

Explaining phonological conditions on affixation: Evidence from suppletive allomorphy and affix ordering¹

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Abstract

This paper examines two domains in which phonology may exert an influence on morphology: suppletive allomorph selection and affix ordering. Cross-linguistic facts about both phenomena are examined and ultimately argued to provide evidence for a phonology-morphology interface in which morphology precedes phonology at each level of the grammar in a cyclic-type approach, and phonological conditions on affixation occur when an affix subcategorizes for a particular phonological unit. This is contrasted with an Optimality Theoretic (OT) approach to the phonology-morphology interface in which phonological effects in morphology are modeled by ranking phonological constraints over morphological ones (i.e. ‘P ≫ M’) within a single component of the grammar. It is argued that the former approach makes better predictions for the two phenomena in question as well as for other areas previously discussed in the literature (e.g. infix placement) and that phonological and morphological constraints should not be interranged in an OT grammar.

1 Introduction

It is well known that there are a number of ways in which phonology can have an effect on affixation. An understanding of these effects is crucial to the development of a theory of the phonology-morphology interface. In this paper, I consider the two primary ways in which phonology can affect affixation, showing how both types of effects support a particular model of the phonology-morphology interface that I will refer to as the ‘subcategorization approach’. The two types of effects involve phonological conditions on *whether* a particular affix may attach to a particular stem, and if so, *where* the affix is placed.²

The *whether* case is manifested in two ways, the first of which is phonologically induced blocking. An example of this is found in English, where the *-ize* suffix is said to attach only to stems with an unstressed final syllable (Raffelsiefen 1996). Other stem types simply cannot undergo suffixation with *-ize*.

Another manifestation of the *whether* case is found in phonologically conditioned suppletive allomorphy ('PCSA'; see Paster 2005a, 2006b, to appear, Bye 2007). An example of this phenomenon is found in Armenian (Vaux 1998), where the definite article is expressed as a *-ə* suffix when the stem is consonant-final, but as *-n* when the stem is vowel-final. I take the position here that phonologically induced blocking and PCSA are two manifestations of a single mechanism in grammar, and that the only difference is that in PCSA, an 'elsewhere' allomorph steps in to fill the gap left behind by blocking.

The *where* question is manifested in three ways. The first is phonologically conditioned infix placement (see Yu 2003, 2007). A famous example of phonologically conditioned infix placement is the agentive focus affix in Tagalog, *-um-*, which occurs before the first vowel (or, in some cases, after the first consonant) of the stem (Orgun & Sprouse 1999).

A second possible phonological answer to the *where* question arises in the case of the ordering of multiple affixes on one side of the stem. Hypothetically, the phonology of a language could determine the relative order of the affixes. Hargus & Tuttle (1997) discuss a possible case in Witsuwit'en, where the position of the *s-* Negative prefix varies for purposes of syllable structure optimization (though see section 6.1 below for a possible reanalysis).

A third manifestation of the *where* case is in the orientation of a single affix to the stem. If an affix is unspecified as to whether it is underlyingly a prefix or a suffix, phonological considerations could determine which side of the stem the affix attaches to. This type of phonologically governed 'mobile affixation' has been claimed to exist in Huave (Kim to appear, Noyer 1994), where some affixes can occur either as prefixes or suffixes depending on a phonological property of the stem of affixation.

Knowledge of the existence and nature of these phenomena across languages is fundamental to modeling the phonology-morphology interface, since different types of models make different predictions for what these phenomena should look like. In particular, different predictions are made depending on whether phonology and morphology operate in tandem on a single input (as in a common version of Optimality Theory in which phonological and morphological constraints are interranged in a single ranking schema (McCarthy & Prince 1993a, b)) or whether morphology feeds phonology (as in traditional models exemplified by Chomsky (1986)).

In this paper, I contrast McCarthy & Prince's (1993a, b) model with an alternative model in which morphology feeds phonology (but with interleaving, as in Lexical Phonology and Morphology (Kiparsky 1982a)) and phonological conditions on affixation are handled via subcategorization for phonological elements. I discuss the predictions made by each model for two types of phonological conditions on affixation representing the *whether* and *where* cases discussed above: phonologically conditioned suppletive allomorphy ('PCSA') and phonologically conditioned affix order ('PCAO').

I then synthesize the results of cross-linguistic surveys of PCSA and PCAO, showing that the findings support the subcategorization approach rather than McCarthy & Prince's approach. Finally, I summarize the implications of these cross-linguistic facts for our model of the phonology-morphology interface.

2 The 'P » M' approach

In McCarthy & Prince's (1993a, b) version of Optimality Theory, P(honological) constraints can outrank M(orphological) constraints in a single 'P » M' ranking schema. In this model, roots and affixes (including all possible suppletive allomorphs) exist, unordered, in the input. P and M constraints work in tandem to select the appropriate allomorphs and the proper linear order of the morphemes; in any case where a phonological constraint determines the selection or placement of an affix, this is modeled by ranking the relevant P constraint ahead of an M constraint.

An example of the use of this model can be seen in McCarthy & Prince's (1993a) analysis of affix placement in Ulwa (Misumalpan, Nicaragua; Hale & Lacayo Blanco 1989). In this language, possessive markers occur immediately after the main stressed syllable, as in the examples below. (Examples are from McCarthy & Prince (1993a: 79, 109–110); I have added stress marking. Commas indicate infix boundaries.)

- | | | | | |
|-----|-----------|--------------------|---------------|-----------------|
| (1) | bás-ka | 'his/her hair' | siwá,ka,nak | 'his/her root' |
| | sú:,ka,lu | 'his/her dog' | kí:-ka | 'his/her stone' |
| | ás,ka,na | 'his/her clothes' | saná-ka | 'his/her deer' |
| | sapá:-ka | 'his/her forehead' | aná:,ka,la:ka | 'his/her chin' |

As can be seen in the examples, the phonological distribution of this affix causes it to be realized sometimes as a suffix and sometimes as an infix with respect to the root. McCarthy & Prince (1993a: 110) propose an analysis using the P constraint shown in (2) (F_t' is the head foot):

- (2) ALIGN-TO-FOOT (Ulwa): Align([POSS]_{Af}, L, F_t' , R)

An M constraint (McCarthy & Prince 1993a: 111) designates the possessive affixes as suffixes by aligning them to the right edge of the stem:

- (3) ALIGN-IN-STEM: Align ([POSS]_{Af}, R, Stem, R)

The ranking of the P constraint (ALIGN-TO-FOOT) over the M constraint (ALIGN-IN-STEM) yields both the infixed and suffixed forms, shown below in (a) and (b), respectively (McCarthy & Prince 1993a: 112).

- (4) (a) siwa,ka,nak ('his/her root')

/siwanak, ka/	ALIGN-TO-FOOT	ALIGN-IN-STEM
i. (siwa)nak-ka	*!	
ii. \mathcal{E} (siwa),ka,nak		*

(b) *sapa:-ka* ‘his/her forehead’

/sapa:, ka/	ALIGN-TO-FOOT	ALIGN-IN-STEM
i. $\text{\textcircled{S}}$ (sapa:)-ka		
ii. sa,ka,pa:	*!	*

It is crucial to note that in this model, morphemes are unordered in inputs, as suggested in (4). Affixes surface as prefixes or suffixes due to affix-specific alignment constraints. The relative ordering of multiple affixes is also not specified in the input, but instead follows from the relative rankings of the affix-specific alignment constraints. Even the precise identity of the affix is not fixed in the input; in cases of suppletive allomorphy, all of the suppletive allomorphs are present in the input.³

3 The subcategorization approach

The approach that I will contrast with the ‘P \gg M’ model in this paper is a model based on subcategorization (Lieber 1980, Kiparsky 1982a, b, Selkirk 1982, Inkelas 1990, Orgun 1996, Yu 2003, 2007, Paster 2006b) in which affixation is a process that matches an affix with missing elements required in its subcategorization (‘subcat’) frame. In this approach, the possibility of attaching an affix to a particular stem depends on whether the stem is compatible with the subcategorizational requirements of the affix; these requirements can include syntactic, semantic, and, crucially, phonological aspects of the stem. The subcat frame also specifies the location of attachment relative to the stem (e.g., whether the affix is a prefix or suffix) and, in some cases, relative to phonological elements of the stem (as in infix placement). In some instances the subcat frame can determine the relative ordering of affixes, as when a strictly root-adjacent suffix combines with another suffix that does not have this strict requirement. In general, however, I argue that affix ordering follows from one of the following: Scope (Rice 2000), the Mirror Principle (Baker 1985), or arbitrary templates (Bloomfield 1962, Zwicky 1985, Anderson 1986, Simpson & Withgott 1986, Speas 1990, Stump 1992, Inkelas 1993, Hyman & Inkelas 1999, Good 2003).⁴

I assume that affixation occurs within a distinct morphological component of grammar, and that only those combinations of roots and affixes allowed by subcat frames are assembled. Subcategorization is compatible with both serial and parallel models of morphology, although I argue that the model must incorporate serialism at least to the extent of OT models with interleaving (e.g. Stratal OT (Kiparsky 2000)).⁵ In this paper, I assume the general mechanics of subcat frames as in Orgun (1996) and Yu (2003, 2007). Yu (2003, 2007) proposes that the possible phonological elements that affixes may subcategorize for are elements of the prosodic hierarchy plus ‘C’ and ‘V’; based on results in the domain of PCSA, I make the additional claim that affixes may subcategorize for a C or a V that bears a particular phonological feature.

