROOT}}$ CUP		M: CUP ERG PL	M-FAITH	BE-WORD
a.	[[ ]$_{\text{ROOT}}$ -Ø]$_{\text{STEM}}$	[gel]$_{\text{STEM}}$	CUP	**!	*
☞ b.	[[ ]$_{\text{ROOT}}$ -um]$_{\text{STEM}}$ PL	[gelum]$_{\text{STEM}}$	CUP PL	*	*
c.	IDENTITY FUNCTION	[gel]$_{\text{ROOT}}$	CUP	**!	**

The output Stem selected in (40) is then input to a subsequent round of morphology. In the lexicon fragment in (39), case endings are the only type of affix that can combine directly with a Stem; two competing possibilities are illustrated in (40). The winning candidate contains the affix producing an output closest to the meaning target:

(41) Next round of affixation: Input = Stem

	Input =[gelum]$_{\text{STEM}}$ CUP, PL		M: CUP ERG PL	M-FAITH	BE-WORD
a.	[[ ]$_{\text{STEM}}$ -li]$_{\text{WORD}}$ CUP, ERG, SG	[gelumli]$_{\text{WORD}}$	CUP ERG SG	*!	
☞ b.	[[ ]$_{\text{STEM}}$-čaj]$_{\text{WORD}}$ CUP, ERG, PL	[gelumčaj]$_{\text{WORD}}$	CUP ERG PL		
c.	IDENTITY FUNCTION	[gelum]$_{\text{STEM}}$	CUP PL	*!	*

These examples illustrate the local optimization that is a crucial part of OCM. If combinations of constructions were assessed globally, the wrong output would be selected, as illustrated below. In this tableau, both forms (one with the semantically superfluous inner plural suffix, in (b), and one without, in (a)) appear to tie, as both are faithful to the meaning target and are of type 'Word'. All morphological matters being equal, the tie would presumably be broken by phonological constraints such as the very general *STRUC, which favor shorter candidates. *STRUC would incorrectly select (a) as the winner.

(42) Global assessment of competing forms realizing 'cup, ERGATIVE, PLURAL':

		M: CUP, ERG, PL	M-FAITH	BE-WORD
💣 a.	[[gel]ROOT]STEM čaj]WORD cup-Ø-ERG.PL	CUP ERG PL		
☞ b.	[[gel]ROOT -um]STEM čaj]WORD cup-PL-ERG.PL	CUP ERG PL		

In conclusion, Superfluous ME can result from type-shifting in the direction of Wordhood, and from local (vs. global) optimization of the match between the meaning of the target and that of the subconstituent under construction in any given tableau.

7.3 ME as a repair of weakness of exponence

A well-known diachronic source of ME is the weakening of an exponent to the point where a new, outer layer of morphology is required in order to robustly expone the relevant property. In the diachronic literature this is known as 'hypercharacterization', a change in stem or word form brought upon paradigmatic analogy when an inner marker is not marking a category transparently enough, and an outer, more productive marker is available (Lehmann 2005:20-21; see also Dressler 2004). Donohue points, for example, to this type of change in the history of Skou (Skou, Indonesia), in which subject person is marked through proclitics, initial consonant alternations, and vowel alternations (Donohue 2003:485). Donohue analyzes this profusion of subject person marking as stemming from a series of sound changes that led to consonant cluster simplifications. These changes affected agreement prefixes, leading to loss of contrast in a large number of verb forms in paradigms. This loss of contrast in turn triggered a restructuring of verbal paradigms, through a second process of cliticization that took place in order to preserve contrastive verbal agreement on the verb (Donohue 2003:493).

The scenario in which a weak inner affix co-occurs with an strong outer affix can be modeled synchronically in OCM through the introduction of the notion of feature strength. ME can result in OCM when an inner exponent expresses a feature or a derivational category only weakly, and an outer one expresses it more strongly. That is, the redundant layer brings the word closer to target meaning M by increasing the strength of one of the components of M. Since affixation is cyclic, a weak expression of a feature in M is better than none, on that cycle, but the later, stronger expression improves the word further.

The notion of strength/weakness of exponence just sketched is inspired by the proposal in recent literature that morphological complexity is itself gradient. Work by Hay (2002), Hay & Baayen (2002, 2005), Hay & Plag (2004) and others has suggested that morphological structures exhibit varying degrees of decomposability or parsability in speech perception. On this view, each morphological construction occupies a place along a processing complexity scale. Many factors contribute to the parsability of an affix, including allomorphy, phonological size, the salience and probability of the junctural phonotactics at the base-affix boundary, and the frequency of the affixed word relative to that of its base (Hay 2002; Hay & Baayen 2002; Hay & Plag 2004). For example, the suffix *-ness* in English rates as more parsable, by these criteria, than the suffix *-ity*. The more salient or segmentable the parts of a construction are in the word, the stronger the paradigmatic relations that the whole word develops (Hay & Baayen 2005:345; see also Taft 1981; Seidenberg 1987; Laudanna & Burani 1995; Wurm 1997; Reid & Marslen-Wilson 2003; Burani & Thornton 2003; and Bergen 2004). A summary table is provided below:

