

Deriving morphophonological (mis)applications*

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Etenim quaedam foedera exstant, ut Cenomanorum, Insubrium, Helvetiorum, Iapydum, non nullorum item ex Gallia barbarorum, quorum in foederibus exceptum est ne quis eorum a nobis civis recipiatur. Quod si exceptio facit ne liceat, ubi non sit exceptum, ibi necesse est licere.

Cicero, *Pro L. Cornelio Balbo Oratio*

A proposition of SPE that has received relatively little attention, but gains notable support from the stress facts discussed below, is that rules may have lexically marked exceptions. We wrote that

*...not infrequently an individual lexical item is exceptional in that it alone fails to undergo a given phonological rule or, alternatively, in that it is subject to some phonological rule...The natural way to reflect such exceptional behavior in the grammar is to associate with such lexical items diacritic features referring to particular rules...
(SPE, 374)*

Halle, 1998:541

1 Morphophonology and exceptionality

By *morphophonology* in the narrow sense, we refer to alternations that are (i) not obviously part of the “normal” phonology of a language, but (ii) which effect changes that can be defined in terms of the phonology, in ways that (iii) relate to the presence of particular morphemes, or morphological features. The main analytical challenge posed by such alternations is that most theories of grammar provide (at

*We are delighted to be able to contribute a paper to this volume in honor of Andrea Calabrese. One of the pleasures in reading Andrea’s work is that there is always a comprehensive analysis, with a minimum of hand-waving about details. This kind of approach is manifested in this paper in an adjacent way— in many of our case studies, phenomena that are, at a first glance, apparently quite ‘well-behaved’ turn out to be more complex on closer examination. Moreover, some of these complexities do not yield obvious solutions. We hope that by presenting and illustrating a particular framework, and identifying open questions that arise along the way, attention will be focused on the kinds of important interface questions that are addressed in Andrea’s work.

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least) two ways in which they could be analyzed, each of which has independent motivation. On the one hand, morphophonological alternations could be handled by phonological rules (or their equivalent); i.e. they could be treated as part of the phonological grammar, broadly construed so as to include contact with morphology. On the other hand, morphophonological alternations could be treated as (suppletive) contextual allomorphy, such that one alternant is not actually related to the other phonologically; instead, both alternants are stored, and employed in the appropriate contexts. Since both the phonological grammar and the need to store at least some suppletive allomorphs are essential parts of most linguistic theories, the status of morphophonological alternations raises what we call the Fundamental Question of Morphophonology (FQM): *Are morphophonological alternations the result of phonological rules, or do they result from the storage in memory of distinct allomorphs?*

Part of the interest of the FQM is its generalizability; though centered on details of form, it implicates questions of much more general interest; in particular, the tension between “derivation by rule” (or its equivalent) on the one hand, versus “storage” on the other. The high-profile “past tense debate” in the experimental domain is— whatever one might conclude about the positions taken, and the conclusions reached— testimony to the importance that questions of computation versus storage have for the scientific study of language, with perhaps broader implications as well.

Terminologically, we will refer to theories that take the former option as *morphophonologically dynamic* (MPD) theories, since they involve phonological changes effected in ways that involve morphological triggers or targets, or more broadly, they treat morphophonology without memorized alternants. The latter type of theory will be referred to as involving Stem Storage (SS), since (in the typical case) it involves storing multiple distinct stems for the same Root.

Although we will touch on the FQM at various points below, our main goal in this paper is to explore another aspect of morphophonology— specifically, the conditions under which such alternations apply, do not apply, and misapply (over- or underapply), to work towards a general theory of morphophonological application.

The theory of morphophonology starts with the observation that a defining aspect of such alternations is their **exceptionality** when viewed next to “normal” phonology. This exceptionality can take different forms. One form involves the nature of the alternation itself. Some morphophonological alternations involve changes in a single environment whose phonological properties might be difficult to state in terms of a single rule, or changes (sometimes classified as “mutations”) that appear bizarre or unexpected from the perspective of (a particular theory’s) priors about phonological naturalness.

A second type of exceptionality— the one that is of interest to us here— concerns the conditions under which morphophonological alternations apply. Morphophonological alternations of the typical type are exceptional in that they are either (i) triggered by certain morphemes, often for no apparent reason when viewed from the perspective of the (synchronic) phonology, (ii) apply to certain morphemes and not to others, again for reasons that do not appear to be phonological in nature; or (iii), show both property (i) and property (ii).¹

Exceptionality of the type just mentioned is, for the most part, what produces the FQM. From the perspective of many different theories, the exceptionality of an alternation is a sufficient condition for classifying it: any form that is exceptional in any way is stored as an unanalyzed whole. In the framework that is adopted here, on the other hand, exceptionality is not in and of itself evidence for storage. Rather, exceptions are an important part of the (morpho)phonological grammar, and one of the goals of the theory is to characterize the conditions (in terms of locality in different representations, or cyclic domains, and so on) under which exceptionality may or may not be found.

Part of the argument that we will develop is that at least some types of exceptional behavior require a

¹The qualification concerning *apparent* phonological motivations in (i-ii) is motivated by the possibility of phonological representations with e.g. floating features; see §5.

morpheme to be seen as a particular morpheme, and not simply as a phonological representation. Thus, the theory of exceptional behavior is a subpart of a more general theory of the conditions under which morphemes may affect each other's form; this general theory is, for lack of a better term, what could be called the theory of *morphophonology in the broad sense*. Along these lines, the approach that we develop here is an outgrowth of an approach to on contextual allomorphy (Embick 2010a) that hypothesizes that both syntactic (=phase theoretic) and PF-specific (see below) locality conditions interact to produce the conditions under which allomorphy may be found. To the extent that our approach is on the right track, then we should expect exceptional behavior in morphophonology as (narrowly) defined above to be constrained by the same factors implicated in the study of contextual allomorphy: in particular, by different types of locality— phase cyclic, linear, and phonological— that appear to play an important role in morphophonology broadly construed.

We will begin our discussion by outlining a specific approach to morphophonological interactions (§2), and by systematizing and illustrating a number of predictions that it makes about exceptional behavior (§3). The discussion of these sections is in part illustrative, and in part meant to provide an impetus for further investigation: in a number of domains, the theory makes specific predictions about morphophonological interactions that have not been connected with specific case studies, and our hope is that by making these predictions explicit we will be able to move inquiry in productive directions. Following this overview, we turn in §4 to a look at Umlaut in Standard German, where a number of the factors considered in §§2-3 interact in complex ways. While Umlaut has been touched on at various points in the literature assuming the general architecture that we adopt here, it turns out on a close inspection to have a number of important properties whose analysis implicates several ongoing areas of active theoretical research; our discussion highlights these, and suggests several areas for further investigation. Following this, §5 synthesizes the main theoretical points from preceding sections, and makes pertinent comparisons with alternative approaches to morphophonology, including those framed in “affixless” theories of morphology, and those employing floating features and other purely phonological devices; we also discuss some of the broader prospects for stem storage theories, making reference to examples examined earlier in the paper. §6 offers general conclusions.

2 An Approach to Morphophonology

The approach that we develop here is based on the idea that different types of locality constraints apply in morphophonology broadly construed; some of these are syntactic, deriving from phase theory; some are more “morphological”, in that they are stated in terms of morphemes, and their relations; and others are more “phonological”, and are stated in terms of phonological representations. Building on the outlines of Embick (2010a), this set of assumptions is developed in works by Embick (2010b, 2012, 2014), Calabrese (2012, 2013a,b, 2015, 2016), Ingason (2016), Petrosino (2016), and others; its most developed phonological form is Shwayder (2015) (see also Shwayder 2017, on which our analysis of Umlaut in §4 is built).

Our work is centered on research intuitions that derive from *generative* approaches to the study of grammar, and on the idea that— speaking informally— memorization of alternants is sometimes necessary, but dispreferred relative to rules (or their equivalent) whenever possible. In the particular domain that we investigate here, this assumption comes close to what is called *Full Decomposition* in Embick (2015); for obvious reasons, this idea has manifestations in both the theoretical and experimental domains (see e.g. Stockall and Marantz 2006).

For the types of morphophonology that we investigate here, we have been at pains in other works to stress the point that, whatever one might make of conceptual arguments, the reasons for deciding

between more memory-oriented and more rule-centered theories (SS and MPD of §1) must ultimately be empirical. Before turning to the details of (grammar-related) evidence about how morphophonological alternations work, we would like to outline in one paragraph one of the reasons that we assume a generative perspective.

Put simply, we believe that *a priori*, there is very little reason to think that alternants should not be memorized as much as possible. Memory is clearly vast— human beings certainly have the capacity to memorize a large number of irregular forms, and it would be unsurprising if they were able to memorize alternate “stems” for thousands of Roots (although, of course, it would be important to identify which memory system(s) could do this). Thus, it is always possible to fall back on a position in which much morphophonology involves memorizing alternants, and deploying them in the proper contexts. Given that memory is so vast and that memorizing alternants is clearly an option, our view is that any evidence that speakers are **not** memorizing forms should be given special priority. If the language system broadly construed could in principle memorize this information but does not, then it is presumably because of the architecture. And, we believe that there is sufficient evidence from both the theoretical and experimental sides to suggest that even “irregular” alternations of various types do not involve storage of alternants, even if evidence from these domains has not been synthesized.

Intuitions like the one outlined above are, of course, productive to the extent that they generate empirical hypotheses. From this point on most of the rest of the paper we will concentrate on an approach and its predictions, with some additional discussion of larger claims appearing again in §5.3.

The predictions that we will examine in the sections to come center on the locality of morphophonological interactions. As a first step, we adopt the assumption that an important difference derives from the types of information that are referred to in the statement of an alternation: that is, whether the alternation applies only to morphologically defined *targets* or to phonologically defined *targets*; the *triggers* of such alternations can be either morphological or phonological as well, yielding (1):

(1) Trigger/Target Classification of Alternations

	P-Targets	M-Targets
P-Triggers	1	2
M-Triggers	3	4

The Type 1 interactions are purely phonological rules— they apply when their structural descriptions met. These are thus “exceptionless” phonological changes, of the type schematized in (2):

(2) $A \rightarrow B/X_Y$

A rule of this type applies when the phonological conditioning environment that it specifies (in this case, the sequence XAY) is met. The information that the rule refers to is only phonological in nature. Though exceptionless, these rules need not be surface true, in spite of being purely phonological; they could over- or underapply, attributable (in some theories, anyway) to opacity produced by rule ordering, for example.

Alternations of Types 2 and 3 have morphologically-specified targets and triggers respectively. The defining property of these rules is that they mix morphologically- and phonologically-defined information: that is, morphological triggers with phonological targets, or vice versa. As a cover term, we will sometimes refer to these two together as *MP* rules or alternations, taking their “hybrid” nature into account.

Spanish diphthongization is a Type 2 rule according to this classification. Diphthongization applies to certain vowels only when they are stressed, to change /e/ to /ie/ and /o/ to /ue/. However, whether diphthongization applies to a particular Root is something that has to be memorized; so, for instance,

in *pensar* ‘to think’, the Root is subject to this change, so that the 1s present form is *pienso*; but e.g. *tensar* ‘to make tense’ does not diphthongize (cp. 1s present *tensio*). In sum, while the trigger is defined phonologically, the target of the change appears to be defined morphologically, in the sense that some morphemes undergo the change in the relevant phonological environment, whereas others do not.

Conversely, Type 3 alternations are triggered by particular morphemes but apply to phonologically defined targets. The metaphony reported in the Italo-Romance variety of Ischia shows this property, as shown in (3), which also shows Standard Italian for purposes of comparison. It can be seen that in the second person singular, the agreement morpheme in these verbs is realized as schwa (just as it is in the first and third person singular forms). Certain stressed vowels in the syllable preceding this morpheme undergo metaphonic raising; in these examples, we see /a/ to /ɛ/ (underlined) in the 2s forms, as opposed to the 1s and 3s which show /a/:

(3) Metaphony triggered by AGR (Maiden 1991:159); *cant/kand* ‘sing’

	<i>Standard Italian</i>		<i>Ischia, Campania</i>	
	<i>present</i>	<i>imperfect</i>	<i>present</i>	<i>imperfect</i>
1sg	canto	cantavo	kandə	kandavə
2sg	canti	cantavi	kɛndə	kandɛvə
3sg	canta	cantava	kandə	kandavə

In short, for both Type 2 and Type 3, one member of the alternation is defined phonologically and the other morphologically. For this reason, rules of these types are *prima facie* amenable to treatments that employ (relatively) “abstract” phonological representations; e.g. different underlying representations for the Roots that do and do not undergo diphthongization (see e.g. Harris 1985), or by positing a floating [+high] autosegment with 2s Agr (but not with the other singular agreement morphemes) in the Ischia variety. For present purposes, we acknowledge that this type of analysis is possible for many MP alternations; we will continue to refer to these processes as having morphologically-defined triggers and targets in the discussion of the next two sections, though, putting off further discussion of what might adjudicate between morphophonological and “purely” phonological accounts until §5.

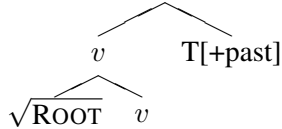
Type 4 alternations are both triggered by specific morphemes (or features) and restricted to apply to certain morphemes and not others. Many of the alternations seen in e.g. the English past tense are of this type. The specific trigger T[+past] is responsible for changes to specific hosts, in ways that make reference to morphological identity, not phonology: e.g. *think, thought, drink, drank*. In examples of this type, there are two morpheme-specific pieces of information at play. The first concerns the identity of the Root: e.g. $\sqrt{\text{THINK}}$ does not behave like $\sqrt{\text{DRINK}}$. The second concerns the specific identity of the trigger: while one type of change is triggered by the past tense morpheme, it is sometimes the case that a different change is triggered by the participial morpheme, so that, for example $\sqrt{\text{SING}}$ has past tense *sang* and participle *sung*. Thus, unlike the MP alternations of Types 2 and 3, neither the trigger nor the target are defined phonologically— both must be identified as particular morphemes. For this reason, we employ the term *MM* (“Morpheme/Morpheme”) for Type 4 alternations. It will be assumed that while *MM*-rules are activated when two morphemes are concatenated, they are still possible phonological rules: that is to say, they obey phonological locality and so on.²

²We remain neutral as to how many rules are required to effect the relevant changes (see e.g. Halle and Mohanan 1982 for a “reductionist” view). Considerations of this type might be important in weighing evidence for and against stem suppletion.