An example of the use of subcategorization is shown below. Recall the Ulwa example discussed above, in which the *-ka* possessive infix occurs immediately after the main stressed syllable in the word. In subcategorization terms, we could say that the infix

placement results from the subcategorization of the possessive marker for a phonological element, namely the head foot (Ft'). The subcat frame is shown below.⁶

- (5) $-ka : [[Ft'] \text{---} \dots]$

This subcategorization frame specifies that the $-ka$ marker occurs immediately to the right of Ft' , with optional additional phonological material coming after it within the word.

4 Predictions for PCSA and PCAO

The $P \gg M$ and subcategorization-based models make distinct predictions for both PCSA and PCAO. The predictions for PCSA are enumerated below, beginning with the predictions of the $P \gg M$ approach (see also Paster 2006b, to appear).

- (6) Predictions of $P \gg M$ for PCSA
- (a) PCSA is ‘optimizing’ and analyzable using externally motivated P constraints.
 - (b) PCSA is sensitive to phonological properties of surface forms, not underlying forms.
 - (c) Phonological conditioning between stems and affixes can go in either direction.
 - (d) The conditions on allomorph selection can be located anywhere in the word.

First, if PCSA results from $P \gg M$, then the observed patterns of PCSA should be phonologically ‘optimizing’ in some way, and to the extent that constraints are assumed to be universal, the relevant P constraints should be motivated elsewhere—either in some other language or within the grammar of the language in question. Second, PCSA should be sensitive to phonological properties of surface forms, not underlying forms. Since the $P \gg M$ approach relies on output constraints, affixation should never be sensitive to any phonological property of an input form that is not also present in the output. Third, stems and affixes should each be equally likely to induce suppletive allomorphy in the other; the $P \gg M$ approach predicts PCSA in both roots and affixes and allows for ‘outer’ affixes to affect the selection of ‘inner’ affixes. Finally, the conditions on PCSA can occur anywhere in the word with no limit on the distance between the condition and the relevant allomorph, so that, e.g., an element at the left edge of the stem could affect the selection of a suffix allomorph, or an element at the right edge could affect the selection of a prefix.

Having discussed the predictions of $P \gg M$ for PCSA, we turn now to some predictions of the subcategorization-based approach, which are given below.

- (7) Predictions of subcategorization approach for PCSA
- (a) PCSA is not always phonologically optimizing.
 - (b) PCSA is sensitive to phonological elements in underlying/input forms, not in surface forms.
 - (c) Phonological conditions on PCSA can come only from the ‘inside’.
 - (d) Affix allomorphs are adjacent to the phonological elements of stems that condition their distribution.

The first prediction is that PCSA is not necessarily phonologically optimizing. The subcategorization-based approach predicts that some cases of PCSA should exist in which there is no discernible phonological ‘benefit’ from the distribution of the allomorphs, and even cases where the distribution of allomorphs is ‘perverse’ with respect to cross-linguistically established phonological well-formedness constraints. A second prediction is that PCSA should be sensitive to phonological properties of underlying forms, not only to surface forms. We should be able to find some cases in which PCSA refers to some phonological element that fails to surface, rendering the allomorph selection opaque. A third prediction of the subcategorization approach is that PCSA should be ‘inside-out’, not ‘outside-in’; i.e., that stems can condition affix allomorphy but affixes cannot condition stem allomorphy. This follows from the inside-out word-building process that I am assuming, and also from the notion that only bound elements subcategorize for other morphemes, which I assume following, e.g., Inkelas (1990).⁷ A final prediction of the subcategorization approach is that affix allomorphs should occur adjacent to the phonological elements that condition their distribution. So, for example, a prefix allomorph should not be sensitive to an element at the right edge of the stem, nor should a suffix allomorph be sensitive to an element at the left edge of the stem. This prediction follows from the assumption that, when an affix subcategorizes for a phonological element, nothing may intervene between the two.⁸

As can be seen in comparing (6) and (7) above, the two models make quite distinct predictions for PCSA. Similarly, the two models also make very different predictions for PCAO. Some predictions of $P \gg M$ are given below.

(8) Predictions of $P \gg M$ for PCAO

- (a) Phonology can produce morpheme orderings that disobey other principles (i.e., PCAO exists).
- (b) Entire morphemes, not just segments, may be phonologically ordered.
- (c) A sequence of multiple affixes may be re-ordered for reasons of phonological optimization.
- (d) PCAO results from externally motivated P constraints.

The first prediction follows straightforwardly from the possibility of $P \gg M$ rankings. As long as we assume that M constraints are responsible for affix ordering, then $P \gg M$ should produce phonologically conditioned affix ordering in some language. The second prediction states that entire morphemes can be phonologically ordered; this is a corollary of the first prediction. I have stated it explicitly because, as we will see in section 6.1, there are several putative cases of phonologically conditioned affix order in which the affixes in question consist of only a single segment, which allows for a reanalysis in terms of purely phonological metathesis. So the crucial case would be an example of phonologically conditioned affix ordering where the relevant affixes consist of multiple segments. A third prediction made by $P \gg M$ is that a sequence of multiple affixes may be phonologically re-ordered. This prediction results from the fact that in the original $P \gg M$ model (McCarthy & Prince 1993a, b), all of the morphemes in a word are present (but unordered) in the input, and the constraints sort out the order of the morphemes. Therefore, the prediction is that PCAO can re-order not only

sequences of two affixes, but all of the morphemes in an entire polymorphemic word. One way in which this might be manifested is if a long series of affixes were ordered along some phonological scale. A final prediction is that PCAO should follow from P constraints that are motivated elsewhere in the language and/or cross-linguistically. Even if some constraints are learnable on a language-by-language basis, if we assume that most constraints are universal,⁹ then PCAO should usually (if not always) be driven by these externally motivated P constraints rather than by stipulative, language-specific constraints.

We turn now to the predictions made by the subcategorization approach for PCAO:

- (9) Predictions of subcategorization approach for PCAO
- (a) True PCAO does not exist.
 - (b) Segments belonging to affixes may undergo phonological metathesis, but entire affixes cannot.
 - (c) No case exists in which multiple affixes are phonologically ordered with respect to each other.
 - (d) Phonological conditions on the placement of affixes may or may not be phonologically optimizing.

First, and most importantly, the subcategorization approach that I am considering predicts that PCAO should not exist. Because word-building proceeds from the ‘inside-out’ (as discussed above with respect to PCSA), an affix cannot have any effect (phonologically-based or otherwise) on the location of another affix that was attached at an earlier stage in the derivation. A second, related prediction is that while segments may metathesize, affixes cannot. Since in this model phonology and morphology are distinct from one another, an entire morpheme may not undergo a purely phonological process. An individual *segment* of a morpheme can undergo phonological metathesis, which (as will be seen in §6.1) gives the appearance that a morpheme has metathesized when the morpheme consists only of a single segment (I term this situation ‘fake PCAO’). But when polysegmental morphemes are considered, we should find no cases of entire morphemes being phonologically re-ordered.¹⁰ A third prediction made by the subcategorization approach is that we should not find any case in which multiple affixes participate in phonological re-ordering. An outer affix could, in theory, be infixated between some inner affixes for phonological reasons, but this should result in only pairwise ordering effects that can be easily modeled via subcategorization for a phonological element (as in the standard subcategorization approach to infix placement; see Yu (2003, 2007)). What we do not expect to find is the situation predicted by the $P \gg M$ model in which a series of multiple affixes is comprehensively re-ordered as a whole, e.g., along a phonological scale, since the subcategorization approach does not assume that all morphemes are present in the input with the ordering sorted out by the constraints. A final prediction is that phonological conditions on the placement of affixes may or may not be phonologically optimizing. Subcategorization for a phonological element differs from a phonological constraint or rule in that subcategorization is arbitrary. There need not be any relationship between the distribution/placement of affixes and their shape. Thus, in cases of phonologically conditioned affix placement, we

expect to find examples in which the placement creates words that are no more harmonic (or, possibly, are even less harmonic) than they would be if the placement were different.

