Stem alternations and stem distributions*

David Embick
University of Pennsylvania

Version of June, 2010

ABSTRACT: The analysis of stem alternations (e.g. *sang* as past of *sing*) is controversial; there is a lasting tension between morphophonological theories (*sang* is derived from *sing* by rule) and stem storage theories (*sang* and *sing* are stored allomorphs). This paper argues that in many cases of stem alternation (e.g., Spanish diphthongization) the locality conditions on contextual allomorphy provide crucial evidence for deciding between these views, and crucial evidence for a morphophonological theory in particular. However, the argument is only that *some* alternations must be treated morphophonologically; it is based only on one subtype of alternation. Another ("morpheme-morpheme") type of alternation, one that applies only to certain morphemes, and which is triggered only by a particular morpheme (or morphemes), appears to take place under the same locality conditions that are obeyed by contextual allomorphy. In morpheme-morpheme alternations, distributional arguments based on locality conditions might not be able to decide between storage and morphophonology. At the same time, it can be shown that the two theories make different predictions about how such alternations are represented in the minds of speakers. This leads to a potentially unified theory, in which the boundaries between theoretical and experimental approaches are effectively eliminated.

1 Introduction The analysis of alternations is a central topic in linguistic theory because treating alternations requires an explicit theory of two main components of language: the basic representations that are in the memory of speakers, and the computations that apply to these representations to produce surface forms. While the margins of this area of research reveal some consensus about the division of labor between storage in memory versus computation by rule, a large class of phenomena found in a grey area between phonology and morphology continues to provoke controversy between theories that instantiate two distinct research intuitions. These opposing research programs differ in terms of the emphasis that they place on storage of alternants on the one hand versus the derivation of alternants by rule on the other. The programs come into conflict over alternations in form– say, between forms $\mathscr{F}_1$ and $\mathscr{F}_2$– because in many cases it appears that either theory is able to derive the correct results. In particular, the alternation could be analyzed in a way that involves storage, so that $\mathscr{F}_1$ and $\mathscr{F}_2$ exist as separate objects in the memory of speakers; or the alternants could be analyzed as coming from a single underlying form, so that $\mathscr{F}_2$ is derived from $\mathscr{F}_1$, or vice versa. In the first type of approach, the alternation is treated in terms of static representations,

* <Thanks to...>

as a relationship between whole memorized objects; in an approach of the latter type, it is treated derivationally, with alternant(s) derived via the (morpho)phonology from a basic (i.e. memorized) form.

In practice, the richest empirical domain for this controversy is found with what are often called *stem alternations*. Informally, this term covers the non-affixal changes in the phonological form of a morpheme that are found in particular morphosyntactic contexts. For example, the past tense of *give* is *gave*, and the normal phonology of English is not responsible for changing *give* into *gave*. For alternations like this, the question is whether *give* and *gave* exist in memory as distinct stem allomorphs, or whether *gave* is derived from *give* via a phonological rule that makes reference to lexical and morphological information. Exactly the same question arises for a wide range of phenomena; another example is provided by alternating diphthongs in Spanish. The verb *pensar* 'think' shows an alternation in the stem, depending on whether the stem vowel is stressed or not. Thus, the 1s present indicative form of this verb is *piénso*, with a diphthong, whereas the 1pl is *pensámos*. While many verbs with an /e/ stem vowel alternate with a diphthong in this way, not all verbs with /e/ do. So, for example, the verb *tensar* 'to make taut' shows 1s *ténso* (not **tienso*) and 1pl *tensámos*. The diphthongal alternation is thus evidently specific to some Roots and not others; in principle, it could be treated with memorized stem alternants, or with a rule that derives the surface alternants from a single underlying form.

A storage-based view of stem alternations is found in much recent work on this topic. This kind of analysis is typically motivated by the assumption that alternations that are irregular, or that involve morphological or lexical conditioning, must involve stored alternants. The assumption that irregularity requires storage is central to some theoretical models, and is particularly prominent in experimental (psycho- and neurolinguistic) work directed at the division of labor between "storage" and "computation" in natural language. One of the central themes of this paper is that arguments based on notions of (ir)regularity and type of conditioning factor provide only one source of information about how alternations are represented in the minds of speakers. Crucially, theories that focus on an alternation's classification as regular or irregular almost invariably ignore the conditions that determine when one stem alternant or another is employed: that is, the conditions under which morphosyntactic (or phonological) features determine whether one form occurs as opposed to another. In terms of the *give*/*gave* example, it is not enough to say that *gave* is stored in memory, or that it is derived by rule from *give*; there must also be a theory of the conditions under which the different alternants surface.

The statement of such distributional patterns might appear trivial; for example, with *give*∼*gave*, it looks like it might be simple to say that *gave* surfaces as the "past tense of GIVE". This apparent simplicity is deceptive, though, as is clear from the existence of a sizeable literature devoted to the analysis of *blocking effects* in grammar (see Embick and Marantz 2008). This paper argues that the theory of stem allomorph distributions– a theory that connects with a more general theory of the locality conditions on allomorphy– provides a decisive answer to part of the controversy between storage-based and rule-based theories. Storage-based theories effectively treat alternations between forms $\mathscr{F}_1$ and $\mathscr{F}_2$ as a relationship between two suppletive (stem) allomorphs, whereas rule-based analyses treat this relationship morphophonologically. When the conditions governing the distribution of stem alternations are examined, it can be shown that there exist stem alternations that (i) are irregular according to an analysis based on (lexical or morphological) conditioning factors, but which (ii) do not obey the locality conditions on contextual allomorphy. It follows from this that

morphophonological rules– i.e., phonological rules that refer to specific morphemes– must be part of the grammar, and must be responsible for certain types of stem alternation.

The argument for a morphophonological theory is one step in the development of a comprehensive theory of stem alternations; it turns out to be partial, in an interesting way. Locality-based arguments show that there are at least *some* stem alternations that must be treated morphophonologically; they do not show that *all* stem alternations must be so treated. Stem alternations can in fact be classified into different categories. Putting to the side for the moment the full classification, the case studies that are used to argue for morphophonological rules are based on one particular type of stem alternation: those that are (i) restricted to certain morphemes, but (ii) triggered by phonological properties of outer morphemes. Another class of stem alternations does not require reference to the phonology in this way; rather, such alternations are triggered by particular morphemes. The *give*∼*gave* alternation, for example, applies only to a restricted set of morphemes (particular verbs), and is triggered by a specific morpheme (past tense), not phonological material. It is conjectured in section 5 that such *morpheme-morpheme* stem alternations are restricted to occur under linear adjacency, a locality restriction that also applies to suppletive allomorphy of functional heads. This conjecture is important for two reasons. First, it suggests that all "stem changes" in the broad sense might not be identical. Rather, there are different types of alternations that are defined in terms of whether they make reference to morphological information, or to phonological information (or a combination). The second point is about the representations in the PF component of the grammar. If morpheme-morpheme interactions are constrained to apply under linear adjacency, this would be a (perhaps surprising) restriction on possible alternations in form, one that places significant constraints on possible stem alternations.

A final part of the discussion looks seriously at the limits of arguments based on distributions. In the morpheme-morpheme stem-alternations, distributional information might not be able to force a decision between stem storage versus morphophonological analyses. However, because the stem storage and morphophonological theories make different predictions about psycho- and neurolinguistic implementation, investigation linking these methodologies with the program advanced here could prove decisive. The upshot of this is that a truly comprehensive theory of alternations in grammar requires unification of inquiry in the theoretical and experimental domains.

1.1 Phenomena The alternations that are the topic of this paper are best seen in comparison with two other phenomena. The first, illustrated in (1a), shows two realizations of the second person singular agreement morpheme in Latin: *-istī* in the Perfect indicative tense of the verb, and *-s* in other tenses. The second phenomenon, seen in (1b), involves the English plural morpheme; this morpheme surfaces as /s/, /z/, or /əz/, depending on the phonology of the noun to its left:

(1) a. Latin 2s AGR

laudāv-**istī** 'You (have) praised' (perfect)
laudā-**s** 'You praise' (present)

b. English pl

cat, cat-**s** (/s/)
dog, dog-**s** (/z/)
church, church-**es** (/əz)

In each of (1a,b), there is an alternation in the general sense: an object that is "the same" at some level of description (Latin AGR[2 sg]; English [pl]) is expressed by distinct phonological realizations (Latin *-istī* and *-s*; English /-s/, /-z/, and /-əz/). Despite this superficial similarity, the patterns in (1a) and (1b) are analyzed differently in most theories of grammar. The class of phenomena represented by Latin 2s involves two phonological realizations that are by hypothesis not relatable by the phonology; rather, the realizations are (suppletive) allomorphs of AGR[2 sg]. There are some borderline cases in which it is not obvious if an alternation is suppletive.[1] Nevertheless, it is generally agreed that suppletive allomorphy exists, and that accounting for its properties is one of the primary tasks for the theory of morphology.

Unlike Latin AGR[2 sg], the English (regular) plural realizations can be related to one another by the phonology. According to the standard analysis of these facts, the surface realizations /s/, /z/ and /əz/ are derived phonologically from a single morpheme with the underlying form /-z/. Thus, in the Latin example, the morphology deals with two distinct objects, *-istī* and *-s*. For the English plural, there is one morphological object, and the distinct surface realizations of this morpheme are the result of the phonology. In the terminology that is employed below, the Latin agreement example involves distinct Vocabulary Items in memory, whereas the English plural example involves a single Vocabulary Item.

Suppletive allomorphy and (normal) phonological processes provide two clear endpoints for the study of alternations. The difficult cases are those that do not fit neatly into either of these two extremes. The *give*∼*gave* example is of this type. There is no normal phonological process of the language that is responsible for the change in the stem vowel; verbs that are phonologically similar to *give* like *live* do not undergo this alternation in the past tense. These considerations make a treatment in terms of the normal phonology a non-starter. At the same time, though, there are reasons for being cautious about treating such alternations as suppletive allomorphy. After all, *give* and *gave* share most of their segmental material, and an allomorphic treatment makes phonological resemblance an accident.

1.2 Criteria for Classifying Alternations Essentially every modern theory of linguistic structure says something about how to divide labor between alternations of the morphological type and those of the more phonological type. Many of these theories extend as well to stem alternations, which have been studied intensively since the early 20th century.[2] As noted above, a widely-held view is that the status of an alternation is determined by the factors that condition it. The standard version of this view is that if a process is morphologically- or lexically-conditioned, then it is morphological, not part of the phonology. There are some different versions of this position. Aronoff (1976), for example, posits a special class of "allomorphy rules": a type of rule that "...effects a phonological change, but which only applies to certain morphemes in the immediate environment of certain other morphemes" (1976:98). The emphasis in this claim is not on the type of change effected, or on the locality conditions that regulate the relationship between the designated morphemes. Rather, it

[1] That is, there are cases in which simply looking at two forms $\mathscr{F}_1$ and $\mathscr{F}_2$ will not make it clear whether they are suppletive or not. In such cases, it is only in the context of a fleshed out theory (for example, of allomorphic locality, of what the phonological component is capable of doing, etc.) that a conclusion could be reached.

[2] Trubetzkoy (1929) is a standard starting point. A survey of subsequent work is far beyond the scope of this paper. Some overviews of the relevant positions can be found in the literature. Kilbury (1976) provides an overview of the discussion from a "morphophonemic" point of view up to early generative theories of the 1960s. Dressler (1985) also surveys a number of earlier claims in outlining his own view. See also Mohanan (1995) and Singh (1996) for perspectives from Lexical Phonology, as well as the Kiparsky 1996 paper discussed at various points in the paper.

is on the fact that there is "morphological" conditioning in the first place. For ease of reference below, I will use the cover term *M-Conditioning* below to refer to alternations in which there is morphological or lexical conditioning.

In Aronoff's theory, allomorphy rules are still rules; as such, stem allomorphy does not necessarily involve storing the alternants. The primary claim that Aronoff makes is that allomorphy rules are ordered prior to the rules of the normal phonology. In another line of work that emerges in the same period, influenced by comments about storage in Halle (1973), two significant departures from Aronoff's view are found. The first is that the definition of allomorphy as M-conditioned is retained, but the rule-based treatment is dispensed with in favor of storage of alternants. This view characterizes many Lexicalist theories of morphology; see Carstairs-McCarthy (1992) for a lucid discussion. The second change, often associated with experimental approaches to grammar, is that M-conditioning is sometimes combined or conflated with *productivity* as the key factor in classifying an alternation. The clearest statement of this position is the claim that any alternation that is irregular or unproductive involves memorization of alternants. This position is found in the "dual system" view of inflectional morphology; see Pinker and Prince 1988 and Pinker and Ullman 2002, which make reference to various lexicalist theories of the period mentioned immediately above.

Although M-conditioning and productivity-based notions of irregularity are distinct, they are typically taken together in works arguing for storage of alternants.[3] While there is much to be said about how the notion of irregularity does or does not correspond to different definitions of productivity, my intention here is to put these details to the side, and concentrate on the core claim that M-conditioning requires storage. For the purposes of this paper, any theory that appeals to storage of stem alternants is referred to as a *stem storage* theory.

At the other extreme from the stem storage program is the view that stem alternations are part of the phonology, even if they are not part of the "general" or "regular" phonology. This requires a theory in which (certain) phonological rules can make reference to morphological information: that is, rules that are triggered only by certain morphemes, or which apply only to certain morphemes. I refer to theories with such rules as *morphophonological* theories. The morphophonological view is advanced in early generative works like Chomsky (1957), Halle (1959), and Chomsky and Halle (1968) (even if these works differ in terminology and some other details); it is also part of more recent frameworks like Distributed Morphology, where it is assumed that stem changes are the result of "Readjustment Rules" (see Halle and Marantz 1993, Embick and Halle 2005).

Before looking at the details of stem storage theories, some comments are in order concerning the claim that all irregular alternations require storage. A large amount of research is devoted to finding any differences or dissociations between regular and irregular morphology. Works in this vein typically take any such differences to support the computation versus storage dichotomy. It bears repeating, though, that experimental results used to argue for this dichotomy can be interpreted in a morphophonological framework as well. Differences between regular and irregular morphological patterns do not necessarily require an analysis with memorization of irregular alternants. Rather, differences between irregulars and regulars in some task is evidence that irregulars and regulars differ in at least one way; it is not necessarily evidence in favor of either a morphophonological or stem storage theory (see e.g. Embick and Marantz (2005) and Yang (2002) for some discussion

[3] An exception is Kiparsky (1996), who argues that M-Conditioning does not require storage unless it is unproductive. This theory posits morphophonological rules for "fully productive" M-Conditioned alternations (Kiparsky illustrates with German Umlaut and English trisyllabic shortening).

along these lines).