Note as well that when we identify a process as having morphologically-defined targets, we do not wish to imply that there are no “phonological neighborhoods” that cover the undergoers; there often are. While these neighborhoods are important to language acquirers, and how they construct lists (or other ways of specifying undergoers), the point is that the alternation cannot be defined phonologically in toto.

The idea that MM alternations occur under concatenation implicates some additional assumptions about when morphemes can interact. The structure of a past tense verb is shown in (4):

(4) Past tense verb



In this structure, a verbalizing head *v* appears structurally between the Root and Tense. This head is sometimes realized overtly, e.g. in *color-ize* or *dark-en*. Irregular past tense (and participle) forms are found only when there is no overt realization of *v*. Embick (2003, 2010a,b) hypothesizes that (certain) morphemes are *pruned*— that is, eliminated from a representation. In the particular example of the past tense, pruning *v* has the effect that the Root and T[+past] are concatenated $\sqrt{\text{ROOT}} \cap \text{T[+past]}$, so that these two morphemes can see each other for allomorphic purposes.

As main point of interest in classifying alternations according to their trigger and target properties is that it becomes possible to connect this part of morphophonology with more general properties of the theory of allomorphy. Based on the theory of contextual allomorphy advanced in Embick (2010a), which proposes that morphemes must be concatenated (=linearly adjacent) in order to see each other for the purposes of Vocabulary Insertion, we have been exploring the more general claim that *any* interaction in which two morphemes must be identified as morphemes requires linear adjacency; this is advanced as the Morpheme Interaction Conjecture in Embick (2010b, 2012):³

(5) **Morpheme Interaction Conjecture:** PF Interactions in which two morphemes are referred to as morphemes occur only under linear adjacency (concatenation).

According to the MIC, there are two primary expectations concerning MM and MP processes, each of which will figure in our discussion of exceptionality in the following sections.

The first prediction is that MP rules, which mix morphological and phonological information should be able to show “morpheme skipping” effects, where the target and the trigger of the alternation have a morpheme intervening linearly between them. In fact, the example of metaphony from Ischia above in (3) contains an illustration of this very effect. While the 2s Ischia verb in the “present” column of (3) shows metaphony affecting the vowel of the Root $\sqrt{\text{KAND}}$, in the imperfect 2s metaphony applies to the theme vowel *-a*, which is separated from the trigger of metaphony— 2s Agr— by the past tense morpheme, whose exponent is *-v*:

(6) kand -a -v -ə → kandɛvə
 sing TH TNS Agr.2s

Several other MP processes have been shown to exhibit this type of “phonologically-defined” locality as well; see the works cited above for additional examples, as well as §3.1 below. We note that while phonological locality is clearly implicated in examples of this type, morphological representations are also crucial, in at least the following sense: morphemes that trigger phonological changes are the *locus* of the phonological effect (Embick 2013), and thus define the position from which the phonological operation applies. So, for example, the reason that the theme vowel undergoes metaphony in (6), and not

³For some additional discussion of the MIC, see Smith et al. (2016), where it is argued that pronouns are a counterexample to it; and, for a suggestion as to why pronouns (as opposed to lexical nouns) might be “special” in the relevant way that allows MIC to be retained, see Akkuş and Bezrukov (2016).

the stem vowel, is that the trigger of metaphony is the 2s Agr morpheme: this trigger is linearly closer to the vowel of the Theme, and it is thus this vowel that is phonologically raised. Thus, even though phonological interactions may “skip” morphemes, in the way illustrated above, they are constrained by the morphological representations.

The second prediction is that MM rules should **not** apply when there is a morpheme intervening linearly between the trigger and the target; that is, such alternations should exhibit morphologically-defined locality, which we take to require concatenation. Since this prediction is part of the more general theory of exceptionality that is the topic of §3, we illustrate it there.

Before we proceed to illustrations, a final note is in order concerning terminology. While we will often refer to a particular rule *R* as being an MM rule, or an MP rule, this phrasing should be taken as shorthand for “rule *R* is triggered in an MM (or MP) way”. As will become clear as the discussion proceeds, and in §4 in particular, it is possible that the same rule *R* may be activated in both the MP and MM ways, depending on which targets and triggers are involved. Under these circumstances, it is clearly inappropriate to refer to a rule as having MM or MP properties.

3 Application and exceptional behavior

The theory that we have outlined in the preceding section talks about rules that apply in ways that respect either morphologically defined locality, which we take to involve concatenation of morphemes, or phonological locality, which implicates phonological representations. In addition, it has been hypothesized that phase cycles (Chomsky 2000, 2001) constrain interactions in ways discussed in Embick (2010a); see below.

With these proposals at hand, we now look at three different situations in which (already exceptional) morphophonological rules do not apply. First, the different types of locality constraints implicated in the difference between MP and MM processes predict non-application of rules under different kinds of **intervention**. Second, phase cycles predict a further type of effect, in which an MM rule fails to apply because of **cyclic inactivity**. Finally, we examine something that we call **exceptional switching**, in which an MP rule is deactivated by a local morpheme. In summary:⁴

INTERVENTION: Under certain circumstances, material that intervenes linearly between a trigger and a target will preclude an alternation from taking place. In the case of MP alternations, which may skip morphemes, the relevant intervention is in terms of phonological representations; in the case of MM rules, it is morphological intervention that is at issue.

CYCLIC INACTIVITY: MM rules will not apply when the trigger and the target cannot see each other as morphemes in the same phase cycle (cp. “Readjustment activity hypothesis” of Embick 2010a).

EXCEPTIONAL SWITCHING: MP rules that are turned (ON) by particular morphemes may be exceptionally switched (OFF) by morphemes that are concatenated with them. In the type of case that we will see twice in this paper, an MP rule *R* is turned (ON) by a morpheme [X], and typically applies. However, a specific set of Roots or morphemes that is potentially subject to *R* fails to undergo the rule. Exceptional switching requires two morphemes to interact as morphemes; hence, exceptional switching is predicted to happen under linear adjacency.

⁴Our focus on these types of (mis)application is motivated by a particular set of concerns and is not meant to be exhaustive. There are certainly other types, arising from e.g. phonological cyclicity (not the same as phase cyclicity; Embick 2014, Shwayder 2015). See Myler (2015) for a pertinent discussion of Spanish diphthongization.

We illustrate these predictions in subsequent sections. The emphasis in §3.1 and §3.2 is on providing synthesized looks at some of the locality based part of the theory, with the goal of showing how patterns of exceptionality require something like the distinction between MP and MM rules, and the theory of phases that has been developed as part of the theory of contextual allomorphy.

The discussion of §3.3 on exceptional switching is more exploratory in nature, and is meant to highlight some fine-grained predictions that have not been articulated in detail; it also provides a foundation for understanding some of the complexities of German Umlaut that are addressed in §4.

3.1 (Linear) intervention

Here we illustrate two different types of intervention effect that are expected given the difference between MP and MM alternations. For MP, it is expected that while morphemes might intervene between triggers and targets, such rules will show phonological locality that is determined by the position of the triggering morpheme. Thus, only relevant phonological material intervening between a trigger and a potential target will cause the rule to not apply. For MM rules, which are subject to morphological locality, the prediction is that any morphemes intervening between the trigger and target will prevent the application of the rule.

3.1.1 MP: Icelandic Umlaut

Ingason (2014, 2016) and Wood (2015) argue that Icelandic *u*-Umlaut ($a \rightarrow \ddot{o}$) is an MP rule, triggered by certain suffixes. As such, it is expected to exhibit phonologically-defined locality. To illustrate this point, consider (7), where *u*-Umlaut is triggered by certain nominal inflectional morphemes, boldfaced below; as can be seen in this (7b), *u*-Umlaut affects a Root across an overt intervening suffix:

- (7) Icelandic Umlaut: Phonological locality
- a. rak-ur ‘moist-masc.nom.sg’
rök-**Ø** ‘moist-fem.nom.sg’
 - b. dan-sk-ur ‘Dan-ish-masc.nom.sg’
dön-sk-**Ø** ‘Dan-ish-fem.nom.sg’

While *u*-Umlaut is able to skip intervening morphemes, it is only able to do so provided that its phonologically-defined locality conditions are met. In particular, if an affix containing a non-umlauting vowel appears between the Root and the MP trigger, it is expected that *u*-Umlaut should not occur. Ingason (2016) provides a particularly clear example of this effect with the Icelandic word for ‘Assamese’, *assam*, which variably takes *-sk* (as in 7b) and *-ísk* adjectival exponents. With the former, Umlaut occurs, whereas with the latter, it does not:

- (8) ‘Assamese’, in Icelandic
- a. assam-sk-ur (masculine nominative singular)
assöm-sk-**Ø** (feminine nominative singular)
 - b. assam-ísk-ur (masculine nominative singular)
assam-ísk-**Ø** (feminine nominative singular)

In the second example in (8b), the *u*-Umlaut trigger fails to have an effect on *assam*, due to the **phonological** intervention of a non-umlauting vowel in the nationality suffix; when this vowel is not present, as in the (8a) variant, Umlaut takes place. That is, *u*-Umlaut can skip morphemes, but not relevant phonemes.

As we discussed earlier in this section, there are two components that are required for the analysis of the effect. The first concerns the *u*-Umlaut rule, which, as an MP-rule, obeys phonological locality. The second is morphological: although phonologically defined, the locality of Umlaut requires an analysis in which the trigger of Umlaut *is in the position of the triggering morpheme*. Otherwise— i.e. if the umlaut trigger did not have a morphologically defined locus— the absence of *u*-Umlaut in (8b) would be unexpected (or at least, it would have to be stipulated). The latter point might seem trivial in the context of the current discussion, but assumes greater importance when we consider that many morphological theories dispense with morphemes, and are hence unable to state this kind of restriction in a straightforward way (see Embick 2013, and §5.1).

3.1.2 MM: Icelandic Verbs

Wood (2015) and Ingason (2016) provide valuable discussion of linear intervention effects in Icelandic verb alternations, highlighting the importance of the MM versus MP distinction as we have outlined it above.

As a starting point, consider the transitive forms of the verb $\sqrt{\text{BROT}}$ ‘break’ in (9). $\sqrt{\text{BROT}}$ is a *strong* verb that shows changes to vowel quality (Ablaut) characteristic of such verbs in Germanic (as opposed to *weak* verbs, which do not exhibit these changes).

(9) Transitive forms of $\sqrt{\text{BROT}}$ ‘break’

	<i>Indicative</i>		<i>Subjunctive</i>	
	<i>present</i>	<i>past</i>	<i>present</i>	<i>past</i>
1s	brýt-Ø	braut-Ø	brjót-i	bryt-i
2s	brýt-ur	braut-st	brjót-ir	bryt-ir
3s	brýt-ur	braut-Ø	brjót-i	bryt-i
1p	brjót-um	brut-um	brjót-um	bryt-um
2p	brjót-ið	brut-uð	brjót-ið	bryt-uð
3p	brjót-a	brut-u	brjót-i	bryt-u

There are several things going on in the forms in (9), including what Wood and Ingason treat as rules triggered by Tense and having effects on specific (Root) targets whose identity must be memorized— the defining properties of MM rules.

Strikingly, all of the stem allomorphy exhibited in (9) disappears when $\sqrt{\text{BROT}}$ appears in an intransitive form in which an overt morpheme *-n* appears between the Root and the Tense morpheme, as can be seen in comparing (10) with (9):

(10) Intransitive forms of $\sqrt{\text{BROT}}$ ‘break’

	<i>Indicative</i>		<i>Subjunctive</i>	
	<i>present</i>	<i>past</i>	<i>present</i>	<i>past</i>
1s	brot-n-a	brot-n-að-i	brot-n-i	brot-n-að-i
2s	brot-n-ar	brot-n-að-ir	brot-n-ir	brot-n-að-ir
3s	brot-n-ar	brot-n-að-i	brot-n-i	brot-n-að-i
1p	brot-n-um	brot-n-uð-um	brot-n-um	brot-n-uð-um
2p	brot-n-ið	brot-n-uð-uð	brot-n-ið	brot-n-uð-uð
3p	brot-n-a	brot-n-uð-u	brot-n-i	brot-n-uð-u

The overt *-n* exponent in intransitives prevents the vowel-changing Roots and Tense from being linearly adjacent, with the result that the MM changes that apply in the transitive are not found. There is, moreover, a symmetrical effect in the realization of the past tense morpheme T[+past]. In the transitives in (9), this morpheme does not have an overt realization. In one way of analyzing this, the T[+past] morpheme shows a \emptyset contextual allomorph in the context of $\sqrt{\text{BROT}}$ and other Roots. In the intransitives in *-n*, on the other hand, both the indicative and subjunctive pasts show $\text{-}\delta$ exponents for T[+past]: its default form (cf. Wood 2015). Thus, in the same way that *-n* intervenes between the Root and Tense for the purposes of MM rules, it also intervenes for contextual allomorphy of T[+past], as expected under the MIC.⁵

Wood (2015:126) makes the important observation that there is one exception to the exceptional non-application of exceptional rules in these verb forms: u-Umlaut, discussed above as an MP rule, continues to apply in intransitives with overt *-n*, as shown in (11) for the verb $\sqrt{\text{BAT}}$ ‘improve’ (umlaut triggers are boldfaced):

(11) Umlaut in $\sqrt{\text{BAT}}$ (indicative forms)

	present	past
1s	bat-n-a	bat-n-aði
2s	bat-n-ar	bat-n-aðir
3s	bat-n-ar	bat-n-aði
1p	böt-n- um	böt-n- uð -um
2p	bat-n-ið	böt-n- uð -uð
3p	bat-n-a	böt-n- uð -u

This is, as noted earlier, what is expected if MP rules follow phonological and not morphological locality.

In sum, we see in this case study the different locality conditions that apply to MM versus MP alternations, as highlighted by the different patterns of exceptionality that ablaut and umlaut show with morphological interveners.⁶

⁵In these comments we abstract away from the vowels accompanying $\text{-}\delta$, and some additional questions about allomorphy for agreement suffixes.