Now that we have seen how the $P \gg M$ and subcategorization approaches make different predictions for both PCSA and PCAO, let us turn to an examination of the cross-linguistic facts of both phenomena in an effort to distinguish between the two theories. I will argue that the empirical findings in both PCSA and PCAO support the subcategorization approach rather than the $P \gg M$ approach.

5 Findings for PCSA

Paster (2006b) presents results of a large survey of cases of PCSA in the world's languages, which I summarize in this section. The survey involved consultation of over 600 grammars and descriptive or theoretical articles. 137 examples of PCSA were uncovered in 67 languages representing 29 different language families (plus two isolates and one creole). In sections 5.1–5.4 below, I consider each of the predictions for PCSA given above and show how the cross-linguistic findings line up with these predictions. As will be discussed further in § 5.5, the characteristics of PCSA across languages provide evidence in favor of the subcategorization approach.

5.1 Optimization

Recall that the $P \gg M$ approach predicts that PCSA should be optimizing, while the subcategorization approach does not make this prediction. It is true that many examples found in the survey do appear to have an ‘optimizing’ character. One such example is found in Hungarian (Kenesei, Vago & Fenyvesi 1997, Rounds 2001), where in present tense indefinite verbs, the 2sg is usually marked by *-s* (Kenesei, Vago & Fenyvesi (1997: 289–290); note that [s] corresponds to Hungarian orthographic <sz>, as in the examples below). However, when the stem ends in a sibilant, the 2sg is marked by *-El* (where *E* is a mid vowel that undergoes backness and rounding harmony). Examples are given below (from Abondolo (1988: 102) except where noted).

- | | | | | |
|------|-----------|-------------|------------|------------------------------|
| (10) | mond-a-sz | ‘you say’ | vonz-ol | ‘you attract’ |
| | vág-sz | ‘you cut’ | edz-el | ‘you train’ |
| | vár-sz | ‘you wait’ | hajhász-ol | ‘you seek’ |
| | nyom-sz | ‘you press’ | főz-öl | ‘you cook’ (Rounds 2001: 27) |
| | rak-sz | ‘you place’ | | |

This example could be seen as phonologically optimizing, and analyzed using the Obligatory Contour Principle (Leben 1973), since the pattern of allomorphy avoids sequences of sibilants in adjacent syllables.

Not all examples of PCSA have this character, however. Many examples in the survey are not phonologically optimizing in any discernible way. One example of apparently non-optimizing allomorphy is found in Turkish (Lewis 1967). The Turkish passive is marked by *-n* following a stem ending in a vowel or /l/, and by *-l* elsewhere. Examples are shown below (Underhill 1976: 332).

- | | | | | |
|------|---------|-------------|------------|------------|
| (11) | ara-n- | ‘be sought’ | kullan-Il- | ‘be used’ |
| | de-n- | ‘be said’ | yor-ul- | ‘be tired’ |
| | oku-n- | ‘be read | kaybed-il- | ‘be lost’ |
| | çal-İn- | ‘be struck’ | | |
| | bil-in- | ‘be known’ | | |

We can explain the alternation between the -C and -VC via epenthesis, so we are left with two underlying forms, /-n/ and /-l/, whose distribution has no apparent optimizing effect on syllable structure or any other aspect of well-formedness. Although the use of -n with stems ending in /l/ has a dissimilatory effect as in the Hungarian example discussed above, there is no motivation for OCP[lateral] elsewhere in the grammar, and there is no apparent motivation for using -n with vowel-final stems.¹¹

As discussed by Paster (2006b), there are a number of other non-optimizing examples in the survey from languages including Mafa, Winnebago, Jivaro, Woleaian, and Turkana. There are even some languages, such as Martuthunira and Haitian Creole, where a pattern of PCSA is arguably not only non-optimizing but even ‘perverse’. (See also Paster (to appear) and Bye (2007) for discussion of the Haitian Creole example.) Thus, the prediction of the P ≫ M model that PCSA is optimizing is contradicted by the survey data.

5.2 Input- vs. output-based conditioning

The P ≫ M approach characterizes PCSA as an output-based phenomenon, while the subcategorization approach can model only input-based examples. Most examples in the survey are transparent and therefore compatible with both input- and output-based analyses. However, there are a few examples in the survey that are crucially input-based. One such example is found in Turkish (Lewis 1967), where the third person possessive suffix has /-i/ and /-si/ allomorphs. As seen in (12), the /-i/ form occurs when the stem ends in a consonant, while the /-si/ form occurs when the stem ends in a vowel. (Examples are from Aranovich *et al.* (2005) and from Gizem Karaali, p.c.; note that vowel alternations are due to regular Turkish vowel harmony.)

- | | | | | |
|------|---------|-------------|---------|-------------|
| (12) | bedel-i | ‘its price’ | deri-si | ‘its skin’ |
| | ikiz-i | ‘its twin’ | elma-sı | ‘its apple’ |
| | alet-i | ‘its tool’ | arı-sı | ‘its bee’ |

At first, this looks like an output-based example motivated by syllable structure considerations. However, Aranovich *et al.* (2005) point out that the distribution of allomorphs is sometimes opaque due to the operation of a regular Velar Deletion rule (Sezer 1981) that deletes intervocalic /k/. Some examples are given in (13).

- | | | |
|------|------------|--------------------------------------------------|
| (13) | açlı-I | ‘its hunger’ (cf. <i>açlık</i> ‘hunger’) |
| | bebe-i | ‘its baby’ (cf. <i>bebek</i> ‘baby’) |
| | gerdanlı-I | ‘its necklace’ (cf. <i>gerdanlık</i> ‘necklace’) |
| | ekme-i | ‘its bread’ (cf. <i>ekmek</i> ‘bread’) |

These examples can be explained if we assume that the morphology first chooses the /-i/ allomorph of the possessive suffix due to the presence of final /k/ in the underlying form of the root. The affixed forms are then passed on to the phonology. Due to the presence of the /-i/ suffix, the /k/ is now in intervocalic position and is therefore deleted. The result is an opaque form exhibiting vowel hiatus. This situation is very easy to model in a subcategorization-based approach in which morphology feeds phonology; it is problematic for the surface-based $P \gg M$ approach.

We have thus seen an example of crucially input-based PCSA, but I know of no example of crucially output-based PCSA. If no such example exists, then this constitutes a failed prediction of the $P \gg M$ approach.¹²

5.3 Directionality of conditioning

The $P \gg M$ and subcategorization approaches make differing predictions regarding the direction of conditioning: $P \gg M$ predicts that conditioning may be ‘inside-out’ or ‘outside-in’, whereas in the subcategorization approach, conditions on PCSA are strictly ‘inside-out’. That is, the subcategorization approach predicts that there should be no examples of, e.g., affix-conditioned root allomorphy. Any such examples would constitute counterexamples to the subcategorization approach that I am arguing for.

Almost all of the examples in the survey are very clearly ‘inside-out’, involving affix allomorphy conditioned by some phonological property of the stem of affixation. Of the 137 examples included in the survey, 135 indisputably have ‘inside-out’ conditioning. Only two cases were found in the survey that look even remotely like possible examples of ‘outside-in’ conditioning. The most promising such example is found in Italian (Hall 1948).¹³ In Italian, some stems have allomorphs ending in /isk/ that occur only in contexts where the word stress falls on the stem-final syllable, namely, in the present and subjunctive 1sg, 2sg, 3sg, and 3pl, and in the 2sg imperative (Hall 1948: 25, 27). One such stem is *fin-* ‘finish’, shown below (Hall 1948: 214).

(14) Present

finísk-o	‘I finish’	fin-iámo	‘we finish’
finíšš-i	‘you (sg.) finish’	fin-íte	‘you (pl.) finish’
finíšš-e	‘s/he finishes’	finísk-ono	‘they finish’

Subjunctive

finísk-a	‘that I finish’	fin-iámo	‘that we finish’
finísk-a	‘that you (sg.) finish’	fin-iáte	‘that you (pl.) finish’
finísk-a	‘that s/he finish’	finísk-ano	‘that they finish’

Imperative

fin-iámo	‘let’s finish’		
finíšš-i	‘(you (sg.)) finish!’	fin-íte	‘(you (pl.)) finish!’

Other stems of this type include *ağ-* ‘act’ (Hall 1948: 43), *argu-* ‘argue’ (1948: 44), *dilu-* ‘add water’ (1948: 45), *mént-* ‘lie’ (1948: 45), *diminu-* ‘diminish’ (1948: 52), and *ammon-* ‘admonish’ (1948: 61). This appears to be an arbitrary class of verbs.