Connections with the experimental domain are examined further in section 5 below. In the first sections of this paper, the primary claim is that the locality conditions on stem alternation provide crucial evidence that some form of the morphophonological theory is correct, even if the exact boundaries between morphophonology and contextual allomorphy remain obscure in other domains.

2 Allomorphy and Stem Alternation The basic question to begin with is whether stem alternations should be treated with stored alternants, or with morphophonological rules. According to the former approach, stem changes are allomorphic, in a technical sense: they are instances of *contextual allomorphy*. Thus, the behavior of stems must be considered in the light of a general theory of allomorphy in language.

Contextual allomorphy is found when a single terminal node is realized by distinct exponents, as in the case of Latin second person singular agreement in (1a). Or, in English plurals, to take another example, the default plural exponent *-z* is blocked by *-en* in the context of certain nouns, like *ox*. This kind of allomorphy is accounted for by positing two distinct Vocabulary Items:

(2) [pl] ↔ -en/*ox* __
[pl] ↔ /-z/

The first VI spells out [pl] as *-en* when the plural node is in the context of the noun *ox* (and perhaps a few other nouns). This VI is more specific than the default VI for [pl], which realizes the [pl] node with the phonological exponent */-z/*. Vocabulary Items compete for insertion, such that the most specified one that can apply in a particular context wins. This competition for insertion yields *blocking*, in the familiar way (see Embick and Marantz 2008).

The two VIs in (2) produce suppletive allomorphy for the [pl] node. As emphasized earlier, this effect is different from what is found with the /s/, /z/, and /əz/ realizations of the plural that are found in *cat-s*, *dog-s*, and *church-es* respectively. In this alternation, there is a single VI at play, i.e., the one with the /-z/ exponent in (2). The surface alternants are derived from this underlying form phonologically.

2.1 Conditions on Contextual Allomorphy Contextual allomorphy can occur only under certain locality conditions (see Carstairs (1987) and subsequent work). According to the theory developed in Embick (2010), allomorphic interactions are constrained by the manner in which Vocabulary Insertion operates, and by the interaction of *linear* and *cyclic* locality conditions. Three different conditions are at the center of this theory.

The first of these conditions enforces "inside out" cyclicity:

(A1) Insertion proceeds from the inside-out.

Variants on (A1) exist, which differ in terms of e.g. whether or not the insertion process deletes or erases features that are mentioned in the Vocabulary item that is employed (see Noyer (1992) and Bobaljik (2000) for different takes on this). But something like (A1) is assumed in almost all work in this area.

The ordering on insertion imposed by (A1) has consequences for the types of information that may be referred to in Vocabulary Insertion. In particular, it follows from (A1) that (i) insertion at an "inner" node may make reference to an outer node's morphosyntactic features, but not its

phonology, whereas (ii) insertion at an outer node could in principle refer to either type of feature on an inner node.

A second condition on allomorphy advanced in Embick (2010) (see also references cited there) specifies a linear condition on contextual allomorphy:

(A2) Contextual allomorphy requires concatenation (linear adjacency).

One piece of information that is represented at PF is the concatenation of terminal nodes. This relation is represented with $\frown$, such that X$\frown$Y is read as "the terminal X is immediately left-adjacent to the terminal Y"; (A2) holds that X may show contextual allomorphy determined by Y only when X$\frown$Y. As a linear relation, concatenation (and therefore contextual allomorphy) can ignore intervening syntactic brackets.

A further aspect of the linear condition (A2) is that certain nodes that are motivated in the syntactico-semantic analysis are ignored for the purposes of allomorphy. These are all nodes that have no overt phonological exponent. As a working hypothesis, it will be assumed that the relevant phonologically null nodes are deleted; some additional discussion concerning the general theory of "invisibility" of nodes is found in section 5.

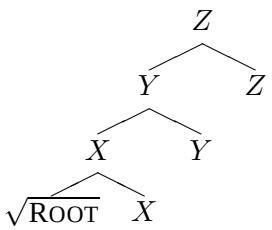
Beyond (A1) and (A2), it appears that cyclic domains (phases) also impose constraints on when nodes may interact for allomorphic purposes:

(A3) Two nodes can see each other for allomorphic purposes only when they are both active in the same cycle.

In some cases that respect (A1) and (A2), two nodes cannot interact for contextual allomorphy because they are separated by a cyclic boundary (Chomsky 2000,2001). For some views on how such boundaries relate to "word formation" in the typical sense, see Embick and Marantz 2008, Marantz 2007 and the implementation in Embick 2010. While phase-cyclic locality is essential to allomorphic interactions, especially those that involve "category-changing" morphology, the main arguments of this paper are framed with respect to (A1-2). I include (A3) in this initial overview because ultimately the study of stem alternations must take into account cyclic domains as well; see 3.1.2 for some further comments.

(A1,2) work together to constrain possible allomorphic interactions in a way that is illustrated in (3), which shows a complex head (3a) and its linearization (3b):

(3) a. Complex head



b. Linearization: $\sqrt{\text{ROOT}}$-X-Y-Z (=$\sqrt{\text{ROOT}}\frown X$, $X\frown Y$, $Y\frown Z$)

By (A1), Vocabulary Insertion occurs first at X, then at Y, then at Z. Thus, VI at X could be sensitive to either morphological or phonological features of the Root, but only to morphological

features of Y; similarly, VI at Y could in principle see either phonological or morphosyntactic features of X but only morphosyntactic features of Z; and so on. In short, a node may show *inward* sensitivity to either morphosyntactic or phonological features, but it may show *outward* sensitivity only to morphosyntactic features, because outer nodes do not (by (A1)) have phonological content.

A further point seen in (3) is that insertion at X could only be affected by $\sqrt{\text{ROOT}}$ or Y. The reason for this is that only the Root and Y are concatenated with X, and, by (A2), contextual allomorphy requires concatenation.

Implementing stem storage in a theory with Vocabulary Insertion amounts to treating stem alternation as contextual allomorphy. In most of the cases that are examined below, this means allomorphy for Roots. Thus, for this aspect of the discussion, I put aside various objections to the idea that Roots are subject to Late Insertion; see section 5.

As instances of contextual allomorphy, stem alternations should be subject to (A1-2); a clear consequence of this is as follows:

(4) CONSEQUENCE 1: If an alternation is conditioned by (a) an "outer" node's phonological properties, (b) the phonological properties of the whole word, or (c) a non-adjacent element– i.e., if it behaves in a way that is not compatible with (A1,2)– then it is not contextual allomorphy (not suppletive).

That is, any alternation that is triggered by outer phonology cannot be suppletive allomorphy. Thus, if a particular stem alternation is triggered this way, it cannot be treated by stem storage.

Relatedly, another consequence of (A1-2) for stems is stated in (5), with reference to suppletion:

(5) CONSEQUENCE 2: If an alternation is suppletive, then it is contextual allomorphy, and obeys (A1-3).

For stem alternations, this is a strong claim: all truly suppletive alternations involving stems must be subject to (A1-3). Thus, there should be no cases of "outward-looking" suppletion that make reference to phonological features (or aspects of the whole word's phonological form).

Consequences 1 and 2 are examined in sections 3 and 4 respectively. In section 3, the emphasis is on stem alternations that cannot be treated as contextual allomorphy, by (A1-2). Section 4 looks at alternations that are suppletive, but prima facie problematic from the perspective of (A1-2) because of putative outward-looking sensitivity to phonology. These alternations are shown to be triggered morphosyntactically, in a way that complies with (A1-2).

2.2 Some general remarks A substantive and quite general assumption that underlies this paper is that there are at least *some* locality conditions that constrain patterns of stem allomorphy. The alternative to this is that stem distribution obeys no conditions on locality whatsoever. If that were true, then stem distributions could be more or less arbitrary; that is, they could pattern in a ways that make reference to arbitrary bundles of morphosyntactic features. There would be no need for a theory of stem alternations if this turned out to be the case. If any bundle of features (i.e., combination of features that defines a particular "paradigmatic slot") could be referred to in stating the distribution of stems, the best that could be achieved would be a description of such distributions, nothing more.

My starting point in this paper assumes that the pessimistic view is incorrect. It is important to note that this assumption is shared by a number of recent works on allomorphy. The consensus is

particularly clear with reference to the effects of phonology on allomorphy. A crucial argument in the early parts of this paper is based on the idea that outer phonological material cannot be referred to in suppletive allomorphy. This paper takes this effect to derive from the specific details of (A1-2) above. However, it is important to note that other discussions of contextual allomorphy have also arrived at the conclusion that outer phonological material cannot condition suppletive allomorphy; see, for instance, Paster (2010) and related work.

More generally, a shared conclusion of a number of different works on allomorphy, including Carstairs 1987, Bobaljik 2000, Paster 2006, Wolf 2008, and Embick 2010, is that there are significant generalizations about the constraints on allomorphic interactions (including stem alternations) that must be accounted for in any theory. I will thus put to the side the "anything goes" view that stems can be distributed in a morphosyntactically arbitrary way.

3 Stem Alternations I: Verb Stem Alternations in Spanish By Consequence 1 above, an alternation that is conditioned by outer phonological properties cannot be contextual allomorphy; it must be treated morphophonologically. This section examines two "irregular" (according to the familiar dichotomy) alternations in Spanish verbs that are conditioned by outer phonology in the relevant way.

3.1 Diphthongization The alternation between simple vowels and diphthongs in Spanish– referred to as *diphthongization*– provides a first argument against stem storage. The alternation is item-specific in the sense that certain verbs with /o/ and /e/ stem vowels alternate (6a), while other verbs with the same vowels do not undergo the alternation (6b); the present indicative forms of two verbs are shown in (6c):[4]

(6) Diphthongization and listedness

a. Diphthongization: *pensar* 'think', *poder* 'be able to', *tender* 'hang', *sentar* 'sit'

b. No Diphthongization: *tensar* 'tauten', *poner* 'put', *podar*,'prune' *rentar* 'yield, rent'

c. Present Indicative forms for *pensar* and *tensar*

p/n	*pensar*	*tensar*
1s	pienso	tenso
2s	piensas	tensas
3s	piensa	tensa
1p	pensamos	tensamos
2p	pensáis	tensáis
3p	piensan	tensan

The fact that diphthongization is not found in all verbs with /e/ and /o/ vowels in the Root generates the tension between morphophonological and stem storage analyses; arguments in favor of each are well-attested in the literature. Harris (1969), for instance, argues for a morphophonological analysis, whereas Hooper (1976) argues for stem storage. Each of these positions has been advanced in later work as well.[5]

[4]The alternation typically involves /e∼ie/ and /o∼ue/. According to the standard description, there are a few verbs with underlying /i/ that alternate, such as *adquirir* 'acquire', and maybe one verb with stem /u/ that diphthongizes (*jugar* 'to play').

[5]Subsequent work argues that an apparent lack of productivity in diphthongization supports the storage view; see the discussion in Albright et al. (2000). Brovetto and Ullman (2005) classify diphthongizing verbs as irregular in a typical

3.1.1 The Distribution of Alternants In the framework of section 2, treating diphthongization as competition between stored stems requires an analysis with stem allomorphs *pens* and *piens* of the Root $\sqrt{\text{PENS}}$. A provisional analysis with competing stems is shown in (7), where ENV_1 and ENV_2 are abbreviations for the hypothetical contextual specifications conditioning insertion of *pens* and *piens* respectively:

(7) $\sqrt{\text{PENS}} \leftrightarrow$ *pens*/_ENV_1
$\sqrt{\text{PENS}} \leftrightarrow$ *piens*/_ENV_2

Vocabulary Items like those in (7) are available in any theory that allows late insertion for Roots; see section 5 for extensive discussion. The crucial aspect of (7) is what determines whether one or the other VI is used; i.e., what must be specified in the ENVs in order for the correct distribution of stems to be derived. When the full distribution of alternants is considered, it is clear that the alternation is conditioned by stress. As can be seen in (8), the diphthong occurs when the stem vowel is stressed, and otherwise the simple vowel is found ((8) departs from orthographic practice by marking the stress in all forms):

(8) Forms of *pensar* 'to think'

	1s	2s	3s	1p	2p	3p
pr. ind.	piénso	piénsas	piénsa	pensámos	pensáis	piénsan
pr. subj.	piénse	piénses	piénse	pensémos	penséis	piénsen
pret.	pensé	pensáste	pensó	pensámos	pensastéis	pensáron
impf.	pensába	pensábas	pensába	pensábamos	pensábais	pensában

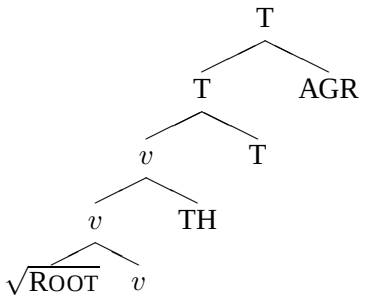
Although only four tenses are shown in (8), the pattern according to which the diphthong occurs under stress is general.[6]

The fact that stress determines the distribution of alternating diphthongs in this way is well known. But this fact has direct consequences for the comparison of stem storage and morphophonological theories. Sensitivity to stress along the lines seen in (8) requires information about stress placement that is not available when insertion at the Root node takes place. Thus, by (A1-2), the contextual factor determining which stem alternant appears is not something that can be referred in the ENVs in (7). More concretely, the verb forms shown in (8) are realizations of the complex head structure (9), which consists of a v head, a TH(eme) node, a Tense node, and an AGR(eement) node (Oltra-Massuet 1999, Oltra-Massuet and Arregi 2005):

(9) Verbal structure

"dual system" dichotomy. Rodriguez-Fornells et al (2002) conclude that diphthongized and undiphthongized stems are separate lexical entries, on the basis of a repetition priming experiment. Linares et al. (2006) also seem to suggest that these stem alternants are stored.

[6]There is a set of prima facie exceptions in which an alternating diphthong is found without being stressed on the surface. This is found with evaluative morphology like diminutives; e.g. *viéjo* 'old (person)', cp. *vejéz* 'age'; but diminutive *viej-ít-o* 'old (person)-DIM' (see discussion and references in Halle et al. (1991)). It appears, however, that this exceptionality is part of a larger generalization about the status of (certain types of) diminutives; see Bachrach and Wagner (2006) for a morphophonological treatment of some related phenomena in Brazilian Portuguese, and for additional discussion of the syntax of such morphemes Wiltschko and Steriopolo (2007) and de Belder et al. (2009). See also the outline of category-changing derivations later in the text.