⁶A reviewer points that there is at least one type of stem change in Icelandic strong verbs that raises an additional set of questions about MM/MP rules and their locality conditions. Some strong verbs, like the one seen in (9), are not solely Tense/Mood sensitive, but are also sensitive to number (e.g., indicative pres sg *brýt-*, pl *brjótt-*; past sg *braut-*, pl *brutt-*). In fact, this type of verb shows several stem changes, as can be seen from the fact that in the indicative, there are four different stem forms for the combinations [±past] and [±plural]. This is a potential problem for an MM analysis because for at least some of the relevant changes (those in the past indicative singular in particular), information from three distinct morphemes—the Root (strong or weak), Tense ([±past]), and Number ([±plural]) is evidently required. Linearly, these morphemes appear as Root-Tense-Agr (assuming that *v* is pruned). While both the Root and Agr morphemes are concatenated with Tense, the Root and Agr morphemes are not concatenated with each other; and, apparently, the features of the Agr morpheme are inducing changes on the form of the Root.

Several properties of the Agr-driven changes call for detailed study (cf. Árnason 2011, Gussmann 2011). First, the phonological changes associated with Agr are complex. One of them, *i-umlaut*, can be stated as a fronting rule phonologically (cf. its application in deriving the present indicative singulars from the stem form seen in the present indicative plurals). However, it remains to be seen whether another set of changes, affecting singular forms in the past indicative, can be accounted for with a single rule.

Second, in terms of locality, Agr-driven stem changes appear to skip the past tense morpheme, since they affect the Root. This is not expected of MM processes. However, the application of Agr-driven rules crucially refers to features of the intervening Tense morpheme. That is, [-pl] stem changes are different for indicative present and indicative past. This suggests to us that while [±plural] is certainly implicated in the relevant changes, the locus of the effect is the **Tense** morpheme, much as is seen in the patterns discussed in the main text. On the face of it, this could be analyzed by having rules with a locus in Tense turned (ON) when Agr bears specific features where, crucially, the effects of the rules are seen on the Root. Such a proposal would have implications for how to understand the MM/MP distinction, in ways that warrant careful study. Though we are unable to

3.1.3 MM: Italian Passato Remoto

Calabrese's (2012, 2013a,b,2015) discussion of the Italian *passato remoto* contains a number of components that resonate with the discussion of Icelandic stem alternations immediately above. Verbs that show irregularity in this tense, like those in (12a-d), show different patterns that are systematically correlated with person and number: in particular, the 1sg, 3sg, and 3pl forms show a number of changes to the stem that are not found in the other person number combinations; for purposes of comparison and contrast, a regular verb is shown in (12e):

(12) Some verbs in the Italian *passato remoto*

	inf.	*1sg*	2sg	*3sg*	1pl	2pl	*3pl*
(a) 'come'	venire	vénni	venísti	vénne	venímmo	veníste	vénnero
(b) 'move'	mwovere	móssi	mwovésti	mósse	mwovémmo	mwovéste	móssero
(c) 'put'	mettere	mísi	mettésti	míse	mettémmo	mettéste	mísero
(d) 'see'	vedere	vídi	vedésti	víde	vedémmo	vedéste	vídero
(e) 'fear'	temere	teméi	temésti	temé	temémmo	teméste	temérono

The Root-specific stem changes here are correlated with two other effects: first, they are found only in athematic forms; and, second, some of these forms (b,c) show an overt *-s* exponent of tense in the stem-changing forms—unlike the regular *passato remoto*, where T[+past] has a \emptyset exponent.⁷

Calabrese's insight is that the interesting allomorphic effects in the *passato remoto* are found in athematic verb forms (forms lacking a theme vowel immediately after the Root), and that they are found there because it is in such forms that the verb Root and the past tense morpheme are concatenated. Putting to the side the exact statement of how the verbs in question lose their theme vowel, the relevant representations are those in (13):

(13) Linear order for Verbs:

- a. **Thematic:** Root-TH-Tense-Agr
- b. **Athematic:** Root-Tense-Agr

In these linear orders, the correlation between irregular tense allomorphy and the stem changing processes follows from how MM locality works. When the TH position intervenes between the Root and Tense, there are (i) no MM processes triggered by Tense that affect the Root, and (ii) no Root conditioned allomorphy of Tense, as predicted by the MIC.

3.1.4 MM: The Kashaya Decrement Rule

Kashaya, a Southwestern Pomo language of California, has a process called the *decrement* in Oswalt (1961), by which a laryngeal increment (a /ʔ/ or /h/ linked with the following consonant, see Buckley 1994) is deleted in certain morphologically-defined environments. The triggers of the decrement rule are heterogeneous both phonologically and morphologically, as shown in (14):

(14) Some Triggers for the Decrement (Buckley 1994, p.288ff.)

go further into the matter here, the analysis of the full set of effects associated with Tense and Agr is an important topic for further investigation.

⁷For example, according to Calabrese's analysis, (12b) shows the *-s* exponent of Tense in the 1sg, 3sg, and 3pl, (e.g. 1sg *muov-s-i*) with subsequent assimilation of the stem-final /v/ to yield /ss/.

- a. Directional suffixes (some not all): *-ibic* ‘up, away’, *-aq* ‘out hence’, *-ala* ‘down’, *-ay* ‘against’, etc.
- b. Plural Act allomorphs (most not all): *-t*, infixing *-t-*, *-w*, *ʔta*, $-\emptyset$, *-aq*, *-ataq*, etc.
- c. Derivational suffix *-t* forming verbs from nouns and adjectives
- d. The nominal locative suffix *-ʔ*
- e. 3sg. possessor prefix of kinship nouns *miya-*

In (15) are examples of the decrement applying with two different allomorphs of the plural act morpheme, *-aq* and *-t*; for clarity, these triggers are boldfaced, and the target of decrement is underlined (note that there are some other phonological processes reflected in the outputs; what is important is that the underlined segments are deleted):

(15) Decrement with Pl.Act.

- a. ba- hc^hital **-aq** -ʔ → bac^hita^ʔlaʔ
Pfx:mouth $\sqrt{\text{STRING}}$ Pl.Act Abs.
‘string together meat (plural) to make jerky’
(Compare *bahc^hitalʔ* ‘string together meat (singular) to make jerky’)
- b. mu- ʔk’a **-t** -ʔ → muk’aʔ
Pfx:energy $\sqrt{\text{CRACK}}$ Pl.Act Abs.
‘crack (plural) with heat’
(Compare *muʔk’aw* ‘crack (singular) with heat’)

As noted above, the decrement rule is morphologically-triggered since there is nothing phonological that unifies the triggering morphemes in a way that would produce the deletion in question, or otherwise. In addition to this, the decrement rule targets a specific set of morphemes; other morphemes do not undergo the process (Buckley 1994, p.302), as illustrated in (16), which employs the same Plural Act suffixes seen above:

(16) Failure to Decrement with Pl.Act.

- a. di- ʔk’ol **-aq** -ʔ → diʔk’olaʔ
PFX:GRAVITY $\sqrt{\text{CUT}}$ PL.ACT ABS.
‘cut off parts (plural); prune (trees)’
- b. da- ʔc^ha **-t** -ʔ → daʔc^haʔ
PFX:HANDS $\sqrt{\text{STOP}}$ PL.ACT ABS.
‘(falling forward) land on extended arms (plural)’

As expected given its morphologically-defined triggers and targets, the decrement rule obeys morphological locality. If a morpheme intervenes between the trigger and the target, it does not apply. In (17), the intervening movement morpheme realized as *-w* blocks decrement between the directional morpheme trigger *-ay* ‘against’ and the root; when the *-w* is not present, the Root is subject to decrement, as shown in (17b):

(17) Intervening */-w/* MOVEMENT suffix

(Buckley 1994, p. 296)

- a. $\overline{\text{mihca}}$ -w -**ay** -ʔ → $\overline{\text{mihcaway}}$
 $\sqrt{\text{TOSS}}$ Mvmt Dir:Against Abs.
 ‘toss to someone (pl)’
- b. $\overline{\text{mihca}}$ -**ay** -ʔ → $\overline{\text{micay}}$
 $\sqrt{\text{TOSS}}$ Dir:Against Abs
 ‘toss...’

The idea that the intervention effect is morphological— and not phonological— is important for identifying the decrement as an MM process. In both the examples in which decrement applies like (15) and in examples where it does not like (17), there are several phonological segments intervening between the trigger morpheme and the target of deletion. (For a formulation of the rule, see Buckley 1994). The difference is that in the latter cases, there is a morpheme intervening between the trigger and the target, whereas in the former there is not. Thus, we are able to rule out a possible analysis according to which decrement is an MP rule that is (ON) by default with the triggers listed above. If this analysis were correct, we would not expect to find the morphological intervention effect (compare the MP alternations seen to skip morphemes in the Ischia variety (§2) and in Icelandic Umlaut (§3.1.1)).

3.2 Phase-cyclic effects

By definition, MM rules require two morphemes to see each other *as morphemes*. In the approach that we have adopted here, visibility as a particular morpheme is also affected by phase cyclicity. The version of phase adopted here is developed for PF purposes in Embick 2010a, 2014 and Shwayder 2015, building on and connecting with Chomsky (2000, 2001), Marvin (2002), Marantz (2001, 2007), Embick and Marantz (2008), Newell (2008), and related work. In summary form, we take the view that certain morphemes cease to be identifiable as morphemes when they become inactive in terms of phase theory; this is stated in the ACTIVITY COROLLARY in (18):⁸

- (18) ACTIVITY COROLLARY (AC): In $[[\dots x] \dots y]$, x and y cyclic, the complement of x is not *active* in the PF cycle in which y is spelled out. (Embick 2010a)

Putting to the side the specific mechanics that produce (18), the prediction that the ACTIVITY COROLLARY makes for MM rules is that in category-changing derivations, where a $\sqrt{\text{ROOT}}$ is first categorized by x , then changed to category y ($[[\sqrt{\text{ROOT}} x] y]$), an MM rule triggered by y (or material outside of y) cannot apply to the Root, because the Root is not visible as a morpheme when y is spelled out.⁹

By way of illustrating one of the scenarios relevant to this prediction, consider fricative voicing (FV) in English, which is triggered by the plural morpheme, as well as by the verbalizer v :

- (19) fricative voicing
- a. wolf, wolvy-es /f/~/v/

⁸The qualification “cease to be identifiable *as morphemes*” leaves open the possibility that cyclically inactive elements may have phonological representations that can be affected in various ways; see Embick (2014) for discussion and some specific proposals.

⁹This view assumes that “typical” derivational exponents realize category-defining heads (n, v, a, \dots), and that these heads define phase domains. Different assumptions about this and related issues concerning Roots have led to different predictions concerning (for the most part) phonological behavior; see, for example, Lowenstamm (2015b) and Creemers et al. (2017).

- path, path-s /θ/~/ð/
house, hous-es /s/~/z/
- a. shelf, to shelve /f/~/v/
bath, to bathe /θ/~/ð/
house, to house /s/~/z/

This process has MM properties: it is triggered by specific morphemes ([+pl] and *v*),¹⁰ and it applies only to some Roots, and not to others that are phonologically identical to the undergoers (e.g. there is no voicing in plurals like *gulfs*, *deaths*, or *excuses*). The last example illustrates the further point that some Roots undergo voicing in one environment, but not another: the verb *to excuse* takes the voiced allomorph, unlike the plural noun *excuses*. As further illustration of this point, consider *one leaf*, *two leaves*; but *leaf through a book*; *one wolf*, *two wolves*, but *wolf down some food*. The trigger and target specificity of FV suggests that it is an MM rule.¹¹

Most relevant for our immediate purposes is that with the verbal trigger it is possible to prevent FV from applying by introducing a cyclic boundary between the trigger and the target. This point is illustrated with the root $\sqrt{\text{HOUSE}}$ in Marantz (2013). In its Root verbalization [$\sqrt{\text{HOUSE}} v$], the voiced allomorph appears. However, like other English nouns (preferably concrete), [$\sqrt{\text{HOUSE}} n$] can form a denominal verb, whose meaning is something like ‘provide with noun’:

- (20) table those rooms =provide those rooms with tables
room those houses =provide those houses with rooms
house those lots =provide those lots with houses

In the last example here, where the noun *house* is verbalized, it is the voiceless allomorph that surfaces. This is the effect that is predicted by the phase theory: when the Root is not visible to the *v* morpheme, FV does not occur.¹²

There is more that could be said here about the structure underlying verbalizations—like *house* with the voiceless allomorph. As noted in Fn. 11, there might not be [[$\sqrt{\text{ROOT}} n$] *v*] derivation productively in English. On this point, we agree with the spirit (though not necessarily the letter) of Borer (2013). Concerning the specifics of the derivations in (20), it is possible that the derivation of *to house* with this meaning involve additional structure (beyond just *n* and *v*), including perhaps a head expressing a “prepositional” meaning. What is crucial for our purposes is that when there is a denominal verb formation, the Root and the triggering *v* morpheme are not active as morphemes in the same cycle; and, when this happens, there is no fricative voicing, as predicted by the version of phase theory we have adopted.¹³

¹⁰Possibly some nominal morphemes trigger the process as well: consider *housing* and *shelving* (unless there is a *v* in these that is responsible).

¹¹If, for example, the verb *to leaf* were denominal [[$\sqrt{\text{LEAF}} n$] *v*], but e.g. *to house* were Root-derived [$\sqrt{\text{HOUSE}} v$], the voicing difference between these two could be explained in terms of phase theory. However, there is little reason to believe that this structural difference should be posited for this pair, let alone more generally. Along these lines, Borer (2013) discusses at length why derivations like [[$\sqrt{\text{ROOT}} n$] *v*] (with *v* not realized phonologically) might be ruled out in general.

Our view is that the clearest case of verbalization involving a noun is found with the “provide with” interpretation discussed in (20) in the main text.

¹²Relatedly, Root verbalization *to shelve the book* means to ‘put the book on a shelf’, or, idiosyncratically, to put the book ‘on the back burner’; on the other hand, to *shelve a wall* means to ‘put a shelf or shelves on a wall’. It might be possible to produce the voiced alternant with the latter (locatum) interpretation, as pointed out to us by a reviewer. This would suggest both denominal and Root-based derivations of locatum meanings, a matter that could be studied in greater detail. However, our judgment is that in a scenario in which shelves are put into a room for some reason, but not mounted on a wall, along the lines of (20), it is the voiceless allomorph that surfaces (*We need to shelve two more rooms*).