Italian would appear to be a counterexample to the prediction of the subcategorization approach since it seems to involve affix-conditioned root allomorphy. However, it is possible to analyze this example using subcategorization. Crucially, the shorter allomorph is in each case a subset of the longer allomorph, and the longer allomorph is always extended with /isk/. This allows an analysis of /-isk-/ as an affix and, in particular, an infix, following DiFabio (1990). Under such an analysis, the subject agreement suffix would be added to the bare root, and then in cases where the suffix is unstressed, *-isk-* would be infixed before the final unstressed syllable(s). Although this analysis may seem to be a convoluted attempt to rescue the subcategorization approach, the lack of other examples of root PCSA is undeniably suspicious. Furthermore, as discussed by Paster (2006b, to appear), we would not have been able to explain away the Italian example were it not for the fact that the extended stem invariably consists of the short stem plus /isk/. If the pairs of short vs. long stems were etymologically unrelated, and if /isk/ did not appear in all of the long forms, we would not be able to explain the allomorphy in terms of an added morpheme.¹⁴ See Paster (2006b, to appear) for further discussion of the Italian example and a possible historical explanation for this pattern.

5.4 Adjacency

As discussed earlier, the subcategorization approach predicts that affixes exhibiting PCSA must be adjacent to the element in the root that they subcategorize for. The $P \gg M$ approach allows for this type of conditioning but makes a further prediction. Under $P \gg M$, we expect that a word-final segment, even in a suffix, could trigger PCSA in a prefix (and even if the suffix is ‘external’ to the prefix in terms of morphological constituency), or that a root-initial segment could trigger PCSA in a suffix. Many examples involve same-edge conditioning or allomorphy conditioned by an overall property of the stem and are therefore compatible with both $P \gg M$ and subcategorization. But there are no examples of opposite-edge conditioning. Therefore, the $P \gg M$ approach overgenerates.

PCSA in prefixes is not very common in the survey, but one example is found in Kwamera (Central-Eastern Oceanic, Vanuatu: Lindstrom & Lynch (1994)), where the perfective is marked by /in-/ when the verb begins with /a/, /i/, or /o/, but by /uv-/ when the verb begins with a consonant or with /i/ or /u/ (Lindstrom & Lynch (1994: 12); note that verbs beginning with /e/ exhibit some variability and are not discussed here). In Kwamera, /i/ is considered a non-high vowel, so the generalization is that /in-/ is used with verbs beginning in a non-high vowel, while /uv-/ is used elsewhere. Hence, this is an example of prefix PCSA that is sensitive to the leftmost segment of the stem.

There are many examples of PCSA in suffixes, and all are conditioned either by general properties of the stem (e.g. syllable count) or by elements at the right edge of the stem. One example is found in Yidijɪ (Dixon 1977), where Ergative is marked by *-ɪgu* with vowel-final stems but by *-du* with consonant-final stems. Examples are given below (Dixon 1977: 126–127).

(15) *waguda-ŋgu* ‘man-ERG’ *warabal-du* ‘flying squirrel-ERG’

Again, the allomorph distribution is determined by an element at the edge of the stem where the affix attaches.

As mentioned above, the ‘same-edge’ examples are consistent with both models. However, the $P \gg M$ approach predicts a type of example that does not seem to exist, where an element at one edge of the stem determines the selection of an allomorph at the opposite edge. Imagine, for example, a hypothetical case of prefix allomorphy in a tone language that allows only up to one high tone (H) per word. Suppose the H is on the word-final syllable, and suppose there are two suppletive allomorphs of a particular prefix, one with a H and one without (e.g. *naná-* and *bi-*). The $P \gg M$ approach predicts that a ‘culminativity’ constraint in the phonology should be able to select the *naná-* prefix for roots with no H tone, and the *bi-* prefix for roots with a final H, even if the root has intervening L tones. To my knowledge, no such language exists.¹⁵

5.5 Summary of findings for PCSA

As I have discussed throughout § 5, the cross-linguistic generalizations about PCSA all converge in support of the subcategorization model. The predictions made by each approach are summarized below.

(16)

Prediction	$P \gg M$	Subcategorization
(a) PCSA is optimizing	Yes	✓No
(b) Input- or output-conditioned	Output	✓Input
(c) Directionality of conditioning	Any	✓Inside-out only
(d) Adjacency required	No	✓Yes

As indicated in the table, the empirical facts about PCSA fulfill the predictions of the subcategorization approach rather than the $P \gg M$ approach. In the following section, I turn to PCAO as another area in which to test the conflicting predictions of the two models.

6 Findings for PCAO

Paster (2006a) gives an overview of the results of a cross-linguistic survey intended to uncover examples in which phonology determines the relative ordering of multiple affixes. In this section, I discuss the results of that survey (section 6.1) as well as examples of phonologically conditioned ‘mobile affixation’ (section 6.2) and phonologically conditioned infix placement (section 6.3).

6.1 Relative ordering of multiple affixes

A cross-linguistic search was implemented to look for possible cases of phonological affix order. As discussed in Paster (2006a), very few cases of the phenomenon emerged from a study of hundreds of languages. The methodology involved scanning grammars as well

as descriptive and theoretical articles for any case of affix ordering in which a semantic or syntactic principle did not immediately explain the pattern. This method yielded dozens of possible examples, but the vast majority of them turned out to be best analyzed as purely arbitrary template/position-class systems with no possible phonological generalization to explain them. (See e.g. Inkelas (1993) on Nimboran, Hyman (2003) on Chimwiini, and Nordlinger (2008) on Murrinh-Patha.) What remained were five languages in which the ordering of some affixes could possibly be attributed to phonological principles; as we shall see, however, even this low figure is generous because it includes cases in which the surface ordering can be explained in purely phonological terms without requiring the morphological affixation process itself to be phonologically motivated.

One example of this type is found in Doyayo (Adamawa-Ubangi, Cameroon; Wiering & Wiering (1994)). In this language, there is a series of verb suffixes that is generally ordered according to semantic scope as predicted by Rice's (2000) Scope principle, and/or by Relevance as defined by Bybee (1985). Though it is difficult to find examples that clearly exhibit scope-based ordering due to the semantics of the individual suffixes, Wiering & Wiering's examples are consistent with this principle and with Relevance despite their claim that '...the most significant factors in the ordering of the suffixes are phonological restrictions' (1994: 69). Furthermore, we do find examples in which a change in the order of affixes signals a change in the meaning of the word, which is a characteristic of scope-based affix ordering (see e.g. Hyman 2003, Paster 2005b). An example is *baa-y-i-t* (pierce-Resultative-(epenthetic vowel)-Iterative) 'is pierced by many things' vs. *baa-t-i-y* (pierce-Iterative-(epenthetic vowel)-Resultative) 'is pierced many times' (Wiering & Wiering 1994: 67). Exceptions to Scope/Relevance arise, however, in examples involving the *-m* Augmentative suffix. That affix comes first in combination with any other suffix, as in the examples in (17).

- | | | | | |
|------|------------------|-----------------------------------|-----------------|---------------------------------------|
| (17) | haa- m | '(several) are sour' | ε- m | 'sing (many)' |
| | haa- m-z | '(several) turned sour (rapidly)' | εε- m-l | 'sing (many) (over a period of time)' |
| | *haa- z-m | | *εε- l-m | |

In these examples, based on functional considerations we would have predicted the opposite ordering of affixes. Since in these examples the Augmentative suffix relates to a plural subject, it is reasonable to expect this affix to behave like a subject agreement marker, in which case Bybee's (1985) Relevance principle predicts that it should occur outside the *-z* Immediate marker and the *-l* Distributive marker, both of which can be categorized as aspect markers. The fact that *-m* occurs inside both of these other suffixes suggests that the affixes may be phonologically ordered. However, closer examination reveals that the correct generalization is one not involving phonological affix ordering *per se*. Consider the data in (18), which show that the *-m* suffix occurs as an infix when it occurs by itself with a consonant-final root.

- | | | | | |
|------|-----------------|-------------------------------|-----------------|-------------------------|
| (18) | tus | 'spit out' | kab | 'catch' |
| | tu, m ,s | 'spit out (several)' (*tus-m) | ka, m ,b | 'catch (many)' (*kab-m) |

In fact, the generalization that [m] occurs first in any coda cluster is a surface-true fact about Doyayo phonotactics, so the location of the *-m* suffix follows from a general phonological property of the language rather than a phonological condition on affixation. All that must be said is that the phonology of Doyayo includes the rule in (19).

(19) Cm → mC / _.

This rule applies *after* the morphology attaches the *-m* suffix, so only the surface order of segments, not the affixation process itself, is affected by phonology. I therefore consider this to be a case of ‘fake PCAO’.

Another potential example of PCAO is found in Witsuwit’en (Athapaskan, British Columbia; Hargus & Tuttle 1997), where the position of the *s-* Negative is said to be phonologically determined. According to Hargus & Tuttle, this prefix usually occurs inside the Tense/Aspect prefix, as shown in (20) (1997: 207).