The choice between *pens-* versus *piens-* at the Root node requires reference to the position of stress in the entire word, which in turn requires insertion at the outer nodes (v, TH, T, AGR). This is not possible by (A1). In addition to this, there is no sense in which the choice would be determined by the properties of a morpheme concatenated with the Root, as required by (A2).

The argument developed to this point relies on the idea that diphthongization is phonologically-determined. For this reason, it is worth considering an alternative that employs the VIs in (7), but with the alternation triggered by morphosyntactic features, not phonology. As noted earlier, nothing in (A1,2) prevents outward-looking stem allomorphy in principle, as long as it is conditioned by morphosyntactic features on local nodes.

If diphthongization could be treated morphosyntactically, it would not provide an argument against stem storage. There is, however, little motivation for a morphological treatment. Given only the present tense verb forms in (8), the non-diphthongized stem form could be restricted to first and second person plural; but how the distribution of alternants in the rest of the system would be stated is not obvious. Furthermore, an analysis with morphological conditioning fails to account for the broader generalization that alternating diphthongs occur under stress elsewhere in the language (in nouns, adjectives, etc.):

(10) v<u>ié</u>jo ‘old’, vej<u>é</u>z ‘age’
n<u>ié</u>ve ‘snow’, nev<u>á</u>do ‘snowy’
m<u>ié</u>l ‘honey’, mel<u>ó</u>so ‘like honey’
Venez<u>ué</u>la ‘Venezuela’, Venez<u>o</u>láno ‘Venezuelan’

The fact that the same phonological factor regulates the alternation in verbs, nouns, and adjectives points to the same conclusion: this alternation is phonologically determined.

3.1.2 Representing alternating diphthongs Different types of (morpho)phonological analyses of diphthongization could be given in the framework developed here. One factor that complicates the analysis of diphthongization is that, in addition to there being non-alternating simple vowels (recall that e.g. *tensar* does not diphthongize, while *pensar* does), there are also non-alternating diphthongs in the language: e.g. *frecuénto* ‘I frequent’, *frecuentó* ‘he frequented; *Viéna* ‘Vienna’, *vienés* ‘Viennese’ (Harris 1985:32). Thus, the Roots and morphemes that have alternating vowels have to be distinguished from the Roots and morphemes that do not.

Harris (1985) represents alternating diphthongs as phonologically special, with two timing slots, only the first of which is linked to a vowel.. In this analysis, the empty position is associated with a vowel when it is in the rime of a stressed syllable, yielding a diphthong; if this association does not occur, a simple vowel surfaces (see also Inkelas et al. 1997).

A theory that has morphophonological rules– i.e., phonological rules that apply to some morphemes, and not others– makes other options available. In such a theory, alternating diphthongs can be represented in a way that is unexceptional phonologically. The alternating morphemes can be lexically specified to undergo diphthongization (or monophthongization, if it is assumed that the diphthong is underlying). This analysis essentially makes use of morphological diacritics, or their equivalent. The difference between the phonologically-special and morphological diacritic approaches boils down to the debate between phonological exceptionality (or prespecification) versus morpheme-specific phonology (morphological or lexical diacritics on rules); see Gouskova (2009) for a recent discussion.

It appears that both the phonological or the morphological analysis are compatible with my assumptions from section 2; seeing how this works leads to some other points of interest as well.

As discussed by Halle et al. (1991) and others, in terms of a theory with cyclic versus non-cyclic phonological rules, diphthongization is part of the non-cyclic phonology (Harris 1989 argues for this point against Halle and Vergnaud's (1987) cyclic analysis of the rule). In terms of the model assumed here, one way to implement this is by saying that the rule(s) that result in diphthongization apply in a phonological cycle that applies when the boundary of the entire word is reached; that is, the M-Word boundary, in the sense of Embick and Noyer 2001: an entire complex head.

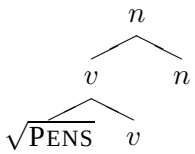
In addition to this specific point about diphthongization applying in the non-cyclic phonology, some further assumptions about cyclic domains for morphophonology are required. In terms of the fleshed out version of (A3) of section 2 (see Embick 2010), the verbs that have been examined to this point, which have the structure in (9), are contained within one cyclic domain. In other words, there is no "Bracket Erasure" (or equivalent) within (9); as a result, the Root morpheme still exists as a morphological object, and can be referred to as such, when the morphophonology reaches the outermost morpheme in (9). As a result, when the stress in the entire word is calculated, it is known whether e.g. $\sqrt{\text{PENS}}$ or $\sqrt{\text{TENS}}$ is present, and whether or not there is stress on the potentially alternating vowel. Thus, a diphthongization rule that has morphological conditioning could apply at that stage, and produce the correct results.

Assuming that alternating diphthongs are represented as phonologically special, in the Harris (1985) etc. sense, would also work. Again, all of the morphemes in (9) are in one cyclic domain. Thus, the phonological representation of the Root, which has two timing slots according to the view being entertained, is capable of being realized as a diphthong if it bears stress, even if the position of that stress is determined by the phonology of outer morphemes.

3.1.3 Cyclic Domains While both the morphological and phonological theories could work for the verb forms under consideration, it is possible that there are other phenomena in which they make different predictions. One conceivable source of information is in derivations that involve multiple phase-cyclic domains: cases of category-changing morphology, for example. In the case of Spanish diphthongization, however, it does not appear to be the case that category-changing derivations can decide between the morphological and phonological treatments. At the same time, there are some important points about the cyclic aspect of the theory (A3) that can be illustrated with such examples.

A relevant form is *pensador*, 'thinker', which contains the root $\sqrt{\text{PENS}}$. This form shows stress on the final syllable, and a simple vowel (not a diphthong) in the Root. On the assumption that *pensador* is a deverbal noun, with both v and n heads, it has the structure (11):

(11) *pensador*



The important fact about this form is that there is no diphthongization: **piensador*. That is, even though there are two cyclic domains in this word (associated with the v and the n, both cyclic heads), the Root does not get diphthongized. Because category-changing forms are important for understanding how phonology interacts with phase-cyclic derivation, some additional comments on (11) are in order.[7]

For forms like *pensador*, the absence of diphthongization is expected in the cyclic theory based on (A3), as long as diphthongization applies non-cyclically: i.e., at the M-word boundary, along the lines discussed above. The reason that the diphthong is not found is as follows. According to the theory of Embick (2010), category-defining heads like n and v are cyclic. When such heads are merged, cyclic domains in their complement are spelled out. In (11), this means that when the n is merged, the cyclic domain in the complement of n is spelled out: this consists of the Root $\sqrt{\text{PENS}}$ and the head v. When the Root and v are spelled out, they are linearized, and they undergo Vocabulary Insertion. In terms of phonological cycles, it is possible that phonological rules apply to this object as well, although in the case at hand, there is no evidence for such an inner phonological cycle.

Non-cyclic rules like diphthongization do not apply to the object [$\sqrt{\text{PENS}}$ v], where there is no M-Word boundary. So, if there are cyclic stress rules that place a stress mark on the stem syllable of $\sqrt{\text{PENS}}$, the form *piens* is not created in this inner cycle, because diphthongization applies only when the entire M-Word is processed. At that stage, when the non-cyclic phonology is computed, there is no stress on the Root; rather, stress is on *-dor*; so there is no diphthongization. In short, **piensador* is not found because (i) in the inner cycle (where there might be stress on the Root, if stress is assigned cyclically), there is no diphthongization process; while (ii) in the outer cycle (non-cyclic, M-word level) there is no stress on the Root.

As noted earlier, there is something further to be said about why there appears to be a "cyclic" effect in diminutives like *viej-ít-o* 'old (one)-DIM', which show diphthongized stems even though surface stress occurs on a later syllable. I assume with Bachrach and Wagner (2006) and others (see e.g. Newell (2008)) that this effect results from the syntactic status of diminutive morphemes. According to their approach, the diminutive morpheme is adjoined, in a way that is related to certain effects found in compounding. The intuition is that an object involved in adjunction can undergo word level phonology prior to adjunction (or, at a minimum, as if the adjoined piece were not present). In e.g. *viej-ít-o*, this would mean that *viej-o* undergoes M-Word level phonology when the diminutive morpheme is not present; subsequent to the diminutive morpheme being added (and realized as *-it-*), stress rules remove the stress from the stem syllable, yielding an unstressed diphthong

[7] Some points about cyclic domains and diphthongization are raised by Bermúdez-Otero (2010). That paper reiterates important questions from Harris 1989 about the status of cyclic stress assignment in Spanish, a topic that warrants careful study on its own. Bermúdez-Otero takes the absence of diphthongization in forms like *pensador* to be problematic for a theory with cyclic domains as in (A3). However, the argument is based on a number of his own assumptions about how phonology might work in a theory like that developed here, assumptions that, for the most part, I do not share.

in the surface form.

The details of the adjunction analysis are important, and might shed some light on the phonological versus morphological approach to diphthongization. While the analysis of such effects goes beyond the range of my argument in this paper, it appears that the overall (structural) approach to diphthongs in "unexpected" places appears quite promising. For one, it connects with the behavior of diminutive and related morphemes cross-linguistically (recall footnote 6). Another reason to think that this approach is on the right track is internal to Spanish. In compounding, the alternating diphthongs are also found without surface stress. So, for example, the Root *contar* 'tell' appears as the first element of the compound *cuenta-cuéntos* 'story-telling'. The alternating diphthong appears in the first position, even though the (main) stress of the whole compound appears on the second element. It appears that each member of the compound shows the results of having undergone M-Word level phonology (see Harris 1989; thanks to Andrés Saab for bringing the compounds to my attention).

3.1.4 Final Remarks The verb forms analyzed in this section illustrate a distribution of stem alternants that is determined by the (morpho)phonology, but not the "regular" phonology. It requires an analysis in which the Root has a single underlying representation, one that produces either a simple vowel or a diphthong when subjected to (morpho)phonological rules. Employing stored alternants from memory (distinct VIs) does not work, because such an analysis is impossible given the locality conditions (A1-2) that apply to contextual allomorphy.

As far as I can tell, this conclusion holds for either the phonological (two timing slots) or morphological (diacritic) analysis of alternating vowels. In either case, the alternation is still irregular in the way that is typically used to motivate stem storage. Some further points along these lines might be worth investigating in a broader study of phonological exceptionality. For example, it could be argued that if alternating diphthongs are part of the regular phonology, then diphthongization is not related to lexical listing, i.e., it is not "irregular". The force of this objection relies on a number of other points: first, whether the phonological analysis is better than the one with morphological diacritics; second, whether exceptional phonological representations are irregular in the same way that unpredictable morphological information is; and so on.

In order to broaden the empirical base of the arguments about locality and stems, the next section looks at another alternation in Spanish verbs that is triggered by outer phonological properties.

3.2 "Raising" verbs in the* -ir *Conjugation Spanish verbs of conjugation III (the *-ir* conjugation) show an alternation that is often referred to as *raising*; in diachronic terms, this is because it involves the raising of mid vowels. The raising phenomenon is seen in the verb *pedir* 'to ask', which has 1s present *pid-o*, with stem /i/, but 1pl present *pedimos*, with stem /e/. Almost all of the verbs of Conjugation III that show an /e/ vowel in the infinitive alternate with /i/ in this way.[8] There are a few exceptions; e.g. *agredir* 'attack', *transgredir* 'transgress', *sumergir* 'submerge' are listed in Malkiel 1966:472; Harris 1969:115 lists *divergir* 'diverge' and *concernir* 'concern' as well. As will be shown below, the alternation is better viewed as the result of a lowering or dissimilation rule in the synchronic grammar, as originally proposed by Harris (1969); for consistency of reference, however, I retain the term *raising verbs* for this class.

There is no rule of the normal phonology that would raise /e/ to /i/.[9] In the other direction–

[8] In addition to the /e/∼/i/ alternation, there are a few verbs in which /o/ alternates with /u/ in the same way; see below.

[9] Historically there are rules of metaphony that do this; see e.g. Malkiel 1966. There are also some verbs that show a

that is, assuming a stem /i/– there is a distributional motivation for a (lexically-specified) rule that lowers /i/ to /e/; see below. The irregularity of the phonological process (along with the fact that the alternation is restricted to verbs of conjugation III) has led to various storage-based analyses.[10] As in the case of diphthongization, little attention has been devoted to the factors that determine the distribution of the different stem alternants; an important exception is Harris 1969 (see below).

The distributional question is highlighted when additional tense/mood forms of the raising verb *pedir* are considered:

(12) Forms of *pedir* 'to ask'

	1s	2s	3s	1p	2p	3p
pr. ind.	**pido**	**pides**	**pide**	pedimos	pedís	**piden**
pr. subj.	**pida**	**pidas**	**pida**	**pidamos**	**pidáis**	**pidan**
pret.	pedí	pediste	**pidió**	pedimos	pedisteis	**pidieron**
impf.	pedía	pedías	pedía	pedíamos	pedíais	pedían
impf. subj.	**pidiera**	**pidieras**	**pidiera**	**pidiéramos**	**pidierais**	**pidieran**
fut	pediré	pedirás	pedirá	pediremos	pediréis	pedirán
cond	pediría	pedirías	pediría	pediríamos	pediríais	pedirían

All of the verbs in the raising class alternate in exactly the same way as *pedir*, with one further complication. A subset of the raising verbs also show diphthongization. With verbs of this latter type, diphthongs appear in exactly the expected forms (i.e., those where the stem vowel is stressed).[11]

The generalization governing the distribution of *ped* and *pid* in (12) does not appear to be morphosyntactic: there is no coherent set of tense, mood, or person/number features that could be referred to in conditioning one of the alternants. If the distribution of the alternants like *ped* and *pid* had to be stated in a way that did not refer to the phonology, the only conceivable treatment would be one in which the environments taking each stem form are simply enumerated:

(13) *pid* appears in

a. first, second, third singular, and third plural present indicatives;

b. all the present subjunctives;

c. all the imperfect subjunctives;

d. 3s and 3p preterites.

raising of the stem vowel in the preterite, such as *hacer* 'make', with 1s preterite *hice*. This process is restricted to a small set of verbs in this tense.