(43) Factors contributing to affix 'strength', i.e. parsability, based on Hay & Plag 2004:

	High parsability	Low parsability
Allomorphy:	no allomorphy	signficant allomorphy (variation in form may diminish the reliability with which a construction signals its category)
Phonological size of affix:	large phonological size	small phonological size (smaller exponents may be less reliably segmented, all else being equal)
Base-affix juncture:	no junctural alternations	junctural alternations (less phonologically segmentable exponents are more difficult to parse, and hence hold weaker links with the morphological category they expone)
Base frequency:	Unaffixed base frequency higher than affixed base frequency	Unaffixed base frequency lower than affixed base frequency

The strength scale in (44) represents the encoding, in each individual grammatical construction, of the strength with which it expones a given morphological category F. A morphological category could be a single feature like [plural] or [durative] or [noun], or it could be a stem type like 'transitive verb'. The scale ranges from 0 (does not expone F at all) to 1 (expones F strongly). A value between these extremes means that the construction expones F weakly. Construction strength can be understood in processing terms as expressing the probability that a given construction will be recognized as realizing a piece of morphosemantic or morphosyntactic information. In terms of lexical storage, it can be understood in terms of whether the construction expresses a given piece of information strongly, weakly, or not at all:

(44) Weak..Strong

0	.5	1
no or irrelevant construction	*weak construction*	*strong construction*

Given this scale, ME can be seen as a strategy to improve exponence in cases where the inner morphological exponent is weaker than the outer exponent. ME of this kind crucially involves affixes attaching to different stem types, e.g. to Root and Stem. The inner affix attaches 'first' because it is capable of combining with a stem of a low type. Although an affix exponing F only weakly (say, 50% strength) does not bring the input fully into 100% conformity with the target, it does improve exponence of F from 0 to 50%. Once type shifting has occurred, either by virtue of the inner affix attaching or by virtue of some other layer of morphology, the outer affix is able to combine, bringing the exponence of F closer to 100%.

To illustrate this source of ME with an actual example, consider the following Choguita Rarámuri (Uto-Aztecan) data (in (33)). In this language, an inner, lexicalized marker (e.g. *-n*) weakly marks Applicative, while a second, regular, outer exponent (*-ki*) brings target meaning to minimum threshold level (Caballero 2008).[14]

(45) Choguita Rarámuri (Caballero 2008)

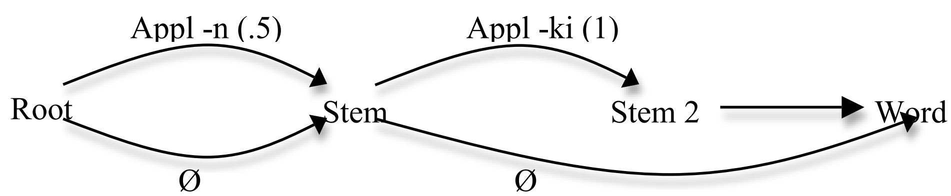
a.	sú-**n**-**ki**-ma	'sew-**APPL**-**APPL**-FUT.SG'
	boto-bú-**n**-**ki**-ma	'sink-TR-**APPL**-**APPL**-FUT.SG'
	pá-**s**-**ki**-ma	'throw-**APPL**-**APPL**-FUT.SG'
b.	sú-**n**-ti-**ki**-ma	'sew-**APPL**-CAUS-**APPL**-FUT.SG'
	rarí-**w**-ti-**ki**-ma	'buy-**APPL**-CAUS-**APPL**-FUT.SG'

The scale in (46) illustrates the relative placement of each of these redundant markers along the strength scale.

(46) Weak..Strong
no affix (0) -n (.5) -ki (1)

Within the larger context of more general morphological and phonological properties of the layered morphology of this language, it is possible to determine that the inner applicative *-n* suffix creates an inner stem level ('Stem 1'), while the outer applicative creates a different constituent type ('Stem 2') with different morphophonological and affixation properties (Caballero 2008).[15] We may visualize word construction in Choguita Rarámuri as in the flow chart in (35), which illustrates the alternatives available for a root to be mapped to a 'Stem 1', 'Stem 2' and 'Word' constituent type.

(47) Choguita Rarámuri grammar fragment



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[14] This case of ME is unusual in involving derivational, valence-changing morphology; most cases of ME are inflectional.

[15] Assessment of the relative processing and parsability of affixes has so far involved corpus-based methodologies, such as estimating parsing ratios and productivity (Hay & Baayen 2002). While an analogous study is not available for Choguita Rarámuri yet, it is possible to assess the relative parsability of affixes by qualitatively assessing their productivity, and their morphotactic and morphophonological properties. It is relevant to note that there are several affixes in this language that may be characterized as 'weak' according to these criteria (i.e., they are phonologically reduced, highly variable and/or unproductive). In each one of these potential but unattested cases of ME of other 'weak' exponents, other independent factors, including general phonotactic well-formedness constraints, preclude the possibility of ME (for details, see Caballero 2008). Crucially, ME is not a property arbitrarily assigned to individual markers; synchronically active, well-formedness constraints on output forms rule out ME as a repair for weak exponence elsewhere in the language.