¹³By way of providing a preview for §3.3 and for §4.2 in the analysis of Umlaut, we note that there are in principle two ways

3.3 Exceptional switching

Finally, we arrive at the topic of exceptions to exceptional behavior. In many cases, being an exception to an exception amounts to being unremarkable. Halle (1998) observes something to this effect in his analysis of English stress, where exceptions, though not the norm, are also not uncommon (emphasis ours):

To reinforce the point that rules may have lexical exceptions, I note that the majority of suffixed adjectives such as those in (8b) are subject to RLR Edge marking. As shown in (12a), however, adjectives in *-ic* generally are not. Since the suffix *-ic* makes a light rime, the Main Stress Rule assigns penultimate stress to these adjectives. However, in a handful of such adjectives—of which a few are listed in (12b)—RLR Edge Marking does apply. *The latter are thus exceptions to exceptions; that is, they are regular.* (1998:550)

For the types of morphophonology that we are interested in here, the exceptionality that is of interest involves (i) an MP trigger that can be (ii) turned off under concatenation with a particular set of morphemes. In part, our interest in this kind of effect stems from what we will say about German Umlaut in §4. Here, we will examine a case that appears to have something like the correct properties, and which connects to other predictions of interest in a few ways. While there are alternatives to the analysis that we arrive at, and while some of the key empirical predictions deriving from this analysis have not been tested, it is our hope that the line of reasoning that is found in this part of the discussion will provide a useful focus for additional research on this and related questions.

The Arpinate variety of Italo-Romance (Calabrese 1998, Parodi 1892, Torres-Tamarit and Linke 2016) shows metaphonic changes that are triggered morphologically. This case of metaphony is phonologically opaque, in that the exponent of the triggers is $-\text{ə}$ due to many of the (final/post-tonic) vowels in this variety having been reduced (cp. the Ischia variety in §2). It is also non-uniform phonologically,

of talking about the “Root-specific” aspect of FV. The first (and most obvious) is that the presence of a specified (‘+’) Root next to one of the trigger morphemes turns FV (ON):

- (i) $\text{Root}^+ \cap \text{TRIGGER} \Rightarrow \text{FV (ON)}$

A second way of conceiving of the trigger/target relation, much less obvious given the facts of English under consideration, would be to hold that the triggers in question “default” to activating FV, so that the non-undergoers are specified (‘-’) as turning off the rule:

- (ii) a. $\text{TRIGGER} \Rightarrow \text{FV (ON)}$
b. $\text{Root}^- \cap \text{TRIGGER} \Rightarrow \text{FV (OFF)}$

This latter way of analyzing the MM effect, with Root-triggered exceptionality to an MP rule, may appear counterintuitive, but it is able to account for the “basic” facts about fricative voicing like those considered in (19). Interestingly, though, it makes incorrect predictions about the consequences of introducing a cyclic boundary between the trigger and target like in (20). Under the analysis in (ii), the default setting of FV would be (ON) for [+pl] and *v*, such that FV has to be turned (OFF) when these morphemes are concatenated with particular sets of Roots. If the Roots are not visible as Roots due to phase inactivity, the prediction is that FV should be (ON), so that voicing is found across the board for such denominal verbs: even for Roots that never show FV with [+pl] and *v*. That is, (ii) predicts overapplication of FV, contrary to fact:

- (iii) mouse (/s/, */z/) the room =provide the room with mice
mammoth (/θ/, */ð/) the exhibit =provide the exhibit with mammoths
smurf (/f/, */v/) the kids =provide the kids with smurfs

However, the first approach (i), with FV turned on under concatenation, does not make these incorrect predictions.

The general point is that overapplication across phase boundaries would provide important evidence about how triggering works; see in particular §4.2.3.

in that it can produce both mid-vowel raising and diphthongization, as well as the raising of /a/ (called “hypermetaphony” in Maiden 1991) with verbs.

Nominal inflection in Arpinate is shown schematically in (21), where the boldfaced cells are metaphony triggers:

(21) Arpinate noun inflection

class	singular	plural
I (fem.)	-a	-ə
II (masc.)	-ə	-ə
III (fem./masc.)	-ə	-ə

So, for example, adjectives which alternate between Class I and II (in feminine and masculine, respectively) show metaphony in the masculine singular and plural but not in the feminine plural, despite the desinence being realized as /-ə/ for all three categories:

(22) Class I/II adjectives

	gender	singular	plural	
(a)	f	sól-a	sól-ə	‘alone’
	m	súl-ə	súl-ə	
	f	bón-a	bón-ə	‘good’
	m	bwón-ə	bwón-ə	
(b)	f	nér-a	nér-ə	‘black’
	m	nír-ə	nír-ə	
	f	vékkj-a	vékkj-ə	‘old’
	m	vjékkj-ə	vjékkj-ə	

As can be seen in these examples, metaphony in this variety has two different effects, raising and diphthongization reflecting the difference between [±ATR] mid-vowels (/e,ɛ/, /o,ɔ/).

Interestingly, there are some lexical exceptions to metaphony; certain Class III nominals fail to show metaphony in the plural (Parodi 1892).

(23) Class III nouns

a. Normal metaphony in:

sg.	pl.	gloss
kər-ə	kwor-ə	‘heart’
fjor-ə	fjur-ə	‘flower’
mes-ə	mis-ə	‘month’

b. but not in:

sg.	pl.	gloss
mont-ə	mont-ə	‘mountain’
pont-ə	pont-ə	‘bridge’
pef-ə	pef-ə	‘fish’

The situation in Arpinate calls for an analysis with at least two components: first, there are certain morphemes that are triggers for metaphony; and second, certain Roots are specified to turn this process off.

We take the morphemes that trigger metaphony to be MP triggers (we use features like [II] and [III] here for convenience; there might be better ways of encoding these classes):¹⁴

(24) Metaphony: (ON) with [II], [III,+pl], ...

The precise form of the metaphony rule (better, rules) is a question that has been examined extensively in Calabrese’s work, most recently in Calabrese (2016). Putting aside the formal phonological details of these processes, the two different outcomes (raising for /o,e/, diphthongization for /ɔ,ɛ/) are activated when metaphony is (ON).

This process is “exceptional” in the sense that it is triggered morphologically, and not phonologically. We take it to be MP because it appears that the triggering morphemes are triggers by default. That is, they produce a metaphony environment, except in the case of a limited set of exceptions: those in (23b). In principle it would be possible to take the exceptionality of these Roots as evidence for metaphony being an MM rule. While such an analysis is able to account for the facts that we have access to (it is not clear from the available descriptions whether morpheme-skipping metaphony happens in Arpinate), it is somewhat forced given that the trigger morphemes are triggers across the board, with a limited set of listed exceptions. For this reason, our analysis treats metaphony as turned (ON) with the [III,+pl] morpheme whenever it occurs.¹⁵ Then, to account for the exceptionality seen in (23b), the rule is locally turned (OFF) when this morpheme is concatenated with a particular list of Roots. As a result, the Roots in question are exceptions to exceptions, and nothing happens to them in the plural environment.

In summary, we have advanced the idea that Arpinate metaphony is an MP process triggered by certain morphemes; the rule can be exceptionally turned (OFF) when those morphemes are concatenated with particular Roots. In principle, this behavior could be handled with MM activation as we have defined it. In making the exceptional switching proposal, we have two differences from MM in mind.

First, the MP+exceptional switching versus MM treatment produces different expectations concerning the productivity of the metaphonic process. All else equal, the MP analysis predicts that metaphony should apply with nonce Roots affixed with [III,+pl], whereas the MM treatment does not necessarily make this prediction. As indicated by the *all else equal* qualification, other factors (including but not limited to phonological neighborhood effects, Fn. 2) complicate the predictions concerning “productivity”. See also the comments at the end of this section, and in §4.

Second, our analysis predicts that exceptional switching requires concatenation between the trigger and the morpheme that turns the trigger off, because these two morphemes need to see each other as morphemes. Schematically, where $\sqrt{\text{ROOT}^-}$ stands for the list of Roots that turn (OFF) an MP rule turned (ON) by X, and M is a linearly intervening morpheme, the configuration of interest is shown in (25):

(25) $\sqrt{\text{ROOT}^-}$ -M-X

That is, assuming that M creates a phonological environment in which the MP rule triggered by X could target the Root, the prediction is that the Root could not turn the MP rule off because it is not local to the trigger.

Although we do not have data to (dis)confirm this additional prediction in Arpinate study, the prediction is a strong one, and thus worth highlighting for future work.

Finally, we note that in this particular case study, the exceptional switching is relatively simple, in that there is a single list of Roots that are unaffected by a metaphony trigger. In our analysis of Umlaut

¹⁴Other metaphony triggers— e.g. [+2] Agr— would be included in this list as well; as noted above, metaphony in the verbal system (but not in nouns) raises /a/ in addition to the mid vowels.

¹⁵Since metaphony occurs with class II masculines as well, there could be a more general statement here about the triggering in plural forms.

in §4, it will be shown that exceptional switching might sometimes become entangled with more varied relations between triggers and potential targets, producing surface patterns of considerable complexity.

3.4 Summary

In this section we have looked at a number of different alternations, both MP and MM, in terms of our classification in §2, and we have looked at a number of predictions concerning when these (exceptional) processes should have exceptions.

Broadly speaking, there are two main points that arise from this survey and synthesis. The first is that something like the distinction between MP and MM rules is required, as there appear to be systematically different patterns of application among morphophonological alternations broadly construed. We have pursued the hypothesis that MP alternations require phonological locality (and thus may skip morphemes), whereas MM alternations require concatenation of morphemes, bringing them under the MIC.

The second focus of this section was on two additional types of application effects, involving phase cyclic boundaries and exceptional switching. Our hope is that highlighting the predictions that the theory produces in these domains will provide an impetus for further investigations along these lines. Finally, in addition to extending the theoretical dimension of the discussion, these phenomena play an important role in understanding the complex behaviors of German Umlaut, to which we now turn.

4 Some properties of German Umlaut

In this section we develop an analysis of the alternation called *Umlaut* in (Standard High) German. Descriptively, Umlaut is a vowel fronting process, whose effects (represented orthographically by \ddot{V}) are shown in (26):

(26) Umlaut Examples

Vowels		Examples	
/u:/	/y:/	Huhn	Hühn-er
/ö/	/ʏ/	dumm	dümm-lich
/o:/	/ø:/	hoch	höch-st
/ɔ/	/œ/	Holz	hölz-ern
/a	/ɛ:/	Europa	europä-isch
/a/	/ɛ/	Stand	ständ-ig
/aʊ/	/ɔʏ/	sauf	Säuf-er

While originally a phonological alternation triggered by a suffixal front vowel or glide, Umlaut is clearly morphophonological in contemporary German, in the sense that the phonemes that originally triggered it no longer are present in the triggering affixes.¹⁶ In addition to this trigger behavior, Umlaut is (for the most part) sensitive to particular targets: for example, Umlaut triggered by 3s verb inflection applies to the verb *laufen* ‘to run’ to yield *läuft*, but not to e.g. *kaufen* ‘to buy’, which has 3s *kauft*. The “mixed” character of Umlaut—a phonological change that is associated with sets of morphologically defined triggers and targets—has been at the center of an intense discussion of the boundaries between morphology and phonology (see e.g. Wiese 1996b for a concise statement and review of the literature).

¹⁶This is a standard description of how Umlaut has been “morphologized”; it might be possible to posit, with e.g. Lieber (1987), a floating [-bk] autosegment with Umlaut-triggering affixes. See §5 for discussion.

Our goals for this section are to analyze Umlaut within the framework that we have outlined and illustrated in §§2-3. The main direction of the discussion is an argument to the effect that while Umlaut has many *prima facie* MM properties, there are some indications that Umlaut might be activated as an MP rule as well. After developing this main point, we will point to a number of fine-grained details in the study of Umlaut that could provide the basis for future work.

4.1 The Analysis in Outline

As noted above, Umlaut is triggered by a number of different morphemes. A non-exhaustive list, chosen to emphasize the syntacticosemantic heterogeneity of the triggers, is given in (27):¹⁷

- (27) Umlaut: Morphosyntactic Environments (Not Exhaustive)
- a. Verb forms: *fahr-en* ‘drive’ infinitive, *fähr-t* 3s pres.
 - b. Noun Plurals: *Huhn* ‘hen’, *Hühn-er* ‘hens’
 - c. Diminutives: *Glocke* ‘bell’, *Glöck-chen* ‘bell-Dim.’
 - d. Adjective Formation: *Europa* ‘Europe’, *europä-isch* ‘European’
 - e. Comparatives: *lang* ‘long’, *läng-er* ‘longer’

As has been amply noted in the literature, most of the Umlaut triggers have targets that they do not apply to; these have to be specified on a case-by-case basis for individual trigger/target pairs, in the sense that a single Root can undergo Umlaut in some of the environments in (27), but not others. An illustration of this effect is shown for plurals with *-e* and adjectives with *-ig* in (45) (cf. Wurzel 1970, Janda 1998):

- (28) Trigger-Target pair specificity for umlaut in Nouns

Singular	Plural	Adjective in <i>-ig</i>	Glosses
Harz	Harz-e	harz-ig	‘resin-resins-resinous’
Tag	Tag-e	täg-ig	‘day-days-days.long’
Saft	Säft-e	saft-ig	‘juice-juices-juicy’
Macht	Mächt-e	mächt-ig	‘power-powers-powerful’

While almost all Umlaut triggers must be specified to apply to some Roots and not others, there is also one context in which Umlaut is exceptionless: when it is triggered by “true” diminutives, realized in Standard German as *-chen*.

Building on what has been discussed in prior sections, there must be at least three components to the analysis of Umlaut:

1. **Phonology:** The first is a phonological rule, abbreviated \tilde{R} ; this rule effects the phonological changes called *Umlaut*.
2. **Triggers:** The rule \tilde{R} is activated by certain morphemes— i.e. those in (27); but
3. **Targets:** Certain Roots (or morphemes) do not undergo \tilde{R} in the presence of the Triggering morphemes.

¹⁷We are speaking of the triggers as morphemes, not the exponents of these morphemes. There are some reasons to think that one could look into this part of Umlaut in more detail. For example, *-s* plurals never trigger Umlaut, whereas *-er* plurals apparently always do (Lowenstamm 2012, 2015a). See §4.2 for some related comments.