(20)	we-c’-ε-s-ʔεnʔ	we-ts’-ə-s-tl’et
	NEG-UNSP_OBJ-PROG-NEG-see	NEG-1PL-IMPFF-NEG-fart
	‘s/he doesn’t see anything’	‘we’re not farting’

However, when the *s-* prefix occurs with a so-called ‘inner’ subject such as the 2pl *xw-*, the *s-* prefix occurs *outside* the Tense/Aspect prefix, as seen in (21). As Hargus & Tuttle point out, the effect of this change in the position of *s-* is to avoid a complex coda.

(21)	we-c’-[ə]-s-ε-xw-ʔεnʔ	we-s-ə-xw-tl’et
	NEG-UNSP_OBJ-[epenth]-NEG-PROG-2PL-see	NEG-NEG-IMPFF-2PL-fart
	‘you (pl.) don’t see anything’	‘you (pl.) aren’t farting’

Hargus & Tuttle offer a P ≫ M account of this phenomenon. Their characterization of the situation is that the default order is *Negative-Tense/Aspect-root* (1997: 199), and that the order of the *s-* prefix changes so that it can be syllabified in coda position, except where changing the order would create a complex coda, in which case the *s-* prefix remains in its original position. Hargus & Tuttle propose the constraints in (22) to achieve these effects.

(22) P constraints: *COMPLEX
 DEP-ə
 M constraints: ALIGN-CODA-S_{NEG}: S_{NEG} should be a coda.
 TENSE-STEM: Align the right edge of the Tense prefix to the left edge of the verb stem.
 NEG-STEM: Align the right edge of the Negative prefix to the left edge of the verb stem.

The P ≫ M ranking shown in (23) yields the correct surface ordering of affixes (Hargus & Tuttle 1997: 207).

(23) *COMPLEX ≫ ALIGN-CODA-S_{NEG} ≫ TENSE-STEM ≫ NEG-STEM ≫ DEP-ə
 (P) (M) (M) (M) (P)

This example would therefore seem to constitute a case of PCAO. However, an alternative analysis is possible. One important observation about Hargus & Tuttle's analysis is that it hinges on the assumption that the default order of affixes supplied by the morphology has the Negative prefix before the Tense/Aspect prefix. This is reflected in the ranking TENSE-STEM \gg NEG-STEM. However, it is not clear, at least from the data presented by Hargus & Tuttle, that this is a necessary assumption. Suppose instead that the regular ordering in Witsuwit'en is *Tense/Aspect-Negative-root*. In that case, the frequently occurring ordering shown in (19) is actually the default ordering, and it is (20) that exhibits a change. This change can be analyzed in purely phonological terms as a case of metathesis driven by avoidance of complex codas. If the ban on complex codas is exceptionless, we can say that *COMPLEX is undominated. If, however, the ban is specific to clusters beginning with /s/ or even to the Negative prefix in particular, we can still analyze this using a phoneme-specific or morpheme-specific version of *COMPLEX without any need for it to outrank any morphological constraints. In effect, then, this example reduces to a case of phonological metathesis like the Doyayo example discussed above. The metathesis applies to the output of the morphology, changing the order of the *segments* of the affixes, but not the affixes themselves; this therefore can be viewed as another example of 'fake PCAO'.

Notice that a phonological metathesis-based analysis is available in both Doyayo and Witsuwit'en only because the affixes in question consist of single segments. In cases like these, the entire surface realization of the affix ends up changing its order when metathesis applies, and this makes it seem as if the affix itself has changed its position in the morphology. However, it is important to distinguish between the placement of an affix in morphology and the surface ordering of the segments belonging to those affixes. An example that differs minimally from the Doyayo and Witsuwit'en cases in involving affixes with two segments makes this point clear.

Zoll (1996) discusses an example of what she terms 'exfixation' in Hamer (South Omotic, Ethiopia; Lydall (1976: 408–409)). In Hamer, the suffixes *-ta* and *-no* occur sometimes as regular suffixes, but at other times with the suffix-initial consonant coming before the final consonant of the root, as seen in (24).

- | | | | | |
|----------|------|--------------|---------|---------------------------|
| (24) (a) | isin | 'sorghum' | isin-ta | 'small amount of sorghum' |
| | rac | 'Rac (clan)' | ratca | 'Rac man' |
| (b) | oto | 'calf' | oto-no | 'all calves' |
| | isin | 'sorghum' | isin-no | 'all sorghum' |
| | Rac | 'Rac (clan)' | ranco | 'all Rac' |

The generalization is that when the root-final consonant is non-coronal, it metathesizes with the initial consonant of the suffix. Zoll states this in terms of a Coda Condition: 'Noncoronal place must open into a vowel' (1996: 176). She notes that this is an exceptionless generalization in the language.

Zoll's analysis is that the CODA-CONDITION constraint outranks another constraint, NO-INTERVENING, which is roughly equivalent to an ANCHOR or ALIGN constraint

that locates suffixes at the right edge of the word. (See Zoll (1996) for an explanation of the difference between NO-INTERVENING and ANCHOR/ALIGN.) This therefore constitutes a $P \gg M$ analysis. However, no $P \gg M$ ranking is required to analyze this case. It is a straightforward example of metathesis, motivated by the coda condition, and this occurs after the morphological suffixation process is complete. The fact that the suffix remains a suffix rather than being phonologically ‘re-ordered’ is apparent from the fact that the vowel of the suffix remains in its original suffixed position; only the suffix-initial consonant moves. Zoll refers to this as an example of ‘exfixation’, but in fact, this is not a special case at all. Like the Doyayo and Witsuwit’en examples, the Hamer example follows directly from a model in which morphology precedes phonology. The only difference is that in the Hamer case, it is easier to see that it is the segments rather than the affixes themselves that have metathesized since the suffixes have more than one segment.

Included in the survey discussed in Paster (2006a) was a particularly intriguing case in Gombe Fula (West Atlantic, Nigeria; Arnott (1970)), which at first pass appears to exemplify the across-the-board phonological re-ordering of multiple affixes that is predicted by $P \gg M$. If upheld, this would have been the only example of that type that was revealed by the survey. However, as argued by Paster (2005b), this language does not have phonologically conditioned affix ordering at all. Arnott’s original claim (1970: 366) was that there is a series of ten verbal ‘extensions’ (derivational suffixes) in Fula, each consisting of only a single coronal consonant, whose order followed the phonological formula ‘TDNR’. If this was indeed the correct generalization, it would be explainable according to sonority, since the $[t] > [d] > [n] > [r]$ sequence lines up neatly with the sonority scale (see, for example, Ladefoged (1982)). But further work with a speaker of a related dialect of Pulaar spoken in Senegal, as well as closer scrutiny of Arnott’s examples, revealed that the true principle behind affix ordering in Fula/Pulaar is semantic scope and that TDNR was not the correct generalization. No example in Arnott (1970) violates the Scope principle, and the few examples in the Senegalese dialect that were found to violate Scope reflect arbitrary pairwise ordering restrictions rather than phonological principles. Thus, the Gombe Fula example did not turn out to be a case of PCAO at all; see Paster (2005b) for details.

The final two examples uncovered in the survey were cases found in Washo (Hokan, California/Nevada; Jacobsen (1973)) and Awtuw (Ram, Papua New Guinea; Feldman (1986)). These examples were argued (Paster 2006a: 503) to reduce to morphological subcategorization for a prosodic unit (i.e. a case of phonologically conditioned infix placement, not PCAO) and morphologically conditioned blocking, respectively. Thus, we find no examples of true PCAO in the realm of multiple affixes on the same side of a root;¹⁶ to foreshadow the discussion in sections 6.4 and 7, this remains an unfulfilled prediction of the $P \gg M$ approach. In the next section, I extend the notion of PCAO to ‘Phonologically Conditioned *Morpheme* Order’, which would include the possible phonologically conditioned placement of a single affix with respect to the root, and consider whether cases of ‘mobile affixation’ might uphold the predictions of the $P \gg M$ approach where the examples in this section did not.

6.2 Mobile affixation

A few cases of phonologically conditioned ‘mobile affixation’ are discussed in the literature. Mobile affixation is a phenomenon in which one affix can occur as either a prefix or a suffix; in the phonologically conditioned type, the edge of attachment depends on some phonological property of the stem. Probably the most well-known case is found in Huave (isolate, Mexico; Noyer (1994), Kim (to appear)), where certain affixes can occur as either prefixes or suffixes, apparently in order to create CV sequences. As shown in (25), the first person marker *š/s* can be a prefix (a) or a suffix (c, d), the first person subject marker *n* can be a prefix (a) or a suffix (b), and the completive marker *t* can be a prefix (c) or a suffix (d) (examples are from Kim (to appear); italicized vowels are analyzed as epenthetic).

