PHASE CYCLES, ϕ-CYCLES, AND PHONOLOGICAL (IN)ACTIVITY*

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1 Introduction

An essential question for many theories of grammar is how the phonological properties of a complex form relate to the phonological representations of its constituent parts. A working hypothesis (with an analogue on the semantic side) is that the phonological form of a complex expression is affected not only by the phonology of its individual parts, but also by the way in which the complex form is assembled. Determining (i) the division of labor between these two components of the theory, and (ii) specifying how information about combinatorics affects phonological representations are two major goals of research in this area.

Although it is in principle compatible with a number of different assumptions about the operation of the phonology, Distributed Morphology is centered on the idea that investigations of phonological form are inextricably linked to the theory of morpheme composition. In particular, a consequence of the assumption that morphemes are syntactic objects that are combined in syntactic derivations is that part of the theory of phonology interacts with broader issues in syntactic derivation, like phase-based cyclicity. Lowenstamm's recent work (2010, 2012) develops important insights on this theme. The main focus of his 2010 paper is the observation that there are *prima facie* difficulties in reconciling phonological effects attributed to cyclic derivation with recent theories that posit the cyclic spell out of syntactic structure. My goal in this paper is to look at the nature of these difficulties. Although I will work towards a different set of conclusions

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from those advanced by Lowenstamm, the overarching themes addressed below are inspired by his ideas in ways that I hope are clear throughout the discussion.

Lowenstamm (2010) argues that theories with cyclic spell out like Marvin (2003) and Embick (2010a) are incapable of accounting for patterns of stress placement in English morphology. This argument is based on the assumption that these theories employ a version of *phase impenetrability* by which stress in spelled out domains is inalterable. For convenience, the general position at issue will be referred to as *Phase Impenetrability for Phonology* (PIP):

(1) **PIP:** The complement of a phase head x is inaccessible to computation (=cannot be seen or altered) for phonological computation at the next phase head y outside of x and beyond.

Lowenstamm's position is that two assumptions produce problems with PIP; these are: **(A1)** that derivational exponents realize (cyclic) category-defining heads, as in Embick and Marantz (2008) and references cited there; and **(A2)** that the cyclic domains of phase-based theories are identical to the phonological cycles of Chomsky and Halle (1968) (SPE) and related work. Most of his paper is devoted to eliminating (A1) and (A2), by reworking the definition of phases in a way that allows for the derivation of stress shift while maintaining PIP.

This paper develops another response to difficulties with PIP. I argue that it is PIP that should be abandoned, at least as stated in (1). I will propose that phonological representations in cyclically inactive domains are visible to certain phonological computations, and may even be altered. In programmatic form, I will suggest that potential changes to cyclically inactive phonological representations are limited in a way that is embodied in the division between cyclic and non-cyclic (including with the latter phrasal or phonosyntactic) phonological rules. A key idea at work here, which is addressed at various points below, is that phase cyclic locality interacts with parochial properties of the PF interface, so that concerns of the latter sometimes override the former in limited ways.

The approach that I develop allows (A1) to be maintained. This is important to the extent that (A1) makes correct predictions about cyclic domains for allomorphy (and allosemy; Marantz 2013), as opposed to the cyclic domains posited in Lowenstamm's approach. My view is that Lowenstamm's theory allows for PIP-compatible phonology in a way that is problematic for the theory of domains for allomorphy/allosemy, but it is not possible to undertake a point-by-point comparison of these predictions here. With respect to (A2), the idea that cyclic spell out domains correspond to SPE cycles, section 5 advances the argument that this identification of domains is untenable: whether or not a phonological cycle is triggered on the domain defined by a particular morpheme appears to be unrelated to whether or not that morpheme is cyclic in the sense of phase theory. In articulating this point, I draw on work done in the theory of Lexical Phonology, which (interpreted in the framework assumed here) provides numerous examples of mismatches between phonological and phase cycles.

2 Phase Cycles and *(In)activity*

The theory of phases in Embick (2010a) is based on the assumption that certain morphemes– including the "category-defining" heads v, n, a, etc.– define the domains that are cyclically spelled out (cf. Marantz 2001, 2007; Embick and Marantz 2008). While Embick (2010a) is focussed on PF, and on allomorphy in particular, the (strong) hypothesis that the same domains are relevant for meaning is explored in work by Marantz (2013) for allosemy (contextual effects on polysemy).[1] Moving to particulars, this theory holds that a domain defined by cyclic head x is spelled out when another cyclic head y is merged into the structure. When this happens, non-cyclic morphemes X, Y, etc. that are on the spine between x and y are spelled out along with x, as shown schematically in (2):

(2) Schematization of cyclic domains

a. Step 1: cyclic y merged with [X [Y [x $\sqrt{\text{ROOT}}$ ...]]]

b. Step 2: cyclic domain centered on x = [X [Y [x $\sqrt{\text{ROOT}}$ ...]]]] sent to interfaces.

