The role of morphology in Optimality Theory

Zheng Xu
Shanghai Jiao Tong University

1 Introduction

Since the creation of Optimality Theory (OT) (Prince and Smolensky 1993/2004, McCarthy and Prince 1993b/2001), it has been widely applied in various linguistic sub-disciplines. OT was initially designed for phonology. Kager (1999:16) illustrates the fundamental assumptions of conventional OT with an example from Dutch (1). The symbol '-' indicates a morpheme boundary and '.' indicates a syllable boundary.

(1)	a.i	/bɛd/	bɛt	'bed'
	a.ii	/bɛd-ən/	bɛ.dən	'beds'
	b.i	/bɛt/	bɛt	'(I) dab'
	b.ii	/bɛt-ən/	bɛ.tən	'(we) dab'

Assume an underlying form or input for the phonology is /bɛd/ 'bed', which surfaces in the plural form (1a.ii). The input for 'bed' cannot be /bɛt/, with intervocalic voicing in its plural form, otherwise the surface form for 'dab' in (1b.ii) would be *[bɛ.dən]. The function GEN(ERATOR) generates a list of logically possible output candidates for the input /bɛd/, which are submitted to the Dutch grammar for evaluation. This grammar consists of the *markedness* constraint *VOICED CODA, favoring voiceless obstruent codas, and the *faithfulness* constraint IDENT-I(NPUT)O(UTPUT) (voice), enforcing identity between an input and its output in terms of the voicing feature. The constraint *VOICED CODA dominates or outranks IDENT-IO (voice) in Dutch so that a violation of *VOICED CODA is more serious than any number of violations of IDENT-IO (voice). The surface form or winning output candidate [bɛt] violates IDENT-IO (voice), but satisfies *VOICED CODA. This form is optimal because it incurs the least serious violation of the above set of constraints, taking into account their hierarchical ranking. By contrast, the losing candidate *[bɛd], for example, violates the higher ranked constraint *VOICED CODA so that it is ruled out by the grammar.

This example of pure phonology reflects several fundamental assumptions of conventional OT such as input and output, basic types of constraints such as markedness constraints and faithfulness constraints, the function GEN, and the way an OT grammar picks out the optimal candidate. I will elaborate on these fundamentals in section 2.

Conventional OT has been extended to the morphology-phonology interface — morphophonology in particular. McCarthy and Prince (1995:365) for example observe that Arabic roots contain pharyngeals, but affixes do not. To account for this observation in OT, they propose the constraint ranking in (2) where the constraint at the left of ">>" outranks the one at the right.

(2) IDENT-ROOT(Place) >> *[pharyngeal] >> IDENT-AFFIX(Place)

The markedness constraint *[pharyngeal] bans any pharyngeal in the output. The faithfulness constraint IDENT-ROOT(Place) requires an input segment of a root to be identical with its output in terms of the place feature. The faithfulness constraint IDENT-AFFIX(Place) requires an input segment of an affix to be identical with its output in terms of the place feature. The constraint *[pharyngeal] outranks IDENT-AFFIX(Place) so that an output candidate of an affix which does not contain a pharyngeal will be preferred over one that has a pharyngeal. The constraint *[pharyngeal] is outranked by IDENT-ROOT(Place) so that an input pharyngeal of a root will surface. This is a case of morphophonology, in which morphological categories such as root and affix show their effects in the phonological component of the grammar.[1]

Conventional OT is not sufficient to account for cases of the morphology-phonology interface such as phonologically conditioned allomorphy or allomorph selection (see chapter 6). Here *allomorphy* refers to a phenomenon in which a lexical morpheme or morphosyntactic feature set has multiple phonological representations that cannot be derived from a single underlying form (cf., Kager 1999, Bonet and Harbour 2012). An extra mechanism has been introduced into conventional OT to account for phonologically conditioned allomorphy, i.e., an input allomorph set, in which multiple input allomorphs are stipulated (Kager 1996, Lapointe 2001, Bonet 2004, Bonet et al 2007, Mascaró 2007, Bonet and Harbour 2012).

There are at least three problems for a conventional OT approach with an input allomorph set. In conventional OT, either a stem or an affix is placed in an input, which predicts that stem-conditioned affix allomorphy and affix-conditioned stem allomorphy should be equally prevalent. However, based on cross-linguistic surveys, Paster (2006, 2009) found that the direction of conditioning of allomorphy is inside-out: there are many cases of stem-conditioned affix allomorphy while few cases of affix-conditioned stem allomorphy.[2]

Second, Paster (2009) argues that phonologically conditioned allomorphy is sensitive to phonological properties of underlying or input forms, not surface forms. By contrast, a conventional OT approach with an input allomorph set predicts that phonologically conditioned allomorphy is sensitive to phonological properties of surface forms, not underlying forms.

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[1] See other works that index constraints to non-phonological information. Ringen and Vago (1998) and Noske (2000), for example, discuss faithfulness constraints encoding morphological categories such as root and affix in Hungarian and Turkana, respectively. Itô and Mester (1999) index faithfulness constraints to etymological information or vocabulary strata in Japanese such as native, Sino-Japanese, foreign vocabularies. Smith (1997) indexes faithfulness constraints to the lexical category noun. Pater (2000, 2007) indexes both faithfulness and markedness constraints to either lexical or morphological information. In contrast to the indexed constraint theory, other OT frameworks have been proposed to account for morphophonology. These frameworks include Stratal Optimality Theory (Kiparsky 2000) and Cophonology Theory (Orgun 1996, Inkelas et al. 1997, Inkelas 1998, to appear, Anttila 2002, Inkelas and Zoll 2007).

[2] Unless a footnote is provided, the definition of stem in Aronoff (1994: 39) is used throughout this chapter. That is, a stem is a "sound form to which a given affix is attached or upon which a given nonaffixal realization rule operates."

Third, sometimes one allomorph can occur in a specific phonological context while the other allomorph occurs elsewhere. The precedence of spellout between the two allomorphs is determined by Pāṇini's Principle. Stipulating this precedence in an input allomorph set misses Pāṇini's Principle given that in OT any general principle should be reflected in a grammar rather than stipulated in an input. I will demonstrate this point in section 4.

Given the above problems, an improved version of OT phonology is called for to account for phonologically conditioned allomorphy, if it is still assumed to take place in the phonological component of the grammar. Wolf (2008) for example proposes the framework of Optimal Interleaving (OI) and attempts to account for phonologically conditioned allomorphy. OI assumes that lexical insertion takes place in the phonological component of the grammar. Another possibility is to assume that phonologically conditioned allomorphy is essentially a phenomenon in which phonological effects are observed in the morphological component of the grammar, which is not a target of conventional OT, so that some assumptions of conventional OT do not apply to the morphological component. Either way, morphological realization must be taken into account to explain phonologically conditioned allomorphy. This chapter argues for the second solution. Extending the other assumptions of conventional OT into the domain of pure morphology can not only account for phonologically conditioned allomorphy, but also shed light on some well-known morphological issues such as blocking and extended morphological exponence, and syncretism.

Section 2 presents various fundamental assumptions of conventional OT, some of which are also taken in OT frameworks for morphology. Section 3 discusses some differences among the mechanisms of several OT frameworks for morphology. Section 4 compares three types of OT approaches to phonologically conditioned allomorphy, a case of the morphology-phonology interface: conventional OT, Optimal Interleaving, and Realization Optimality Theory. Section 5 discusses the mechanisms, advantages, and problems of several OT frameworks in terms of how they account for cases of morphology proper such as blocking and extended morphological exponence as well as syncretism. Section 6 summarizes the discussions in previous sections.

Each theoretical framework in this chapter is evaluated using criteria such as the accuracy of their predictions, the complexity of their mechanisms, the quantity of linguistic data they can account for, and the extent to which stipulations are referred to so that generalizations based on linguistic principles are either captured or lost.

2 Fundamentals of conventional Optimality Theory

The central idea of conventional OT (Prince and Smolensky 1993/2004, McCarthy and Prince 1993b/2001), whose target is phonology, is that surface forms of language arise from the interaction between competing demands or constraints. There are three major components of a conventional OT grammar (3) (Kager 1999: 19).

(3) LEXICON: contains lexical representations (or underlying forms) of morphemes, which form the input to:
GENERATOR: generates output candidates for some input, and submits these to:
EVALUATOR: the set of ranked constraints, which evaluates output candidates as

to their harmonic values, and selects the optimal candidate.

The Lexicon provides inputs, which are to be submitted to the function GEN. Conventional OT makes the Richness of the Base assumption, i.e., no constraints hold at the level of the input and grammatical generalizations are expressed as interactions of constraints at the level of the output only.

> "GEN generates all logically possible candidate analyses of a given input." "The only true restriction imposed on all output candidates generated by GEN is that these are made up of licit elements from the universal vocabularies of linguistic representation, such as segmental structure (features and their grouping below the level of the segment), prosodic structure (mora, syllable, foot, prosodic word, etc.), morphology (root, stem, word, affix, etc.), and syntax (X-bar structure, heads/complements/specifiers, etc.). Within these limits, 'anything goes' ". (Kager 1999: 20).

The crucial role of EVALUATOR (abbreviated as EVAL) is to "assess the 'harmony' of [output candidates] with respect to a given ranking of constraints" and "select the most harmonic one of these as optimal — the actual output of the grammar." (Kager 1999: 21) In conventional OT frameworks such as McCarthy and Prince (1993b), no reference is permitted to morphosyntactic information. Notions such as affix, root, and stem are deemed to constitute enough morphological information for the grammar to select the output.