Specifically, when the input is a Root constituent, the output must be a 'Stem 1' constituent, given no constructions in the grammar which promote Root directly to Word. Choguita Rarámuri has two relevant options for converting a verb root into a 'Stem 1', namely zero conversion (48)a) and weak applicative suffixation (48)b). A weak applicative satisfies M-FAITH better than a form with no applicative marking, so the former wins.

(48) Choguita Rarámuri: input = Root, output = 'Stem 1'

	Input = $[su]_{ROOT}$ SEW		M: SEW FUT SUBJ = SG APPLICATIVE	M-FAITH	BE-WORD
☞ a.	$[[\ \ ]_{ROOT}$ -n $]_{STEM1}$ APPLICATIVE (.5)	$[sun]_{STEM1}$	SEW APPLICATIVE (.5)	.5	**
b.	$[[\ \ ]_{ROOT}$ -Ø$]_{STEM1}$ Ø	$[su]_{STEM1}$	SEW	*!	**
c.	IDENTITY FUNCTION	$[su]_{ROOT}$	SEW	*!	***

When the input is a 'Stem 1', the output is either a 'Stem 2' or 'Word.' Choguita Rarámuri provides two relevant options: zero conversion to Word (49)a) and strong applicative suffixation, creating a 'Stem 2' constituent (49)b). If we assume that a strong applicative is better than a weak one, the double-suffixation candidate (49)b) wins:

(49) Choguita Rarámuri: input = Stem 1, output = Stem 2 or Word

	Input =$[sun]_{STEM1}$ SEW, APPL (.5)		M: SEW FUT SUBJ = SG APPLICATIVE	M-FAITH	BE-WORD
a.	$[[\ \ ]_{STEM1}$ -Ø$]_{WORD}$ Ø	$[sun]_{WORD}$	SEW APPLICATIVE (.5)	.5 *!	
☞ b.	$[[\ \ ]_{STEM1}$ -ki $]_{STEM2}$ APPLICATIVE (1)	$[sunki]_{STEM2}$	SEW APPLICATIVE (1)	1	*
c.	IDENTITY FUNCTION	$[sun]_{STEM1}$	SEW APPLICATIVE (.5)	.5 *!	

This analysis is possible because the model is inherently local and incremental. A global analysis would predict the form with just the strong applicative (*[su-ki]), to be grammatical, if not optimal, and could not generate a form with two applicative markers ([su-n-ki]) as the unique winner. A hypothetical global evaluation of Choguita Rarámuri suffixation is shown in (50):

(50) Hypothetical global evaluation of Choguita Rarámuri applicative suffixation

	Input = [su]$_{\text{ROOT}}$ sew		M: SEW FUT SUBJ=SG APPL	M-FAITH	*STRUC (?)
💣 a.	[[[[su]$_{\text{ROOT}}$] -Ø]$_{\text{STEM1}}$]-ki]$_{\text{STEM2}}$ -Ø]$_{\text{WORD}}$ APPLICATIVE (1)	[suki]$_{\text{WORD}}$	SEW APPL (1)	1	
(☞)b.	[[[[su]$_{\text{ROOT}}$ -n]$_{\text{STEM1}}$ -ki]$_{\text{STEM2}}$ Ø]$_{\text{Word}}$ APPLICATIVE (1)	[sunki]$_{\text{WORD}}$	SEW APPL (1)	1	c ≻ a ≻ b
c.	[[[su]$_{\text{ROOT}}$ -n]$_{\text{STEM1}}$ Ø]$_{\text{WORD}}$ APPLICATIVE (.5)	[sun]$_{\text{WORD}}$	SEW APPL (.5)	.5 *!	

In the cyclic analysis in (48)-(49), the form with the strong applicative (the unattested *[su-ki]) is never considered, since the lexicon does not turn a root into a 'Stem 2' constituent directly. Thus, candidate [suki]$_{\text{STEM2}}$ does not compete with first-round winner [sun]$_{\text{STEM1}}$. The input to [su-ki] would be [su]$_{\text{STEM1}}$, which loses to [su-n]$_{\text{STEM1}}$ in the first round. A resulting prediction is that if the position of the weak and strong affixes in the flow chart were reversed, ME would *not* be predicted, as adding a weak affix to a strong one doesn't improve M-FAITH further.

In sum, the introduction of the notion of feature strength and gradient M-faithfulness permits OCM to model synchronically the result of the familiar diachronic scenario that produces an inner, weaker affix co-occurring with an outer, stronger affix. This scenario can only occur when the inner and outer affixes attach to stems of different types (51). If both affixes combine with stems of the same type (51), there is no motivation to use the weaker affix at all. (The ellipses indicate the possibility of intervening affixes, which we did not see in the Choguita Rarámuri examples but which does occur in some cases.)