As far as the phonology goes, we have little to say as long as there is a single rule that effects Umlaut. As for specifics (see Wiese 1996a,b for discussion), it could be that this “rule” is written so as to front a vowel in the context of a trigger:

$$(29) \quad V \rightarrow [-bk] / _ \langle \text{Trigger} \rangle$$

Or, it could be that the process is actually bipartite:

(30) Implementing Umlaut in 2 steps

- a. Insert [-bk] to the left of the phonological exponent (if any) of the morpheme that triggers Umlaut;
- b. Associate [-bk] to the left.

For the purposes of what we will concentrate on here, either one of these treatments works (though, of course, we leave open the possibility that there might be ways of distinguishing them that are not known at present). What is crucial for our purposes is that there is a single Umlaut rule that is activated under a complex set of circumstances.

As illustrated above, the type of exceptionality that is seen with Umlaut needs to make reference to both Triggers and Targets. For this reason, it looks *prima facie* like an MM rule; that is:¹⁸

$$(31) \quad \text{Target} \wedge \text{Trigger} \rightarrow \check{R} (\text{ON})$$

More concretely, the grammar of German would, on an MM analysis, contain a series of statements specifying a trigger and a target, such that Umlaut would be turned (ON) under concatenation of certain pairs; for example, with reference to (28):¹⁹

$$(32) \quad \begin{aligned} \sqrt{\text{TAG}} \wedge [a, -ig] &\rightarrow \check{R} (\text{ON}) \\ \sqrt{\text{SAFT}} \wedge [+pl, -e] &\rightarrow \check{R} (\text{ON}) \\ \sqrt{\text{MACHT}} \wedge [a, -ig], [+pl, -e] &\rightarrow \check{R} (\text{ON}) \\ &\vdots \end{aligned}$$

Listing pairs of morphemes like this, and specifying certain pairs as turning Umlaut (ON), is inelegant; but as far as we can determine, *something* along these lines must play a role in any analysis of the phenomenon. The reason for this is that particular Roots do not undergo umlaut in every possible Umlaut environment; rather, the information required to set \check{R} correctly comes from trigger/target pairs.

A consequence of this kind of “sporadic” application to a given Root is that it is not possible to appeal to different underlying forms for surface-identical vowels, depending on whether they undergo umlaut or not. This point requires some unpacking.

In outline, and considering e.g. *täg-ig* versus *saft-ig*, this means that the vowel of $\sqrt{\text{TAG}}$ would be specified phonologically in such a way as to undergo Umlaut, but the vowel of $\sqrt{\text{SAFT}}$ would be specified so that this did not happen.²⁰

¹⁸Later in this section we will consider the possibility that Umlaut could be MP triggered (by at least certain morphemes), and exceptionally switched (OFF) (recall the discussion of Arpinate in §3.3).

¹⁹In this way of encoding things, we are being intentionally vague about whether the Umlaut trigger is the morpheme (defined in terms of synsem features) or its exponent. Some additional comments on this point are advanced below.

²⁰Some comparative considerations are useful here, since a kind of “underlying phonological difference” solution appears promising for certain types of alterations. For example, as we noted earlier in this paper, Spanish diphthongization is a typical morphophonological alternation, in the sense that it applies to some Roots (e.g. *pensar*, ‘to think’, with 1s *pienso*, but not others

If we looked only at one possible trigger— adjectives with *-ig*— this type of solution might appear promising.²¹ However, while this kind of analysis is able to account for the $\sqrt{\text{SAFT}}$ versus $\sqrt{\text{TAG}}$ difference with *-ig* adjectives, it does not account for the fact that $\sqrt{\text{SAFT}}$ **does**, in fact, undergo Umlaut in the plural (*Säfte*), while $\sqrt{\text{TAG}}$ does not (*Tage*). If underlying phonological specification determined Umlaut behavior of Roots, then a particular Root should either umlaut with all triggers, or never umlaut; but this is not what happens. In short, because the same Root may or may not undergo Umlaut depending on which Umlaut trigger it appears with, some statement of trigger/target pairs along the lines of (32) is needed.^{22,23}

As an interim summary, it appears that a basic treatment of Umlaut is possible in which the rule \tilde{R} is triggered under concatenation of triggers/targets pairs, making this look like an MM alternation.

4.2 MM versus MP

Building on the results of the preceding subsection, we now look at a further set of phenomena which, taken collectively, suggest that there is much to be said about this phenomenon’s properties, and that, in particular, there might be evidence for an MP treatment of Umlaut with certain morphemes.

As a first step, we note that there is one primary reason for taking Umlaut to be an MM rule: its trigger/target specificity. There are two further things to consider. The first is to ask, given the illustrations of intervention effects of different types in §3, whether there is converging evidence for this treatment of Umlaut when we examine its locality properties. With this in mind, we examine an argument that Umlaut shows “morpheme-skipping” in §4.2.1.

The second part of the discussion looks at one case where Umlaut shows MP properties, at least as far as trigger/target relations are concerned— diminutives (§4.2.4). After examining additional points of interest involving apparent overapplication of Umlaut in compounds (§4.2.3) and the challenges presented by *-er* Nominals (§4.2.4), we provide in §4.3 a summary of why further investigation of Umlaut in terms of MM/MP is needed.

4.2.1 Locality: *The Konjunktiv II (Past Subjunctive)*

Kiparsky (1996) argues that Umlaut can skip morphemes, based on his take on the “Konjunktiv II” (past subjunctive) verb forms in German. Briefly, the argument is based on verbs like *brauchen* ‘to need’, which has the forms shown in (33):

(33) brauchen ‘need’; 1s forms

e.g. *tensar*, 1s *tenso*). Building on the idea that diphthongization applies to stressed vowels, Harris (1985) proposes that the underlying phonological representations of Roots that undergo diphthongization are different from those that do not: the former have two timing slots, the latter one. This difference— neutralized on the surface when the vowels in question are not stressed— works in conjunction with a number of other rules to produce diphthongization under stress with the Roots that have two timing slots underlyingly, and no change with the Roots that have a single timing slot.

²¹For example, Wiese (1996b) puts a floating [+front] feature in the URs of Roots that undergo Umlaut; more recently, Scharinger (2009) proposes something along these lines as well.

²²Regarding the structure of trigger/target interactions, it is unknown to us whether there are meaningful patterns in terms of how Roots behave when considered in all possible Umlaut environments. That is, subsets of the data like (28) clearly show that for the two morphemes considered there, all four possible Root Umlaut behaviors are found. But this does not mean that all four types are equally common in the language. There could be a number of correlations relating trigger behaviors that would be revealed by a quantitative study of the vocabulary, leading to generalizations that would be relevant both to language acquisition and language change. See Wurzel 1970 for an attempt to create implicational relationships between Umlaut triggers, although we note that he allows exceptions to his implications.

²³An alternative to encoding Umlaut phonological in targets is to encode it in triggers, by specifying their exponents with a floating [-bk] feature, for example (this is done in Lieber’s work). See §5 for some discussion of this kind of approach.

present: brauche
preterite: brauchte
past subjunctive: bräuchte

On Kiparsky's analysis, the past subjunctive is *bräuch-t-e*, where *-t* is an exponent of Tense (also found in the preterite), and *-e* an agreement morpheme that triggers Umlaut. If *-e* (or the morpheme it realizes) were indeed the trigger of Umlaut, this would be clear evidence for the MP status of the rule, since the trigger and target (the Root) are separated by an intervening Tense morpheme.

A closer look at the past subjunctive shows that it is not actually agreement that triggers Umlaut. There is thus no evidence in these forms that Umlaut skips morphemes, as would be expected from an MP rule.

Some additional facts are important in developing this argument. The past subjunctive form shows four patterns. For weak verbs (34a), it is formed with *-t*, like the preterite. The majority of strong verbs (34b) show past subjunctives that are the Umlauted versions of the preterite. The preterite itself shows a set of vowel changes called *Ablaut*, so that past subjunctives are derived by applying Umlaut to the output of Ablaut (cf. Wiese 1996a). In addition, a subset of strong verbs (34c) show vowel forms that are not the Umlaut derivatives of the Ablauted preterite form. Finally, there is a "mixed" type (34d) to which *brauchen* belongs, with both the *-t* seen in the weak verbs, along with Umlaut (forms cited in first person singular):²⁴

(34) Past Subjunctive forms

	present	preterite	past subj,	gloss
a.	sage	sagte	sagte	'play'
	loben	lobte	lobte	'praise'
	suchen	suchte	suchte	'look for'
b.	komme	kam	käme	'come'
	sehe	sah	sähe	'see'
	fahre	fuhr	führe	'drive'
c.	stehe	stand	stünde	'stand'
	sterbe	starb	stürbe	'die'
	verderbe	verdarb	verdürbe	'spoil'
	werfe	warf	würfe	'throw'
d.	brauche	brauchte	bräuchte	'need'
	bringe	brachte	brächte	'bring'
	denke	dachte	dächte	'think'
	weiss	wusste	wüsste	'know'

There are some different types of generalizations at play in these patterns. For example, the verbs that show Ablaut—those in (34b,c)—also show a \emptyset exponent of Tense, not the *-t* seen elsewhere. Moreover, all of these verbs show Umlaut in the past subjunctive. However, while Umlaut occurs with some of the verbs showing *-t* for Tense like those in (34d), for the much larger class of weak verbs in (34a), Umlaut is not found. If Umlaut were able to skip morphemes, then in our terms it would be an MP rule; as such, it would not be sensitive to specific Roots over an intervening overt tense morpheme: either all *-t* past subjunctives should show Umlaut, or all should not, contrary to fact.

²⁴For some speakers of German, the Konjunktiv II is reported to be archaic, or, at least, not frequent in day-to-day usage (this is particularly true of the (c) type). For our purposes, this is immaterial, as the behavior of Umlaut seen in these verb forms were clearly active and not archaic in a recent form of the language.

This line of reasoning suggests that Agr is not the trigger for Umlaut in the past subjunctive. There are further observations that support this claim. For illustration, consider the inflection of *kommen* ‘to come’ in (35):

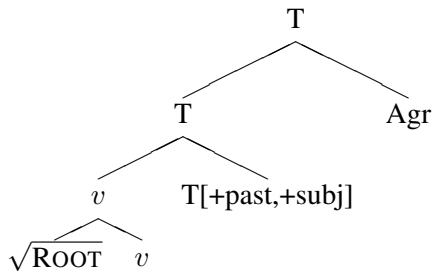
(35) Some forms of *kommen*

	present	preterite	present subj.	past subj.
1s	komme	kam	komme	käme
2s	kommst	kamst	kommest	kämeſt
3s	kommt	kam	komme	käme
1p	kommen	kamen	kommen	kämen
2p	kommt	kamt	kommet	kämet
3p	kommen	kamen	kommen	kämen

The agreement exponents in the present subjunctive are identical to the agreement that is found in the past subjunctive (and different from agreement in the indicative);²⁵ but there is no Umlaut in the present subjunctive. We take this to show that Agr is not the Umlaut trigger in the past subjunctive. Similarly, the preterite shows the stem alternant that is found in the past subjunctive, but does not show Umlaut. This shows that T[+past] is not the Umlaut trigger. The most transparent interpretation of these observations is that neither [+subj], nor T[+past], nor Agr in the subjunctive is individually an Umlaut trigger; rather, it is the features T[+past,+subj] together that trigger it.

Our analysis of the forms (34) is based on the structure in (36), where [+past] and [+subj] features occur on the same morpheme (which is labelled T(ense), but could be called T/M for “Tense/Mood”):

(36) structure for past subjunctive



There are three aspects of the analysis to be unpacked:

- First, the morpheme T[+past,+subj] shows allomorphy between *-t* and *-∅* in the past subjunctive (in fact, exactly as it does in the preterite).
- Second, T[+past] triggers Ablaut (and other changes) on certain verb Roots, in a way characteristic of MM rules. Ablaut will be viewed here abstractly; that is, as a set of rules that are triggered when a particular class of Roots is local to an Ablaut trigger. What we mean by the “abstract” treatment of this diacritic is that it actually stands proxy for a set of different phonological changes, whose properties and interrelations could be examined in their own right. Although the question of which patterns of Ablaut are triggered in the preterite and participle forms are of some interest, they do not play a role in our analysis here.

²⁵Wiese (1996a:127) suggests that the schwa (orthographic *e*) that appears in the final syllable of the subjunctive forms is inserted to satisfy a morphophonological requirement specific to that mood. The status of this vowel— in particular whether it might be an exponent of a morpheme— is worth looking into further, but is beyond the scope of the present discussion.

- Third, the morpheme T[+past,+subj] is an Umlaut trigger. In the linear representation derived from (36), the Root is concatenated with the Tense morpheme; this allows for Roots to affect whether or not Umlaut applies.²⁶ For the verbs of type (34b), the output of Ablaut is subjected to Umlaut (cf. Wiese 1996b). (The (34c) type verbs are more complicated than this; see below).

Starting with Tense allomorphy, we posit the Vocabulary Items in (37). These are underspecified, so that the same exponent is inserted in both the preterite T[+past], and the past subjunctive T[+past,+subj]. LIST1 here contains all the verbs that take a -Ø:

- (37) T[+past] ↔ -Ø/LIST1__
 T[+past] ↔ -t

For the second component of the analysis, there needs to be a set of MM rules that effect the vowel changes seen in (34b-d) (Ablaut, at least for (b-c), along with the additional changes seen in e.g. *bringen*, with preterite *brach-t-e*). As noted earlier, these MM rules could be implemented in different ways, but we will abstract away from details here. What is important for our purposes are two additional points, which comprise the third bullet above: first, the fact that Umlaut follows Ablaut for the (34b) class; and second, the behavior of the (34c) class, where the past subjunctive is **not** the umlauted preterite (but is nevertheless a front vowel).