An OT grammar consists of ranked and violable constraints. Constraints are assumed to be universal in conventional OT. Languages differ by constraint rankings. There are two basic types of constraints in conventional OT: markedness and faithfulness. Markedness is a relative notion and usually expresses an implicational relation: the structure A is more marked than the structure B if and only if the presence of A implies the presence of B in a language but not vice versa. Markedness constraints ban marked output forms, which are crosslinguistically dispreferred. For example, if a language has voiced obstruent codas, it will also have voiceless obstruent codas (e.g. English). If a language has voiceless obstruent codas, it will not necessarily have voiced obstruent codas (e.g. Cantonese). Hence, voiced obstruent codas are more marked than voiceless obstruent codas. The markedness constraint *VOICED CODA bans voiced obstruent codas in the output (1).

Faithfulness constraints, which preserve lexical contrasts in conventional OT, enforce identity either between an input and its output or between two outputs. There are three major types of faithfulness constraints in conventional OT: MAX, DEP, and IDENT (McCarthy and Prince 1995). The MAX constraint prevents loss of information, either from an input to its output or from one output to another. The DEP constraint prevents the occurrence of new information, either from an input to its output or from one output to another. The IDENT constraint requires two corresponding forms to be identical with respect to a feature.

Output candidates are evaluated by an OT grammar. The output or optimal candidate incurs the least serious violations of constraints. Consider the following tableau, which shows how an OT grammar selects the optimal candidate. There are four constraints in this tableau: C_1, C_2, C_3,and C_4. C_1 is the highest ranked or undominated constraint. It outranks C_2 and C_3, which is indicated by a solid line. C_2 and C_3 are equally ranked, which is indicated by a dotted line. Both C_2 and C_3 outrank C_4, which is the lowest ranked constraint. Due to transitivity of ranking, C_1 outranks C_4. Three output candidates are listed in this tableau. Candidate c makes one violation of C_1, which is indicated by one violation mark '*'. Candidates a and b satisfy C_1. Because C_1 is undominated, a violation of C_1 is more serious than any number of violations of the lower-ranked constraints so that candidate c is ruled out by the grammar. The violation which causes an output candidate to be ruled out is fatal, which is indicated by the exclamation mark '!'. Candidate a violates C_3 and candidate b violates C_2. Because C_2 and C_3 are equally ranked, the violations of C_2 and C_3 are equally serious so that the decision of choosing the output between candidates a and b is left up to the lowest ranked constraint C_4. Candidate a makes one violation of C_4 while candidate b makes two violations. The violation of C_4 incurred by candidate b is more serious than that incurred by candidate a. Therefore, candidate b is ruled out and candidate a is selected as the optimal candidate, which is marked by the index '☞'.

(4)

	C_1	C_2	C_3	C_4
☞ *candidate a*			*	*
candidate b		*		**!
candidate c	*!			

In conventional OT frameworks such as Prince and Smolensky (1993/2004) and McCarthy and Prince (1993b/2001), the derivation of the output from its input is usually parallel, i.e., no intermediate stage of derivation or intermediate output is involved.

3 Differences among the mechanisms of several OT frameworks for morphology

Extending some of the assumptions of conventional OT into the morphological component of the grammar not only accounts for phonologically conditioned allomorphy, but also sheds light on some well-known morphological phenomena such as blocking and extended morphological exponence, and syncretism. Before turning to these issues, I should first mention not only the assumptions of conventional OT that are taken in almost all OT frameworks for morphology, but also the differences among their mechanisms. These differences lead to both advantages and problems in analyzing various morphological phenomena.

In recent years, there have appeared various OT frameworks for analyzing morphological issues. These frameworks all share some basic conceptions of conventional OT such as input and output, the function GEN, and the way an OT grammar picks out the optimal candidate. These frameworks also show various differences in terms of, for example, whether input morphosyntactic features can be changed or not, whether a morph is introduced via an input, an output candidate, or a constraint, whether the function GEN generates a list of output candidates or introduces output candidates from the lexicon, what types of constraints are used, and whether a morphological derivation should be serial or parallel.

First, there is a difference in terms of whether an input morphosyntactic feature can be changed in the output. Unlike conventional OT, an input in an OT framework for morphology usually includes morphosyntactic information. Frameworks such as Realization Optimality Theory (e.g., Xu and Aronoff 2011a, b), Optimal Interleaving (e.g., Wolf 2008), Optimal Construction Morphology (e.g., Caballero and Inkelas 2013), whose target is morphological realization, do not assume any change of input morphosyntactic features. By contrast, Distributed Optimality (Trommer 2001), for example, allows the impoverishment of input morphosyntactic features, but does not allow the insertion of morphosyntactic features in the output.

Second, there is a difference in terms of whether a morph is introduced via an input, a constraint, or an output candidate. In conventional OT, morphs, either a stem or an affix, are usually placed in an input. In Realization OT, for example, an uninflected stem is usually placed in an input while inflectional affixes are encoded in constraints. In the frameworks of Optimal Interleaving and Optimal Construction Morphology, morphs, either a stem or an affix, are usually introduced via output candidates.

There is a third difference with regard to the definition of the function GEN. Most OT works simply assume that GEN generates a list of logically possible output candidates. By contrast, in Optimal Interleaving and Optimal Construction Morphology, it is assumed that GEN inserts lexical items or constructions into output candidates from the lexicon. In Optimal Interleaving, for example, it is assumed that morphological realization takes place in the phonological component of the grammar. An input usually consists of morphosyntactic features and a grammar consists of phonological constraints and morphosyntactic ones that either require output candidates to mirror syntactic structures or require the morphosyntactic properties of an output candidate to be faithful to those of its input, which are introduced from a syntactic tree structure. On the other hand, the lexicon supplies inputs for the function GEN, which faithfully maps them to output candidates. Hence, in OI there are actually two sets of input and grammar. One set consists of an input from a syntactic tree structure and a grammar consisting of both phonological constraints and morphosyntactic ones. The other set consists of an input from the lexicon and the function GEN. Such an assumption that two sets of input and grammar share the same output is not taken in morphological frameworks such as Realization OT.

Fourth, several types of constraints have been proposed in OT morphology. In addition to markedness and faithfulness constraints, there are realization constraints and morphotactic constraints. Their significance differs among OT frameworks for morphology. Realization constraints require morphosyntactic features to be expressed by phonological information. Rose (2000), for example, proposes the constraint MORPHEXPR, which requires every morphological category to be marked by some affix. Trommer (2001) proposes realization constraints such as PARSE [2], which requires the second person feature value to be realized by an exponent. Russell (1995), Kager (1996), Yip (1998), MacBride (2004), Xu (2007), and others propose realization constraints which require a specific morphosyntactic feature value to be expressed by a specific exponent. For example, the realization constraint {pl}: *-z* requires the plural feature value to be expressed by the suffix *-z*.

Morphotactic constraints determine affix positioning. These include alignment constraints (e.g., McCarthy and Prince 1993a, Trommer 2001) and templatic constraints (e.g., Hyman 2003, Paster 2005a, Caballero 2010, Ryan 2010).

Last but not least, there is a question of whether parallel or serial approaches should be taken in OT derivations. On a parallel approach there is usually one input and output only. By contrast, on a serial approach there is at least one intermediate output.[3] A parallel approach is simpler and more straightforward compared to a serial approach given that the former involves no intermediate stage of derivation. Unless a serial approach is shown to be indispensable, a parallel approach is generally preferred. Rule-based frameworks are usually serial in nature. A strict serial framework predicts neither inward-looking morphosyntactically conditioned nor outward-looking phonologically conditioned realization (cf. Trommer 1999, Bobaljik 2000). Although not all rule-based frameworks claim the non-existence of inward-looking morphosyntactically conditioned realization, almost all rule-based frameworks assume the non-existence of outward-looking phonologically conditioned realization. That is, complex words are built up from the root outwards so that the choice of an inner morph cannot be influenced by the phonological information of a morph that is added later (see e.g., Anderson 1982). A rule-based framework therefore predicts no affix-sensitive stem allomorphy.

Optimal Interleaving (Wolf 2008) is a framework based on Optimality Theory with Candidate Chains (OT-CC) (McCarthy 2007), a serial architecture for OT to do phonology. In OT-CC, the function GEN makes one change of an input when it is mapped to an output candidate.[4] This can bring about an intermediate output, which becomes another input for GEN to manipulate. A candidate chain consists of an input, intermediate outputs, and a final output. An input is considered an initial link of a chain. Every output, either intermediate or final, is considered a non-initial link of a chain. A candidate chain is assumed to be harmonically improving, i.e., every non-initial link of a chain should be more optimal than its previous link. The grammar evaluates the final links of chains and selects the optimal output.

In one version of OI, it is assumed that spellout strictly starts from the root and proceeds outwards. I use Wolf's hypothetical language to demonstrate why this assumption alone cannot predict the non-existence of outward-looking phonologically conditioned allomorphy. Assume there are two root allomorphs, /xof/ and /za/, in this

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[3] See McCarthy (2000), for example, for a discussion of the distinction between parallelism and serialism in OT.