(51) Predicted type of ME:
a. [[[[base]$_{\text{STEM=n}}$ weaker affix] …] $_{\text{STEM=n+m}}$ …] stronger affix]

Not Predicted:
b. [[[[base]$_{\text{STEM=n}}$ weaker affix] …] $_{\text{STEM=n}}$ …] stronger affix]

Another case to which this analysis extends readily is Maay pluralization, as documented by Paster (2007). Maay has two plural suffixes, *-o* and *-yal*. The former combines only with consonant-final nouns, while the latter can combine with all nouns. What makes this more than a case of normal suppletive allomorphy is that consonant-final nouns can take either *-o* or both suffixes, i.e. *-o-yal*:

(52) Pluran nouns in Lower Jubba Maay (Eastern Cushitic; Paster 2007)
a. Vowel-final nouns: *-yal* only

Singular	*Plural*	
šati	šati-yal	'shirt'
buundo	buundo-yal	'bridge'
aweesa	aweesa-yal	'worm'
liwa	liwa-yal	'lion'
bakaile	bakaile-yal	'rabbit'

b. Consonant-final nouns: *-o*, *-yal*, or *-o-yal* (optional ME)

Singular	*Plural -o*	*Plural -yal*	*Plural ME*	
gaʔaŋ	gaʔam-o	~ gaʔañ-yal	~ **gaʔam-o-yal**	'hand'
ereŋ	erem-o	~ ereñ-yal	~ **erem-o-yal**	'goat'
biŋ	bin-o	~ biñ-yal	~ **bin-o-yal**	'pin'
mukulal	mukulal-o	~ mukulal-yal	~ **mukulal-o-yal**	'cat'
eey	eey-o	~ eey-yal	~ **eey-o-yal**	'dog'
geet	geeð-o	~ geed-yal	~ **geeð-o-yal**	'tree'
af	af-o	~ af-yal	~ **af-o-yal**	'mouth'

Our OCM account of these facts is that *-yal*, because it can combine with any type of input noun and because of its larger phonological size, and because it begins a syllable, is a stronger exponent of PLURAL than *-o* is. For purposes of concreteness, we may say that *-yal* expones PLURAL with a strength of 1, and *-o* expones plural with strength .5. By itself, this difference in strength would predict that *-yal* would always be used. What motivates the use of *-o,* either by itself or in combination with *-yal?* We suggest that Maay exhibits a tension between phonological well-formedness and morphological strength of exponence. Consonant-final nouns taking *-o* avoid the syllable coda and resulting consonant cluster produced when they combine with *-yal*. (The phonological constraint(s) at issue will be represented by the cover constraint SYLLSTR, which penalizes vowel hiatus, consonant clusters, and codas.) Thus *-o* is phonologically optimal. Yet it does not sufficiently expone PLURAL. Depending on the ranking of SYLLSTR and M-FAITH, *-o*, *-yal* or *-o-yal* will be optimal, as shown below:[16]

(53) First cycle of affixation: *-o* and *-yal* are both potential winners, depending on ranking

	Input = [af] MOUTH		M: MOUTH PL	SYLLSTR	M-FAITH (PL)
☞ a.	*-o* PL	[[af]-o]	MOUTH PL (.5)		* (.5)
☞ b.	*-yal* PL	[[af]-yal]	MOUTH PL (1)	**	
c.	IDENTITY FUNCTION	[af]	MOUTH	*	* (1)

(54) If *-yal* wins on the first cycle, identity is optimal; derivation ends

	Input = [afyal] MOUTH, PL		M: MOUTH PL	SYLLSTR	M-FAITH (PL)
a.	*-yal* PL	[[afyal]-yal]	MOUTH PL (1)	***!	
☞ b.	IDENTITY FUNCTION	[afyal]	MOUTH PL (1)	**	

[16] The order *-yal-o* is never observed. Since from the perspective of improved syllable structure, *-yal-o* would be better than *-o-yal*, we assume that the absence of *-yal-o* is due to an ordering restriction of the kind that we have modeled elsewhere with stem type; *-o* attaches only to roots, while *-yal* can attach to bases of any type but forms stems, bleeding the subsequent attachment of *-o.* For simplicity, we leave the *-yal-o* candidates out of these tableaux.

(55) If *-o* wins on the first cycle, either identity or *-yal* suffixation is optimal:

	Input = [afo] MOUTH, PL		M: MOUTH PL	*SYLLSTR	M-FAITH (PL)
a.	*-o* PL	[[afo]-o]	MOUTH PL (.5)	*	*
☞ b.	*-yal* PL	[[afo]-yal]	MOUTH PL (1)	*	
☞ c.	IDENTITY FUNCTION	[afo]	MOUTH PL (.5)		*

In sum, both Maay and Choguita Rarámuri are cases of superfluous multiple exponence driven by the need for an outer affix to strengthen the exponence of an attribute which is only weakly exponed by an inner affix. In both cases, the inner affix is phonologically smaller and has a more restricted distribution than the outer affix.

8. Some empirical predictions

An important prediction of OCM is that if superfluous multiple exponence does not improve an output, either structurally or in terms of feature strength, it is not optimal and hence it does not occur. What this means is that no word will require exactly the same construction (e.g. affix) to occur twice in immediate succession.