- (25) (a) *š-i-n-a-ndjak* ‘I will speak’ (b) *čut-un* ‘(that) I sit’
 1-FUT-1SUB-TV-speak sit-1SUB
 (c) *t-a-ndjak-as* ‘I spoke’ (d) *čut-ut-u-s* ‘I sat down’
 CPL-TV-speak-1 sit-CPL-ITR-1

According to Kim (to appear), these mobile affixes occur as prefixes when the base is vowel-initial, but as suffixes when the base is consonant-initial, in which case a vowel may be epenthesized since non-final syllables cannot have codas.

In Kim’s $P \gg M$ analysis, the mobile affixes are underlyingly unspecified as to their direction of attachment, and the ranking of *COMPLEX ahead of ALIGN-L and ALIGN-R drives the placement of the affixes. However, it is possible that the mobile affixes could be analyzed as ‘floating’ segmental features unassociated to the CV skeleton, rather than as full consonants. One could say that the location of the morphemes themselves in the morphological tree structure is unaffected by phonology (a position adopted by Kim) and that the association of the segmental features to the CV tier, but not the affixation itself, is handled by the phonology. The analysis would be somewhat like Rose’s (1995) proposal of an ‘extended template’ to solve a problem in Chaha affix ordering (see Hale (2001) for a similar proposal for Navajo). Rose’s analysis assumes that affixation extends CV sequences out from the root, and that the floating segments of the Chaha subject markers attach to the CV skeleton from left to right following regular autosegmental association conventions. Though I will not attempt to implement this analysis here for Huave, the plausibility of such an analysis is increased by the fact that Huave has very rigid syllable structure requirements ((C)V for non-final syllables; (C)V(C) for final syllables). If an autosegmental analysis works for Huave, then this example would be consistent with a model in which morphology precedes phonology and would not require $P \gg M$.

Another example of phonologically conditioned mobile affixation discussed in the literature is found in Afar (Cushitic, Ethiopia). According to Fulmer (1991), in this language, some affixes (e.g. the second person marker *t*) occur as prefixes when root begins with a non-low vowel, but as suffixes elsewhere.¹⁷ Examples are shown in (26).

- (26) *t-okm-è* ‘you ate’ *ab-t-é* ‘you did’
t-ifric-é ‘you wrote’ *yab-t-à* ‘you speak’

There is no readily available phonological constraint that could explain this distribution, so the P constraint in any P \gg M analysis would have to be an item-specific constraint requiring the *t* affix to occur to the left of a root-initial non-low vowel (the M constraint would require *t* to be aligned to the right edge of the root). Like the ALIGN-CODA-S_{NEG} constraint proposed in Hargus & Tuttle's analysis of Witsuwit'en discussed above, the P constraint needed for Afar would be arbitrary and would merely state the distribution of the affix rather than explaining it. As such, it would basically amount to a subcategorization frame in the form of a constraint.

It follows, then, that a subcategorization-based account of Fulmer's Afar example is possible without P \gg M. I propose that, rather than a single 'mobile' affix, there are actually two different *t* affixes: a prefix that right-subcategorizes for a [-low] vowel at the beginning of the root, and an 'elsewhere' suffix. Hence, this is a case of suppletive allomorphy rather than mobile affixation. Such an analysis does involve some redundancy in that it requires positing two affixes with the same shape and meaning, but the similarities between this case and a clearer case of suppletive allomorphy to be discussed below suggests that there is good reason to allow this redundancy into the analysis.

The Afar example can be compared with a similar example found in Chimariko, an extinct Northern Hokan language of California (Dixon 1910). Chimariko had some pronominal markers that occurred as prefixes to vowel-initial stems but suffixes to consonant-initial stems, as shown in (27). (Examples are taken from Conathan (2002: 20).)¹⁸

- (27) Set I: /y-ama/ 'I eat' /kow-ʔi/ 'I holler'
 Set II: /čhu-iman-damu-t/ 'I fell down' /čheleʔ-č̣i-t/ 'I am black'

The difference between Chimariko and Afar is that the relevant affixes in Chimariko have different phonological shapes depending on whether they occur as prefixes or suffixes. Therefore, the 'mobile affixation' analysis is not available and this must be analyzed as a case of suppletive allomorphy. Note, however, that the shape of the Chimariko prefixes and suffixes is similar (*y-* vs. *-ʔi* and *čhu-* vs. *-č̣i*), though no regular phonological rules of the language would allow them to be reduced to a single underlying form. One might speculate that the affixes had a shared etymological source and diverged over time. If this is the case, then Chimariko may represent a logical next step for a language like Afar. It makes sense to analyze these two very similar cases as both involving suppletive allomorphy, rather than saying that Afar has mobile affixation while Chimariko has suppletive allomorphy.

A final possible case of phonologically conditioned mobile affixation is discussed by Wolf (2008: 229–230).¹⁹ In Choctaw (Muskogean, Mississippi/Oklahoma; Broadwell (2006), Stemberger & Bernhardt (1999)), the Instantaneous aspect marker *-h* always occurs to the right of the penultimate vowel of the stem. Some examples are given below (Wolf (2008: 230), citing Stemberger & Bernhardt (1999); \surd indicates the root).

(28)	<u>Plain</u>	<u><i>h</i>-grade</u>	
(a)	√pisa-či →	pisa-h-či	‘show’
(b)	√pisa →	pi,h,sa	‘see’
	√ona →	o,h,na	‘arrive’
(c)	sa-√bi →	sa-h-bi	‘he kills me’
	či-√bi →	či-h-bi	‘he kills you’

As seen in (28), the phonologically based distribution of *-h* causes it to be realized sometimes as a suffix to the root (a), sometimes as an infix (b), and sometimes as a prefix (c). On the surface, this therefore seems to qualify as phonologically conditioned mobile affixation. There are multiple possible analyses of this, however, that do not require $P \gg M$. First, *-h-* can be analyzed simply as an infix that left-subcategorizes for the penultimate vowel of the stem, or for the *head foot* (since according to Broadwell (2006: 165), the *h*-grade accents the penultimate vowel); on the other hand, it could be an infix that right-subcategorizes for the stem-final CV.²⁰ Whatever the proper statement of the distribution (it is not clear whether there exist any examples that could differentiate the possibilities), under the infixing analysis we can assume that in the examples in (28), *-h-* is added last, and that it does not ‘see’ the internal morphological structure of the stem of attachment. It therefore does not ‘know’ whether the penultimate stem vowel underlyingly belonged to the root or an affix; it merely seeks out the phonological material that it subcategorizes for. Yet another possible analysis would have *h* as a floating feature that simply docks onto the penultimate vowel, in effect phonetically ‘preaspirating’ that vowel. This seems plausible given that, as mentioned above, the penultimate vowel is accented in the *h*-grade. If this is the correct analysis, then it does not matter whether *h* is affixed to the stem earlier or later than other affixes; its surface location will be phonetically automatic. Under any of these analyses, no special mechanism is needed to account for the position of *h*; all are perfectly compatible with a model in which morphology feeds phonology.

Based on these cross-linguistic findings, I claim that phonologically conditioned mobile affixation does not really exist. The very small number of documented cases discussed in the theoretical literature is suggestive; fifteen years after the publication of Noyer (1994), Huave remains the single most convincing example. To my knowledge, however, no comprehensive cross-linguistic survey of mobile affixation has been carried out, so this does remain an open empirical question.²¹ If phonologically conditioned mobile affixation does not really exist, we can explain this within the subcategorization-based approach by requiring that affixes always subcategorize for stems *in some direction*. This is implicit in the form of subcategorization frames, such as the one given earlier in (5), and there is good reason to believe that this is a real principle of grammar: apart from mobile affixation, we do not find evidence for subcategorization that does not specify a direction. For example, in the realm of infixation, to my knowledge there is no language in which an infix subcategorizes for a stressed syllable but can occur either to the right or left of that syllable as long as it is adjacent. Future research will show whether mobile affixation is indeed a robust phenomenon or whether all of the putative cases reduce to other explanations, as I have claimed.

6.3 Infix placement

A third way that phonology can affect the location of an affix is in the placement of infixes. Unlike PCAO and mobile affixation, phonologically conditioned infix placement is well-documented in many languages. Importantly, however, the documented examples are all compatible with the subcategorization approach. In looking at infix placement, although we are still within the realm of phonological effects on *where* an affix is located, we are now moving outside the realm of PCAO *per se*. Hence, the existence of phonologically conditioned infix placement does not constitute a counterexample to the prediction that PCAO does not exist. In fact, Yu (2003, 2007) shows that the results of large survey of cases of infixation in the world's languages provide arguments in favor of subcategorization and against the $P \gg M$ approach. I summarize these findings below.