In addition to defining spell-out domains, this theory also defines which subdomains are *inactive* for computation in later cycles. The specific claim of Embick (2010a) is that when a higher cyclic head like y is spelled out in [y [X [Y [x [$\sqrt{\text{ROOT}}$ ...]]]]], the complement of the inner phase head x is inactive (cp. Chomsky (2001)). For convenience, the part of the theory that defines when elements are (in)active is summarized in (3):

(3) ACTIVITY COROLLARY (AC): In [[.... x] ... y], x and y cyclic, the complement of x is not *active* in the PF cycle in which y is spelled out.

With reference to (2), the AC specifies that in the PF and LF cycles in which y is operated on, the Root (and other material in the complement of x) is inactive.

The AC implements a version of the Phase Impenetrability Condition that refers to the specific concerns of PF. To understand what it rules out, a definition of what it means to be *(in)active* is required. Looking at contextual allomorphy, Embick (2010a) proposes that *active* means *identifiable as a particular morpheme*. By this definition, when material becomes *inactive*, its identity as a morpheme (i.e., as a particular functional morpheme, or Root) can no longer be referred to. With respect to PIP, the point is that inactive material in the sense just defined possesses a phonological representation. And, evidently, the phonological representations of inactive material are **not** inert for all PF computation– this is my take on Lowenstamm's observations about stress shift in English derivational morphology, and on the cases to be examined in section 3.

[1] For some related questions in derivational morphology see also Embick (2012b) with reference to some questions raised in Lowenstamm (2010).

Before looking in more detail at phonological (in)activity, it is important to be precise about two sets of predictions that derive from the AC, for (i) contextual allomorphy, and (ii) morphophonological alternations. These predictions are essential because to the extent that they are correct, they show that aspects of PF operate in ways that are predicted by a theory with phase-based spell-out.

For contextual allomorphy, with x, y cyclic and Y and W non-cyclic in [[[[$\sqrt{\text{ROOT}}$ W] x] y] Y], the ACTIVITY COROLLARY says that the complement of x– i.e., the Root and W– are not active in the cycle when y and Y are operated on. Thus, the theory predicts that contextual allomorphy at y (or at Y) could not make reference to the identity of the Root, or to the morpheme W. This prediction is discussed in detail in Embick (2010a).

The AC also makes predictions for *morphophonological* rules: i.e., phonological rules whose trigger or target is a particular morpheme or set of morphemes.[2] Because a morpheme M must be referred to in these rules, AC predicts that they can apply only in a cycle in which M is active. With reference to (2-3), then, there are the following predictions:

(4) Predictions of the AC for morphophonology

a. Outer y or Y cannot undergo morphophonological rules triggered by the presence of a particular $\sqrt{\text{ROOT}}$ or by the morpheme W; and

b. Inner $\sqrt{\text{ROOT}}$, W cannot undergo morphophonological rules that are triggered by the presence of y/Y.

Some other predictions derive from AC as well. In particular, it is predicted that a particular rule or morpheme cannot be an *exception* to a phonological rule unless that Root or morpheme is active in the cycle in which the rule applies. So, for example, the fact that *obesity* is an exception to the Trisyllabic Shortening rule of English is compatible with this prediction: *-ity* realizes a Root-attached n-morpheme, so that the Root $\sqrt{\text{OBESE}}$ is active in the cycle when the shortening rule applies. What is predicted not to occur is Root exceptionality to a phonological process associated with x when Root is separated from x by another cyclic head y, as in [[[$\sqrt{\text{ROOT}}$ ...] y] ... x].

The two sets of predictions just reviewed both require reference to particular morphemes as morphemes (i.e., to morpheme identities). As mentioned earlier, a crucial point about the AC, which is touched on in Embick (2010a) but not examined in detail, is that activity operates in terms of *morphological* identity, not in terms of phonological representations. That is, nothing in the ACTIVITY COROLLARY precludes the phonological representation of inactive material from being visible to altered by later phonological computation.

[2]Rules of this type are called *Readjustment Rules* in Halle and Marantz 1993 and related work; see Embick (2012a,2013a) for a view that identifies two distinct types of morphologically-conditioned phonological rules.