(56) Not predicted:

$[[[\text{base}]_{\text{stem type=n}}$ affix "A" $]_{\text{stem type=n}}$ affix "A"]

Affix doubling does occur in some languages — but only, as far as we know, in the event of a intervening affix. This is predicted in OCM. An input ending in affix "A", of stem type n which expones a feature set F cannot be improved by adding affix "A" again, preserving stem type and leaving F unchanged. However, the addition of an affix outside the inner instance of affix "A" could change either stem type or F in such a way that adding "A" again will improve the candidate word, structurally or featurally. OCM thus predicts that exact affix repetition will always require an intervening affix, a layer of morphology which bumps down an output form to a point lower in the Wordhood scale or weakens the output form in terms of meaning strength.

In this section we examine several cases in which exactly the same affix appears more than once in a word, apparently fulfilling the same exponence function. One relevant case occurs in Jita (Bantu E.25, Tanzania; Downing 2005).[17] In Jita, the causative suffix is added both inside and outside of other derivational suffixes. However, a stem in which no other suffix is present has just one causative suffix, not two:

[17] Related doubling effects occur in other Bantu languages as well. See Hyman 2003, 2005 and Good 2005 for discussion.

(57) Multiple causative suffixation in Jita

Expected order of morphs, given input	Causative doubling	Output
/gur-y-a/	—	[gus-y-a]
/gur-y-ir-a/	/gur-y-ir-y-a/	[gus-i:s-y-a]
/gur-y-an-a/	/gur-y-an-y-a/	[gus-y-an-y-a]
/gur-y-ir-an-a/	/gur-y-ir-y-an-y-a/	[gus-i:s-y-a:n-y-a]

Morphemes: /gur/ 'buy'; /-y/ CAUSATIVE; /-ir/ APPLICATIVE; /-an/ RECIPROCAL; /-a/ FINAL VOWEL

Downing (2005) proposes that Causative doubling results from a morphophonological requirement on causative stems, formulated in terms of paradigm uniformity pressures. In Jita, according to Downing, the causative attaches 'first', i.e. closest to the root. This is consistent with the 'CARP' (Causative-Applicative-Reciprocal-Passive) affix ordering generalization reported for Bantu by Hyman 2002. Jita obeys CARP by ordering causative suffixation first morphologically, but also cyclically imposes the requirement that embedded stem in a causative verb, like the original inner causative stem, must end in *-y*. As a result, hence, *-y* appears multiple times in multiply suffixed verbs.

(58) Stem shape requirement in Jita (Downing 2005: 131)[18]

STEMSHAPE-Causative: Align right edge of (Causative) PStem with the right edge of Causative /y/

In an OCM analysis, Downing's StemShape constraint would function like the stem shape constraint used to model the morphophonological requirements of Ndebele final *-a* suffixation (§7). The StemShape imperative for the Causative to be 'last' co-exists with a morphological imperative for the Causative to attach 'first', i.e. as the innermost suffix. Both are ranked very highly, with the result that the Causative must be added twice, in satisfaction of both, when any other suffix is present.[19] The tableaux in (59)-(62) show how StemShape induces ME in Jita, using as an example a verb whose meaning target is both causative and applicative.

Given the 'Causative first' imperative (Hyman 2002), the best affix to add to a bare root is the causative. This is shown in Tableau (59). A second round of morphology then adds the applicative, matching the meaning target (Tableau (60)). Tableau (61) shows that a second affixation of Causative is motivated to satisfy StemShape. Tableau (62) closes off the derivation

[18] The PStem is defined as a morpho-prosodic constituent that is delimited by the stem-initial consonant to its left and the stem-final consonant to its right (see Downing 2005 for details). Jita, like Ndebele and other Bantu languages, also requires inflectional stems to end in a final vowel, a dummy *-a* when no other semantically contentful marker is available (§6.1). While the requirement of causative stems to end in *-y* targets inner derivational stems (the PStem in terms of Downing), insertion of dummy *-a* is a more general requirement that applies to uninflected stems of all types.

[19] Downing specifies the relative ordering of the semantically motivated instance of the causative and other suffixes in the input (2005:132), while the stem shape condition that triggers causative doubling is modeled through an alignment constraint. While we implement this ordering generalization through the split of M-faith, we acknowledge there are other potential ways in which to model the language-specific factors involved in generating specific affix order sequences, whether these are dependent on semantic, phonological, morphological or other factors. We leave the specifics of this particular issue open for further research.

by selecting the identity candidate as optimal:

(59) First affixation cycle of morphology: causative suffix selected

	Input = [gur]$_{\text{ROOT}}$ BUY		M: BUY CAUSATIVE APPLICATIVE	M-FAITH (CAUS)	M-FAITH (APPL)	STEMSHAPE-Causative
☞ a.	*-y* CAUSATIVE	[[gur]-y]$_{\text{STEM}}$	BUY CAUSATIVE		*	
b.	*-ir* APPLICATIVE	[[gur]-ir]$_{\text{STEM}}$	BUY APPLICATIVE	*!		
c.	IDENTITY FUNCTION	[gur]$_{\text{ROOT}}$	BUY	*!	*	*