In the simpler case, the (34b) class, the correct results are produced if Ablaut precedes Umlaut in a theory with rule ordering (cf. Wiese 1996a). In order to function properly, this analysis requires that the trigger of Ablaut, the [+past] feature, not be “used up” or “discharged” when Ablaut applies. This is because [+past] must also be referred to when Umlaut is triggered subsequently; that is (and including only these two rules):

- (38) Ablaut/Umlaut
- Ablaut: Triggered by T[+past]
 - Umlaut: Triggered by T[+past,+subjunctive]

Although not frequently discussed, having a single feature trigger more than one (MP or MM) rule must be part of theories that employ morphologically-triggered phonological changes. For instance, if we approach alternations like *think* ~ *thought* morphophonologically (as the result of MM rules), then there are at least two changes effected (assuming that the underlying form is like the one that surfaces in the non-past *think*): one to the vocalism, and one to the coda (details depend on further assumptions, since, of course, a number of different assumptions could be made about the phonological underlying representation of the Root).²⁷

The idea that features can trigger more than one morphophonological rule provides a way of handling the (34c) class, where the past subjunctive is not the umlauted preterite. Here, we hypothesize that there is an Ablaut rule for these Roots that is triggered by T[+past,+subj] together, in addition to the Ablaut rule triggered by T[+past] alone. This part of the analysis is schematized in (39), where LIST^C stands for the Roots of type (34c):

- (39) Ablaut rules for Type (34c)
- LIST^C ~ T[+past,+subj] ⇒ Ablaut /e/ → /u/ (ON)

²⁶Note that this approach assumes that the *v* morpheme is pruned from the representation, so that the $\sqrt{\text{ROOT}}$ is adjacent to the past tense morpheme; cf. §2.

²⁷For an application in English— and a version of what form a complete reduction of morphophonology to individual rules might look like— see Halle and Mohanan (1985).

b. $\text{LIST}^{C\sim}\text{T}[+\text{past}] \Rightarrow \text{Ablaut } /e/ \rightarrow /a/ \text{ (ON)}$

In a past subjunctive, the more specific (39a) applies; in a preterite, (39b).

Note that although the first rule (39a) is more specific than (39b), something further must be said about why both do not apply, given that we have found that the same features may activate more than one morphophonological rule. The most obvious thing to say is that (39a) bleeds (39b), by virtue of the phonological change that it effects.

Subsequently, the Umlaut rule, which is activated by $\text{T}[+\text{past}, +\text{subj}]$, applies to the output of Ablaut. This produces unlauded *stünde*, *stürbe*, and so on.

In summary, the past subjunctive forms do not provide an argument for “morpheme skipping” in Umlaut, although they do reveal a great deal about the ways in which Umlaut is triggered, and how it relates to other alternations. Concerning the general question of morphologically non-local Umlaut, there is one case that we have identified as being a possible instance; this involves diminutives, to which we turn now.

4.2.2 Exceptionless Triggering in Diminutives

In this and the following section we look at two phenomena that suggest that in some cases Umlaut has MP properties. The first is based on an observation made in numerous works: while Umlaut shows numerous Root-specific exceptions with many triggers, it always applies with Diminutives (cf. Wurzel 1970, Lieber 1980, Wiese 1996b).²⁸

(40) Regularity of Umlaut for *-chen* and *-lein* (Wiese 1996a)

Glöck-chen ‘bell-Dim.’	Fräu-lein ‘miss’ (woman-Dim.)
Hünd-chen ‘dog-Dim.’	Häus-lein ‘house-Dim.’
Melön-chen ‘melon-Dim.’	Lämp-lein ‘lamp-Dim.’
Büs-chen ‘bus-Dim.’	Männ-lein ‘man-Dim.’
Natiön-chen ‘nation-Dim.’	Gärt-lein ‘garden-Dim.’
Programm-chen ‘program-Dim.’	Löch-lein ‘hole-Dim.’

The exceptionless application of Umlaut with $[+\text{dim}]$ is striking when considered in the context of the complex patterns of morpheme-specific exceptions that characterize this process with other triggers. In particular it focuses attention on the question of whether Umlaut with diminutives is MM or MP.

Beginning with an MM approach, the exceptionlessness of $[+\text{dim}]$ triggering could certainly be stated. It would simply have to be the case that every morpheme that appears adjacent to the diminutive morpheme turns Umlaut (ON). Although it is possible to formulate an MM rule with this property, the move seems forced, since what we are observing is that Umlaut does not have morphologically-defined targets with $[+\text{dim}]$. (Moreover this approach might have difficulties with locality— see below).

On the face of it, it looks like diminutives provide evidence for an MP treatment of Umlaut, as stated in (41) (cf. Shwayder 2015):

(41) $[+\text{dim}] \Rightarrow \tilde{R} \text{ (ON)}$

²⁸There are examples with *-chen*, the typical diminutive suffix in Standard German, and no Umlaut: e.g. *Hundchen*, from *Hund* ‘dog’. However, these are not semantically diminutives; rather, they are a type of hypocoristic that is semantically distinguishable from a true diminutive. Thus, *Hundchen* means something like ‘dog’ and conveys endearment, whereas Umlauted *Hündchen* also exists in the language, and means ‘dog.diminutive’; see Ott (2011) for a recent discussion.

Along these lines, there appears to be at least some corroborating evidence that Umlaut has MP properties in diminutives from locality. The Root *fahr*, which surfaces as the verb *fahren* ‘drive’ that is seen at various points above, forms the Root nominal *Fahr-t* ‘trip’, with the exponent *-t* of *n*. From this noun, a diminutive can be formed, and, crucially, it shows Umlaut: *Fähr-t-chen* ‘little trip’. Assuming that *Fahr-t* is in fact bi-morphemic, as we have shown here, this is an example in which Umlaut skips a morpheme, as expected with MP.²⁹

While an improvement over an MM analysis for the reasons noted above, (41) raises a number of questions when we consider the possibility of an analysis involving exceptional switching (§3.3). Note that this sort of analysis could posit an MP application of Umlaut e.g. for [*a,-ig*] that Umlaut is (ON), but switched off when that morpheme is concatenated with certain Roots. While it would be possible to hold to the MM analysis and state that there are simply no Roots or morphemes that turn Umlaut (OFF) for [+dim], a more interesting analysis would be based on the idea that diminutive exceptionlessness arises for **systematic** reasons: ideally, having to do with the structure of diminutives. For example (and not committing ourselves to details of any particular analysis), Ott’s (2011) paper cited above argues at length that the structure in which diminutives are derived differs in crucial ways from more “garden variety” affixation structures that involve head adjunction. Of particular interest would be structures in which there is a head intervening linearly between a Root (or other Umlaut target) and the diminutive morpheme, as this head would prevent the target from being local to the trigger, precluding exceptional switching. While we cannot examine this issue in detail here, we believe that an important avenue for future investigation, since it highlights the question of how closely the morphophonology follows the morphosyntax.

In summary, the fact that there are no exceptions to Umlaut with diminutives suggests that— at least for [+dim]— the rule is triggered in an MP way. While there is more to be investigated concerning the possible structural basis for this exceptionlessness behavior, we have now at least one piece of evidence against treating Umlaut as MM across the board.

4.2.3 Overapplication in Compounds

Lowenstamm (2012, 2015a) presents an analysis of Umlaut in which the sporadic trigger/target properties of the rule are derivative of differences in phase-cyclic structure. While, in our view, the account does not generalize in the ways that Lowenstamm envisions (see below), it contains as a subpart a core set of insights about the behavior of compounds which, in the context of the current discussion, provide further evidence that Umlaut might (sometimes) be MP triggered. At the very least, it provides the motivation for a more detailed look at compounds (cf. also Wiese 1996a).

The basic proposal made by Lowenstamm is similar in many ways to one discussed in §3.2 above, where we noted that phase cyclic derivation could produce situations in which two morphemes could not see each other as morphemes due to cyclic spell out. In particular, Lowenstamm proposes that an Umlaut trigger may only affect a target when the two are in the same phase cyclic domain. Illustrating with the contrast between *männlich* ‘masculine’, from *Mann* ‘man’, and *amtlich* ‘official’, from *Amt* ‘office’, he argues that the Umlaut difference results from the former being a Root adjective [$\sqrt{\text{MANN}}$ *a*], while the latter is denominal [[$\sqrt{\text{AMT}}$ *n*] *a*]. In the Root adjective, the Umlaut trigger and target are in the same phase cyclic domain, and Umlaut applies; in the denominal adjective, the *a* head and the Root are separated cyclically, such that Umlaut does not apply.

²⁹We raise the point about whether or not decomposition is necessary here because of other examples that appear to show the same *-t*, but which might no longer be decomposed in the contemporary language. For example, *machen* ‘do, make’ is the source of the noun *Macht* ‘power’, but the latter might not have the *-t* realizing a morpheme (i.e. there might be a Root $\sqrt{\text{MACHT}}$ distinct from the source of *machen*).

This account might work for the examples with *-lich* just mentioned; it would be useful to have corroborating evidence (whether semantic or phonological) that *amtlich* is denominal and *männlich* is not, since the argument hinges crucially on this point. Beyond this, our view is that while there is clearly something to Lowenstamm’s insight about phases, there are some instances of sporadic application to which a phase-based approach will not extend. For example, Umlaut is triggered by 3rd person Agr in the present tense, to yield 3s *läuf-t* for *laufen* ‘to run’; however, other verbs, such as *kaufen* ‘to buy’, show no Umlaut in this context: 3s *kauf-t*. There does not appear to be any evidence in favor of there being a cyclic boundary between Agr and the Root in the latter case. The same reasoning applies with other Umlaut triggers; for example, the comparative of *kurz* ‘short’ is *kürz-er*, but *stolz* ‘proud’ shows *stolz-er*. It thus appears that while being in different phase domains might prevent Umlaut from applying, something remains to be said about why it can either apply or not when the trigger and target are within the same phase domain.³⁰

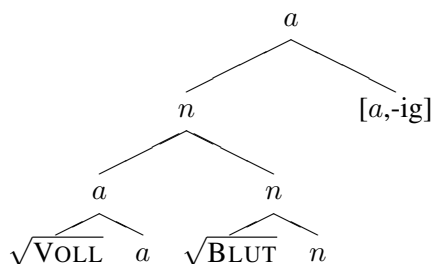
Lowenstamm’s discussion highlights another important behavior of Umlaut— apparent *overapplication* of the process in compounds, an effect noted in passing in Wiese (1996a). The observation is that a Root that is not umlauted on its own shows Umlaut in (at least certain) compounds, as shown in (42):

- (42) a. Blut ‘blood’; blut-ig ‘bloody’
 Voll-blut ‘pure blood’; Voll-blüt-ig ‘pure blooded’
 b. Mut ‘courage’; mut-ig ‘brave’
 Groß-mut ‘magnanimity’; groß-müt-ig ‘magnanimous’

Although based on only a preliminary investigation that is restricted to adjectives with *-ig*, it appears that this effect might prove to be important for distinguishing between MM and MP analyses of Umlaut.

What we have in mind is as follows. It is possible that the exponent *-ig* is inserted into adjective heads that are Root attached ($[\sqrt{\text{ROOT}} a]$, as in *blut-ig*, *mut-ig*, and probably the examples in (28)), and also into a denominal structure, with the meaning “possessed of the noun” (cp. Nevins and Myler 2014). The latter structure is shown in (43):

- (43) Structure for *vollblütig*

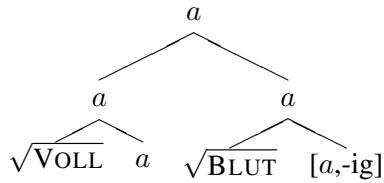


In (43), there is a cyclic boundary between the trigger of Umlaut $[a,-ig]$ and the Root that it targets. If Umlaut is MP triggered by $[a,-ig]$, it would follow that it should overapply in this environment, because $\sqrt{\text{BLUT}}$ would not be visible as a morpheme to exceptionally switch the rule (OFF). On the other hand, an approach with Umlaut switched (ON) as an MM rule would predict no Umlaut in this structure.

While promising, there are some complications to this story that remain to be investigated systematically. For one, it is quite possible that there are other ways of deriving an *-ig* affixed compound— for example, as a compound adjective, in which the *a* head realized as *-ig* is Root attached:

³⁰Lowenstamm suggests that both umlauted and un-umlauted variants are derived by the grammar under certain circumstances, with the choice of which is produced being the result of another system; see Fn. 31).

(44) Root-attached *-ig*



Here, we would expect Umlaut to behave exactly as it does with [$\sqrt{\text{BLUT}}$ *a*], since there is no cyclic boundary between trigger and target. As it turns out, speakers we have consulted have produced complex reactions, such that *vollblutig* is perhaps grammatical, but strongly dispreferred, perhaps because of a competition for use effect of a type that is not infrequent in derivational morphology (Embick and Marantz 2008, Embick 2016).

A further complication, noted by Lowenstamm, is that some of the compounds in question have idiomatic interpretations; for example, from *Rotze* ‘snot’ and *Nase* ‘nose’, there exists *rotznäsigt* ‘bratty’ (=‘snot nosed’), and also, apparently *rotznasigt* ‘with a snotty nose’. At least one speaker we have consulted accepts for *blau* ‘blue’ and *Auge* ‘eye’ the form *blauaugigt* ‘blue eyed in the typical human iris sense’, and interprets *blauäugigt* as idiomatic ‘naïve’, as well as ‘having blue eyes in an atypical sense’ (the latter being for, e.g. an eye painted completely blue on a statue).

Clearly, there are a number of factors at play here, including but not limited to dialect effects, variation in the sociolinguistic sense, idiomaticity, and competition for use. As a way of structuring a closer look at these phenomena, we note by way of concluding that the effects of interest for distinguishing MP from MM can be stated in the following predictions, derived from the discussion of §3.2:

Cyclic Prediction 1: If Umlaut is an MM rule that must be switched (ON) under concatenation of a trigger and a target, Umlaut will underapply in compounds when there is a cyclic boundary between the trigger and the target.

Cyclic Prediction 2: If Umlaut is an MP rule that is (ON) by default with its triggers, then the process should overapply in compounds when there is a cyclic boundary between the trigger and the target, because the cyclic boundary prevents the rule from being exceptionally switched (OFF).

Overall, compounds appear to provide some indication that Umlaut might be MP, not MM for [*a,-ig*]; at the very least, they suggest a domain in which further investigation could look closely at how morphophonology relates to cyclic structure.

4.2.4 A Question about *-er* Nominals

Nominal forms in *-er*— which we abbreviate as N-er— present a particular challenge to the analysis of Umlaut. Many of the nouns in question are referred to as *Agent(ive) Nouns*, a term we will not employ for reasons to be discussed below.