[10]Harris (1969:115) treats the alternation with a "minor rule" that is lexically restricted. Linares et al (2006) use the exceptions of the kind noted in the text as evidence for the irregular nature of the alternation, in spite of the fact that there are very few verbs with unchanging stem /e/ in conjugation III. This conclusion is augmented by results from a productivity task: they report that novel /e/ stem verbs presented in the infinitive were not reproduced with /i/ stems in first person singular forms.

For a developmental angle on these verbs that makes specific reference to vowel change in *-ir* verbs, see Mayol (2007) with reference to the dual system approach of Clahsen et al. (2002).

[11]Thus *mentir* 'lie' has three different stem forms, as seen in e.g. 1s indicative *miento*, 1p indicative *mentimos*, 1p subjunctive *mintamos*. Whether or not a verb shows diphthongization in addition to raising is something that evidently must be listed, as noted in the discussion of diphthongization above.

As discussed in section 2, an approach with the ability to make such statements– i.e., with reference to any possible combination of features that define a particular paradigmatic "cell"– amounts to little more than a reiteration of the facts. If the central thesis of this paper is correct, there are in fact sharp constraints on the factors that can condition stem alternations; and the existence of *any* such constraints is incompatible with a view that simply states in which paradigmatic slots a particular stem alternant is found.

The distribution in (13) suggests that raising is not determined by morphosyntactic features. There is, however, a *phonological* generalization about the distribution of stem alternants in (12). As argued by Harris (1969), the mid vowel in conjugation III verbs appears only when the following syllable contains a stressed /i/ vowel. According to this view, the alternation is not the result of raising an underlying mid vowel; rather, it is the Dissimilation of a high vowel (i.e., a lowering process):

(14) Dissimilation: i ⟶e/__(C)í

Implementing the *Dissimilation* analysis involves a few additional complexities. One regards the conditioning by stressed /i/. Something has to be said about the future and conditional forms, where the mid vowel /e/ surfaces, even though the following syllable contains an /i/ that is not stressed in the surface form; for example, the first singular future of *pedir* surfaces as *pediré*, not **pidiré*. There are some different ways in which this effect can be handled.[12]

An additional question is which verbs show the alternation in the first place. The standard view, with underlying /e/ and raising, holds that all *-ir*-verbs with mid vowels undergo the alternation, minus a few exceptions. If the Dissimilation approach is correct, though, the /i/ must be underlying. The verbs that undergo the /i/∼/e/ alternation then have to be distinguished from other *-ir*-verbs that show a non-alternating /i/, such as *vivir* 'live' and *escribir* 'write'; the simplest way of doing this is by marking the Roots that undergo the Dissimilation rule diacritically (or by restricting the rule to conjugation III verbs, and marking the non-undergoers as exceptions). That is, in the same way that the analysis with underlying /e/ has some exceptions, the analysis with underlying /i/ and Dissimilation must make use of Root-specific information.[13]

Overall, the observations about the raising verbs reinforce the conclusions drawn on the basis of Diphthongization. The distribution of stem alternants does not behave like contextual allomorphy: reference is required to phonological properties of material that is outside of the position of the Root, in a way that is incompatible with (A1,2). A morphophonological analysis of the change is

[12]Historically the future and conditional derived from forms of auxiliary *have* affixed to the infinitive. Even within the historical period, the infinitive + *have* components can be seen to be less closely combined morphophonologically than other verbs are; clitics could intervene between the pieces, as discussed in Fontana (1993). Along these lines, Harris (1985, 1987) treats future and conditional forms as containing two phonological domains (created by word level affixation in the framework he assumes). Oltra-Massuet and Arregi (2005), on the other hand, treat such forms with a single cyclic domain. The dissimilation analysis of the /i∼e/ alternation appears to fit better with the Harris-style analysis. However, alternatives to the cyclic analysis, such as making the infinitive morpheme inherently stressed, are conceivable.

An important topic for further research is how the Roots that show the raising alternation behave in cross-categorial derivations (cp. the discussion of diphthongization in 3.1.2).

[13]Verbs in the *-ir* conjugation showed dissimilation historically, so that, according to a standard view, those with etymological /i/ in the Root came to show /e/ (something similar happens with /o/ and /u/ in *-ir* verbs); see Penny (2002:188,235). It is hypothesized that the retention of Root /i/ in *escribir*, *vivir* etc. is the result of awareness of the Latin origin of these verbs; see Penny 2002:235., as well as Malkiel (1966).

therefore required. Based on the pattern of stem alternants, this is an analysis in which the high vowel is taken as underlying.[14]

3.3 Summary The alternations examined in 3.1 and 3.2 are (i) "item specific", i.e., not part of the general phonology; at the same time, they (ii) nevertheless do not behave like contextual allomorphy, in the sense that they do not respect (A1-2). Alternations with these properties must be treated morphophonologically, with distinct surface forms derived from a single underlying representation that is changed by (morpho)phonological rules.

A possible response to this argument is that Roots are simply not subject to the same contextual conditions on insertion that other morphemes (i.e., functional morphemes) are subject to. The upshot of this objection is that stem insertion (i.e., Vocabulary Insertion for Roots) is subject to different locality conditions from insertion at functional heads. This is a weak position. All other things being equal, the conditions under which the shape of a morpheme can be affected by material in its context should be uniform.[15]

The analyses of this section provide arguments in favor of a morphophonological treatment of certain types of stem alternation. A number of additional questions about such alternations, concerning the status of cyclic structure in particular, remain to be addressed. Given that morphophonological processes must, in the typical case, make reference to the identity of specific morphemes (often Roots in the case of stem alternation), an important question is how cyclic structure might restrict reference to specific morphemes. The general theory assumed here, from Embick (2010), holds that morphophonological rules that make reference to specific morphemes (i.e., Readjustment Rules) are constrained by cyclic domains in the same way as contextual allomorphy; this is the *Readjustment Activity Hypothesis* of Embick 2010. It is important to note that cyclic activity refers to visibility *qua morpheme*. When objects interact across cyclic domain boundaries, the inner ones are not visible as morphemes; but they do have phonological representations that can be referred to by subsequent processes.

While a detailed study of stem alternations in cross-categorial derivation remains to be undertaken, (A3) (as stated in the Readjustment Activity Hypothesis) makes clear predictions that must be tested in future work.

4 Stem Alternations II: Outward-looking Suppletion By (A1,2), all alternations that are suppletive are contextual allomorphy, and thus are conditioned by contextual factors in a way that conforms with (A1-2). The most familiar kind of stem suppletion is found with highly frequent items, along the lines of *be*, *go* in English. This can be treated as contextual allomorphy, with the

[14] A point worth investigating further concerns the verbs with /o/ infinitives, like *dormir* 'sleep' and *morir* 'die', which are in the raising class (and show diphthongization as well). The high vowel should be underlying with these verbs, given that the distribution of /u/ and /o/ parallels that of /e/ and /i/ in the *pedir*-type verbs. There are many verbs with stem /u/ in conjugation III that do not alternate with stem /o/: *cumplir* 'celebrate', *pulir* 'polish', *sufrir* 'suffer', and so on. This means that– unlike in the *pedir* type– the Roots that actually do alternate are the exception, not the norm. A related point is that experimental studies of such verbs (e.g. Allen and Badecker 1999, Badecker and Allen 2002) have based their reasoning on the idea that e.g. stem /o/ is underlying in *morir*. Some steps must be taken to see if the results of these experiments can be reconciled with the dissimilation analysis.

[15] There are, of course, arguments in the literature to the effect that stem changing does not behave like piece-based affixation. However, these have to do with blocking (see Halle and Marantz 1993 with reference to Anderson 1992). Embick and Halle 2005 add some additional points about the coherence of Readjustment Rules; see in this connection Carstairs 1987, which argues on paradigmatic/distributional grounds that stem allomorphy is not the same as piece-based affixation.

suppletive elements treated as light verbs (varieties of v), so that, for example, the verb *go* realizes v_{go}. When v_{go} is combined with the past tense morpheme T[past], a suppletive alternant that makes reference to the adjacent T[past] morpheme is employed:

(15) $v_{\text{go}} \leftrightarrow$ went/__⌒T[past]
$v_{\text{go}} \leftrightarrow$ go

Although the phonological shape of v_{go} is determined by an outer node, this sensitivity is compatible with (A1-2), as v_{go} and the T[past] node are adjacent when Vocabulary Insertion takes place.

While the existence of outward-looking allomorphy for functional morphemes appears to be relatively uncontroversial, the same is not true for Root morphemes. According to some theories, such nodes are not subject to Vocabulary Insertion, and thus cannot show suppletive allomorphy (cf. one version of Embick 2000 and subsequent work); according to some other approaches, e.g. Marantz (1995), insertion at Root nodes is possible, but suppletion for Roots is not. For the purposes of this section, I concentrate on the realization of functional morphemes. A more detailed examination of Roots and insertion is undertaken in section 5.

4.1 Some Sensitivities in Suppletion in Italian By (A1-2), an inner node cannot have its allomorphy determined by the phonological properties of an outer node (or of the whole word); this is Consequence 2 of section 2. There are some suppletive alternations that are claimed to be sensitive to outer phonology in this way; and some care must be taken to see if these can be analyzed in a way that complies with (A1-2).

Carstairs (1988,1990) follows traditional discussions of Italian in presenting the suppletion of *andare* 'go' as conditioned by the surface phonology. Descriptively, the facts show that the stem is *va(d)* when under stress, and *and* otherwise. The same type of pattern is found with the morpheme *-isc-* that occurs with many (but not all) *-ire* (Conjugation III) verbs like *finire* 'to finish'; this "augment" appears when the stress does not fall on the agreement suffix:

(16) Present forms of *finire* and *andare*

	finire		*andare*	
p/n	**pr. ind.**	**pr. subj.**	**pr. ind.**	**pr. subj.**
1s	fin-ísc-o	fin-ísc-a	vádo	váda
2s	fin-ísc-i	fin-ísc-a	vái	váda
3s	fin-ísc-e	fin-ísc-a	vá	váda
1p	fin-iámo	fin-iámo	andiámo	andiámo
2p	fin-íte	fin-iáte	andáte	andiáte
3p	fin-ísc-ono	fin-ísc-ano	vánno	vádano

Following Carstairs' discussion, the relevance of these facts for theories of allomorphy has been noted elsewhere (see e.g Kiparsky (1996), Burzio (1998), and Paster (2006,2009), among others). If the choice of suppletive *va(d)* versus *and* and the choice between *-i-* and *-isc-* truly required reference to the placement of stress in the entire word, then this would be a counterexample to the theory based on (A1-2). It is therefore necessary to show that the patterns in (16) can be analyzed in a way that complies with (A1-2), and, of course, that no significant generalizations are missed by a such an analysis.

A starting point for the analysis of (16) is the observation that while stress *correlates* with the patterns in (16), this correlation does not necessarily mean that it *causes* the relevant alternation. The idea that allomorph selection makes direct reference to output phonology constitutes a further claim (made, for instance, by Burzio (1998) and in related work), and what is at issue is whether the predictions made by a theory of this type are correct.

In order to approach these predictions, it is necessary first to consider the general properties of a theory in which surface phonology can drive allomorph selection. In such a theory, the effects in (16) can be analyzed with competition between words. Schematically (and adapting Burzio (1998) and references cited there), the grammar creates both *and-o* and *vad-o* as candidates for '1s of go', such that further (quasi-phonological) constraints (e.g., *vad* is always stressed, *and* is always unstressed, *-isc-* is always stressed, etc.) then select the appropriate winners. Various constraints along these lines could be employed.

A competition-based analysis along these lines is easy to formalize in many versions of Optimality Theory. However, there are serious doubts as to whether a theory that allows potentially "global" interactions between morphology and phonology in this way is sufficiently constrained (see Embick 2010, also Paster (2006,2009), and Wolf (2008)). To see how these general concerns apply to the particular case at hand, it must be asked if there is any evidence *beyond the stress pattern in (16) itself* for a globalist analysis in which output phonology (i.e. stress) drives allomorph selection.

There are in principle some different ways in which the dependence of allomorphy on stress could be demonstrated. The most obvious ones involve shifting stress away from the "normal" place, i.e., away from the places where it surfaces in (16). If stress really drives the alternation, then there should be a change of allomorphs whenever stress is moved: *allomorphic vacillation* in the terminology of Embick (2010). One conceivable way of doing this would be with affixation of a particular type. If, for instance, there were a prefix– e.g., DE– that always attracted stress, then the phonology-driven theory would predict e.g. 1s *vádo*, but *DÉando*. There are no prefixes like this in Italian, however.[16] Another phenomenon of potential interest, one that is less directly relevant because it goes beyond the confines of Standard Italian, could be seen in Italian dialects that shift stress when enclitics attach to the verb (see Loporcaro (2000) and references cited there). As far as I know, though, there are no reported cases of the stress shift conditioning an allomorphic change.

Italian evidently offers no way of testing the prediction of *allomorphic vacillation*. This failure is evidently not an isolated one; as discussed in Embick (2010), there is a more general problem with this prediction: in all cases where vacillation is predicted by an account which derives inner allomorphy based on outer phonological properties, no such vacillation is found. From this more general point of view, then, it is unsurprising that there are no indications that surface stress drives the alternations in (16). The general conclusion is that allowing outer phonology to drive allomorph selection is problematic, and that the distributions in (16) must be conditioned by determined by local morphosyntactic features.

A morphological analysis of (16) begins with additional forms that go beyond the present tenses. With *andare* 'go', the forms shown in (16) might make it look like *and* appears in a coherent environment, viz. first and second person plural. This is not generally the case, though; *and* also appears

[16]Something along these lines is touched on in Kiparsky (1996:25), citing comments by Dressler in a discussion, with reference to *àndiriviéni* 'coming and going', where secondary stress appears on *and*. This case might not be probative, though, since it might not involve the same morpheme.

in the non-finite forms (gerund *andando*, participle *andato*), as well as in a number of finite tenses:

(17) Forms of *andare*

p/n	**pr. ind.**	**pr. subj.**	**impf.**	**pret.**	**fut.**
1s	vádo	váda	andavo	andai	andrò
2s	vái	váda	andavi	andasti	andrai
3s	vá	váda	andava	andò	andrà
1p	andiámo	andiámo	andavamo	andamo	andremo
2p	andáte	andiáte	andavate	andaste	andrete
3p	vánno	vádano	andavano	andarono	andranno

Thus, it is not the case that *and* is special; in fact, the only place where *va(d)* appears is in the present tense, whether indicative or subjunctive (and in imperatives). Based on this distribution, the *and* exponent of v_{go} is clearly the default, and *va(d)* is the more highly-specified allomorph. Exactly the same distribution is found with *-isc-*; it only appears in the *finire*-class verbs in the present indicative and subjunctive (imperative too), with the rest of the forms showing *-i-*.