[4] Wolf (2008) assumes that GEN can sometimes make two changes of a previous link of a chain. For example, in Axininca Campa, [t] is inserted in the derivation from /no-ŋ-koma-i/ to [noŋ.ko.ma.ti] 'he will paddle' (Payne 1981, McCarthy and Prince 1993b). In OI, GEN must insert [t] and syllabify [noŋ.ko.ma.ti] in one step, i.e., GEN must make two changes of a previous link in one step. Otherwise, the mapping from /no-ŋ-koma-i/ to [noŋ.ko.ma.ti] wouldn't be harmonically improving, assuming the insertion of [t] takes place before the syllabification of [noŋ.ko.ma.ti]: "we've added a violation of DEP-C without removing the violation of ONSET which supposedly motivates epenthesis. Thus, we must allow epenthesis to occur simultaneously with syllabification, so that a direct mapping from /no-ŋ-koma-i/ to [noŋ.ko.ma.ti] is licit." (Wolf 2008: 205)

hypothetical language. The plural feature value is expressed by the suffix -*u*.[5] The following are two legitimate chains, in which each non-initial link contains one more lexical item than a link which immediately precedes it.

(5) a. <ROOT-{pl}, xof-{pl}, xof-u>
b. <ROOT-{pl}, za-{pl}, za-u>

Consider the following tableau (adapted from Wolf 2008: 166), in which both the output candidates are the final links of the above two chains. The partial grammar consists of the constraints ONSET, *x, and *VOICED OBSTRUENT. The constraint ONSET requires every syllable to have a consonant onset. The constraint *x forbids the occurrence of the segment [x]. The constraint *VOICED OBSTRUENT forbids the occurrence of any voiced obstruent.[6] Candidate b is ruled out by ONSET. As we can see, the selection between *xof* and *za* is sensitive to *u*, which is an outer morph. Hence, this is a case of outward-looking phonologically conditioned root allomorphy.

(6) Affix-conditioned root allomorphy in a hypothetical language

Input: ROOT-{pl}	ONSET	*x	*VOICED OBSTRUENT
☞ a. xo.fu		*	
b. za.u	*!		*

In order to rule out outward-looking phonologically conditioned allomorphy, Wolf (2008: 160) proposes Local Optimality (LO), which is defined as follows:

(7) Local Optimality
Let $\langle \dots f_{n-1}, f_n \rangle$ be a valid chain in some language *L*. Let $g_1, \dots g_m$ be all of the forms which can be formed from f_n by applying some operation *O* in GEN. The chain $\langle \dots f_{n-1}, f_n, g_i \rangle$ is then a valid chain in *L* iff:

a. g_i is more harmonic than f_n.
b. g_i is the most harmonic member of the set $\{g_1, \dots g_m\}$

Under LO, a grammar also needs to evaluate intermediate links that are labeled with the same number. Hence, the grammar of the above hypothetical language also needs to evaluate the intermediate links *xof*-{pl} and *za*-{pl}, both of which are the second links of the two chains in (5).

However, LO still cannot rule out outward-looking phonologically conditioned allomorphy, based on the grammar in (6). In (8) the two output candidates are equally

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[5] Wolf (2008) assumes the structure √PETO-$\{xof, za\}_{FEM}$-u_{PL}, in which *xof* and *za* are exponents of the feminine feature value. For simplicity of presentation, I assume that *xof* and *za* are root allomorphs. My assumption will not affect Wolf's (2008) conclusion that OI cannot predict the non-existence of outward-looking phonologically conditioned allomorphy without additional stipulations.

[6] Wolf (2008) assumes the ranking ONSET >> *x >> *VOICED OBSTRUENT. However, it is also reasonable to assume that *x and *VOICED OBSTRUENT are equally ranked.

harmonic. Hence, further derivations based on them are valid. The next round of derivations will result in *xof-u* and *za-u* so that outward-looking phonologically conditioned allomorphy will be observed, as shown in (6).

(8) xof-{pl} vs. za-{pl} in a hypothetical language

Input: ROOT-{pl}	ONSET	*x	*VOICED OBSTRUENT
☞ a. xof-{pl}		*	
☞ b. za-{pl}			*

Wolf (2008) makes an additional stipulation that only one intermediate link under LO can be selected as optimal. Under this stipulation, either *xof*-{pl} or *za*-{pl} will be selected as the optimal link. Further derivations based on the other intermediate link, which is not selected as optimal, are invalid. Hence, no outward-looking phonologically conditioned allomorphy will be observed.

In Realization OT, no input allomorph set is assumed. An uninflected stem, which is to be affixed, is usually placed in an input while inflectional affixes are encoded in constraints. It is therefore predicted that uninflected stem allomorphy cannot be sensitive to inflectional affixation while inflectional affix allomorphy can be sensitive to stems.

There is one type of example which may pose a challenge to the prediction of no affix-conditioned stem allomorphy. In Romance languages such as Italian, stems can exhibit alternations, which can be conditioned by the stress pattern of their suffixes. For example, the preterite stem of *rompere* 'to break' appears as *rupp* when its suffix is unstressed while it appears as *romp* when its suffix is stressed (Carstairs 1990)[7]. Since inflectional affixes are encoded in constraints in Realization OT, it is predicted that outer affixes can condition inner affixation, if we do not refer to the above stipulations in Optimal Interleaving. There are at least several cases which may support this prediction (9).

(9) a. Fulfulde (Southern Zaria district): General future active tense can be expressed by more than one exponent. The suffix -$V_i t$ occurs before V_i-initial suffixes. The suffix -*ay* occurs before consonant-initial ones. (Mary McIntosh, p.c., Arnott 1970: 53, 213, 224, cited in Carstairs 1990)

b. Italian: The augment /-isk/ occurs after some stems when its following suffix does not bear stress, e.g., *fin-ísk-o* 'I finish' vs. *fin-íamo* 'we finish'. (Hall 1948, cited in Paster 2009)

c. Sanskrit: The empty morph -*i* occurs either word-finally or before consonant-initial case-number suffixes, e.g., *asth-i-bhiḥ* ('bone'-EMPTY MORPH-{instrumental, pl}). The empty morph -(*a*(*:*))*n* occurs before vowel-initial suffixes, e.g., *asth-n-aḥ* ('bone'-EMPTY MORPH-{gen, sg}). (Carstairs 1990)

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7 Carstairs (1990: 20) suggests that "the right way to look at the alternation between *rupp*- and *romp*- in the preterite ... is not in terms of inward conditioning of the stem by affixes but in terms of suprasegmental characteristics of the word as a whole."

d. Midob (Nubian, Sudan): The verbal extension denoting 'affirmation' takes the form -*nó* before a consonant-initial suffix and -*nón* before a vowel-initial suffix, e.g., *tii-nò-hèm* ('drink'-affirm-1sg.perfect) 'I drank (completely/really)', *tii-nòn-ùwà* ('drink'-affirm-1sg.continuous.indicative) 'I really drink completely'. (Werner 1993, cited in Paster 2006)

e. Kashaya (Pomoan, northern California): The negative suffix has two phonologically selected allomorphs, -t^h and -$t^h i$. The -t^h allomorph occurs before a vowel, while the -$t^h i$ allomorph occurs before a consonant, and the [i] in the preconsonantal allomorph cannot be treated as epenthetic (Buckley 1994: 334, cited in Paster 2006).

Frameworks such as Distributed Optimality (Trommer 2001) do not propose a clear mechanism of morphological realization so that it is hard to see their predictions with regard to the (non-)existence of outward-looking phonologically conditioned realization.

4 Optimality Theory and the morphology-phonology interface: approaches to phonologically conditioned allomorphy

In this section, I compare three types of OT approaches to phonologically conditioned allomorphy in terms of whether an exponent is introduced via an input or output candidate or grammar. These frameworks are conventional OT, Optimal Interleaving, and Realization OT. I argue that phonologically conditioned allomorphy is essentially a phenomenon in which phonological effects are observed in the morphological component of the grammar. Two types of phonologically conditioned allomorphy are discussed. In one type, allomorph selection is determined by independent phonological constraints and is phonologically optimizing. The other type is idiosyncratic in that allomorph selection references phonology but is not phonologically optimizing.

4.1 Phonologically conditioned allomorphy that is optimizing

Let us first look at the three types of OT approaches to phonologically conditioned allomorphy that is optimizing using the Korean and Spanish data as points of comparison.[8]

The Korean accusative suffix has two allomorphs, -*lul* and -*ul*. The suffix -*lul* occurs after stems ending in a vowel while the suffix -*ul* occurs after stems ending in a consonant (10) (Lapointe 2001, cited in Bonet and Harbour 2012).

(10) cho-lul (*cho-ul) 'cho-ACC'
Kim-ul (*Kim-lul) 'Kim-ACC'

In conventional OT, there is no space for morphological realization. Every morph, either a stem or an affix, is placed in an input. An extra mechanism has been introduced into conventional OT to account for phonologically conditioned allomorphy, i.e., an input allomorph set, in which multiple input allomorphs are stipulated, e.g., {-lul, -ul}. (Kager

[8] See Carstairs (1988, 1990) for more examples of phonologically conditioned allomorphy.

1996, Lapointe 2001, Bonet 2004, Bonet et al 2007, Mascaró 2007, Bonet and Harbour 2012). The alternation between *-lul* and *-ul* can be captured by the phonological constraints ONSET and NO CODA. In (11) I give a conventional OT derivation with an input allomorph set as presented in Lapointe (2001), and cited in Bonet and Harbour (2012).[9] In (11a), candidate b is ruled out by ONSET, which requires every syllable to have a consonant onset. In (11b), candidate b is ruled out because it contains two consonant codas and therefore violates NO CODA twice.

(11) A conventional OT approach with an input allomorph set to the Korean accusative allomorphy

a.

Input: cho, {lul, ul}	ONSET	NO CODA
☞ a. cho.lul		*
b. cho.ul	*!	*

b.

Input: Kim, {lul, ul}	ONSET	NO CODA
☞ a. Ki.mul		*
b. Kim.lul		**!