3 Phonological Behavior of *Inactive* Material

In the terminology of section 2, Lowenstamm's observations about *atomic*, *atom-icity*, etc. show an inactive element (the Root $\sqrt{\text{ATOM}}$ in *atom-ic-ity*) that is not totally inert for phonological computation. In principle, there are two ways in which an element that is inactive could play a role in PF computation. One would be for that element's phonological representation to be visible to a PF process in a later cycle. The second way would be for the inactive element's phonological representation to be altered in a later phonological cycle. Examples of each type are presented below. A question that arises throughout the discussion concerns the nature of the processes that affect inactive material, and what representations they refer to or alter. As noted by Marvin (2013), the stress-shifting effect seen in English *atomicity* etc. involves metrical representations (cf. also Newell (2008)). To the extent that this does not involve deletion of metrical structure, but instead involves e.g. the shifting of prominence that is realized in a higher level of metrical organization, it is a relatively weak counterexample to PIP as stated in (1). The reason to dwell on this point is that the examples of phonologically-affected inactive material that are presented below appear to involve relatively "automatic" processes. I will return to this theme at the end of this subsection, and advance the hypothesis that phonological changes to inactive material must be part of the non-cyclic (or phrasal) phonology.

One place to look for interactions involving inactive material is the (inner) edge of a cyclic domain. It seems that in DP subjects like *The man holding the large orange cat*, properties of the final segment of this phrase are visible in later cycles. If an auxiliary (*has* or *is*, contracted form /z/) contracts onto this DP (*The man with the large orange cat's been waiting for an hour*), the auxiliary is devoiced to /s/. This is a simple observation, but it shows that an inactive element's phonological properties are visible to later phonological computations. In this same type of example it is also possible for the inactive final element to be altered. If the verb following this subject DP is vowel-initial, as in *[The man holding the large orange cat] attacked the senator*, the final consonant of *cat* may be (optionally) flapped to produce /kær/. Again, this is a simple observation, but this instance of flapping would be impossible if PIP held.

While these two examples are from the phrasal phonology of English, I suspect that many examples of PIP-violating alternations are found with tonal interactions, sandhi effects, etc., but I will not pursue this line here.[3,4]

Inside of phonological words we find counterexamples to PIP as stated in

[3]Including phrase-level metrical effects like the *Rhythm Rule* of English (e.g. Hayes (1995), and Marvin (2013) for its relevance to phases). The word-final primary stress of the word *bamboo* can be shifted to the initial syllable in particular phrasal contexts (e.g. *síxteen Jápanese bámboo tábles*). The stress shift occurs only after the stress of the entire phrase is calculated, at which point the Root $\sqrt{\text{BAMBOO}}$ is inactive in the sense of section 2.

[4]Similarly, the prosodic effects seen in templatic morphology of the type seen in Semitic languages would be a rich area for investigation of the phonology of inactive material.

(1) that are parallel to the cases outlined above. For example, in addition to the stress-shifting effect that is noted by Lowenstamm, it is also possible for flapping to occur in words in which the context for the rule is available only in a later cycle. Agentive nominalizations provide one environment of this type. It can be assumed (see Alexiadou and Schaefer (2007) and references cited there) that truly agentive nominals involve an n (realized as *-er*) that attaches outside of a Root that is first categorized with v: [[$\sqrt{\text{ROOT}}$ v] ... n]. Thus, the fact that /t/-final Roots like $\sqrt{\text{EAT}}$, $\sqrt{\text{HIT}}$ etc. is flapped in *eat-er* and *hitt-er* is a further example of a change to an inactive element.

Vowel and consonant harmony phenomena provide a host of phenomena relevant to phases and inactivity. Schematically, PIP makes two main predictions for harmony in [[[$\sqrt{\text{ROOT}}$ x] y] W], where x and y are cyclic. The first is that the Root should not be able to trigger harmony on the exponents of y or W (whereas an overt exponent of x could trigger harmony on y). The second is that y should not be able to trigger harmony that affects the Root's phonology. There appear to be counterexamples to each of these predictions. Although I cannot look at structural details, each of the examples employed below appears to have the structure of true category-changing [[$\sqrt{\text{ROOT}}$ x] ... y], and shows harmony between the complement of x and y in ways that are precluded by PIP.[5]