(60) Second affixation cycle: applicative suffix selected

	Input = [gury]$_{\text{STEM}}$ BUY, CAUSATIVE		M: BUY CAUSATIVE APPLICATIVE	M-FAITH (CAUS)	M-FAITH (APPL)	STEMSHAPE-Causative
☞ a.	*-ir* APPLICATIVE	[[gury]-ir]$_{\text{STEM}}$	BUY CAUSATIVE APPLICATIVE			*
b.	*-a*	[[gury]-a]$_{\text{WORD}}$	BUY CAUSATIVE		*!	
c.	IDENTITY FUNCTION	[gury]	BUY CAUSATIVE		*!	

(61) Third affixation cycle: causative suffix selected

	Input = [guryir]$_{\text{STEM}}$ BUY, CAUSATIVE, APPLICATIVE		M: BUY CAUSATIVE APPLICATIVE	M-FAITH (CAUS)	M-FAITH (APPL)	STEMSHAPE-Causative
☞ a.	*-y* CAUSATIVE	[[guryir]-y]$_{\text{STEM}}$	BUY CAUSATIVE APPLICATIVE			
b.	*-a*	[[guryir]-a]$_{\text{WORD}}$	BUY CAUSATIVE APPLICATIVE			*!
c.	IDENTITY FUNCTION	[guryir]$_{\text{STEM}}$	BUY CAUSATIVE APPLICATIVE			*!

(62) Fourth affixation cycle: Identity candidate selected, derivation is finished[20]

	Input = [guryiry]$_{Stem}$ BUY, CAUSATIVE, APPLICATIVE		M: BUY CAUSATIVE APPLICATIVE	M-FAITH (CAUS)	M-FAITH (APPL)	STEMSHAPE-Causative
a.	*-y* CAUSATIVE	[[guryiry]-y]$_{Stem}$	BUY CAUSATIVE APPLICATIVE			
b.	*-a*	[[guryiry]-a]$_{Word}$	BUY CAUSATIVE APPLICATIVE			
☞ c.	IDENTITY FUNCTION	[guryiry]$_{Stem}$	BUY CAUSATIVE APPLICATIVE			

One aspect of this analysis that is somewhat suspicious is the duplication between the phonological effect of the causative suffixation construction and the phonological effect of the STEMSHAPE-Causative constraint. Both add *-y*. This means that two completely different analyses are being provided for what looks, phonologically, like the same affix. One way to rationalize this apparent duplication problem is to recognize the larger context in which Jita causative morphology exists. As discussed by Bastin (1986) and Good (2005), Proto-Bantu had two suffixes, **-ic* and **-i̹*. These are commonly referred to in the literature as the 'long' and the 'short' causative, respectively. However, Good (2005) argues that the latter is a transitivizer which in some languages differs semantically from the ('long') causative. The two suffixes historically had different distributions, with the ('long') causative occurring earlier in the suffix complex than the transitivizer. In Ciyao (P.21), for example, both suffixes co-occur in causative verbs, but are separated by intervening suffixes such as the applicative (Ngunga 2000:236, Good 2005):

(63) Complex causative stems in Ciyao

Ciyao stem	Proto-Bantu	gloss
won-	*bon-	'see'
won-el-	*bon-id-	'see-APPL'
won-es-y-	*bon-ic-i̹-	'see-CAUS-TRANS'
won-ec-es-y	*bon-ic-id-i̹-	'see-CAUS-APPL-TRANS'

According to Good (2005), it is very rare in the Bantu family to find the transitive suffix (*-i̹) preceding another derivational suffix, such as the applicative. We speculate that the Jita situation arose as the result of a collapsing, at least in phonological form, of the causative and transitive suffixes, enabled by the fact that both suffixes triggered the same spirantizing mutation effects on a preceding consonant. Thus the original situation in Jita may have been more like

[20] The constraint that would select identity candidate (58c) over (58a) and (58b) is not shown here; as mentioned in section §5, it could be *STRUC, favoring phonologically minimal output candidates, or it could be FAITH-IO, favoring candidates identical to the input.

Ciyao, rather than a case of affix doubling proper. However, it has been reanalyzed into the system that Downing describes.

While in Jita, synchronic affix doubling may trace back to the co-occurrence of two different affixes which phonologically merged with each other, other cases of affix doubling seem to be incontrovertibly motivated by the need to have two instances of exactly the same affix.