As pointed out by Paster (2006, 2009), however, a conventional OT approach assuming multiple input allomorphs incorrectly predicts that the numbers of cases of stem-sensitive affix allomorphy and affix-sensitive stem allomorphy should be equal, but there are many cases of stem-sensitive affix allomorphy while few cases of affix-sensitive stem allomorphy.

Additionally, Paster (2009) argues that phonologically conditioned allomorphy is sensitive to phonological elements in underlying or input forms, not in surface forms while a conventional OT approach assuming multiple input allomorphs predicts that phonologically conditioned allomorphy is sensitive to phonological properties of surface forms, not underlying forms. Languages such as Turkish contradict the prediction of such a conventional OT approach. In Turkish, the third person possessive suffix has the allomorphs /i/ and /si/ (Lewis 1967). The marker /i/ occurs when its stem ends in a consonant, while the marker /si/ occurs when its stem ends in a vowel. See the following examples (Aranovich et al 2005 and Gizem Karaali p.c., cited in Paster 2009: 26). Vowel alternations are due to regular Turkish vowel harmony.

(12)	bedel-i	'its price'	deri-si	'its skin'
	ikiz-i	'its twin'	elma-sɪ	'its apple'
	alet-i	'its tool'	arɪ-sɪ	'its bee'

[9] The independent phonological constraints involved in the following discussions are syllable structure constraints and OCP. See Paster (2006) and Nevins (2011) for other types of phonological constraints involved in cases of phonologically conditioned allomorphy that is optimizing.

Paster (2009) remarks that the alternation between *-i* and *-si* in (12) looks like an output-based case motivated by syllable structure considerations, at first glance. However, the distribution of the two allomorphs is sometimes opaque due to the operation of a regular Velar Deletion rule (Sezer 1981) that deletes intervocalic /k/ (cf. Aranovich et al. 2005). See the following examples (Aranovich et al 2005 and Gizem Karaali p.c., cited in Paster 2009: 26).

(13) açlɪ-ɪ ‘its hunger’ (cf. *açlɪk* ‘hunger’)
bebe-i ‘its baby’ (cf. *bebek* ‘baby’)
gerdanlɪ-ɪ ‘its necklace’ (cf. *gerdanlɪk* ‘necklace’)
ekme-i ‘its bread’ (cf. *ekmek* ‘bread’)

As pointed out by Paster, these examples can be explained if we assume that the morphology first chooses the /-i/ allomorph of the possessive suffix due to the presence of final /k/ in the underlying form of the root. The affixed forms are then passed on to the phonology. Due to the presence of the /-i/ suffix, the /k/ is now in intervocalic position and is therefore deleted. The result is an opaque form exhibiting vowel hiatus. This situation is very easy to model in a framework in which morphology feeds phonology but it is problematic for a surface-based conventional OT approach.

In Optimal Interleaving, in which lexical items are serially introduced into output candidates, the above two problems can be resolved. With the various types of stipulations which have been discussed in section 3, OI predicts no outward-looking phonologically conditioned allomorphy and hence no affix-sensitive stem allomorphy. Additionally, derivations are serial in OI. It is natural to assume that the spellout of /-i/ is followed by the deletion of the intervocalic /k/ so that the opacity in (13) can be accounted for.

In OI, the Korean stem *cho* would be spelled out first and then passed on to the next round of derivation. The relevant constraint MAX-M(F), defined as follows, requires that every abstract lexical morpheme or morphosyntactic feature value in an input should have a correspondent in the feature set of a lexical item in the output.

(14) MAX-M(F): For every instance φ of the feature F at the morpheme level, assign a violation-mark if there is not an instance of φ’ of F at the morph level, such that φ R φ’. (Wolf 2008: 26)

In (15) the input consists of the stem *cho* and the morphosyntactic feature value {acc}. The suffixes *-lul* and *-ul* are inserted into output candidates via GEN. Candidate b is ruled out by ONSET. Candidate c is ruled out by MAX-M(F) because the input {acc} does not have a correspondent that is associated with a lexical item in this candidate.

(15) Derivation of Korean *cho-lul* in Optimal Interleaving

Input: cho, {acc}	MAX-M(F)	ONSET	NO CODA
☞ a. cho.lul			*
b. cho.ul		*!	*
c. cho, {acc}	*!		

The Korean form *Kim-ul* can be derived via the same grammar (16).

(16) Derivation of Korean *Kim-ul* in Optimal Interleaving

Input: Kim, {acc}	MAX-M(F)	ONSET	NO CODA
☞ a. Ki.mul			*
b. Kim.lul			**!
c. Kim, {acc}	*!		*

The above mentioned two problems for a conventional OT approach with an input allomorph set will not occur in Realization OT, either. In Realization OT, no input allomorph set is assumed. An uninflected stem is placed in an input while inflectional affixes are encoded in constraints. It is therefore predicted that uninflected stem allomorphy cannot be sensitive to inflectional affixation. Additionally, Realization OT assumes an autonomous morphological component of the grammar. Some phonological effects can be observed in the morphological component so that some phonological constraints can interact with morphological ones such as realization constraints. Morphological processes such as morphological realization take place before phonological processes such as consonant deletion.

(17) accounts for the derivation of the optimal output *cho-lul* in Realization OT. Candidate b is ruled out by ONSET. Candidate c is ruled out because it violates both the realization constraints, given that neither -*lul* nor -*ul* is spelled out. The illicit candidate **cho-lul-ul*, which does not occur in the following tableau and in which {acc} is doubly realized by -*lul* and -*ul*, can be ruled out by the markedness constraint *FEATURE SPLIT, which will be discussed in section 5.1.

(17) Derivation of Korean *cho-lul* in Realization OT

Input: cho, {acc}	{acc}: -lul	{acc}: -ul	ONSET	NO CODA
☞ a. acc | cho.lul		*		*
b. acc | cho.ul	*		*!	*
c. cho, {acc}	*	*!		

Notice that the two realization constraints, {acc}: -*lul* and {acc}: -*ul*, cannot rank lower than the two syllable structure constraints. Otherwise, *cho*-{acc} would be incorrectly picked out as the optimal candidate because it does not violate either of the syllable structure constraints, in contrast to the other two output candidates in (17).

The Korean form *Kim-ul* can be derived via the same Realization OT grammar (18).

(18) Derivation of Korean *Kim-ul* in Realization OT

Input: Kim, {acc}	{acc}: -lul	{acc}: -ul	ONSET	NO CODA
☞ a. acc Ki.mul	*			*
b. acc Kim.lul		*		**!
c. Kim, {acc}	*	*!		*

Bonet and Harbour (2012) discuss the Spanish situation in which there is an arbitrarily determined priority of spellout between the conjunction allomorphs. The Spanish conjunction *y* [i] ‘and’ has the allomorph *e*, which is used only when the next word begins with [i]. The conjunction *o* ‘or’ has the allomorph *u*, which is used only when the next word begins with [o]. Following Mascaró (2007) and Bonet et al (2007), Bonet and Harbour propose a conventional OT approach with the constraint PRIORITY. The two allomorphs [i] and [e] are placed in an input allomorph set, with a precedence relation in which [i] has priority of spellout: {[i] > [e]}. The two allomorphs [o] and [u] are placed in an input allomorph set, with a precedence relation in which [o] has priority of spellout: {[o] > [u]}. Choosing the allomorph which has no priority of spellout violates PRIORITY.[10]

In (19a) from Bonet and Harbour (2012) candidate a is ruled out by OCP because there are two adjacent [o]’s. In (19b), neither candidate violates OCP. Candidate b, in which [u] is selected, violates PRIORITY.

(19) A conventional OT approach to the Spanish conjunction allomorphy

a.

Input: {[o] > [u]} otro	OCP	PRIORITY
a. o otro	*!	
☞ b. u otro		*

b.

Input: {[o] > [u]} alguno	OCP	PRIORITY
☞ a. o alguno		
b. u alguno		*!

Bonet and Harbour (2012) point out that without extraordinary mechanisms, Optimal Interleaving has difficulties accounting for the selection of competing exponents whose priority of spellout is arbitrarily determined. In OI, the allomorphs [o] and [u] would be considered equally harmonic without extraordinary mechanisms. In (20) the OI ranking OCP >> MAX-M(F) incorrectly selects *u alguno* as the winning candidate. The symbol ‘💣’ indicates the candidate incorrectly predicted to win.

[10] See Wolf (2008: 98-99) for criticisms of PRIORITY in terms of how this constraint evaluates output candidates.

(20) An Optimal Interleaving approach to the Spanish conjunction allomorphy

Input: {conj}, alguno	OCP	MAX-M(F)
☞ a. o alguno		
💣 b. u alguno		

We can make a Realization OT account of the above Spanish data by encoding the conjunction allomorphs in realization constraints. In (21a), candidate a is ruled out by OCP. Notice that OCP needs to outrank the two realization constraints in order to derive the output *u otro*. In (21b), candidate b is ruled out by the realization constraint that requires the conjunction feature to be expressed by *o*. This constraint ranks higher than the one that requires {conj} to be expressed by *u*.

(21) A Realization OT approach to the Spanish conjunction allomorphy

a.

Input: {conj}, otro	OCP	{conj}: o	{conj}: u
a. o otro	*!		*
☞ b. u otro		*	

b.

Input: {conj}, alguno	OCP	{conj}: o	{conj}: u
☞ a. o alguno			*
b. u alguno		*!	

A realization type of approach has been criticized in Bonet (2004), Bonet et al (2007), and Mascaró (2007). There are two major objections. First, using realization constraints instead of PRIORITY leaves open the possibility of adding as many constraints as morphemes. Second, it has the unacceptable consequence of excluding allophonic variation of the morph.