Some N-er forms are shown in (45):

(45) Trigger-Target pair specificity for Umlaut

infinitive	3s present	-er nominal	glosses
mal-en	mal-t	Mal-er	‘paint-paints-painter’
back-en	back-t	Bäck-er	‘bake-bakes-baker’
fahr-en	fähr-t	Fahr-er	‘drive-drives-driver’
trag-en	träġ-t	Träg-er	‘carry-carries-carrier’

The question raised by Umlaut patterns in N-er is one of cyclic visibility: briefly, if nominals like those in (45) are deverbal [[[$\sqrt{\text{ROOT}}$ v] ...] n] (the ... stands in for e.g. Voice and other morphemes that have been posited in agentive nominals), then they should, it would seem, all behave identically with respect to Umlaut. The reason for this is trigger/target visibility, as defined by the phase-cyclic part of the theory. The $\sqrt{\text{ROOT}}$ target and the *n* morpheme that triggers Umlaut are not active in the same phase cycle according to the definitions adopted above. Thus, it appears that either there should always be Umlaut (if \ddot{R} is MP (ON) for the *n* realized as *-er*), or it should always be off (if \ddot{R} is an MM rule).

As we noted at the beginning of this section, we are being careful to avoid referring to all of nouns in question as “agentive nominals”—there appear to be a number of different structures in which *-er* realizes a nominalizing head, and not all of these are necessarily deverbal (cf. Alexiadou and Schäfer 2008, 2010). Schematically, what is at issue is whether or not Umlaut or not in a particular derivative can be correlated with the presence or absence of a verbalizing *v* head between the *n* head realized as *-er* and the Root that is the target of Umlaut, since this would produce different phase-locality conditions between trigger and target:

(46) Phase locality:

- a. Root and *n* active together: [$\sqrt{\text{ROOT}}$... *n*]
- b. Root and *n* not active together: [[$\sqrt{\text{ROOT}}$ v] ... *n*]

An ideal scenario would be one in which these or other structural differences had direct consequences for morphophonology. Along these lines, for example, Ingason and Sigurðsson (2015) show that two types of agent nominals in Icelandic exhibit morphophonological differences that derive from the presence of a verbalizing head in one type, but not the other.

To the extent that the phonological differences (Umlaut or not) could be made to correlate with cyclic structure that is motivated by other considerations (syntactic or semantic), there would be converging evidence for the version of the theory that we have adopted here. In addition, such a correlation would help to distinguish between the MM and MP analyses we have developed above. If Umlaut never applied in (46b), there would be evidence for MM; if Umlaut “overapplied” in this context (as with compounds), there would be further evidence for MP Umlaut.

At present it is not clear whether a more detailed study of *-er* nominals will be able to reduce Umlaut differences to differences in cyclic structure. If no such correlations between structure and Umlaut be found, there are important implications for phase theory, or for the treatment of Umlaut’s target-sensitivity, or both. We leave a detailed examination of this question for future work.³¹

³¹As far as the Umlaut part of this question is concerned, it is worth noting that both Lieber (1980,1987) and Lowenstamm (2012,2015) explicitly propose that the grammar of German generates both unumlauted and unumlauted forms for potential undergoers, leaving the determination of which is employed to another system—presumably language use. The move is reminiscent of the “Potential Lexicon” posited in Halle (1973), revisited more recently in Embick (2016).

While it appears to be the case that alternations decided “at the level of use” might not be subject to the locality properties that are posited for grammatical derivations—see Tamminga et al. (2016) for extensive discussion—it is not clear to us at present whether there is evidence that this is what is happening with Umlaut. Along these lines, experimental evidence would be valuable; see e.g. Scharinger et al. (2010) for a study that speaks to the types of questions raised in this note.

4.3 Concluding Remarks

Our analysis of Umlaut starts with the idea that there is a single phonological rule \tilde{R} that is activated by a number of distinct morphemes. It is important, for reasons discussed below, that there be a unified phonological analysis of the alternation, and our treatment provides this directly (*contra* Wurzel 1970, Anderson 1992). With respect to how Umlaut is activated, things are more interesting. On the one hand, the complex patterns of trigger/target behaviors, in which the same Root may or may not undergo Umlaut depending on which trigger it is next to, suggest that Umlaut is an MM rule, with triggers and targets identified as particular morphemes. We provided a working analysis in §4.1 along these lines. On the other hand, data from diminutives and compounds and suggests Umlaut that is sometimes an MP rule, while our overview of *-er* Nominals suggests that there is more to be studied about Umlaut and phase structure.

One possible response to the observations about “overapplication” and exceptionless Umlaut in diminutives would be to say that the Umlaut rule triggered in different ways by different morphemes (i.e. some are MM and some are MP). However, a plausible analysis which unifies the properties of both Umlaut behaviors can be derived with the tools that we have developed in §§2-3. Recall in our discussion of metaphonic changes in Arpinate (§3.3) that while certain morphemes trigger metaphony for most of the Roots that are possible targets, there are a few exceptional Roots that do not undergo any change. We analyzed this effect with what we called “exceptional switching”: under concatenation, as an MM effect, a particular set of Roots turns an MP-triggered rule (OFF).

Umlaut could be treated in essentially the same way, an idea that is investigated in depth in Shwayder (2017) (cf. also Wurzel 1970). There are two components to this analysis:

- (47) Outline of a theory of Exceptional Switching for MP Umlaut
 - a. The morphemes that trigger MP Umlaut are set to \tilde{R} (ON)
 - b. Under concatenation, Roots may turn the (ON) setting of certain triggers to (OFF)

The difference between this exceptional switching analysis and the MM analysis presented above is subtle. In the MM analysis, we said that Umlaut is turned (ON) when e.g. $\sqrt{\text{SAFT}}$ is concatenated with [+pl], but not when it is next to [a,-ig] (unlike e.g. $\sqrt{\text{MACHT}}$). The analysis in (47) says that Umlaut is (ON) when the trigger morphemes are present in a derivation; but, it can be deactivated when the trigger is adjacent to a Root that exceptionally switches it (OFF).

In simple cases, both the MM and exceptional switching analyses can derive the correct results. In more complex cases, like those examined in §4.2, we pointed that even though “non-local” Umlaut is not robustly attested (§4.2.1), there are some cases of overapplication, suggesting that— for at least some triggers— Umlaut behaves like an MP process, one that is exceptionally switched (OFF) by certain Roots. Importantly, this conclusion is restricted to particular morphemes, like the head realized as *-ig* where Umlaut overapplies. For other morphemes, e.g. the 2s and 3s agreement morphemes that trigger Umlaut for certain verbs in the present tense, we have found no such overapplication; for these morphemes, an MP analysis is less obvious.

Taken together, these findings suggest, as noted earlier, that the single Umlaut rule is activated in both MM and MP ways. If this approach is on the right track, evidence from other domains could be sought, since the difference between MP Umlaut “(ON) by default” and MM Umlaut effectively “(OFF) by default” might be detectable in acquisition data or in experimental findings.³²

³²E.g., of the type that is invoked in discussions of *productivity*, although this is often more complex than much of the literature would suggest.

We hope that although this part of the investigation is more exploratory and less decisive than some other case studies that we have engaged in, it will provide structure to further investigation of both Umlaut and other morphophonological patterns.

5 Discussion

Our main goals in this paper fall into two parts. First, in §§2-3, we outlined an approach to morphophonological alternations, one that invokes phonological locality, morphological locality (=linear adjacency), and phases. The case studies brought together in §3 provide evidence for the MP versus MM distinction that is centered on phonological and morphological locality respectively; and, in addition, illustrate phase-cyclic and exceptional switching effects that add further directions for empirical investigation. The main goal of the second part of the paper, §4, is the extension of this approach to an examination of Umlaut in Standard German. Our main argument in that section is that Umlaut looks *prima facie* like an MM rule; but there are several avenues for further investigation suggesting, first, that at least some Umlaut triggers are MP; and second, that there are puzzles with how Umlaut interacts with phase theory that warrant careful study.

The discussion of this section compares some key properties of our approach with some alternative ways of treating morphophonology.

5.1 On the Identity of Exponents and Rules

A basic dichotomy in morphology exists between theories that employ discrete morphemes, like the one adopted here, and theories that eliminate pieces in favor of “word formation rules” or the like, as most definitively argued for in Anderson (1992).

The phenomena analyzed in this paper highlight the importance of grounding morphophonology in a piece-based theory. As discussed elsewhere, affixless theories have a basic difficulty in accounting for what Embick (2013) calls morphophonological *loci*. Abstractly, the observation that such alternations behave as if they originate in a position where a morpheme would be posited in a theory with morphemes. So, for example, where a morpheme-based theory might say that a Root is affixed with morphemes *-X*, *-Y*, *-Z*, in an affixless theory the Root is combined with features $[\pm X]$ etc., and rewritten by word-formation rules referring to these features; the output of these rules is given as phonological */XYZ/* in (48), to emphasize that they are not pieces):

- (48) a. Morpheme-based theory

$$\sqrt{\text{ROOT}}-X - Y - Z$$

- b. Affixless theory

$$\sqrt{\text{ROOT}} \left[\begin{array}{c} \pm X \\ \pm Y \\ \pm Z \end{array} \right] \text{---(Word Formation Rules)---} \text{/RootXYZ/}$$

A theory that employs representations like (48b) does not provide a straightforward way of analyzing the intervention effects that are discussed in §3.1. Those examples show MM changes that are prevented from occurring when a morpheme intervenes between the trigger and the target of the change. Crucially, because the intervention effects are defined morphologically, and not phonologically, they cannot be

stated directly in a theory that does not employ morphemes in the first place.^{33,34}

A second important point of comparison with affixless theories comes into contact with the analysis of Umlaut. One aspect of Umlaut that is emphasized in Embick and Halle (2005) is its “disjunctive” set of triggers. For an exponent— i.e. a phonological representation /XYZ/ inserted into a morpheme— the set of environments that have nothing in common syntacticosemantically would be treated as homophony, with multiple distinct Vocabulary Items that each happen to possess /XYZ/ as their exponent.

An important generalization is missed if Umlaut is treated in this way: *there is a single phonological rule at play, in all of the different environments in which it applies*. Having a different rule for each of the Umlaut triggers, where each of these rules effects exactly the same change, misses the generalization that at a phonological level of analysis, exactly the same change is effected.

As it turns out, proponents of affixless theories like Anderson (1992) have argued that there are multiple rules of Umlaut. In order to see why this is the case, it is necessary to examine a more general set of issues that connects with the specific points considered above.

Within a theory that is centered on morphemes, it is possible to appeal to a general set of principles concerning the differences between piece-based realization on the one-hand versus morphophonological readjustment on the other. In the specific form that is implicated by Umlaut, (49) does this:

(49) **Piece/Process Asymmetry**

- a. When identical exponents are inserted by Vocabulary Items that are specified for feature sets that do not overlap, there is *homophony*; but
- b. A single same phonological rule can be triggered by morphemes that do not overlap at all in feature content (and still be the same phonological rule).

It is important to emphasize that this is but one of the differences between pieces and processes that plays a role in the approach adopted here; another, which occupies much of the discussion of blocking, is that piece-based realization appears to block the insertion of other pieces, but pieces do not block processes, or vice versa (Halle and Marantz 1993, reviewed in Embick 2015).

Formulating something like (49) is not possible in theory without affixes. As a result, such theories have difficulties stating the “unity of process” of Umlaut phonologically. Anderson (1992), which builds on earlier work on Umlaut, is clear on this point. His theory denies the existence of morphophonology in the “narrow” sense: there are either purely phonological rules, or purely morphological rules. In an amorphous theory, **all** of the morphology is treated with morphologically conditioned phonological rules (=Word Formation Rules).³⁵

There is no reason, it would seem, to admit “morphophonologically conditioned phonological rules” as well; how could these be distinguished in effect from WFRs, whose sole function is to effect phonological changes when triggered morphologically?³⁶

³³One possibility would be to use stored stems, effectively suppletion. This approach is deployed for *sing/sang* type alternations in Anderson (1992), but makes incorrect predictions about the “double-marking” of forms that are discussed in Halle and Marantz (1993). For more on stem storage, see also §5.3.

³⁴The same sort of considerations apply with MP rules, where an amorphous theory does not have a natural way of stating the locus of the effect (although of course it could be stipulated). See Embick (2013) for discussion.

³⁵Things are more complicated for this if one assumes, like Anderson does, that derivational morphology involves pieces, whereas inflectional morphology does not, since Umlaut triggers appear to be of both types. We abstract away from this further complication here.

³⁶Anderson in fact suggests that there might be different locality conditions for phonological rules and WFRs— “...we might find that a rule which in its original, purely phonological form only applied to potential ‘foci’ immediately adjacent to its ‘determinant’ would later, when morphologized, come to apply to multiple ‘foci’, not all of which satisfied an adjacency condition” (1992:45). This point has not been developed in detail, however.

The WFRs in Anderson’s approach are required to make reference to a single set of features for application, much as stated in our discussion of formal identity above. But, because there can be no distinction made along the lines of (49), there must be as many “Umlaut rules” as there are triggers for Umlaut. Anderson approaches this point by talking about Umlaut as a phonological rule that, due to diachronic changes, has been restricted to morphologically-defined environments: “...if a change were morphologized so as to apply in a number of distinct morphological categories instead of in a unitary phonological environment, this would result in its formal fragmentation into a number of distinct rules, insofar as there is no single property that unifies the categories involved” (1992:345). After suggesting that rules like German Umlaut are specifically of the type that involve ‘rule fragmentation’, Anderson appeals to historical idiosyncrasies as evidence for the existence of multiple Umlaut rules; his conclusion is that idiosyncrasy “...is exactly what is predicted if ... morphologization involves replacement of a phonological environment by a morphological one (rather than mere adding morphological conditions to phonological ones).” (1992:344-4).