Consider, for instance, the case of reciprocal doubling in Chichewa (Bantu N.31), as documented in Hyman & Mchombo 1992 and Hyman 2002. In Chichewa affix order, there are competing requirements to satisfy semantic scope (formalized through a MIRROR constraint in Hyman 2002) and a pan-Bantu 'CARP' (CAUSATIVE < APPLICATIVE < RECIPROCAL < PASSIVE) template. In the example below, a reciprocalized applicative is consistent with the templatic order ((64)a) (and the opposite affix order is unattested with this reading (64)b)). In an applicativized reciprocal, however, the scopal order conflicts with the morphotactically stipulated APPL-RECIP bigram (64)c), but doubling of the reciprocal satisfies both restrictions: the inner reciprocal suffix is semantically motivated and the outer one preserves the stipulated order (64)d):

(64) Chichewa: reciprocal doubling (Hyman and Mchombo 1992): Root-APPL-RECIP

a. mang-ir-an- 'tie-APPL-RECIP = tie for each other' [reciprocalized applicative]
b. *mang-an-ir-
c. mang-ir-an- 'tie-APPL-RECIP = tie each other for/with/at' [applicativized reciprocal]
d. man-**an**-ir-**an**- 'tie-APPL-RECIP = tie each other for/with/at' [applicativized reciprocal]

Another well-known case of affix doubling is found in Breton (Celtic), illustrated in (65), taken from Stump 1991). The regular Breton plural suffix *-où* is added directly to the root; however, if a diminutive suffix is added as well, the plural must be repeated so that it is word-final:

(65) Breton diminutive plurals: root-**PL**-DIM-**PL** (a) OR root.**PL**-DIM-**PL** (b):

		singular	singular diminutive	plural	plural diminutive
a.	'boat'	bag	bag-ig	bag-où	bag-où-ig-où
	'prayer'	pedenn	pedenn-ig	pedenn-où	pedenn-où-ig-où
b.	'bone'	maen	maen-ig	mein	mein-ig-où
	'stone'	askorn	askorn-ig	eskern	eskern-ig-où

The Chichewa and Breton cases could be given the same analysis as Jita causative doubling. However, the phonological STEMSHAPE condition that figured in Downing's analysis of Jita, and seems less applicable in Chichewa and Breton, where the affixes in question are clearly segmentable and don't carry the same phonological mutation effects that characterize the stems of Jita causatives.

Two alternative analyses present themselves for these challenging cases. One, advocated by Ryan (2010) and also underlying the analysis of Hyman (2002, 2003), involves competition between contradictory bigram constraints on co-occurring affixes. If affixes A and B are compelled by the grammar to occur in the order AB, then the language will exhibit fixed AB affix ordering. But if the grammar also compels the affixes to occur in the order BA, a paradox arises which, in at least some languages, can be satisfied by doubling one affix or the other. The order ABA satisfies both the AB and the BA ordering imperatives, if interpreted existentially.

This line of analysis is interesting and potentially correct. It makes particular sense for Chichewa, in which affix doubling occurs, producing ABA affix order, only when the AB order is driven by morphosyntax and the BA order satisfies an ngram constraint on the order of A and B. In Chichewa, the order *an-ir-an*, RECIPROCAL-APPLICATIVE-RECIPROCAL, occurs only in verbs in which the applicative has scope over the reciprocal. In verbs with the opposite scopal relation, only the order *ir-an*, APPLICATIVE-RECIPROCAL, occurs. In these cases, the morphosyntax predicts the same order that the CARP ngram constraint requires.

In Jita and Breton, however, the ngram constraints in question would be equivalent but contradictory. Jita requires the causative to be initial *and* final in the ngram, regardless of scopal relations. In Breton plural diminutives, the plural has scope over the diminutive, leading to an expected order of STEM-DIM-PL. The inner PL would have to be explained by an arbitrary bigram constraint requiring the order PL-DIM. Breton would thus be the opposite of Chichewa, in which the inner pair of affixes occurs in the expected order and the doubled affix is then added as a repair to satisfy the arbitrary n-gram ordering constraint.

While ngram analyses have a lot of potential, we pursue an alternative analysis here that is more in the spirit of OCM. We suggest that the reason that affixes are doubled in Jita, Chichewa and Breton is that the featural contribution of the inner affix is attenuated by the intervening affix. In Breton, for example, we suggest that the diminutive suffix has inherently singular semantics, nullifying the semantic effect of the inner plural. This is what causes the plural to have to be added again. The representations we assume for the plural and diminutive suffixes are given below. The plural and diminutive suffixes expone the plural and diminutive features, respectively. In addition, the diminutive expones singular. The rationale for this is that all words ending in a diminutive suffix are singular.[21]

(66) Breton plural and diminutive suffixes

$[[\ \ ]\ \text{-où}\ ]_{\text{Pl (1)}}$
$[[\ \ ]_{\text{STEM}}\ \text{-ig}\ ]_{\text{STEM, Dim, Sg}}$
$[[\ \ ]_{\text{ROOT}}\ \ ]_{\text{STEM}}$

As the following tableau shows, the plural suffix is the first to be added to a root in constructing a word whose meaning target is plural and diminutive. We model this by assuming that the plural suffix can attach to stems of any type, including type ROOT, whereas diminutives are restricted to type STEM and can combine with roots only after a type-shifting construction has converted them to STEM. This assumption resonates with Stump's (2001, 2006) proposal that the plural is head-inflecting, that it has special privilege of attaching directly to the root.