These problems can easily be explained away. First, in conventional OT constraints are assumed to have universal status, but realization constraints are necessarily language-specific in that they realize arbitrary Saussurean signs. It is important to emphasize that the target of conventional OT is phonology while Realization OT mainly deals with morphology, which since at least Ferdinand de Saussure, has emphasized arbitrary associations of meaning and form. In other words, morphological realization is language-particular and arbitrary, in any framework. Realization OT is concerned with morphological realization, not with phonology, and language-particular realization constraints are crucial in dealing with morphological phenomena, by definition. Second, as Wolf 2008 points out, if we assume that morphological realization takes place before phonological processes such as assimilation, i.e., an output from the morphological component becomes an input to the phonological component, the so-called problem of excluding allophonic variation of a morph evaporates.

In terms of deriving the output in cases like the Spanish conjunction allomorphy, there is not much difference between ranking realization constraints and using PRIORITY to maintain the stipulated relation between two allomorphs in an input allomorph set.

4.2 Idiosyncratic phonologically conditioned allomorphy

Dyirbal (Dixon 1972) is often cited as a language which exhibits cases of phonologically conditioned allomorphy that is not optimizing.[11] The ergative suffix -*ŋgu* occurs after a disyllabic stem while the ergative suffix -*gu* occurs elsewhere. Wolf (2008) argues that deriving the Dyirbal ergative allomorphs -*ŋgu* and -*gu* from a single underlying representation is questionable. (22) gives examples from Dixon (1972), cited in Wolf (2008: 61).[12]

(22) Dyirbal ergative markers

jaɽa-ŋgu	'man-ERG'
jamani-gu	'rainbow-ERG'
palakara-gu	'they-ERG'

Conventional OT (e.g., McCarthy and Prince 1993b) introduces exponents via an input and accounts for the morphotactic position of *ŋgu* by an alignment constraint, which requires it to occur after a head foot. But affix-specific alignment constraints should be part of the input in conventional OT, given that these constraints are idiosyncratic and an input usually introduces information from the lexicon where idiosyncratic information is stored while a grammar is assumed to consist of universal phonological constraints. Additionally, McCarthy and Prince (1993b) do not take the alternation between -*ŋgu* and -*gu* into account because they think it's outside the scope of their framework.

Bonet (2004) proposes a conventional OT approach to the above Dyirbal data which stipulates idiosyncratic information such as the subcategorization frame of -*ŋgu* in an input. The subcategorization frame requires that the stem which -*ŋgu* attaches to should end in a foot ($)_{\phi}$). Moreover, -*ŋgu* has preference over -*gu* with regard to spellout. These can be encoded in the formulation /{$)_{\phi}$ŋgu > gu}/. Bonet proposes the constraint RESPECT, which requires the output to respect subcategorization requirements.

The problem for Bonet's approach is that the priority of spellout between the allomorphs -*ŋgu* and -*gu* is stipulated in an input, hence missing Pāṇini's Principle since the basic tenet of OT is that any general grammatical principle should be reflected in a grammar rather than in an input.

Without extraordinary mechanisms, Optimal Interleaving cannot account for cases of idiosyncratic phonologically conditioned allomorphy that is not optimizing.[13] If we take

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[11] See Paster (2005b, 2006), Bye (2008), and Nevins (2011) for many other cases of idiosyncratic phonologically conditioned allomorphy.

[12] Wolf (2008) uses -*ŋku* and -*ku* while most other works use -*ŋgu* and -*gu*, which I use in this chapter.

[13] Wolf and McCarthy (2010) propose an approach to the alternation between -*ŋgu* and -*gu*. On this approach, -*gu* cannot be a competing candidate with -*ŋgu* after a head foot so that -*ŋgu* wins. Wolf 2008 criticizes an earlier version of Wolf and McCarthy 2010 and remarks that: "[This approach] suffers from the conceptual drawback of having to impose

the normal assumption that both -*ŋgu* and -*gu* expone {erg}, an OI approach incorrectly predicts that -*gu* would always be a winning candidate, even after a disyllabic stem. Notice that one of the major premises of OI is that lexical insertion takes place in the phonological component of the grammar so that the shorter a form, the better it is. Using a longer form will in general result in more violations of phonological markedness constraints.[14]

The Dyirbal case is often cited as supporting evidence for a subcategorization approach such as the type advocated in Paster (2005b, 2006, 2009). Subcategorization has been proposed by Lieber (1980, 1992), Kiparsky (1982a, b), Selkirk (1982), Inkelas (1990), Orgun (1996), Yu (2003, 2007), Paster (2005b, 2006, 2009), and others. The main idea, for the purpose of accounting for phonologically conditioned allomorphy, is that the representation of an affix includes requirements for stems to which it will attach. These requirements can include syntactic, semantic, and, crucially, phonological aspects of the stem. The following subcategorization frames can be proposed to account for the distribution of -*ŋgu* and -*gu* in Dyirbal. The order of the subcategorization frames is subject to Pāṇini's Principle.

(23) {erg}: *ŋgu* in the context of a stem$_{(\sigma\sigma)}$_
{erg}: -*gu* (elsewhere)

Subcategorization frames can be easily incorporated into Realization OT. We can propose the following ranking schema for the Dyirbal case. The ranking of the following constraints is subject to Pāṇini's Principle. The constraint {erg}: *ŋgu* / stem$_{(\sigma\sigma)}$_ has three components: a process of morphological realization, the position of the affix with respect to its stem, and a selectional restriction on the stem which the affix attaches to. That is, {erg} is realized by *ŋgu*, which is a suffix, and the stem which -*ŋgu* attaches to should be disyllabic (cf. Bye 2008).

(24) {erg}: *ŋgu* / stem$_{(\sigma\sigma)}$_ >> {erg}: -*gu*

In Realization OT, it is assumed that phonological effects can be observed in the morphological component of the grammar. It predicts several types of attested interaction of phonological effects with morphological realization, which are listed below.

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an external mechanism of "ordering of trying" to get the desired result. Since competition is the essence of OT, we would prefer on grounds of parsimony for competition like that between -*ŋgu* and -*gu* in Dyirbal to be hashed out *within* an OT grammar." (p.95)

[14] Following Halle and Vaux (1998), Wolf (2008) decomposes {erg} into a complex feature set, i.e., {-obl(ique), +str(uctural), +sup(erior), -fr(ee)}. Wolf analyzes -*ŋgu* as consisting of both -*ŋ* and -*gu.* Wolf also assumes that -*ŋ* realizes {-fr} and -*gu* realizes {-obl, +str, +sup} so that -*ŋ-gu* realizes a more specific morphosyntactic feature set than -*gu*. If an input contains {-obl, +str, +sup, -fr}, -*ŋ-gu* will win over -*gu*, which can be ruled out by MAX-M(F). However, -*gu* can be analyzed as consisting of both -Ø and -*gu*, with -Ø realizing {-fr} so that -Ø-*gu* wins over -*ŋ-gu*, which violates the markedness constraint *[nasal] (Wolf 2008: 91).

- Phonological constraints are outranked by realization constraints, e.g., the alternation between the Korean accusative markers.
- Phonological constraints outrank realization constraints, e.g., the alternation between the Spanish conjunction markers.
- Phonological conditions are built into realization constraints, e.g., the alternation between -*ŋgu* and -*gu* in Dyirbal.

Realization OT therefore provides a unified account of phonologically conditioned allomorphy in terms of the interaction of phonological effects with morphological realization.

5 Optimality Theory and morphology proper: blocking and extended morphological exponence, and syncretism

Extending some of the assumptions of conventional OT into the domain of morphology proper can shed light on some well-known morphological issues such as blocking and extended morphological exponence as well as syncretism. I compare several types of OT approaches to these issues and discuss their mechanisms, advantages, and problems, showing some of the benefits of a Realization OT approach.

5.1 Blocking and extended morphological exponence

Blocking and extended morphological exponence have been widely discussed in the recent theoretical literature on inflectional morphology (see e.g., Matthews 1974, 1991, Anderson 1986, 2001, 2005b, Noyer 1992, 1997, Stump 2001, Müller 2007, Harris 2009, Xu and Aronoff 2011a, Caballero and Inkelas 2013). Blocking in inflectional morphology refers to a phenomenon in which a rule or affix prevents or 'bleeds' (Kiparsky 1968) the application of another rule or affix that expresses the same morphosyntactic feature value as the bleeding rule or affix (Anderson 1986, Noyer 1992, 1997, Stump 2001, among many others). Blocking thus prevents the occurrence of multiple exponents of a single morphosyntactic feature value. For example, the plural exponent of *ox* is -*en*, which blocks the regular plural exponent -*s* /z/ in English so that the plural form **oxens* becomes illicit because its plural feature value is doubly realized. On the other hand, extended morphological exponence refers to cases in which a morphosyntactic feature value is realized by more than one exponent (Matthews 1991, Noyer 1992, 1997, Anderson 2001, Stump 2001, among many others). For example, in the Tamazight Berber verb *t-dawa-d* 'cure, 2sg' the feature value {2} is realized by both *t*- and -*d* (Abdel-Massih 1971: 171, Noyer 1992: 132, Stump 2001: 157). Natural languages exhibit both blocking and extended exponence, so any theory of morphology must accommodate both.