The problem with this line of reasoning is that to the extent that there are idiosyncrasies with Umlaut, they are not phonological in nature; rather, all of the idiosyncrasies have to do with whether or not a particular Root undergoes Umlaut in the presence of a particular trigger. Once it is determined whether or not Umlaut applies, there is no idiosyncrasy at all in what the rule does: it effects the same phonological changes across the board. A theory that is incapable of stating that this pattern is the result of a single phonological rule is missing an obvious generalization.³⁷

5.2 Phonology + Vocabulary Insertion Only

As noted in §4, one possible approach to Umlaut would be to build a purely phonological cause of fronting into the affixes that trigger it; Lieber (1992) (adapting Lieber 1987), for example, posits a floating [-bk] feature with Umlaut triggers.³⁸ Two things are required for this analysis to work. First, the grammar must contain the pairs of Vocabulary Items listed in (50), for all of the morphemes that trigger Umlaut. In the two Vocabulary Items, the first is the Umlauting allomorph, and the second does not cause Umlaut; the first is shown with a LIST, which represents the Umlaut undergoers for that particular morpheme:³⁹

- (50) Pairs of Vocabulary Items
- a. [-1, -2] ↔ ^[-bk]t/LIST__
[-1, -2] ↔ -t/LIST__
 - b. [+p] ↔ ^[-bk]er/LIST__
[+p] ↔ -er
 - c. [+p] ↔ ^[-bk]e/LIST__
[+p] ↔ -e
 - d. [a] ↔ ^[-bk]ig/LIST__
[a] ↔ -ig

³⁷It is conceivable that the particular approach advanced in Anderson’s (1992) might employ stem storage as well as multiple distinct Umlaut rules. As noted Fn. 33, for inflectional irregularities like that seen in e.g. the English past tense (*sing*, *sang* etc.), Anderson appeals to an analysis in terms of “stem sets” in which *sang* competes with *sing* (and *sung*, *song*) to express the features [SING +V +past]. If *sing* and *sang* are treated as different stored stems of the same lexical item, why not do the same for umlauted and un-umlauted stems? Anderson does not discuss this issue. The most obvious answer is that it is because Umlaut frequently cooccurs with (does not block) an affix, precisely the situation that Anderson’s theory of stem storage is designed to avoid. See Embick (2015) for general discussion.

³⁸Lieber (1992) uses underspecification of vowels, such that the only [-bk] is specified underlyingly. This removes the need to delink [+bk] features when Umlaut occurs.

³⁹Lieber does not address the fact that the same Root may Umlaut in some environments, but not in others. Our allomorphic solution in (50) is what we assume an analysis like a [-bk] in exponents would need to employ.

e. ∴

Along with these Vocabulary Items, the LISTs come into play in specifying which allomorphs are selected by particular Roots. Effectively, this analysis treats Umlaut as deriving from a form of contextual allomorphy, with some attendant action in the phonology to handle the autosegment. The allomorphic aspect of this analysis is important for two reasons. First, it means that this type of approach, like the one that we presented in §4, makes extensive use of lists; it is not better or worse as far as this goes. The second point concerns locality. If MM rules and contextual allomorphy both respect concatenation, locality alone will not distinguish the analysis in (50) from an analysis that makes use of an MM-rule for Umlaut.

The analysis in (50) generates the facts that have been considered to this point. Moreover, it employs only Vocabulary Insertion plus phonology, phonology that does not make reference to morphology. While the analysis is thus restrictive in terms of what it employs, it derives the facts with some violence to the intuition that grammars minimize the storage of morphemes: each of the pairs in (50) consists of two suppletive allomorphs, phonologically identical except for the presence of [-bk] in one of them. This seems like the kind of situation that should be avoided when possible, even in approaches that are liberal with respect to memorization (cf. §2).

One side of the theoretical tension that occupies the last paragraph is based on the intuition that Vocabulary Insertion and “normal” phonology should be used to analyze what we refer to as morphophonology. What is the motivation for this intuition? Aside from “standard” parsimony (e.g. Lieber 1987, or, more recently, Bye and Svenonius 2012), it appears to be based on the idea that phonology should not “see” morphology (in the way that is required for morphological triggering or targeting to be stated), or vice versa.

In our view, a number of developments in morphophonology (broadly construed) suggest that the reasons for adopting this idea are quite limited. For instance, the existence of phonologically conditioned suppletive allomorphy, studied extensively in Paster (2006) and Embick (2010a) because of what it reveals about morphology/phonology interactions, provides evidence that phonological representations are visible to the (morphological) operation of Vocabulary Insertion. In the other direction, Vocabulary Insertion—a basic part of any realizational theory, in some form—requires that a morpheme be visible to an operation that provides it with its phonological content. It is difficult to see how this fundamental association of form with feature content complies with the claim that phonology does not see morphological representations. It could be that establishing basic sound/meaning connections is not as “phonological” as, for example, effecting the changes that are associated with phonological rules or their equivalent. As far as this latter point goes, we note that one of the most productive research programs in morphophonology, Lexical Morphology and Phonology (Kiparsky 1982 and related work), continues to be of interest precisely because of how morphology and phonology see each other in the theory, and because of how the theory is at pains to explain how the exceptional behavior of certain morphemes must be understood in ways that connect with broader architectural questions.

In summary, our intuition, based on observations like those immediately above, is that there is no clear reason at present to completely disallow morphological information from being referred to in the phonology. Intuitions aside, it is difficult to come up with empirical predictions that clearly differentiate theories with morpheme reference from theories without it. Part of the reason for this stems from similarities between the approaches. For example, our MP rules apply under phonological conditions of locality; as such, they are amenable to treatments in which the phonological effect is built into a Vocabulary Item (or into the target of the change). Similarly, our MM rules are (by hypothesis) restricted to apply under the same conditions as contextual allomorphy. Thus, where our theory would say that a rule is switched (ON) when a target X is concatenated with a trigger Y, an alternative without morpheme-

reference could say that X selects for an allomorph of Y that contains an autosegment that effects the change.⁴⁰ Ultimately, it is possible that some of the fine-grained predictions deriving from phase cycles or from exceptional switching might be important here, but we do not have any case studies that speak to these issues at present.

In short, there are alternatives to the approach that we have developed here, alternatives in which only Vocabulary Items and phonological operations are used, with no phonological rules that have particular triggers and targets identified morphologically. Approaches of this type are able to analyze complex phenomena like Umlaut, albeit with accidents of the Vocabulary that look unacceptable from the perspective of many types of theories.

It is not entirely clear at present how to separate the empirical predictions of the two approaches, even though they look superficially quite different; we take the development of pertinent predictions to be an important task for future work on this part of the grammar.

5.3 Stem Storage...

Finally, we come to the Fundamental Question of Morphophonology: Stem Storage (SS) or not (what we have called MPD). In this and related work, we have explored an MPD view, based on a position that is called *Full Decomposition*: the idea that all complex forms are derived, whether they are morphophonologically regular or not. Theories incorporating this view include Chomsky and Halle (1968), and more recently Distributed Morphology (Halle and Marantz 1993; for the generative part, see Embick and Marantz 2008; for Full Decomposition, Embick 2015, and the connections to experimental work in Embick and Marantz 2005 and Stockall and Marantz 2006). Full Decomposition is certainly the minority view when the language sciences as a whole are considered, and it is very likely a minority view within theoretical linguistics as well.

It is important to note that Full Decomposition holds that complex forms (e.g. “past tense verbs”) are decomposed **morphosyntactically** into multiple morphemes (in the approach adopted here, something like $[[\sqrt{\text{ROOT}} v] T[+\text{past}]]$). It leaves open the possibility that the sound form that is heard— e.g. *sang* for the past tense of *sing*— is stored in memory. Thus, the kind of theory that we adopt could employ SS for certain alternations, and, in fact, many approaches both similar and different to the one we assume here use SS for (at least some) irregular alternations. When SS is employed, morphophonology is reduced to Vocabulary Insertion *without* phonology— i.e., to suppletion.⁴¹

With this in mind, and taking into account the importance of FQM, we examine some of the aspects of the phenomena considered above in terms of MPD versus SS. The first place to look is at Umlaut. Here, there are some parallels with our discussion in §5.1. Umlaut is “irregular” in terms of having (apparently) morphological triggers, and in terms of its target/trigger relations. Treating Umlaut with SS would require memorizing umlauted and non-umlauted variants of a large part of the Vocabulary: *Form1* and *Förm2* for most (or many) Roots of the language.⁴² Then, the correct stem form would have to be chosen in the context of “Umlaut triggers”, in a way that would be encoded in lists: e.g. for $\sqrt{\text{SAFT}}$ the umlauted stem would be selected in the context of [+pl] but not [a,-ig], and so on. For most of what needs to be said about Umlaut, this could probably be encoded with contextual allomorphy as it is currently understood.⁴³ While this analysis could produce the correct distribution of forms, it is open to the sorts

⁴⁰Or that a “changed” stem allomorph is selected in the context of the relevant morpheme; recall the comments on Anderson, and see the next subsection.

⁴¹There are, of course, hybrid views, with Vocabulary Insertion plus normal phonology for some alternations and SS for others; Bye and Svenonius 2012, for example.

⁴²It would not have to be all Roots, since some would not appear in environments in which Umlaut is triggered due to independent reasons, having to do with Root distribution.

⁴³The qualification to ‘probably’ is for the phenomena considered in §§4.2.2-4.2.4— MP Umlaut would (by hypothesis) have different locality conditions from contextual allomorphy.

of objections identified in §5.1: in particular, since the two stored stems for all of these Roots would be related directly in a way that reduces to alternations in $[\pm bk]$, this analysis is like the one in (50) in that it appears to miss a clear generalization (perhaps to a greater extent, since there would be more memorized pairs of stem forms in an SS theory than there would be pairs of Vocabulary Items in the analysis summarized in (50)).

Moving beyond Umlaut, the general question at issue is what kinds of empirical evidence could be adduced to decide between MPD and SS. As discussed elsewhere (cf. Embick 2010b, 2012), one question to ask is whether morphophonological alternations show the same trigger/target locality conditions as contextual allomorphy. To the extent that they do not, that is a clear reason for not treating them as suppletion; to the extent that they do, locality-based arguments alone cannot be decisive, and evidence must be sought elsewhere.

It appears that there are some morphophonological phenomena that look like they do not share locality properties with suppletive contextual allomorphy, and others that do. This observation is, in a sense, a (re)statement of part of the MP/MM distinction that is motivated in §§2-3, since MM is predicted (by the MIC) to share locality properties with contextual allomorphy, whereas MP alternations are expected to behave differently. By way of example, consider Ischia metaphony, from §2. The Root \sqrt{KAND} is “irregularly” affected by 2s agreement, to produce *kend-ə*. This fact alone could be treated as suppletion, if the language had competing stem allomorphs *kand* and *kend* for \sqrt{KAND} , as encoded in (51):

$$(51) \quad \begin{array}{l} \sqrt{KAND} \leftrightarrow k\acute{e}nd \\ \sqrt{KAND} \leftrightarrow kand \end{array}$$

However, the effects of 2s Agr skip a morpheme, as seen in past tense forms like *kand-ε-v-ə*, where metaphony from the schwa skips the past tense morpheme with exponent *-v*. If, as hypothesized, contextual allomorphy requires concatenation, then this shows that the effects of 2s Agr cannot be treated as suppletive allomorphy, since a morpheme intervenes between the theme vowel and the agreement morpheme.⁴⁴

On the other hand, some alternations do not show any intervening morphemes between the trigger and the target. In the English past tense, for example, the alternation between *sing* and *sang* could be treated as the result of an MM rule (or rules) applying under concatenation of the Root and T[+past]; or it could be treated along the lines of (51), with *sang* inserted for \sqrt{SING} in the context of T[+past], and *sing* in the present tense. The Root and Tense are adjacent, making it impossible to draw strong conclusions based on locality conditions alone.

The upshot of this line of reasoning is that it might not be possible to determine on the basis of locality or “stem distribution” patterns alone whether MPD or SS is correct. Naturally, the argument depends on a particular set of assumptions about the locality conditions for contextual allomorphy, which may or may not turn out to be correct. We have argued elsewhere (see in particular Embick 2010b) that this area of research is one in which theoretical and experimental (psycho- and neuro-linguistic) approaches must be brought into closer contact, as it is possible that converging evidence from these domains will be required to determine how grammars encode stem alternations that could in principle be analyzed with either MP or SS. In this larger project, grammatical theories of the type that we have developed here are in part generating hypotheses that can guide a wide range of experimental projects, along the lines discussed in works such as Marantz (2005), Poeppel and Embick (2005), and Embick and Poeppel (2015).

⁴⁴For additional arguments along these lines where it is the actual “stem” (and not a theme vowel) that is affected, see Embick (2010b, 2012).

6 Conclusion

The analysis of morphophonological alternations is controversial because there are in principle different ways of analyzing them: phonological rules, phonological rules that make reference to morphemes (or features, or diacritics), and suppletive contextual allomorphy. In practice, and despite there sometimes being rather different guiding intuitions behind approaches that advocate different analyses, it has proven difficult to distinguish analytical options empirically.

The theory outlined in §2 and illustrated further in §3 involves three different types of locality, defined phonologically, morphologically, and in terms of phase-cycles. Part of the claim that we are defending here is that something like these components is required for analyzing morphophonology in the broad sense, as revealed by the complex set of conditions under which morphophonological alternations apply and, crucially, fail to apply even though they “might have”. These tools were then deployed in an analysis of German Umlaut in §4, one that we hope raises a number of questions for further research, in addition to illustrating some of the key components of the theory outlined in the earlier sections.

One of the themes that should emerge clearly from the discussion of §5 is that the research programs that are actively investigating morphophonology are starting from very different priors, and are often linked closely to very different and often diametrically opposed conceptual viewpoints. While we believe it is important to highlight connections with guiding intuitions, much of the focus above has been on ways of trying to find differences in empirical predictions between theories.

By way of offering a general conclusion, there is one aspect of the type of approach presented here that we believe requires further comment. Our theory employs locality conditions of different types. On the one hand, it appeals to phase cyclic domains, which are defined by the way in which syntactic computations operate. On the other hand, it also employs interface-parochial conditions of morphological and phonological locality, which derive from the requirement that PF linearize the hierarchical representations that are produced by syntactic derivations. In its most abstract form, this kind of theory says that the surface complexity of morphophonology is not the result of a single system whose locality properties explain everything; rather, it is the result of “deep” syntactic principles **interacting** with interface-specific types of locality. It might be objected (on conceptual level) that this type of theory is “too rich” ontologically to be correct. Our view is that it is a substantial empirical finding that complex morphophonological phenomena are the product of a sequence of systems interacting, and that while specific formulations of the relevant kinds of locality might change, the core insight that an interaction is responsible for attested patterns must be retained.

In another type of context, this finding could be related to discoveries about the properties of other cognitive systems; but that will have to wait for another occasion.

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