There are two components to the analysis of these patterns. First, *va(d)* is a special allomorph of v_{go} that is conditioned by the present tense head; *and* is the default pronunciation of this head. Second, the first and second plural forms in the present tense show a neutralization, in that they do not show the "special" present allomorph. Rather, the default surfaces in these contexts.

For the first component, the special allomorphs *va(d)* and *-isc-* are specified with a contextual condition that refers to the T[pres] node, as in (18); in (18b) v[III] is the morpheme that underlies the themes *-i-* and *-isc-*, and the LIST referred to contains the verbs like *finire* that show *-isc-*:[17]

(18) a. $v_{go} \leftrightarrow$ va(d)/__⌒T[pres]
$v_{go} \leftrightarrow$ and
b. v[III] $\leftrightarrow$ -isc-/LIST__T[pres]
c. v[III] $\leftrightarrow$ -i-

For the first and second person plural forms in the present tenses (indicative and subjunctive), it is the unmarked forms *and* and *-i-* that appear. This suggests a treatment in terms of *Impoverishment* rule, as in Bonet (1991), Noyer (1992,1998), and related work. The rule deletes the T[pres] node in first and second person plurals (the feature [+part], for participants, is shared by 1st and 2nd person):

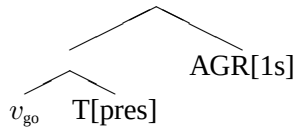
(19) *Impoverishment:* T[pres] $\longrightarrow$Ø/__[+part,+pl]

Impoverishment rules apply early in the PF branch (and do not respect adjacency; according to Halle and Marantz 1993 and more recent discussion by Marantz). They apply before the Vocabulary Insertion process begins, so that when v_{go} and v[III] are spelled out in first and second person plural forms, they cannot have their allomorphy conditioned by T[pres], since that node is deleted by (19). As a result, the default VIs apply.

As an illustration, in the derivation of first person singular *vado*, the syntax produces (20):

[17] The VI for *-isc-* refers to concatenated elements both to the left and to the right of the morpheme undergoing insertion. This might not be necessary in some alternatives to (18), but I will not dwell on this issue here.

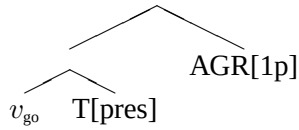
(20) Syntactic structure for *vado*



Vocabulary Insertion inserts *vad* for v_{go} because v_{go} is concatenated with T[pres], and the first VI in (18a) applies. The present tense node itself is null, and 1s agreement spelled out as *-o*.

In the case of first person plural *andiamo*, the output of the syntax is identical to (20), with 1pl instead of 1s features on AGR:

(21) Syntactic structure for *andiamo*



In the case of (21), though, the Impoverishment rule (19) applies, deleting the T[pres] node to yield [v_{go} AGR[1pl]]. When Vocabulary Insertion applies to v_{go}, this node is not adjacent to T[pres], since the latter node is deleted. Thus, *and* is inserted. The same analysis extends to the *-i-*$\sim$*-isc-* alternation in verbs like *finire*. In first and second person plurals the T[pres] node is deleted, preventing the insertion of the *-isc-* allomorph of v[III].[18]

The analysis is thus able to account for the outward-looking suppletion in a way that does not make reference to phonology. Rather, the allomorphy in each pattern is conditioned by morphosyntactic features that are adjacent to the node that alternates in form.[19]

4.2 Summary The patterns of alternation between *va(d)*$\sim$*and* and *-isc-*$\sim$*-i-* in Italian, described as showing outward-looking phonological sensitivity, can be treated straightforwardly as a case of morphosyntactically-conditioned allomorphy. As such, they are not problematic for the theory based on (A1-2).

The analysis of the Italian verbal forms provides some important points of comparison with the behavior of the Spanish verbs examined in section 3. As noted there, the analysis of Spanish diphthongization as a phonologically-triggered process fits with the behavior of alternating diphthongs throughout the language; and a morphological analysis of the alternation would miss this generalization. On the other hand, there is no motivation from anywhere else in the grammar of Italian for maintaining a phonological trigger for the alternations in (16). That is, there are no other

[18]The same T[pres] deletion rule applies in the present subjunctive; in this case, though, the [subj] feature is still present. The presence of [subj] is important, because there are differences in how present indicative and subjunctive get spelled out.

[19]An interesting point from the perspective of this prediction is provided by the Livinallongo dialect (Veneto region), analyzed by Calabrese (2003), who cites work by Benincà. The verb *este* 'be' shows person/number conditioned suppletion in the present tense, showing e.g. 2s *es* and 2pl *sei*. This dialect also shows person/number conditioned suppletion in the Imperfect, though, where the tense head is realized by *-v*. Thus, there is 2s *eve*, and 2pl *seive*. Importantly, while there is person/number based suppletion in the imperfect forms, these are forms in which the agreement morphemes occur to the *left* of the imperfect tense morpheme *-v*. That is, in *seive*, the *-ei* to the left of imperfective *-v* is an agreement morpheme. Although, as discussed by Calabrese, there are a number of analytical challenges posed by (i) patterns of syncretism in these forms, and (ii) the apparent "multiple exponence", the overall pattern is suggestive.

morphemes showing a stress-triggered alternation between *and* and *va(d)* or *-i* and *-isc-*; and there is little reason to think of the alternation as phonological in the first place (at least, in the case of *va(d)* and *and*, which do not share segmental material). There is thus no independent evidence that would suggest that the alternations in (16) are triggered phonologically in the synchronic grammar of Italian, a conclusion that has also emerged in other work.[20]

The analysis of the Italian forms in (16) stands in for the general claim that reference to outer phonological material appears to be universally disallowed in allomorphy. This is a finding that has emerged in several works on allomorphy (recall the references at the end of section 2.3). Suppletive allomorphy may make reference to outer material, as long as phonological properties are not referred to.

5 New Directions The argument to this point shows (i) that morphophonological rules are required for at least certain types of stem alternation, and (ii) that a suppletive alternation that appears to look outward to the phonology, in apparent violation of (A1-2), is better handled with morphosyntactic conditioning. One further conclusion that emerges is that "stem alternation" in the informal sense is not a uniform phenomenon in the grammar: it covers both non-suppletive (Spanish, section 3) and suppletive (Italian, section 4) alternations. This section turns to a finer-grained analysis of different classes of stem alternation, with a specific emphasis on the *triggers* and *targets* that are involved.

Beginning with the latter, some morphophonological processes affect only a particular set of Roots; these are *target-specific*. Another kind of alternation that is morphophonological in the broad sense (i.e., not part of the normal phonology) is not target-specific in this way. Rather, this kind of alternation results from rules that have specific morphemes as *triggers*, but that apply target-indifferently to phonological objects in their context. Most of the processes examined above (in section 3, for the most part) are target-specific. After illustrating some trigger-specific processes in section 5.1, the discussion turns to a general cross-classification of morphophonological interactions in trigger/target terms in 5.2.

What emerges from this classification is a new set of questions about the kinds of arguments that can be deployed in order to decide between stem storage and morphophonology. The primary argument *against* stem storage treatments of stem allomorphy– i.e., the argument developed in section 3– is that some irregular stem alternations can be conditioned by outer phonology, something that is impossible for contextual allomorphy by (A1-2). Section 5.2 below conjectures that another class of stem alternations, one triggered by specific morphemes, and applying only to specific Roots, is found only when the trigger and the target are linearly adjacent. The *sing*/*sang* alternation is of this type. A specific morpheme (T[past]) triggers a specific change, but the change only applies to certain Roots (like $\sqrt{\text{SING}}$). If it is true that such "morpheme-morpheme" alternations occur only under linear adjacency, then they could be analyzed either with stem storage, or with morphophonological rules. The reason for this is that outward-looking allomorphy is compatible with (A1-2), as long as it makes reference to morphosyntactic features only (recall the discussion of section 4). Thus, as far

[20]Maiden (2004:159ff) argues against a phonological account, on the basis of historical developments in various Romance varieties; although he concludes that this is evidence for a "morphomic" analysis in the Aronoff (1994) sense, the overall connection with the argument in the text is suggestive. That stress does not play the defining role in the synchronic grammar does not mean that it was irrelevant diachronically, even if the diachronic developments are not straightforwardly phonological. See Vincent (1988), Maiden (1992,2004a,b,2005), Aski (1995), all probably drawing on Malkiel (1966,1968).

as locality conditions of the A-type go, there is no way to choose between morphophonology and stem storage.

Section 5.3 extends this point by formalizing a "stem insertion" version of the theory of section 2, in which stems like *sing* and *sang* are contextual allomorphs of a root $\sqrt{\text{SING}}$ that compete for insertion. Section 5.4 suggests that the morphophonological approach and the alternative stem insertion approach make crucially different predictions about the psycho- and neurolinguistic status of inflected forms like *sang*. If the conclusions of this section are on the right track, then theoretical and experimental lines of investigation must be employed together in order to determine whether the grammar represents morpheme-morpheme stem alternations in terms of stem storage, or with morphophonological rules.

5.1 Morphophonological rules triggered by specific morphemes The phenomena examined in section 3 involve rules that apply to specific targets, under conditions that are incompatible with (A1-2). It appears that morphophonological alternations triggered by specific morphemes can be incompatible with (A1,2) as well. Carstairs-McCarthy (1992) highlights an alternation with relevant properties in Zulu. Palatalization of labial consonants, which is triggered by the passive suffix *-w*, skips the intervening causative morpheme *-is*, as shown in (22):

(22) Zulu palatalization of labials (Carstairs-McCarthy 1992:70)

	Active	**Passive**
a.	bamb-a 'catch'	ba**nj**-wa 'be caught'
	boph-a 'tie'	bo**sh**-wa 'be tied'
b.	bamb-is-a 'cause to catch'	ba**nj**-is-wa 'be caused to catch'
	boph-is-a 'cause to tie'	bo**sh**-is-wa 'be caused to tie'

The stem consonants are palatalized when the passive affix is present even when the causative morpheme intervenes between the stem and the passive. This effect thus cannot be contextual allomorphy by (A2). This palatalization phenomenon thus looks like an alternation that requires a morphophonological analysis, although there may be some questions as to how "morphologized" the process actually is (Carstairs 1987; see Kotzé and Zerbian (2008) for discussion and references).

Another phenomenon that implicates "skipping" intervening morphemes is seen in certain dialects of Italian that show *metaphony*: a type of vowel raising (for different perspectives see Rohlfs (1949); Calabrese (1985,1999,2009); Maiden (1991); and works cited there). Metaphony is a phonological process in which a stressed vowel is raised when the following syllable contains a high vowel (the precise details of the raising vary from dialect to dialect; see Maiden 1991). In some dialects, it appears that the process has been "morphologized", in the sense that it is triggered morphologically, not phonologically. Morphologically-triggered metaphony can be seen in dialects in which post-tonic vowels have merged to /ə/ (see Maiden 1991:159). Some verb forms from one such dialect, from Ischia (Campania) are shown in (23), next to the same verb forms from Standard Italian:

(23) Metaphony triggered by AGR (Maiden 1991:159)

	St. Italian		*Ischia, Campania*	
	pr. ind.	***impf. ind.***	***pr. ind.***	***impf. ind.***
1s	canto	cantavo	kandə	kandavə
2s	canti	cantavi	**kɛ̲ndə**	**kandɛ̲və**
3s	canta	cantava	kandə	kandavə

It can be seen in the forms from the Ischia dialect that metaphony, which affects the underlined segments, is triggered by 2s AGR, even though that morpheme is realized as *-ə*. Clearly at some earlier historical stage the 2s agreement morpheme triggered metaphony for phonological reasons (compare Standard Italian 2s AGR *-i*). But for the Ischia dialect seen in (23), the metaphonic raising is morphologically triggered by the 2s AGR morpheme. The only alternative to this is to treat the vowel change phonologically, triggered by an underlying *-i* 2s agreement that always surface as /-ə/. There seems to be little motivation for such an analysis.[21]

As far as (A1-2) are concerned, the imperfect 2s form in (23) shows the metaphonic change skipping an intervening morpheme: 2s AGR triggers metaphony over the imperfective tense morpheme *-v* in *kand-ɛ-v-ə* (Root-TH-TNS-AGR), where the theme vowel is raised. Whether or not this is a "stem alternation" in the strict sense depends on whether or not the theme vowel is segmented as a separate morpheme. As far as the general conditions on triggering alternations go, though, this example shows a trigger-specific rule that is not restricted to apply to linearly adjacent objects; i.e., something that is incompatible with (A1-2).[22]

5.2 Types of Interactions The discussion to this point can be synthesized to produce a classification of different types of alternation. Alternations can be classified in terms of their *target* and *trigger* properties. For *targets*, an alternation can be either *target-specific* (requiring reference to Root-/morpheme-identity) or *target-indifferent* (making reference only to phonological features). Triggers can be either morphological (*morph-triggered*) or phonological (*phon-triggered*). The target and trigger parameters are schematized in (24); as stressed above with reference to (A2), the potential intervention of a discrete morpheme α must be considered as well:[23]

(24) Schematization of interactions

$$\text{Target}\left\{\begin{array}{l}\text{Specific}\\ \text{Indifferent}\end{array}\right. \quad \ldots \left(\begin{array}{c}\\ \alpha \\ \\ \end{array}\right) \ldots \text{Trigger}\left\{\begin{array}{l}\text{Morph}\\ \text{Phon}\end{array}\right.$$

The cross-classification of the target and trigger parameters in (24) produces the four possibilities in (25):

(25) Classification

[21] See also Maiden 1991:ch.8 for a "morphological" analysis of this effect.

[22] Some other possible cases of morphophonological rules that skip morphemes have been discussed in the literature. Kiparsky (1996) analyzes German Umlaut as operating across intervening morphemes, although the crucial cases might be subject to reanalysis with adjacent triggers.

[23] In (24) the interactions are represented with the trigger and related material as a "suffix", but the relationships in question could equally be found with prefixation.