There are three major approaches to blocking and extended exponence based on the ordering of either affixes or rules. Noyer (1992, 1997), for example, proposes a feature discharge approach. On this approach, once a morphosyntactic feature value has been spelled out or discharged, it is no longer available for further realization, which therefore blocks the realization of another exponent that expresses the same feature value. On the other hand, in order to allow for extended exponence, Noyer makes a distinction between primary and secondary exponents. Only an exponent that realizes a morphosyntactic feature value as a primary exponent can block or get blocked by another exponent that also realizes the same feature value as a primary exponent. An exponent that realizes a morphosyntactic feature value as a secondary exponent cannot block or get blocked by another exponent that realizes the same feature value as either a primary or a secondary exponent. In cases of extended exponence like *t-dawa-d* in Tamazight Berber, in which *t-* realizes {2} and *-d* realizes {2, sg}, Noyer analyzes *t-* as a primary exponent of {2} and *-d* as both a primary exponent of {sg} and a secondary exponent of {2}. Therefore, no blocking takes place between *t-* and *-d*.

Noyer's analysis of extended exponence has been subject to criticism. Stump 2001 argues that there are no good grounds for distinguishing between primary and secondary exponents. Müller 2007 argues against a distinction between primary and secondary exponents. He remarks that:

> "[S]econdary exponence is not an unproblematic concept. For one thing, it complicates the ontology. For another, it threatens to undermine the notion of feature discharge under fission. Furthermore, it may raise problems for determining specificity: Should secondary features be taken to count for the purposes of specificity or not?" (p.260)

Stump 2001 takes an approach to blocking and extended exponence within the framework of Paradigm Function Morphology (PFM). In PFM, an exponent is introduced via a realization rule. Blocking between exponents arises because of Pāṇini's Principle, which is assumed to only apply within a rule block. Rules encoding exponents that realize the same morphosyntactic feature value can belong to different rule blocks so that extended exponence arises. For example, in Tamazight Berber both *t-* and *-d* realize {2}. The rule realizing {2} by *t-* and the one realizing {2} by *-d* belong to two rule blocks so that the extended exponence of {2} arises.

In PFM, there are various requirements concerning rule blocks (Gregory Stump p.c.). Rules in the same block are disjunctive in their application. Rules apply in the sequence determined by the ordering of the blocks to which they belong. All else being equal, Occam's Razor entails that it is preferable to postulate fewer rule blocks. All else being equal, it is preferable for rules belonging to the same block to realize the same inflectional categories. Rules belong to the same rule block if the exponents encoded in them stand in paradigmatic opposition (Stump 1993). Paradigmatic opposition refers to a phenomenon in which two exponents never co-occur in a language's paradigmatic cells.

Like other rule-based frameworks, in PFM affix positions often determine the ordering of rule blocks, although affix positions do not always work in determining the ordering of rule application. A rule encoding an exponent closer to a root usually applies before a rule encoding an exponent farther away from the root. Rules encoding exponents in the same affix position often belong to the same rule block while rules encoding exponents occupying different affix positions often belong to different rule blocks. Hence, there remains a question of whether affix positions would have to be used as a criterion to determine whether two rules belong to the same rule block, given the above requirements concerning rule blocks.

Müller (2007) proposes a feature enrichment approach to extended exponence, on which a morphosyntactic feature can be inserted if necessary. For example, to account for the Tamazight Berber form *t-dawa-d*, in which {2} is realized by both *t-* an *-d*, Müller proposes the following rule of enrichment.[15] A second person feature value is inserted in the context of {2} so that each {2} is realized by one exponent, either *t-* or *-d*.

(25) Ø → [2] / [2] __

Müller's approach circumvents the notion of extended exponence via a stipulative mechanism and hence makes no prediction of extended exponence. Harris (2009: 294) criticizes Müller's enrichment approach and remarks that "[i]n the case of extended exponence, our understanding of morphology is not advanced by claims of a one-to-one correspondence of morpheme to meaning, accompanied by ways of dealing with examples that do not meet this ideal. We learn more about the morphology of natural language by admitting the existence of such examples and producing theories that predict their existence."

None of the above approaches provides a unified account of blocking and extended exponence. On these approaches, blocking is subject to Pāṇini's Principle while extended exponence is allowed for via either secondary exponence or rule blocks or got around with rules of feature enrichment.

Xu (2007, 2011) and Xu and Aronoff (2011a) argue for a unified account of blocking and extended exponence in Realization OT. The key device is the markedness constraint *FEATURE SPLIT, which forbids a morphosyntactic feature value being realized by more than one exponent. This constraint favors simple exponence, which is assumed to be morphologically unmarked (Wurzel 1989).[16] By ranking *FEATURE SPLIT together with realization constraints, we can derive both blocking and extended exponence. If two constraints that realize the same morphosyntactic feature value outrank *FEATURE SPLIT, extended exponence will arise. Otherwise, blocking of exponents will be observed.

Spencer 2014 points out that Realization OT is problematic and falsifiable. (The following discussion of the problem for Realization OT in terms of how it accounts for blocking and extended exponence is based on Spencer 2014. Readers are referred to this manuscript for detailed discussion.) Consider the following Swahili past tense paradigm (Ashton 1947, cited in Caballero and Inkelas 2013: 106). The prefix *ku-* is a marker of {past, neg}.[17] The prefix *si-* is a marker of {1, sg, neg}, which also occurs in contexts such as future and present indefinite. The prefix *ha-* is a marker of {neg}, which also occurs in contexts such as future and present indefinite.

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[15] Such a rule of feature insertion can also be formulated as [2] → [2] [2] (cf., Arregi and Nevins 2012, Arregi et al 2013).

[16] Noyer (1993) and Ackema and Ad Neeleman (2005) propose similar constraints that encode the observation of Natural Morphology (Wurzel 1989) that a one-to-one correspondence between meaning and form is morphologically unmarked.

[17] In Swahili, the prefix *ku-* is a polyfunctional morphome: (i) it marks infinitives; (ii) it serves as a prosodically motivated stem extension in finite forms of monosyllabic verbs; (iii) it serves as a marker of past-tense negation in all verbs. Hence, the following problem for Realization OT arises only if *ku-* is analyzed as a marker of {past, neg} in the data in question.

(26) 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

When an input contains the feature set {1, sg, neg, past}, both *si*- and *ku*- are spelled out while *ha*- gets blocked. The following Realization OT grammar would be proposed to account for this. Both the realization constraints {1, sg, neg}: *si*- and {past, neg}: *ku*- outrank *FEATURE SPLIT so that {neg} is realized by both *si*- and *ku*-. By contrast, {neg}: *ha*- is outranked by *FEATURE SPLIT so that *ha*- can get blocked.

(27) {1, sg, neg}: *si*-, {past, neg}: *ku*- >> *FEATURE SPLIT >> {neg}: *ha*-

In (28) candidate a is optimal, even if it violates the lower ranked constraint *FEATURE SPLIT because {neg} is realized by both *si*- and *ku*-. Candidate b is ruled out because it violates *FEATURE SPLIT twice given that {neg} is realized by *ha*-, *si*-, and *ku*-, and assuming that *FEATURE SPLIT is satisfied if a morphosyntactic feature value is realized by one exponent and each additional exponent of the same feature value will cause one violation of it. Candidate c is ruled out by the constraint {past, neg}: *ku*- because *ku*- is not spelled out. Candidate d is ruled out by the constraint {1, sg, neg}: *si*- because *si*- is not spelled out.

(28) Swahili *si-ku-taka* {1, sg, neg, past}

Input: taka 1, sg, neg, past	{1, sg, neg}: *si*-	{past, neg}: *ku*-	*FEATURE SPLIT	{neg}: *ha*-
☞ a. 1, sg, neg, past si- ku- taka			*	*
b. 1, sg, neg, past ha- si- ku- taka			**!	
c. 1, sg, neg, past si- taka		*!		*
d. 1, sg, neg, past ku- taka	*!			*

The grammar (27) incorrectly predicts that *ha*- would never occur in the context of {neg, past} because otherwise the combination of *ku*- and *ha*-, both realizing {neg}, would be ruled out by *FEATURE SPLIT. In (29) the input contains {2, sg, neg, past}. The constraint {2, sg}: *u*- is not shown in the tableau for simplicity of presentation. Candidate a is incorrectly chosen as the optimal candidate even if *ha*- is not spelled out.

(29) Swahili *ha-u-ku-taka* {2, sg, neg, past}

Input: taka, 2, sg, neg, past	{1, sg, neg}: *si*-	{past, neg}: *ku*-	*FEATURE SPLIT	{neg}: *ha*-
💣 a. 2, sg, neg, past u- ku- taka				*
b. 2, sg, neg, past ha- u- ku- taka			*!	
c. 2, sg, neg, past ha- u- taka		*!		

One solution to the above problem would be to assume that {neg}: *ha*- dominates *FEATURE SPLIT by default so that *ha*- can be spelled out in general while it is outranked by *FEATURE SPLIT in the context of {1, sg, neg} so that *ha*- gets blocked. That is, a specific morphosyntactic feature set such as {1, sg, neg} can have its own realization grammar. This approach is spiritually similar to Cophonology Theory (Orgun 1996, Inkelas et al. 1997, Inkelas 1998, to appear, Anttila 2002, Inkelas and Zoll 2007), in which different affixes can be associated with different phonological grammars. See also Hyman 2003, which argues that different morphosyntactic feature structures can have different rankings of morphotactic constraints on affix order in Bantu languages.

There are several alternative OT-based approaches to blocking and extended exponence. In conventional OT models such as McCarthy and Prince (1993b), no reference is permitted to morphosyntactic information. There is no space for morphological realization. The phonological content of every affix is introduced via an input. Competing exponents that express the same morphosyntactic feature value would be stipulated in an input set in the style of Bonet (2004) and Mascaró (2007), which therefore predicts neither blocking nor extended exponence.