Yu (2003, 2007) refers to the $P \gg M$ approach to infix placement as 'OT-PR' since it is an approach based on 'Phonological Readjustment' couched in Optimality Theory. In the OT-PR approach (e.g. McCarthy & Prince 1993a), infixation is analyzed by ranking prosodic well-formedness constraints ahead of the morphological constraints that state whether a given affix is a prefix or suffix (in OT-PR, no affix is an underlying infix). Yu (2003, 2007) argues that the OT-PR approach to infixation makes several inaccurate empirical predictions. One inaccurate prediction of OT-PR pointed out by Yu is that infixation should always result from considerations of prosodic well-formedness. Contrary to this prediction, Yu discusses (2007: 28–30) several cases in which the location of the infix does not yield any readily apparent decrease in phonological markedness. Although such cases can be modeled in the OT-PR approach, the analyses require highly stipulative, un insightful P constraints to drive the infix placement.

Another inaccurate prediction of OT-PR is what Yu calls 'hyperinfixation' (2007: 37–41), where an affix that belongs at one edge of a root migrates any number of segments towards the opposite edge, even going so far as to surface on the opposite periphery (for example, a formal prefix might surface as a suffix). Hyperinfixation is not attested in any of the languages found in Yu's survey. Yu acknowledges (2007: 40) that there are ways to avoid hyperinfixation in OT-PR with the proper constraints and rankings, but questions why we should need a special solution to rule out hyperinfixation since it apparently never occurs in any language.

A third problem for the OT-PR approach to infix placement is that, because it treats infixes as 'failed' prefixes and suffixes, affixes are predicted to surface as infixes only if the result is prosodically better-formed than if the affix had surfaced in its underlying, peripheral position. Contrary to this prediction, Yu finds several cases in his survey where certain affixes are obligatorily infixed, never surfacing in what an OT-PR analysis would claim to be their underlying prefixal or suffixal positions (2007: 41–42). An analysis where an affix that invariably surfaces as an infix is treated as a formal prefix or suffix is counterintuitive and unnecessarily abstract in comparison to an alternative approach that treats infixes as infixes. Given this and the above objections based on cross-linguistic findings about infixation, we can conclude that phonologically conditioned infix placement offers no support to the $P \gg M$ approach.

6.4 Summary of findings for PCAO

As was discussed in §§6.1–6.3, $P \gg M$ is inferior to the subcategorization approach in its predictions *vis à vis* the domains of affix ordering, the placement of affixes relative to the root, and the location of infixes. Therefore, in terms of *where* affixes are located, the evidence seems to support the subcategorization approach.

Two caveats are in order. The first is that there is evidence that phonology can play a role in the linear ordering of morphemes outside the domain of affixation. For example, it has been argued that in syntactic processes such as English Heavy NP shift, ‘heaviness’ is defined in phonological terms (e.g., the NP corresponds to a branching Intonational Phrase, as proposed by Zec & Inkelas (1990: 376)). Wasow (2002) argues instead that it is a combination of multiple *non*-phonological factors that determine heaviness; regardless of the outcome of that debate, the existence of phonologically conditioned syntactic processes would not directly contradict any of the claims I have made regarding the phonology-morphology interface. Of perhaps greater concern is the existence of phonological effects in the ordering of elements in compounds (Mortensen 2006, Wolf 2008: 230–233). Compounding does not constitute affixation and is therefore outside the scope of this paper, but a successful theory of phonology-morphology interaction must ultimately contend with phonologically driven compound ordering. A possible solution is to propose that compounds (at least, those that have no internal branching structure, unlike the well-known Japanese ‘lacquered chopsticks box’ examples) can emerge from the morphology with their elements unordered, allowing the phonology to determine the order later on. This would be consistent with the subcategorization-based approach to affixation: the direction of attachment of an affix is specified in the subcategorization frame, but since free morphemes do not subcategorize for other morphemes, there is no inherent mechanism in the morphology that would order them with respect to each other. In my approach, syntactic/semantic ordering principles such as the Mirror Principle are encoded as M constraints, so I certainly do not claim that the morphology *never* orders compound elements. But since I do not assume that M constraints are universal, it is possible that the output of a morphological compounding process could be a set of unordered roots, and that would allow for phonologically conditioned compound ordering without $P \gg M$.

A second caveat is that, since I am making a negative generalization (‘PCAO does not exist’) based on the available literature, there remains the possibility that I have missed some attested examples or that some newly described language will be demonstrated in the future to exhibit PCAO. It is admittedly true that many descriptive grammars simply do not include any section on affix ordering. Apart from making a good faith effort to look for cases of PCAO, there is no real remedy for this problem. All that can be said is that if true PCAO does exist, it must be exceedingly rare or else some indisputable example should have been uncovered by now.

The table below summarizes the predictions made by $P \gg M$ and subcategorization for PCAO that were discussed in section 4.

(29)

Prediction	P ≫ M	Subcategorization
(a) PCAO exists	Yes	✓ No
(b) What can be metathesized?	Segments & morphemes	✓ Segments
(c) PCAO involving multiple affixes	Yes	✓ No
(d) Phonological affix placement always optimizing	Yes	✓ No

As indicated in the table, and as I have argued throughout section 6, the results overwhelmingly support the predictions of the subcategorization approach rather than those of the P ≫ M approach. As I have argued, true PCAO does not exist, only segments (not entire morphemes) can undergo phonological re-ordering (metathesis), there is no case of PCAO involving multiple affixes—only pairwise orderings that in most cases reduce to phonological metathesis of single segments, and those phonological conditions on affix placement that do exist (e.g. in infix placement) are not always optimizing.

7 Conclusion

In this paper, I have contrasted two competing models of the phonology-morphology interface: the P ≫ M approach and the subcategorization approach. I have shown that the two models make very different predictions for phonological effects in morphology, both in terms of *whether* an affix can occur with a particular stem and, if so, *where* the affix will be placed. I have considered data from a number of different areas: phonologically conditioned suppletive allomorphy (PCSA), phonologically conditioned affix order (PCAO), mobile affixation, and infix placement. In each case, I have argued that the available empirical facts uphold the predictions of the subcategorization model and do not support the P ≫ M model. Therefore, I conclude that morphology and phonology are distinct components of grammar, and that morphology feeds phonology. The phonological conditions on affixation that do exist are quite restricted and are limited to the effects that can be captured via subcategorization frames. Future research in some areas not explored here (e.g. compound ordering, phonologically conditioned ‘empty morphs’, and imbrication) will determine the extent to which the predictions of the subcategorization approach continue to be upheld.

Notes

1. I am deeply indebted to Sharon Inkelas for her role in the development of the ideas and arguments presented here. I am also very grateful to Sylvia Blaho, Noam Faust, Andrew Garrett, Larry Hyman, Yuni Kim, Bernard Tranel, Alan Yu, participants in the UC San Diego Linguistics Department Colloquium, and participants in the Workshop on the Division of Labour between Morphology and Phonology (Meertens Institute, Amsterdam)

for helpful discussions of various parts of this research, and to the reviewers for very useful comments on the first draft of this paper.

2. This general statement leaves out a few types of effects, e.g. reduplication, phonologically conditioned ‘empty morphs’, and imbrication. For more on these subjects, I refer the reader to Inkelas & Zoll (2005) on reduplication and empty morphs, and to Bastin (1983) and Hyman (1995) on imbrication.
3. This, at least, is a ‘standard approach in OT’ according to Wolf & McCarthy (to appear), though they argue against this convention. A reviewer points out that listing multiple allomorphs in the input seems to be inconsistent with Lexicon Optimization, which predicts that the correct allomorph should be stored along with the root. I will not take up this issue here, except to say that this may be yet another problem for the $P \gg M$ approach in addition to the ones that will be discussed in more depth in this paper.
4. Templates could be encoded in subcat frames, but this would result in a certain inelegance in the statement of subcat frames, requiring affixes to regularly subcategorize for optional elements. For example, suppose a language has suffixes A, B, and C and they are always ordered $A > B > C$ when they cooccur. In order to account for this using subcategorization frames, we would have to say that A subcategorizes for a bare root, B subcategorizes for a root optionally suffixed by A, and C subcategorizes for a root optionally suffixed by A and/or B. The number of optional elements would become even more unwieldy in a language with more than three suffixes. Note that this would also require an affix to be able to ‘pick out’ other affixes in a stem whose internal morpheme boundaries would already have been erased (though this could be accomplished via, e.g., morphemic circumscription (Hammond 1992)). Possibly due to these difficulties in encoding templates in subcat frames, a more common approach is to state templates as either general or pairwise constraints on the linear order of affixes (see e.g. Hyman 2003, Paster 2005b, Xu 2007).
5. Note that in a subcategorization-based approach couched in OT, the requirement of subcategorizational compatibility between combining morphs could be a constraint rather than an inherent aspect of the affixation process. If so, I would argue that this constraint must be inviolable, since (once the subcat frame is formulated correctly) there do not appear to be examples of subcat frames being disobeyed.
6. The ellipsis notation is used merely to show that phonological material may occur after the *-ka* affix within the word. This plays no role in the placement of the affix, which will always occur immediately to the right of Ft’ with nothing intervening.
7. An advantage to this proposal is that it allows for limited cases of affix-induced root allomorphy, a few of which are documented in the literature, e.g. the Italian example to be discussed in section 5.3. In such cases, if the roots are bound, then they must subcategorize for affixes and so their selection can be affected by some property of an affix. This does still limit root allomorphy to occurring only in bound roots.
8. Note that subcategorization frames make stricter requirements on adjacency than do phonological rules or constraints. As indicated earlier, morphemes may not subcategorize for elements below the level of C/V (except for phonological features linked to a C/V). This means that in the present formulation, phonological subcategorization (unlike rules or constraints, which can yield long-distance effects across transparent segments) cannot look for a phonological feature across any number of segments that do not bear a feature on the same tier (see also note 15). No additional stipulations must be made in order to require strict adjacency in PCSA, although there does exist an independently motivated