[21] A more interesting analysis would have the dimunitive exponing singular number only weakly, e.g. at strength .5, reflecting the fact that the diminutive occurs in plural words and is therefore not as strongly singular as a suffix that occurs only in singular words. This modification would not affect the outcome of our analysis and therefore we have omitted it, for simplicity.

(67) First affixation cycle: plural is selected (*note: -ig* (DIM) not available for affixation, since *-ig* attaches to bases of type STEM, not ROOT)

	Input = $[\text{bag}]_{\text{ROOT}}$ BOAT		M: BOAT PL DIM	M-FAITH (DIM)	M-FAITH (NUM)	BE-WORD
☞ a.	*-où* PL	$[[\text{bag}]_{\text{ROOT}}\ \text{-où}]_{\text{ROOT}}$	BOAT PL	*		**
b.	-Ø	$[[\text{bag}]_{\text{ROOT}}]_{\text{STEM}}$	BOAT	*	*!	*
c.	IDENTITY FUNCTION	$[\text{bag}]_{\text{ROOT}}$	BOAT	*	*!	**

(68) Second affixation cycle: input ROOT is type shifted to STEM

	Input = $[\text{bagoù}]_{\text{ROOT}}$ PL		M: BOAT PL DIM	M-FAITH (DIM)	M-FAITH (NUM)	BE-WORD
a.	*-où* PL	$[[\text{bagoù}]_{\text{ROOT}}\ \text{-où}]_{\text{ROOT}}$	BOAT PL	*		**!
☞ b.	-Ø	$[[\text{bagoù}]_{\text{ROOT}}]_{\text{STEM}}$	BOAT PL	*		*
c.	IDENTITY FUNCTION	$[\text{bagoù}]_{\text{ROOT}}$	BOAT PL	*		**!

(69) Third affixation cycle: diminutive is added, attenuating number faithfulness

	Input = $[\text{bagoù}]_{\text{STEM}}$ PL		M: BOAT PL DIM	M-FAITH (DIM)	M-FAITH (NUM)	BE-WORD
a.	*-où* PL	$[[\text{bagoù}]_{\text{STEM}}\ \text{-où}]_{\text{STEM}}$	BOAT PL	*!		*
☞ b.	*-ig* DIM	$[[\text{bagoù}]_{\text{STEM}}\ \text{-ig}]_{\text{STEM}}$	BOAT SG DIM		*	*
c.	[IDENTITY FUNCTION]	$[\text{bagoù}]_{\text{STEM}}$	BOAT PL	*!		*

(70) Fourth affixation cycle: plural is added again, improving number faithfulness

	Input = [bagoùig]$_{STEM}$ BOAT, SG, DIM		M: BOAT PL DIM	M-FAITH (DIM)	M-FAITH (NUM)	BE-WORD
☞ a.	*-où* PL	[[bagoùig]$_{STEM}$ -où]$_{STEM}$	BOAT PL DIM			*
b.	*-ig* DIM	[[bagoùig]$_{STEM}$ -ig]$_{STEM}$	BOAT SG DIM		*!	*
c.	[IDENTITY FUNCTION]	[bagoùig]$_{STEM}$	BOAT SG DIM		*!	*

The final cycle(s), not shown here, involve the promotion of Stem to Word and the selection of the identity candidate as optimal. The derivation is essentially complete at *bag-où-ig-où.*

This analysis also works correctly for roots with suppletive plural forms, e.g. *askorn~eskern* 'stone sg ~ pl'. For such forms, the optimal first cycle of affixation will be the diminutive *-ig*; the resulting singularization will require a subsequent cycle of pluralization. The tableaux for *eskern-ig-où* will be identical to those in (69) and (70).

9. Final summary: charting a locally optimizing path through the hierarchical lexicon

In this paper, we have developed a theory of Optimal Construction Morphology, designed to generate words in optimal fashion from the lexicon, given a meaning target. In OCM, blocking, multiple exponence and semantically empty morphology are regulated through independently needed mechanisms. OCM dispenses with constraints required in previous theories to ban, or require, seemingly redundant morphology.

Several components of OCM contribute crucially to this result. One is locality. OCM is a theory that picks out the optimal path through the hierarchical lexicon, with the guiding purpose of building a word that matches the target syntactic/semantic description. In OCM, a word has only the morphological layers that it needs — but need is assessed locally (at each step of word formation), not globally (only after an entire word has been assembled).

A second component of our analysis is the introduction of scalar properties of well-formedness, covering both stem type and feature strength.

Given these properties, the number of times a given morphosyntactic property is exponed in a given word falls out from the interaction of faithfulness and markedness, and need not be stipulated. ME (like any other morphology) is not predicted if it does not contribute to meaning or structural well-formedness. Specifically, there are a number of factors that may condition departure from the canonical one-to-one exponence relation between meaning and form in word construction, any of which may lead to the appearance of ME. These include structural deficiency (as in Archi (§9.2)), and semantic and form deficiency (as in Choguita Rarámuri (§9.3). ME (like any other morphology) is not predicted if it does not contribute to meaning or structural well-formedness.

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