Without extra mechanisms, Optimal Interleaving, either with or without Local Optimality, has difficulties accounting for cases of extended exponence in which the feature sets of competing exponents are either identical or exhibit a subset relation. For example, in the Tamazight Berber case *t-dawa-d* 'cure, 2sg', *t*- realizes {2} and -*d* realizes {2, sg}. Consider the tableau (30) in which an OI account without LO is provided. In the spirit of OT-CC, OI assumes that GEN makes only one change of a previous link and inserts into an output candidate one lexical item at a time. Each of the output candidates in (30) is the final link of a harmonically improving chain, in which each non-initial link has one more lexical item than its previous link. Subscripted co-indexation indicates a correspondence either between two identical abstract lexical morphemes or between two identical morphosyntactic feature values, which are either associated with a lexical item or not. Assume spellout starts from the lexical morpheme DAWA and proceeds outwards. The grammar incorrectly chooses **dawa-d* as the winning candidate, which violates neither of the two constraints MAX-M(F) and *[t]. Candidate a has one more consonant [t] compared to the winning candidate, so it violates the phonological markedness constraint *[t]. OI assumes that lexical insertion takes place in the phonological component of the grammar so that “using a greater number of phonologically-overt morphs will in general result in more violations of phonological markedness constraints.” (Wolf 2008: 64-65) Candidate c causes one violation of MAX-M(F) because the input {sg} does not have a correspondent that is associated with a lexical item in this candidate. Candidate d violates MAX-M(F) twice because neither {2} nor {sg} in the input has a correspondent that is associated with a lexical item in this candidate.

(30)

Input: DAWA$_1$, {2$_2$, sg$_3$}	MAX-M(F)	*[t]
a. *t_2-$dawa_1$-$d_{2,3}$* <DAWA$_1$-{2$_2$, sg$_3$}, *$dawa_1$*-{2$_2$, sg$_3$}, *t_2-$dawa_1$*-{sg$_3$}, *t_2-$dawa_1$-$d_{2,3}$*>		*!
💣 b. *$dawa_1$-$d_{2,3}$* <DAWA$_1$-{2$_2$, sg$_3$}, *$dawa_1$*-{2$_2$, sg$_3$}, *$dawa_1$-$d_{2,3}$*>		
c. *t_2-$dawa_1$*-{sg$_3$} <DAWA$_1$-{2$_2$, sg$_3$}, *$dawa_1$*-{2$_2$, sg$_3$}, *t_2-$dawa_1$*-{sg$_3$}>	*!	*
d. *$dawa_1$*-{2$_2$, sg$_3$} <DAWA$_1$-{2$_2$, sg$_3$}, *$dawa_1$*-{2$_2$, sg$_3$}>	*!*	

An OI account with LO cannot derive the output *t-dawa-d*, either. The first links of the chains in the above tableau are identical. So are the second links. The third link is either *dawa-d* or *t-dawa-*{sg}. The form *dawa-d* is more optimal. Hence, only the chain <DAWA-{2, sg}, *dawa*-{2, sg}, *dawa-d*> is valid under LO. The output *t-dawa-d* cannot be further derived from *dawa-d* because the subchain <*dawa-d*, *t-dawa-d*> is not harmonically improving. The form *dawa-d* violates neither MAX-M(F) nor *[t] while *t-dawa-d* violates *[t].

Caballero and Inkelas (2013) attempt to account for both blocking and extended morphological exponence under Optimal Construction Morphology (OCM). OCM is “a theory of morphology that selects the optimal combination of lexical constructions to best achieve a target meaning.” (Caballero and Inkelas 2013: 104) A construction is a pairing of form and meaning. OCM rejects markedness constraints such as *FEATURE SPLIT. Compared to Realization OT, which uses *FEATURE SPLIT only, OCM is a much more complicated framework in terms of accounting for cases of blocking and extended exponence which involve competing exponents. OCM refers to various mechanisms such as Local Optimality, a distinction between weak and strong exponents, inserting into an output candidate one lexical construction at a time, and labeling each lexical construction with a category such as root, stem, or word.[18] A weak exponent partially expones a morphosyntactic feature and is arbitrarily labeled with the numeral .5. By contrast, a strong exponent fully expones a morphosyntactic feature. Sometimes a distinction between stem1 and stem2 must be made. According to Caballero and Inkelas, a stem2 stands lower than a word but higher than a stem1, which stands higher than a root on the wordhood scale.

[18] In OCM, a root is morphologically simplex while a stem is morphologically complex.

5.2 Syncretism

Stump (2001: 212) remarks that: "[i]n instances of syncretism, two or more cells within a lexeme's paradigm are occupied by the same form. Syncretism is an extremely common phenomenon in languages with inflectional morphology, one which raises a number of fundamental issues for morphological theory." Stump 2001 proposes four types of syncretism:

- Unstipulated syncretism, under which two paradigmatic cells with the same morphosyntactic feature value share the same morphophonological form.
- Unidirectional syncretism, under which a dependent paradigmatic cell copies the morphophonological form of a determinant paradigmatic cell.
- Bidirectional syncretism, under which there is a feature value *x* that takes the form associated with feature value *y* in some contexts, while in other contexts *y* takes the form associated with *x*.
- Symmetrical syncretism, under which two paradigmatic cells with the same morphophonological form do not share any morphosyntactic feature value and there is no discernible direction of syncretism.

In this section, I use the above types of syncretism to examine several OT frameworks for morphology.

A simple instance of unstipulated syncretism is from Hupa, an Athabaskan language (Golla 1970, cited in Embick and Halle 2005) (31). The first person plural object marker is identical to the second person plural object marker. That is, they share the same morphophonological form *noh-*.

(31) Hupa Subject / Object Markers

	SUBJECT	OBJECT
1SG	W-	Wɨ-
2SG	n-	nɨ-
1PL	dɨ-	**noh-**
2PL	oh-	**noh-**

To account for the syncretism, nearly all morphological frameworks would underspecify the person feature so that *noh-*, which expones {pl, obj}, can occur in both the slots of {1, pl, obj} and {2, pl, obj}.

By contrast, Müller (2011, 2013) rejects feature underspecification and proposes a feature changing framework in OT. He proposes the notion *leading form*. A leading form, which is introduced via an input, is an exponent whose morphosyntactic feature set can be adjusted to the morphosyntactic feature set for realization on a stem. Assume that *noh-*, an exponent of {1, pl, obj}, and *nɨ-*, an exponent of {2, sg, obj}, are two leading forms. Assume also that the morphosyntactic feature set on a stem is {2, pl, obj}. The relevant constraints are presented as follows (adapted from Müller 2011, 2013).

(32) a. MATCH: The morphosyntactic feature values of stem and exponent are identical in the output.

b. IDENT NUMBER: The number feature value of an input exponent should not be changed in the output.

c. IDENT PERSON: The person feature value of an input exponent should not be changed in the output.

Consider the tableau in (33) (I: input, O: output). The input consists of a stem with the feature set {2, pl, obj} and an exponent inventory, which consists of leading forms such as *noh-* {1, pl, obj} and *nɨ-* {2, sg, obj}. Candidate a wins out, even if it violates the lowest ranked constraint IDENT PERSON given that the output feature set {2, pl, obj} of *noh-* is not identical to its input feature set in terms of person. Candidate b is ruled out by the higher ranked constraint IDENT NUMBER given that the output feature set {2, pl, obj} of *nɨ-* is not identical to its input feature set in terms of number. Candidate c is ruled out by the highest ranked constraint MATCH given that the output feature set {1, pl, obj} of *noh-* does not match the one on the stem, which is {2, pl, obj}.

(33)

Input: Exponent + Stem-{2, pl, obj}	MATCH	IDENT NUMBER	IDENT PERSON
☞ a. noh- {I: {1, pl, obj} O: {2, pl, obj}} + Stem-{2, pl, obj}			*
b. nɨ- {I: {2, sg, obj} O: {2, pl, obj}} + Stem-{2, pl, obj}		*!	
c. noh- {I: {1, pl, obj} O: {1, pl, obj}} + Stem-{2, pl, obj}	*!		

A major problem for Müller's approach is that the choice of a leading form can be arbitrary. Why can't *noh-* {2, pl, obj} act as a leading form instead? Hence, a feature underspecification approach is superior unless convincing evidence for the directional syncretism between {1, pl, obj} and {2, pl, obj} is presented.

In conventional OT, no reference is permitted to morphosyntactic information in general. Hence, the types of syncretism that are conditioned by morphosyntactic information, which are discussed in this section, are outside its scope.

An instance of unidirectional syncretism is from Rumanian (Stump 2001). In Rumanian, *-m* is the default marker of first person plural agreement, as in the present indicative forms in (34).

(34) Present indicative forms of two Rumanian verbs (adapted from Stump 2001: 214)

	A INVITA 'to invite'	A ŞTI 'to know'
CONJUGATION	1	4
1SG	invít	ştí-u
2SG	invíţ-i	ştí-i
3SG	invít-ă	ştí-e
1PL	invitắ-m	ştí-m
2PL	invitá-ţi	ştí-ţi
3PL	invít-ă	ştí-u

According to Stump, the first person singular forms must be seen as patterning after the first person plural forms in the imperfect paradigms (35).