	Phon-Triggered	**Morph-Triggered**
Target Specific	(T1)	(T3)
Target Indifferent	(T2)	(T4)

The different types of interactions, with some comments relating them to different case studies, are then as follows:

(T1) ***Phon-Triggered and Target Specific:*** Alternations with a phonological trigger; only certain Roots/morphemes undergo the rule, while others that are evidently phonologically identical do not. Spanish diphthongization and raising (section 3) have these properties.

(T2) ***Phon-Triggered and Target Indifferent:*** Alternations that are part of the "normal" phonology, i.e., changes that do not make reference to specific morphemes in either the trigger or the target. Rather, the process makes reference only to phonological information.

(T3) ***Morph-Triggered and Target Specific:*** Alternations that apply only to specific morphemes, and that are triggered only by specific morphemes. The stem alternations seen in the past tense and participles of English verbs fall under this category. These changes only target certain Roots (e.g. *sink* $\sim$ *sank* but *blink* $\sim$ *blinked*), and are triggered only by specific morphemes (past tense T[past], or the Asp(ect) node in past participles).

(T4) ***Morph-Triggered but Target Indifferent:*** Alternations that are triggered by specific morphemes, but that apply to targets defined phonologically (i.e., the targets are not Root- or morpheme-specific). Zulu passive palatalization and Ischia dialect metaphony in 5.1 are of this type.

Of the alternations in (T1-4), (T2) can be put to the side, since it does not implicate morphological information.[24] The remaining types (T1), (T3), and (T4), reveal an interesting effect when the locality conditions (A1-2) are considered. For both the (T1) and (T4) class of interactions, there is clear evidence in the case studies above for alternations that behave in ways that are incompatible with (A1-2). Instances of (A1) like Spanish diphthongization cannot be treated as allomorphy in a theory with (A1-2) because the alternation is triggered by phonological properties of the entire word. Similarly, instances of (T4) like the Zulu passive or the metaphonic alternation seen in the Ischia dialect skip intervening morphemes, in a way that is not permitted by (A2). However, no (T3) alternations were examined in this part of the argument; and it appears that interactions of the (T3) class might actually be compatible with (A1-2).

The (T3) phenomena of interest are those that are *not* obviously suppletive. The outright suppletion examined in section 4, Italian *and* and *va(d)*, could be seen as a (T3) interaction. But this alternation clearly involves two distinct Vocabulary items. The important cases are those that could be treated either with distinct Vocabulary items (i.e., with stem storage), or as the product of morphophonological rules. There are many examples like this.

As noted above, one relevant (T3) interaction is found with English past tense forms like *sang* etc., where the stem change is triggered by the T[past] morpheme. The syntactic structure underlying such forms is [[$\sqrt{\text{ROOT}}$ v] T[past]]. The T[past] morpheme is linearly adjacent to the Root, if it is assumed that v is invisible (see comments on invisibility in 5.3). The same thing is true of irregular

[24] Except to the extent that there are exceptions.

plurals in English, such as *goose∼geese*. In the latter case, parallel to what was said for the verbs above, the Root and the [pl] morpheme are linearly adjacent as long as the n morpheme is not present when VI occurs.

Similarly, stem changes in German preterites and participles (often referred to collectively as Ablaut) are triggered by Aspect and Tense morphemes, so that for *singen* 'sing' the past tense is *sang*, the participle is *gesungen*, and so on. There are a number of different changes like this, but they are all triggered by T[past] and Asp(ect) heads; and these morphemes are adjacent to the Root that is changed. The same sort of effect is seen in Latin perfect verb stems. Many perfects show vowel and other stem changes that apply only when the Root is adjacent to the perfect aspect morpheme Asp[perf]; e.g. *fragere* 'break', perfect *frēgī*; *capere* 'take', perfect *cēpī*; and so on.

The examples just mentioned serve to illustrate the basics of the phenomenon; there are too many (T3) interactions to be surveyed here. The general question that (T3) raises is whether *all* interactions referring to the identity of two morphemes– whether suppletive (contextual allomorphy) or not (morphophonology)– are subject to the same condition on locality. It is possible that (A2) above– the concatenation condition on contextual allomorphy– is part of the larger generalization that all PF interactions that relate two morphemes qua morphemes must occur under linear adjacency. This is stated as a conjecture in (26):[25]

(26) **Morpheme Interaction Conjecture (MIC):** All morpheme-morpheme interactions relevant to allomorphy are subject to the same locality condition– linear adjacency (concatenation).

According to the MIC, a grammatical process (in the PF branch) that makes reference to two morphemes *as morphemes* (i.e., requires reference to their "morphological identity", not phonological form) is restricted to apply under linear adjacency. The MIC is different from (A2) *only if a morphophonological analysis of the (T3) class is assumed*; see 5.3 below.

On the face of it, the MIC seems quite strong; it would be surprising if it were true, although I am aware of no counterexamples. If this condition does hold, this would be an important finding. It would be strong evidence for a consistent notion of morpheme-morpheme locality at PF, in a way that connects with much more general theories of locality.

The theory assumed here, from Embick (2010), has a hybrid property in these terms: phase-cyclic locality, which derives from the syntactic derivation, places constraints on which nodes could potentially interact, by limiting possible interactions to objects contained within a single cyclic domain. However, the linear aspect of that theory– (A2) in the discussion above– also appears to restrict contextual allomorphy. If this theory is on the right track, then the general locality constraints imposed by cyclic derivation have the PF-parochial linear condition (A2) superimposed on them. Something similar to this is argued to be operative in the interpretive component as well, in work by Marantz (2010). In this theory, phase-cyclic locality interacts with a parochial semantic locality condition, that is, "semantic adjacency". Internal to PF representations, the MIC conjectures that there is only one PF-parochial condition under which two morphemes can see each other as such: linear adjacency. From this point of view, then, it would be surprising if MIC were false, as it would be difficult to see why one type of morpheme-morpheme interaction (contextual allomorphy)

[25] As noted in section 1, Aronoff's allomorphy rules change the form of certain morphemes in the context of certain other morphemes. There are some clear connections between that proposal and the MIC.

should require linear adjacency, whereas another type of morpheme-morpheme interaction (stem allomorphy) did not.

For these reasons, I take it that the status of the MIC must be at the center of further research in this area.

5.3 On Stem Insertion In the text above, the MIC is stated in a way that assumes a morphophonological treatment of (T3) alternations. But there is another way of looking at the MIC, one which makes it essentially equivalent to (A2), the concatenation condition on contextual allomorphy. The MIC raises the possibility that (T3) alternations might apply only under adjacency. In the case of such alternations, then, there is no argument based on (A1-2) that shows that a morphophonological analysis is required. Rather, as far as locality conditions are concerned, the (T3) alternations could be treated either morphophonologically, or in terms of stem storage. Before showing what a stem insertion analysis would look like within the framework assumed here, I will first examine some of the basic theoretical positions that are implicated in this discussion.

One of the central tenets of Distributed Morphology is that there is no storage of complex objects. This assumption is not always named; for convenience I will refer to it as the *Decomposition Hypothesis*, Decomposition for short. The particular aspect of Decomposition that is of interest here is the one that is often invoked in psycho- and neurolinguistic studies cited above in section 2. Irregular past tense verbs, like *sang* for *sing*, illustrate the point. In so-called "dual route" models of past tense inflection (Pinker and Ullman 2002 and related work), the past tense form *sang* is not derived from *sing*; rather, it is memorized as a different "word" in the Lexicon, and functions as the past tense of *sing* not because of any derivational relatedness (shared parts), but because of semantic relatedness. This is the kind of analysis that is incompatible with Decomposition; according to the Decompositionalist view, there can be no storage (memorization) of "inflected" forms like *sang* = [SING +past]. Rather, a complex object (containing both $\sqrt{\text{SING}}$ and T[past]) must be derived via grammatical operations that combine the relevant parts.

Another important position that has been at the center of much research concerns the phonological underlying representation of morphemes. In a theory with late insertion for functional nodes, a single morpheme like T[past] does not have a single underlying representation phonologically. Rather, it is provided with a phonological matrix post-syntactically, in the Vocabulary Insertion process. According to one line of work, however, Roots are unlike functional morphemes in that Roots possess a phonological underlying representation; this means that Roots are not subject to Late Insertion in the way that functional morphemes are (see Marantz (1995), Embick (2000), and Chomsky (2001) for some perspectives on this question). For convenience, I use URR (for *Underlying Representation for Roots* as shorthand for this hypothesis:

(27) **Underlying Representation for Roots (URR):** A Root possesses a phonological underlying representation (i.e., Roots are not subject to Vocabulary Insertion).

Much recent work in the framework that I am developing here assumes both Decomposition and URR. These two positions fit together, in the following way. Decomposition says that *sang* cannot be a simplex object in memory, because it must consist of separate pieces, $\sqrt{\text{SING}}$ and T[past]). By URR, *sing* and *sang* must be derived from an object $\sqrt{\text{SING}}$ that has one phonological representation. It follows from this that e.g. *sang* must be decomposed in such a way that the single underlying representation of the Root $\sqrt{\text{SING}}$ is inside of *sang* (and inside of *sing* as well).

An important point for the theory of stem alternations is that a theory can maintain a form of Decomposition while abandoning URR; moreover, this can be done in a way that allows for certain types of stem alternations to be treated as contextual allomorphy. In other words, there is a kind of stem storage theory that is compatible with Decomposition, even if it is Decomposition in a weaker form. In such a theory, Roots are subject to Vocabulary Insertion (see Harley 2009 for some arguments for a theory of this type).

To a first approximation, a Root like $\sqrt{\text{SING}}$ can be associated with a set of distinct stem forms, which are found in different morphosyntactic contexts:

(28) Stem-storage representation of $\sqrt{\text{SING}}$

$$\sqrt{\text{SING}} \begin{cases} \text{sung} \leftrightarrow /\_\_ \text{ Asp} \\ \text{sang} \leftrightarrow \_\_ \text{ T[past]} \\ \text{song} \leftrightarrow \_\_ n \\ \text{sing} \end{cases}$$

In this stem insertion theory, the different stem forms are treated as contextual allomorphs; this is a modified stem theory (m-stem theory).

Superficially, the storage (and insertion) of stems in the m-stem approach is reminiscent of the treatment of stem alternations found in Anderson 1992. However, it differs crucially from Anderson's view in treating e.g. *sang* as a contextual allomorph of $\sqrt{\text{SING}}$, whose insertion is associated with the local [past] node. Anderson, on the other hand, treats *sang* as realizing the [past] feature directly, a move that is problematic for the statement of blocking interactions between stem-changing processes on the one hand, and piece-based realization of morphemes on the other. See Halle and Marantz (1993) and Embick and Halle (2005) for some discussion.

There is a conceptual objection that can be raised against (28). There is nothing in (28) that ensures that the individual phonological forms that are "exponents" of the root $\sqrt{\text{SING}}$ should be phonologically related to one another. Put differently, extending the domain of contextual allomorphy to include alternations in stem forms is tantamount to generalizing the phenomenon of suppletion: the relationship between *sing* and *sang* is essentially the same as that between *go* and *went*. As far as conceptual arguments go, this is a strong one. Generalizing suppletion (the most radical kind of sound/meaning inconsistency) to phenomena in which there are clearly shared phonological properties seems extreme. Nevertheless, if what we are looking for is empirical arguments that favor the morphophonological or stem storage theories, these conceptual objections must be ignored.

The sketch in (28) does not make a clear claim about how exactly the different stems *sing*, *sang*, etc. relate to a single Root. As noted above, URR has to be abandoned in a theory with stem insertion. One way of doing this with reference to the $\sqrt{\text{SING}}$ example is as follows. It can be assumed that Roots are in one sense present throughout the derivation, but that what is present is a non-phonological index of stem identity, not an actual phonological representation. So, for example, the Root vocabulary of a language would consist of objects like $\sqrt{422}$. There is independent motivation for some form of non-phonological indexation along these lines.[26]

[26] At least some indexation is required on any view, since homophonous Roots must be distinguished with one another. So, for example, the roots underlying *bank* 'financial institution' and *bank* 'side of a river etc.' must be specified as e.g. $\sqrt{\text{BANK}_{232}}$ and $\sqrt{\text{BANK}_{729}}$, since the phonology alone is not sufficient to distinguish these Roots from one another.

By the index hypothesis, then, the Root underlying *sing* etc. is, qua Root that is employed in syntactic derivations, simply $\sqrt{422}$. The phonological form of this Root is determined in the PF component of the grammar, via the Vocabulary Insertion process. The particular VIs are as follows:

(29) $\sqrt{422} \leftrightarrow$ sung/__ Asp
$\sqrt{422} \leftrightarrow$ sang/__T[past]
$\sqrt{422} \leftrightarrow$ song/__n
$\sqrt{422} \leftrightarrow$ sing

While (29) contains many VIs, this need not always be the case. Other Roots, such as $\sqrt{\text{KICK}}$, could have a simpler version of (29): for instance, $\sqrt{1337} \leftrightarrow$ kick; or, such Roots could possess a phonological representation inherently. For present purposes, the treatment of such (non-alternating) Roots is immaterial.

The analysis of stem allomorphy in (29) avoids various objections that have been leveled against the "late insertion" of Roots.[27] Because it is based on unique indices for each Root, it also avoids various difficulties with "cross-Root" competition discussed in Marantz 1995). Since the syntax already contains a unique identifier of the Root, it is not possible for e.g. forms of $\sqrt{\text{CAT}}$ to compete with forms of e.g. $\sqrt{\text{FELINE}}$ (or for that matter, $\sqrt{\text{BOOK}}$). The m-stem theory is therefore able to circumvent these and other problems for late insertion of Roots that have been discussed in the literature.[28]

The m-stem theory adheres to Decomposition in a weak form, not the strong form discussed earlier in this section; that is:

(30) a. ***Strong Decomposition:*** Different forms that are derived from the same Root all contain a unique phonological representation of that Root.

b. ***Weak Decomposition:*** Different forms that are derived from the same Root all contain an identical Root in the "indexed" sense introduced above. They do *not* necessarily all derive from a single underlying phonological representation.

It is clear that Weak Decomposition can maintain the ban against memorizing complex objects, as Strong Decomposition can. However, Weak Decomposition does not require that lexically related

[27]For example, the behavior of Latin deponent verbs, discussed in Embick (2000), is a case in which it appears that a syntactic affixation operation (most likely head movement) refers to a diacritic borne by particular Roots. As noted in that paper, if Roots were inserted late, the syntactic operation could not see the relevant diacritic, since it would not be present. In the Root indexation view, it is not the Root itself that is inserted late, but the phonological form of the Root. Thus, the diacritics borne by deponent Roots could be present in the syntax, even if phonological forms are not.