principle (the Generalized Determinant Focus Adjacency Condition) that explicitly requires that '[e]ach phonologically constrained element must be adjacent to each constraining element' (Inkelas 1990: 201). A reviewer asks whether certain combinations of phonological subcategorizational requirements could result in non-local interactions between root elements and affix allomorphs; e.g. a prefix subcategorizing for a prosodic word that ends in a stop (since the prefix would still be adjacent to the PWd). This particular hypothetical example would be incompatible with a subcategorization-based analysis. The subcat frame would look like: [____[PWd ... C_[-continuant]#]]. Though the ellipsis notation is useful as a shorthand, it has no formal status and is not allowed to intervene between triggers and targets. Since the stop consonant is a crucial part of the trigger, the above is not a possible subcat frame.

9. See McCarthy (2002) for discussion.
10. McCarthy & Prince make seemingly contradictory claims about the ability of phonology to determine the linear order of affixes. They claim (1993a: 85) that 'phonological constraints can determine even the linear order of morphemes and morpheme parts,' implying that not only the segments of morphemes but the morphological structure itself can be phonologically determined in their view. They go on, however, to say that '[m]orphological structure represents a commitment only to the hierarchical organization of the constituent morphemes, not to linear ordering ... or continuity of the terminal string ... so principles of phonology can affect linear order' (1993a: 85). This implies that the phonology does not determine morphological constituency, but can determine the linear order of the segments that realizes the morphemes – suggesting that PCAO results in a mismatch between the morphological and phonological structures, rather than an alteration of morphological structure for phonological purposes. One way of reconciling the two statements is to assume that in the earlier quote, the phrase 'morphemes and morpheme parts' means 'some or all of the phonological material that realizes a morpheme'. But regardless of whether or not McCarthy & Prince intend to allow phonology to affect morphological structure above the level of the phonological spellout, their model clearly predicts that strings of multiple segments belonging to a morpheme may have a phonologically determined placement, a prediction avoided by the subcategorization approach.
11. A reviewer suggests that the use of *-n* after vowels could be driven by ONSET if one assumes that the *-l* allomorph is underlyingly /-Vl/ rather than /-l/ as I have assumed. The fact that the vowel is always present before the /l/ does suggest that the vowel could be included in the underlying form of the suffix, but on the other hand, both the location and the quality of the vowel are predictable via the same epenthesis rule that inserts /i/ before the *-n* suffix when it occurs after consonants.
12. This prediction is avoided in Wolf's (2008) 'Optimal Interleaving' model, which is a different implementation of the P ≫ M approach from the one I am evaluating here. The reader is also referred to Dolbey (1997) for an example of 'syllable-counting allomorphy' in Saami that appears at first to be output-conditioned but is argued to be input-based.
13. The second possible example comes from Zahao (Chin, Burma; Osburne (1975), Yip (2004)), but it is very weak as an example of PCSA; as argued by Paster (2006b: 122–124), it is likely not PCSA at all, let alone *outside-in* PCSA.
14. If such an example were to be documented, a possible solution within the subcategorization approach would be to specify the relevant roots as subcategorizing for affixes (the usual situation being that affixes subcategorize for roots but not vice-versa). This approach could also work for the Italian example if we assume that the extended root subcategorizes for an unstressed suffix (which could be justified on the grounds that verb roots always occur with

a suffix and are therefore bound rather than free morphemes). However, given the apparent lack of examples of phonologically conditioned root allomorphy outside of Italian, it seems prudent not to make this move until other, more convincing examples are documented in the literature.

15. A reviewer points out an apparent example of non-local PCSA in Hungarian. In that language, as discussed by Paster (2006b: 34), the 3sg is marked in present definite forms with *-i* after a front vowel in the stem, and with *-ja* after a back vowel in the stem. However, as noted by the reviewer, there exist transparent front vowels in Hungarian, and when a root has a back vowel followed by a transparent front vowel, the back vowel suffix (*-ja*) is used (as in, e.g., *tanit-ja* ‘he teaches’). This would seem to be an example of the opposite-edge conditioning that is ruled out by the subcategorization approach. I see two possible approaches to this problem. The first is to expand the set of elements that an affix may subcategorize for, so that an affix could select for a feature, e.g. [+back], without having to be adjacent to the segment bearing that feature. The second is to assume that, despite always being realized as front vowels, the transparent vowels in Hungarian actually bear the harmonizing [±back] feature. This would mean that in the example *tanit-ja* given above, the [+back] domain would extend rightward all the way through the transparent [i] (and even possibly through the final consonant). Tentative support for this idea comes from the finding (Benus & Gafos 2007) that the tongue is retracted during the production of transparent front vowels in a back harmony context; note also that the transparent vowels, which are [-low] and [-round], have no contrastive [+back] counterparts (Booij 1984). Unless more non-local PCSA examples like the Hungarian case are revealed, I prefer the latter option over modifying the set of phonological elements that subcategorization may refer to.
16. Since the publication of Paster (2006a), a sixth putative example has come to my attention. Wolf (2008: 228–229) discusses a case in Warlmanpa (Pama-Nyungan, Australia), where the reflexive marker *-nyanu* comes after the person/number markers except for the second person marker *-n*, which it precedes. Following Noyer (1994), Wolf relates this exceptional behavior to the fact that *-n* is consonant-final unlike the other person/number markers. Wolf proposes that the affix order changes under pressure from a constraint against geminates or against sonorant geminates in particular, which would be violated by the unattested ordering **-n-nyanu*. The problem for such an analysis is that the data are equally compatible with an analysis in terms of morphologically conditioned affix ordering (i.e. a templatic pairwise ordering between these two morphemes having nothing to do with their shape), since *-n* is the only marker that exceptionally precedes *-nyanu*. The case would be more compelling if there were multiple consonant-final person/number markers and it turned out that they all behaved like *-n*.
17. Recent work by Rucart (2006) arrives at a different generalization from the one given by Fulmer (1991) regarding the conditioning of the prefix vs. suffix variants of the person markers in Afar. Rucart shows how the distinction between verbs that take prefixing subject markers (i.e. ‘strong verbs’) and those that take suffixes (‘weak verbs’) correlates with a difference in the location of the lexical vowel in the verb root; a number of other properties beyond the location of the subject marker follows from the weak vs. strong verb distinction. For the sake of the argument, in the remainder of the present discussion I will assume Fulmer’s generalization, but note that this putative example of phonologically conditioned mobile affixation becomes significantly weaker if it is indeed conditioned by lexical verb classes, even if the class distinction itself correlates with a phonological property of the roots.

18. ‘Set I’ vs. ‘Set II’ refers to verb classes; see Conathan (2002) for more details.
19. In fact, Wolf (2008: 229) in defense of PCAO characterizes Choctaw as ‘[p]robably the most convincing example’ and regards the Huave and Afar examples discussed above as ‘rather dubious’, following arguments made by Marušič (2003).
20. Thanks to a reviewer for the latter suggestion.
21. A third, more abstract example of what has been analyzed as phonologically conditioned mobile affixation is found in Akan, where Ofori (2006a, b) claims that the single floating mora Past marker switches from a suffix to a prefix in Negative forms in order to avoid homophony with the Negative Perfect. However, as argued by Paster (in prep), this example does not hold up because a consideration of grammatical tone patterns shows that there is no risk of true homophony between these forms, and therefore homophony avoidance cannot be driving the pattern.

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