(35) Imperfect forms of two Rumanian verbs (Stump 2001: 215)

	A CÂNTA 'to sing'	A AUZI 'to hear'
CONJUGATION	1	4
1SG	cântá-m	auziá-m
2SG	cântá-i	auziá-i
3SG	cântá	auziá
1PL	cântá-m	auziá-m
2PL	cântá-ţi	auziá-ţi
3PL	cântá-u	auziá-u

In Müller's framework (36), to account for the above syncretism, *-m* {1, pl} would be selected as a leading form. Its morphosyntactic feature set can be changed into {1, sg}, which is spelled out by *-m*. In order to win over a competing leading form like *-i* {2, sg}, we can rank IDENT PERSON higher than IDENT NUMBER. Assume the input consists of the stem *cântá* and an exponent inventory which contains leading forms such as *-m* {1, pl} and *-i* {2, sg}. The morphosyntactic feature set that occurs on the stem is {1, sg}.

(36)

Input: cântá-{1, sg} + Exponent	MATCH	IDENT PERSON	IDENT NUMBER
☞ a. cântá-{1, sg} + -m {I: {1, pl} O: {1, sg}}			*
b. cântá-{1, sg} + -i {I: {2, sg} O: {1, sg}}		*!	
c. cântá-{1, sg} + -m {I: {1, pl} O: {1, pl}}	*!		

In Optimal Interleaving, the above syncretism can be accounted for under the ranking MAX-M(1) >> MAX-M(sg) (37). Candidate a wins out, even if it violates MAX-M(sg) because the input {sg} does not have a correspondent in the feature set of *-m*. Candidate b is ruled out by MAX-M(1) because the input {1} does not have a correspondent in the feature set of -*i*.

(37)

	Input: cântá, {1, sg}	MAX-M(1)	MAX-M(sg)
☞	a. cântá-m$_{\{1, pl\}}$		*
	b. cântá-i$_{\{2, sg\}}$	*!	

In Realization OT, the above syncretism can be accounted for by the paradigmatic output-to-output (OO) correspondence constraint MAX ({1, pl}: {1, sg}), which requires the morphophonological form of {1, pl} to realize {1, sg} (38). OO correspondence constraints make a derived form identical to another output form (Benua 1995, McCarthy and Prince 1995, Kenstowicz 1996, Kager 1999, among others). Candidate b is ruled out because -*m* does not occur.[19]

(38)

	Input: cântá, {1, sg} Output: {1, pl}: -m	MAX ({1, pl}: {1, sg})
☞	a. 1, sg cântá-m	
	b. 1, sg cântá-i	*!

The grammars in Müller's and Wolf's frameworks predict that whenever directional syncretism occurs a determinant cell and its dependent cell must share some morphosyntactic feature value so that faithfulness constraints encoding this feature value can be ranked higher in order to rule out a competing exponent that does not share it. By contrast, Realization OT makes no such prediction.

However, cases like the directional syncretism between {3, sg} and {2, pl} in German verbal conjugations, which do not share any morphosyntactic feature value, contradict the above prediction in Müller's and Wolf's frameworks. Consider the following table (adapted from Duden 2006: 441-442). The marker of {2, pl} is -*t*. In indicative present, the form of {3, sg} refers to that of {2, pl}. Under Müller's and Wolf's grammars, without extraordinary mechanisms, the form of {2, sg}, for example, is a better candidate for the slot of {3, sg} than -*t* because it shares the number feature value with {3, sg}.

[19] If a correspondence is established between -*m* and -*i*, candidate b can also be ruled out by an IDENT constraint.

(39) German weak verb *lachen* ‘laugh’

	INDICATIVE PRESENT	INDICATIVE PRETERITE
1SG	lache	lachte
2SG	lachst	lachtest
3SG	lacht	lachte
1PL	lachen	lachten
2PL	lacht	lachtet
3PL	lachen	lachten

By contrast, Realization OT can easily account for the above syncretism in German. We can simply posit an OO correspondence constraint which requires the {2, pl} form to realize {3, sg} in indicative present.

The type of bidirectional syncretism in Stump (2001) is what Baerman (2004) calls divergent bidirectional syncretism (DBS), under which there is a feature value *x* that takes the form associated with feature value *y* in some contexts, while in other contexts *y* takes the form associated with *x*. A case of DBS is from the Latin second declension.[20] See the following table (adapted from Baerman 2004: 816, cited in Xu and Aronoff 2011b: 261). According to Baerman (2004), the suffix *-us* is the exponent of {nom, sg} and expresses {nom, sg} of both default masculine nouns and a group of neuter nouns such as *vulgus* ‘crowd’. The suffix *-um* is the exponent of {acc, sg} and expresses {acc, sg} of both default neuter and default masculine nouns. The accusative singular of nouns such as *vulgus* takes the nominative singular marker *-us*. The nominative singular of default neuter nouns takes the accusative singular marker *-um*.

(40) Latin second declension

	DEFAULT NEUTER ‘war’	DEFAULT MASCULINE ‘slave’	NOM & ACC in *-us* ‘crowd’
NOM SG	***bell-um***	*serv-us*	*vulg-us*
ACC SG	*bell-um*	*serv-um*	***vulg-us***
GEN SG	*bell-ī*	*serv-ī*	*vulg-ī*
DAT SG	*bell-ō*	*serv-ō*	*vulg-ō*
ABL SG	*bell-ō*	*serv-ō*	*vulg-ō*

Xu and Aronoff (2011b) argue that DBS poses problems for a feature impoverishment-plus-insertion approach (Noyer 1997, 1998, Bobaljik 2002) which stipulates that under directional syncretism it is always a more marked feature set that takes the form of a less marked one. By contrast, DBS can be easily accounted for with either OO correspondence constraints in Realization OT or rules of referral (e.g., Zwicky 1985, Stump 2001). Additionally, OO correspondence constraints have a wider scope of application than rules of referral because rules of referral only apply to two fully identical forms while OO correspondence constraints also apply to partially identical forms. For example, OO correspondence constraints can require the plural form of *man* to occur in the plural forms of a class of nouns which bear the morph *man* and express the sense of

[20] See Baerman (2004) for cases of DBS in other languages.

‘human appearance’, e.g., s*nowmen*. OO correspondence constraints are therefore a more satisfying tool for linguists looking for a unified approach compared to rules of referral.

It is hard to imagine how DBS can be accounted for within the frameworks of Wolf (2008) and Müller (2011, 2013). Without extraordinary mechanisms, their frameworks incorrectly predict that in the case of Latin DBS, for example, the nominative singular of default neuter nouns would take the nominative singular marker *-us* and the accusative singular of nouns such as *vulgus* would take the accusative singular marker *-um*.

Lastly I consider a case of symmetrical syncretism from Hua, a language of New Guinea (Haiman 1980, Stump 2001). In the inflection of Hua verbs, 2sg and 1pl forms always carry the same termination and there is no discernible direction of syncretism between them. In the non-future-tense interrogative forms in the following table, for example, both the 2sg and 1pl forms carry the suffix *-pe* and the default suffix is *-ve*.

(41) Non-future-tense interrogative forms of three Hua verbs (Haiman 1980: 47f, cited in Stump 2001: 216)

	Type I	Type II	Type III
	HU ‘do’	DO ‘eat’	MI ‘give’
1SG	hu-ve	do-ve	mu-ve
2SG	ha-pe	da-pe	mi-pe
3SG	hi-ve	de-ve	mi-ve
1DU	hu-’-ve	do-’-ve	mu-’-ve
2/3DU	ha-’-ve	da-’-ve	mi-’-ve
1PL	hu-pe	do-pe	mu-pe
2/3PL	ha-ve	da-ve	mi-ve

It is hard for a feature underspecification approach to account for the type of symmetrical syncretism in Hua because the morphosyntactic feature sets {2, sg} and {1, pl} do not form a natural class and the 2sg and 1pl suffix is not a default marker. Given that there is no discernible direction of syncretism, we cannot use either rules of referral or OO correspondence constraints to account for symmetrical syncretism. I leave the question of how to account for symmetrical syncretism in OT for future research.

6 Summary

In this chapter I have discussed the fundamental assumptions of conventional OT, some of which are taken in almost all OT frameworks for morphology. I have shown that conventional OT is not sufficient to account for cases of the morphology-phonology interface such as phonologically conditioned allomorphy, which is essentially a phenomenon in which phonological effects are observed in the morphological component of the grammar. Extending some of the assumptions of conventional OT into the domain of morphology proper not only accounts for phonologically conditioned allomorphy, but also shed light on some well-known morphological issues such as blocking and extended morphological exponence as well as syncretism. I have discussed the differences among various OT approaches to morphology in terms of their formal mechanisms. I have compared several OT frameworks and discussed their mechanisms, advantages, and problems with regard to morphological issues such as phonologically conditioned allomorphy, blocking and extended morphological exponence, and syncretism. These morphological issues by no means form an exhaustive list. There are many more morphological phenomena that have been and can be analyzed in OT.

I hope to have convinced readers of the following points. Conventional OT, whose major target is phonology, cannot handle morphology in general. Hence, alternative OT approaches to morphology are called for, with the assumptions that are not taken in conventional OT. OT is a useful tool for doing morphology. Any OT framework for morphology must recognize an autonomous morphological component of the grammar, which interacts with other components of the grammar.

Many questions have not been addressed and therefore await future research. For example, since this chapter focuses on inflectional morphology, there remains a question of whether OT can be well applied to other morphological components such as derivational morphology, compounding, and clitics.[21] Second, since OT approaches often differ in terms of their theoretical assumptions, how might different language data test the validity of these assumptions? Third, how might different language data test the quality of an OT morphological framework in comparison to its competing frameworks, either within OT or not? Fourth, how well can OT contribute to our understanding of the interface between morphology and other components of the grammar? Last but not least, can OT morphology be a useful framework for other linguistic sub-disciplines such as language acquisition, computational linguistics, and psycholinguistics? I hope more work will be done on these research questions.

[21] See Anderson (2005a) for an OT account of clitics.

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