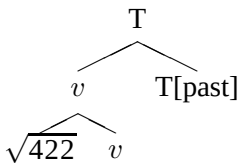
[28]Some related issues involve Fusion, in which a Root node fuses with adjacent functional heads prior to insertion. This might look appealing as a way of making stem change block overt affixation, but it is in fact problematic. The reason for this, stressed amply in the prior literature (Halle and Marantz 1993), is that stem allomorphy can be accompanied by overt affixation (as in *tol-d*, *brok-en*, etc.). Thus even if one wanted to say that e.g. *sang* was derived by fusing $\sqrt{422}$ with T[past], and then inserting *sang* as the exponent of these features, there are still the other cases of "double-marking" to be accounted for, where a fusion treatment is unworkable.

The same considerations argue against allowing Vocabulary Insertion to target non-terminal nodes. In a theories that allow this (see Hankamer and Mikkelsen (2005) for pertinent discussion), the *sing* $\sim$ *sang* alternation could be analyzed with *sang* as an exponent of the topmost node in [[$\sqrt{\text{SING}}$ v] T[past]]. Again, how this fits with double marking is problematic. For a more general set of arguments against insertion at non-terminals, see the discussion in Embick and Marantz (2008).

forms contain the same underlying phonological representation of the Root; it is for this reason that Weak Decomposition allows for stem insertion, whereas Strong Decomposition does not.

The m-stem approach also requires a theory of the "invisibility" of certain nodes for the purposes of Vocabulary Insertion. As stated in (29), the insertion of *sang* is contextually associated with the past tense morpheme. The structure underlying this form is (31), according to standard assumptions:

(31) Structure for *sang*



In order for *sang* to be inserted in the Root position, this node must be in a local relationship with the T[past] morpheme. However, there is a v head between the Root and T[past]. This v head must not be present for VI at the Root node in order for the contextual allomorphy to obtain in a way that complies with (A2).

Embick (2010) discusses the status of invisible nodes, but from an inward-looking perspective. For e.g. a Tense node looking inward, the nodes that do not count for contextual allomorphy, like the v in (31), have the shared property that they have no phonological exponent. Earlier work (see also Embick 2003) proposes that at least some nodes with zero exponents are *pruned* (eliminated from the representation). This kind of solution works mechanically for inward-looking allomorphy, but it does not provide what is necessary for the m-stem theory based on (29). The problem is that, by (A1), insertion at the Root node occurs prior to insertion at v. If pruning applies to nodes with zero exponents, it cannot eliminate v prior to VI at the Root node, because (A1) does not allow that. Rather, insertion at the Root position must take place prior to insertion at v.

There are, however, alternatives to Ø-pruning rules that will eliminate nodes like the v node in (31). Some motivation for an "early" deletion process can be found in recent discussions by Borer (2009) and Marantz (2010); see also Saab (2008) for a more general discussion of deletion and its relation to linearization. It is sufficient to assume here that some such process eliminates certain nodes *prior* to the beginning of the VI process. Representing this pre-VI process under the cover term PRUNE, the derivation of *sang* in the m-stem theory is then as follows:

(32) Input: [[$\sqrt{422}$ v] T[past]]

a. PRUNE: [[$\sqrt{422}$ v] T[past]] $\longrightarrow$ [$\sqrt{422}$ T[past]]

b. Linearization: $\sqrt{422}$⌒T[past]

c. VI, Root: sang⌒T[past]

d. VI, T[past]: sang⌒Ø

There is of course more to be said about the general line of research that motivates an approach to invisibility like the one based on PRUNE. But for the purposes of formalizing stem insertion, (32) illustrates how competition for Root insertion can be treated in a way that complies with (A1-2).

5.4 Stem storage, morphophonology, unification The m-stem theory is able to treat at least some stem alternations as contextual allomorphy, in a way that respects (Weak) Decomposition. As contextual allomorphy, m-stem alternation must respect (A1-2). Thus, an m-stem treatment could not be extended to e.g. the stem alternations in Spanish verbs examined in section 3.

If the MIC is correct, then all morpheme-morpheme interactions require concatenation; i.e., they obey (A2). This means that all cases of morpheme-morpheme interaction could be treated either with an m-stem analysis, or with a morphophonological analysis. The m-stem analysis of *sing*∼*sang* is articulated in (32) above. The morphophonological alternative to this is given in (33); I have parenthesized the PRUNE step, since this approach could employ post-VI rather than pre-VI pruning of v:

(33) Syntax: [[$\sqrt{\text{SING}}$ v] T[past]]

a. (PRUNE: [[$\sqrt{\text{SING}}$ v] T[past]] $\longrightarrow$ [$\sqrt{\text{SING}}$ T[past])

b. Linearization: $\sqrt{\text{SING}}\frown$T[past]

c. VI, T[past]: $\sqrt{\text{SING}}\frown$Ø

d. Readjustment Rule: sing$\longrightarrow$ sang/__$\frown$T[past]

e. Output: sang$\frown$Ø

This analysis takes the root $\sqrt{\text{SING}}$ to have an underlying representation (by URR), which is then altered by a morphophonological rule that makes reference to T[past] to produce *sang*. Such an analysis of stem alternations is proposed in numerous places in the literature (see Halle and Marantz 1993, Embick and Marantz 2005, Embick and Halle 2005).

As (32-33) show, both the m-stem theory and the morphophonological theory with Readjustment Rules seem to be able to account for the facts, in a way that complies with specific conditions (A1-2), and also with at least some form of Decomposition. They differ along some other dimensions. For one, they have commitments to different auxiliary theories. For instance, the m-stem theory requires a particular theory of node invisibility/pruning, as outlined above. The morphophonological theory, on the other hand, requires Readjustment Rules of a particular type. They also differ, as noted above, with respect to certain conceptual claims; viz., the m-stem theory puts more emphasis on memory than on derivation by rule, it generalizes suppletion, and so on. But the main point is clear: the kind of distributional arguments based on locality and related notions– those encapsulated in (A1-2)) and used in section 3 to show that a morphophonological theory is needed in some form– cannot, evidently, choose between stem storage and morphophonological theories for a substantial class of stem alternations.

The overall picture that emerges from this section illustrates both the successes of a theory based on locality considerations (and resulting distributional patterns), and the apparent limits of such a theory. Exactly this kind of limitation is of critical importance as the sciences of language move towards some form of unification; that is, towards a state in which currently existing boundaries between theoretical and experimental methodologies in linguistics (and perhaps between the cognitive and neurobiological domains) are blurred and ultimately eliminated (Poeppel and Embick (2005), Embick and Poeppel (2010)). The specific tension between the m-stem and morphophonological theories is central to this project because the crucial evidence adjudicating between these theories might have to come from psycho- and neurolinguistic studies of linguistic representation. And, crucially, the theoretical models must be employed to interpret the experimental findings.

The particular relevance of experimental data becomes clear when the predictions of the m-stem and morphophonological theories are considered in more detail. The m-stem analysis in (29) says two different things about the syntacticosemantic and morphophonological relatedness of the different forms *sing*, *sang*, etc. On the syntacticosemantic level, it says that all the forms in (29) are built from the same object, viz. $\sqrt{422}$. On the morphophonological level, on the other hand, there is no sense in which e.g. *sing* is part of *sang*. Rather, these are two distinct objects. So, as far as one level of representation goes– the syntacticosemantic level– both e.g. *sing* and *sang* are derived from the same object. As far as phonological relatedness goes, though, there is no sense in which *sang* is derived from *sing*.

In the morphophonological theory, on the other hand, the Root form $\sqrt{\text{SING}}$ is present syntacticosemantically in *sing*, *sang*, etc.; its phonological underlying representation– abbreviated /sing/ for convenience– is part of the derivation as well.[29] It is this underlying representation that is converted to *sang* by rule. Thus, although the two theories ultimately both derive *sang*, they do so with very different commitments to the stages leading up to this form. These different stages lead to different hypotheses about the representations and computations that underlie the production or comprehension of *sang*, as stated in (34):

(34) Predictions

	m-stem theory	**morphophonological theory**
a.	Root $\sqrt{422}$ activated	Root $\sqrt{\text{SING}}$ activated
b.	Phonological form /sing/ **NOT** activated	Phonological form /sing/ activated
c.	(No further rules)	Vowel-changing rule activated

With respect to (34a), both theories say the same thing. For (34b,c), though, they differ. The morphophonological theory says that the phonological form /sing/ is active; that is, that /sing/ is part of *sang* (it also says that a rule is activated to execute the vowel change). In the m-stem theory /sing/ is not part of *sang* phonologically, as *sing* and *sang* are separate Vocabulary Items. The role of the unification project is then clear: while distributional criteria might not distinguish between the m-stem and morphophonological theories, since they are both capable of producing the correct surface forms, the dependent variables that are examined in psycho- and neurolinguistic studies of language provide a window on the stages that are part of the computation of these forms. And if it could be shown using these techniques that /sing/ is a part of *sang*, this would be an argument that the morphophonological theory is correct.

Experimental research looking at exactly this sort of question has not been undertaken in detail, for a few different reasons. First, much research in this area approaches morphological relatedness at a much coarser level of granularity, as in the single-system (connectionist) versus dual-system dialogue. Another reason is that much of the literature uses visually-presented stimuli, where phonological representations take a back seat to orthography. For example, Allen and Badecker (1999) and Badecker and Allen (2002) look at a question related to (34), in the domain of Spanish verbs,

[29] It is possible that /sing/ is not *sing*; that is, that both *sing* and *sang* share a single underlying representation /sing/ in a way that requires derivation in each case. As long as *sing*, *sang* etc. share a single phonological underlying representation, STRONG DECOMPOSITION is respected.

asking, in effect, if the diphthongized verb form *muere* 'dies-3s' has the non-diphthongized stem *mor-* (from infinitive *morir*) inside of it. The results reported in those works suggest that *muere* does in fact derive from *mor*. However, as important and suggestive as these results are, they are not based on *phonological* representations. Rather, the logic of the experiment is based on orthographic representation (the paradigm exploits effects related to stem homography). In order to address the issues surrounding (34) directly, the emphasis must, of course, be on phonological representation (see also Stockall and Marantz (2006) for some pertinent discussion).

It is possible that there are other results in the experimental domain that relate directly to (34); a comprehensive review of that literature must wait for another occasion. Ultimately, there are different ways in which a unified research program could be pursued. My own view of these matters is that Strong Decomposition must be pushed to its limits; i.e., it must be assumed to be correct, and positive evidence that e.g. *sing* and *sang* derive from a shared phonological representation should be sought. This, however, is a research intuition, one that must be shown to be correct or incorrect empirically.

6 Conclusions The central thesis of this paper is that stem alternations are constrained to apply under certain conditions, and not others, and that they must be studied with reference to a more general theory of locality in allomorphy. The theory developed in sections 2-4 of this paper holds that suppletive allomorphy must respect (A1-2); a consequence of this view is that many types of stem alternation must be treated as the product of (morpho)phonological rules, because they are triggered in ways that are impossible for suppletive contextual allomorphy.

The idea that the distribution of stem alternants is crucial to understanding the debate between stem storage and morphophonological theories ("storage" versus "computation" in the experimental domain) is mostly absent from the recent literature. But the main line of argument that is articulated here connects with a line of research developed in a paper by Kiparsky (1996). Analytically, Kiparsky poses the same question that section 1 begins with: how "morpholexical" (=allomorphic) and "morphophonemic" processes can be distinguished from one another. The guiding idea of his paper is that "...the essential criteria have to do with the nature of the alternation, the locality relation between the focus and the triggering context, and the relationship of the process to other rules of the system" (1996:17). A number of details about the analysis of alternations do not look the same in Kiparsky's Lexicalist model as they do in the syntactic approach assumed here, and there are some differences with respect to productivity as well; but the overall point advanced in these quotes is, I believe, exactly on target.

Beyond the arguments based on (A1-2) and their implications for the controversy between morphophonological and stem storage theories, section 5 of this paper advances the claim that not all stem alternations are the same. Rather, when the properties of the targets and triggers of an alternation are taken into account, it appears that some stem alternations are more (morpho)phonological– i.e., those in which either the trigger or target are defined in phonological terms– whereas others, the (T3) morpheme-morpheme class of stem alternation, are more morphological in nature. Stem alternations in which either the target or the trigger are defined phonologically do not have to respect (A1-2); rather, they may make reference to "outer" phonological properties, skip intervening morphemes, and so on. It is this class of stem alternation that must be treated in terms of morphophonological rules, not with stored allomorphs.

The key question with the morpheme-morpheme alternations is whether they behave similarly to the morphophonological interactions, or whether they obey the linear adjacency condition (A2).

That morpheme-morpheme interactions do in fact obey (A2) is the content of the *Morpheme Interaction Conjecture*, which provides a central focus for future work on the distribution of stem alternants.

A final theme of this paper is in part methodological. If the arguments of the first sections of the paper are correct, then looking at patterns of stem distribution in the light of (A1-2) provides an argument for a morphophonological theory. If the considerations of section 5 are correct, and the Morpheme Interaction Constraint holds, then stem distributions on their own cannot be used to distinguish the predictions of stem storage versus morphophonological theories in this type of phenomenon. This point is made precise in terms of the m-stem theory, which implements stem storage in a way that is compatible with many of the central tenets of the framework assumed here. The conclusion is that only with the use of other methodologies, psycho- and neurolinguistic techniques in particular, can the crucial evidence be found.

It is, of course, possible that other types of evidence, not from the experimental domain, could be brought to bear on the status of morpheme-morpheme interactions. The orientation of the latter part of this paper is directed toward the unification project, because morpheme-morpheme interactions seem like a prime example of a phenomenon where this can be seriously undertaken. In a sense, at least some form of unification across the theoretical and empirical domains is inevitable. At a minimum, it is only by articulating the details of the morphophonological and m-stem theories, in the manner outlined above, that precise predictions about representation and computation in the brain can be developed. If the basic line of reasoning here turns out to be correct, and only experimental evidence can prove decisive, it would certainly be a striking development.

Much research in the framework I assume here, along with my own work, is guided by the intuition that something like Strong Decomposition is correct. The hope is that evidence for this position will emerge from an integrated research program like the one I have outlined here. But in the end, any steps towards unification across domains is an important step in the right direction.

References

Albright, Adam, Agelia Andrade, and Bruce Hayes (2000) "Segmental environments of Spanish diphthongization," ms., UCLA.

Allen, Mark, and William Badecker (1999) "Stem homograph inhibition and stem allomorphy: Representing and processing inflected forms in a multi-level lexical system," *Journal of Memory and Language* 41, 105–123.

Anderson, Stephen (1992) *Amorphous Morphology*, Cambridge University Press, Cambridge.

Aronoff, Mark (1976) *Word Formation in Generative Grammar*, MIT Press, Cambridge, MA.

Aronoff, Mark (1994) *Morphology by Itself: Stems and Inflectional Classes*, MIT Press, Cambridge, MA.

Aski, Janice, "Verbal suppletion: an analysis of Italian, French, and Spanish *to go*," *Linguistics* 33, 403–432.

Bachrach, Asaf, and Michael Wagner (2006) "Syntactically driven cyclicity vs. output-output correspondence: The case of adjunction in diminutive morphology," ms., paper presented at the *Penn Linguistics Colloquium*.

Badecker, William, and Mark Allen (2002) "Morphological parsing and the perception of lexical identity: A masked priming study of stem homographs," *Journal of Memory and Language* 47, 125–144.

Bermúdez-Otero, Ricardo (2010) "The Spanish lexicon stores stems with theme vowels, not roots with inflectional class features," ms., University of Manchester.

Bobaljik, Jonathan (2000) "The Ins and Outs of Contextual Allomorphy," in *University of Maryland Working Papers in Linguistics* 10, 35–71.

Bonet, Eulàlia (1991) *Morphology After Syntax: Pronominal Clitics in Romance*, Doctoral dissertation, MIT.

Borer, Hagit (2009) "Very late insertion," talk handout, USC.

Brovetto, Claudia, and Michael Ullman (2005) "The Mental Representation and Processing of Spanish Verbal Morphology," in David Eddington, ed., *Selected Proceedings of the 7th Hispanic Linguistics Symposium*, Somerville, MA, Cascadilla Proceedings Project, 98–105.

Burzio, Luigi (1998) "Multiple correspondence," *Lingua* 104, 79–109.

Calabrese, Andrea (1985) "Metaphony in Salentino," *Rivista di grammatica generativa* 9-10, 3–140.

Calabrese, Andrea (1999) "Metaphony Revisited," *Rivista di Linguistica* 10, 7–68.

Calabrese, Andrea (2003) "Fission and Impoverishment in the Verbal Morphology of the Italian Dialect of Livinallongo," in Christina Tortora, ed., *The syntax of Italian Dialects*, Oxford University Press, New York, 3–30.

Calabrese, Andrea (2009) "Metaphony," ms., University of Connecticut.

Carstairs, Andrew (1987) *Allomorphy in Inflexion*, Croom Helm, London.

Carstairs, Andrew (1988) "Some implications of phonologically conditioned suppletion," in G. Booij and J. van Marle, eds., *Yearbook of Morphology 1988*, Foris, Dordrecht, 67–94.

Carstairs, Andrew (1990) "Phonologically Conditioned Suppletion," in Wolfgang Dressler, Hans Luschutzky, Oskar Pfeiffer, and John Rennison, eds., *Selected Papers from the Third International Morphology Meeting*, Mouton de Gruyter, Berlin.

Carstairs-McCarthy, Andrew (1992) *Current Morphology*, Routledge, London.

Carstairs-McCarthy, Andrew (2002) "How stems and affixes interact," in Sabrina Bendjaballah, Wolfgang Dressler, Oskar Pfeiffer, and Maria Voeikova, eds., *Morphology 2000*, John Benjamins, 49–57.

Chomsky, Noam (1957) *Syntactic Structures*, Mouton, The Hague.

Chomsky, Noam (2000) "Minimalist Inquiries: The Framework," in Roger Martin, David Michaels, and Juan Uriagereka, eds., *Step by Step: Essays on Minimalist Syntax in Honor of Howard Lasnik*, MIT Press, 89–156.

Chomsky, Noam (2001) "Derivation by Phase," in Michael Kenstowicz, ed., *Ken Hale. A Life in Language*, MIT Press, Cambridge, MA, 1–52.

Chomsky, Noam, and Morris Halle (1968) *The Sound Pattern of English*, Harper and Row, New York.

Clahsen, Harald, Fraibet Aveledo, and Iggy Roca (2002) "The development of regular and irregular verb inflection in Spanish child language," *Journal of Child Language* 29, 501–622.

de Belder, Marijke, Noam Faust, and Nicola Lampitelli (2009) "On inflectional and derivational diminutives," paper presented at NELS 40, Cambridge MA.

Dressler, Wolfgang U. (1985) *Morphonology: The dynamics of derivation*, Karoma Publishers, Ann Arbor.

Embick, David (2000) "Features, Syntax and Categories in the Latin Perfect," *Linguistic Inquiry* 31:2, 185–230.

Embick, David (2003) "Locality, Listedness, and Morphological Identity," *Studia Linguistica* 57:3, 143–169.

Embick, David (2010) *Localism versus Globalism in Morphology and Phonology*, MIT Press, Cambridge, MA.

Embick, David, and Morris Halle (2005) "On the status of *stems* in morphological theory," in T. Geerts and H. Jacobs, eds., *Proceedings of Going Romance 2003*, John Benjamins, Amsterdam/Philadelphia, 59–88.

Embick, David, and Alec Marantz (2005) "Cognitive Neuroscience and the English Past Tense: Comments on the Paper by Ullman et al." *Brain and Language* 93.

Embick, David, and Alec Marantz (2008) "Architecture and Blocking," *Linguistic Inquiry* 39:1, 1–53.

Embick, David, and David Poeppel (2010) "Linguistic computation and neurobiology," ms., University of Pennsylvania and New York University.

Fontana, Josep (1993) *Phrase Structure and the Syntax of Clitics in the History of Spanish*, Doctoral dissertation, University of Pennsylvania.

Gouskova, Maria (2009) "Unexceptional Segments," ms., New York University.

Hale, Kenneth, Jeanne LaVerne, and Paula Pranka (1990) "On suppletion, selection, and agreement," in Carol Georgopoulos and Roberta Ishinara, eds., *Interdisciplinary approaches to languages*, Kluwer, Dordrecht, 255–270.

Halle, Morris (1959) *The Sound Pattern of Russian*, Mouton, The Hague.

Halle, Morris (1973) "Prolegomena to a Theory of Word Formation," *Linguistic Inquiry* 3–16.

Halle, Morris, James Harris, and Jean-Roger Vergnaud (1991) "A reexamination of the Stress Erasure Convention and Spanish Stress," *Linguistic Inquiry* 22:1, 141–159.

Halle, Morris, and Alec Marantz (1993) "Distributed Morphology and the Pieces of Inflection," in Kenneth Hale and Samuel Jay Keyser, eds., *The View from Building 20: Essays in Linguistics in Honor of Sylvain Bromberger*, MIT Press, Cambridge, MA, 111–176.

Halle, Morris, and Jean-Roger Vergnaud (1987) *An Essay on Stress*, MIT Press, Cambridge, MA.

Hankamer, Jorge, and Line Mikkelsen (2005) "When Movement Must be Blocked: A Response to Embick and Noyer," *Linguistic Inquiry* 36:1, 85–125.

Harley, Heidi (2009) "Locality and roots," talk presented at *Roots* workshop, Stuttgart.

Harris, James W. (1969) *Spanish Phonology*, MIT Press, Cambridge, MA.

Harris, James W. (1985) "Spanish Diphthongization and Stress: A Paradox Resolved," *Phonology Yearbook* 2, 31–45.

Harris, James W. (1987) "The accentual patterns of verb paradigms in Spanish," *Natural Language and Linguistic Theory* 5, 61–90.

Harris, James W. (1989) "The Stress Erasure Convention and Cliticization in Spanish," *Linguistic Inquiry* 20:3, 339–363.

Hooper, Joan (1976) *An Introduction to Natural Generative Phonology*, Garland Academic Publishers.

Inkelas, Sharon, C. Orhan Orgun, and Cheryl Zoll (1997) "The implications of lexical exceptions for the nature of grammar," in Iggy Roca, ed., *Constraints and derivations in phonology*, Oxford University Press.

Kilbury, James (1976) *The Development of Morphophonemic Theory*, volume 10 of *Amsterdam Studies in the Theory and History of Linguistic Science*, John Benjamins.

Kiparsky, Paul (1996) "Allomorphy or Morphophonology?" in Rajendra Singh and Richard Desrochers, eds., *Trubetzkoy's Orphan*, John Benjamins, Amsterdam/Philadelphia, 13–31.

Kotzé, Albert E., and Sabine Zerbian (2008) "On the Trigger of Palatalization in the Sotho languages," *Journal of African Languages and Linguistics* 29, 1–28.

Linares, Rafael, Antoni Rodriguez-Fornells, and Harald Clahsen (2006) "Stem allomorphy in the Spanish mental lexicon: Evidence from behavioral and ERP studies," *Brain and Language 97* 97, 110–120.

Loporcaro, Michele (2000) "Stress Stability under Cliticization and the Prosodic Status of Romance Clitics," in Lori Repetti, ed., *Phonological Theory and the Dialects of Italy*, John Benjamins, Amsterdam/Philadelphia, 137–168.

Maiden, Martin (1991) *Interactive morphology: Metaphony in Italy*, Routledge, London and New York.

Maiden, Martin (1992) "Irregularity as a determinant of morphological change," *Journal of Linguistics* 28, 285–312.

Maiden, Martin (2004a) "Morphological autonomy and diachrony," *Yearbook of Morphology* 137–175.

Maiden, Martin (2004b) "When lexemes become allomorphs– On the genesis of suppletion," *Folia Linguistica* XXXVIII, 227–256.

Malkiel, Yakov (1966) "Diphthongization, Monophthongization, Metaphony: Studies in Their Interaction in the Paradigm of Old Spanish -IR Verbs," *Language* 42:2, 430–472.

Malkiel, Yakov (1968) "The inflectional paradigm as an occasional determinant of sound change," in Winfred P. Lehmann and Yakov Malkiel, eds., *Directions for Historical Linguistics*, University of Texas Press, Austin, 23–64.

Marantz, Alec (1995) "A Late Note on Late Insertion," in *Explorations in Generative Grammar*, Hankuk Publishing Co., 357–368.

Marantz, Alec (2007) "Phases and words," in S. H. Choe et al, ed., *Phases in the theory of grammar*, Dong In Publisher, Seoul.

Marantz, Alec (2010) "Constraints on contextual allosemy," talk handout, New York University.

Matthews, Peter H. (1965) “The inflectional component of a word-and-paradigm grammar,” *Journal of Linguistics* 1:2, 139–171.

Matthews, Peter H. (1972) *Inflectional Morphology; A Theoretical Study Based on Aspects of Latin Verb Conjugation*, Cambridge University Press, Cambridge.

Mayol, Laia (2007) “Acquisition of Irregular Patterns in Spanish Morphology,” in Ville Nurmi and Dmitry Sustretov, eds., *Proceedings of the Twelfth ESSLLI Student Session*.

Mohanan, K. P. (1995) “The Organization of the Grammar,” in John A. Goldsmith, ed., *The Handbook of Phonological Theory*, Blackwell, 24–69.

Newell, Heather (2008) *Aspects of the morphology and phonology of phases*, Doctoral dissertation, McGill University.

Noyer, Rolf (1992) *Features, Affixes, and Positions in Autonomous Morphological Structure*, Doctoral dissertation, MIT.

Noyer, Rolf (1998) “Impoverishment Theory and Morphosyntactic Markedness,” in Steven Lapointe, Diane Brentari, and Patrick Farrell, eds., *Morphology and Its Relation to Syntax and Phonology*, CSLI, Stanford.

Oltra-Massuet, Maria Isabel (1999) *On the Notion of Theme Vowel: A New Approach to Catalan Verbal Morphology*, Master’s Thesis, MIT.

Paster, Mary (2006) *Phonological Conditions on Affixation*, Doctoral dissertation, University of California at Berkeley.

Paster, Mary (2009) “Explaining phonological conditions on affixation: Evidence from suppletive allomorphy and affix ordering,” *Word Structure* 2:1, 18–47.

Pinker, Steven, and Alan Prince (1988) “On language and connectionism: analysis of a parallel distributed processing model of language acquisition,” *Cognition* 28, 73–193.

Pinker, Steven, and Michael Ullman (2002) “The past and future of the past tense,” *Trends in Cognitive Sciences* 6:11, 456–463.

Poeppel, David, and David Embick (2005) “Defining the relation between linguistics and neuroscience,” in Ann Cutler, ed., *Twenty-first century psycholinguistics: Four cornerstones*, Lawrence Erlbaum.

Rodriguez-Fornells, Antoni, Thomas Münte, and Harald Clahsen (2002) “Morphological priming in Spanish verb forms: An ERP repetition priming study,” *Journal of Cognitive Neuroscience* 14, 443–454.

Rohlfs, Gerhard (1949) *Historische Grammatik der Italienischen Sprache und ihrer Mundarten*, A. Francke Ag. Verlag, Bern.

Saab, Andrés (2008) *Hacia una teoría de la identidad parcial en la elipsis*, Doctoral dissertation, Universidad de Buenos Aires.

Singh, Rajendra, ed. (1996) *Trubetzkoy’s Orphan*, John Benjamins, Amsterdam/Philadelphia.

Stockall, Linnea, and Alec Marantz (2006) “A single-route, full decomposition model of morphological complexity: MEG evidence,” *Mental Lexicon* 1:1, 85–123.

Trubetzkoy, Nikolaj S. (1929) “Sur la ‘morphonologie’,” *Travaux du Cercle linguistique du Prague* 1, 85–88.

Vincent, Nigel (1988) "Italian," in Martin Harris and Nigel Vincent, eds., *The Romance Languages*, Oxford University Press, New York, 279–313.

Wiltschko, Martina, and Olga Steriopolo (2007) "Parameters of Variation in the Syntax of Diminutives," in *Proceedings of the 2007 Annual Conference of the Canadian Linguistics Association*.

Wolf, Matthew (2008) *Optimal Interleaving: Serial Morphology-Phonology Interaction in a Constraint-Based Model*, Doctoral dissertation, University of Massachusetts, Amherst.

Yang, Charles (2002) *Knowledge and learning in natural language*, Oxford University Press.

Address:
Department of Linguistics
619 Williams Hall
University of Pennsylvania
Philadelphia, PA 19104-6305

embick@ling.upenn.edu