A first example, drawn from Turkish, shows harmony triggered by inactive material affecting a suffix. I take the examples in (5) are adjectives derived from nouns [[$\sqrt{\text{ROOT}}$ n] a], on the basis of the transparent relationship of the adjective to the noun. The a affixes are *-sIz* '-less', and *-(s)Al*, 'pertaining to N' (Kornfilt 1997:454); the n in these examples is null:

(5) a. merhamet 'pity, compassion'; merhamet-**siz** 'without compassion'
yağmur 'rain'; yağmur-**suz** 'without rain; dry'

b. kamu 'the public'; kamu-**sal** 'public'
bilim 'science'; bilim-**sel** 'scientific'
öz 'self'; öz-**el** 'private'

A second example of an inactive Root triggering harmony is seen in the Cushitic language Ts'amakko (Rose and Walker 2011, citing Savà 2005). The language shows sibilant harmony, so that the causative suffix *-as* is realized as *-aʃ* when the stem contains palatoalveolar fricatives or affricates. In (6), the glosses indicate syntactic causatives, which involve two v heads [[$\sqrt{\text{ROOT}}$ v] ... v] (see e.g. Marantz 2007, Embick 2010). The outer v, realized as *-as* underlyingly, shows harmony triggered by the inactive Root in (6c):

(6) a. bas 'do'; bas-**as** 'make somebody do'

[5]Note that in assessing the predictions in the text, iteration has to be taken into account; if, for example, in $\sqrt{\text{ROOT}}$-x-y, harmony proceeded from the Root to x, and then from x to y, it would not be a counterexample to PIP, since x is active in the cycle in which y is operated on.

b. zaqʹ ‘slaughter’; zaq’-**as** ‘make somebody slaughter’
c. tʃʹur ‘throw’; tʃʹur-**aʃ** ‘cause to throw’

In (5-6) changes are *triggered* by inactive material. There also appear to be cases in which it is the inactive element that is changed under harmony. One case is found in the formation of “gerunds” in Turkana (Nilotic; Dimmendaal 1983). The gerund suffix *-e* (1993:297sqq.) induces harmony to its left, in some cases affecting the (boldfaced) Root. If, as seems plausible, these gerunds are [[$\sqrt{\text{ROOT}}$ v] ... n], then this is a case of an inactive element being changed:[6,7]

(7) -ìmʊj ‘eat’; e-k-**imùj**-e ‘way of eating’
-cɪl-ɪ-cɪl ‘scratch’; e-**cil-ì-cil**-e ‘way of scratching’

Another domain to look for the phonological manipulation of inactive material is with copying (reduplication) and “displacement” processes (metathesis, infixation). With a particular focus on reduplication, Bennett (2010) adduces a number of examples in which it appears that the phonological form of a reduplicant is provided by (i.e., copied from) a phase-cyclically inactive element. This copying from inactive material would not be possible if PIP held.

A pertinent case that involves both copying and infixation is found in the Austroasiatic language Jahai (Burenhult 2005). Jahai has a nominalizing affix that is used for a number of meanings that seem to require [[$\sqrt{\text{ROOT}}$ v] ... n]; Burenhult reports in addition to the “gerundive” meaning (i) object nominals; (ii) instruments; and (iii) locations. This n morpheme has the exponent *-n-* with disyllabic Roots (8c), and *-nC* for other bases (8a,b); the -C- component of the latter is copied from the final position of the base:

(8) V → ‘Act of V-ing’ etc.

Verb	**Noun**	**Gloss**	
a.	cɨp	**np**-cɨp	‘go’/‘act of going’
	sam	**nm**-sam	‘hunt’/‘act of hunting’
b.	ɟhɨt	ɟ-**nt**-hɨt	‘smoke’/‘act of smoking’
	tbɔh	t-**nh**-bɔh	‘beat’/‘act of beating’
c.	ckwɨk	c-**n**-kwɨk	‘talk’/‘act of talking’
	kajil	k-**n**-ajil	‘fish’/‘act of fishing’

[6]The grave accent in the forms in (7) marks a low tone. Dimmendaal reports that affixation of the gerund *-e* is accompanied by an obligatory low tone on the second vowel of the stem, if the stem (=Root+close affixes) consists of more than one mora. This is another instance of inactive material being altered phonologically.

[7]Another possible case of changing an inactive Root’s phonology is found in Assamese (Indo-Aryan), which has regressive harmony for [+ATR]. Assamese has a number of suffixes with [+ATR] vowels that trigger harmony (i.e., change from [-ATR] to [+ATR]) in vowels to their left (Mahanta 2007:97ff.). Although some of the examples look relevant to the concerns of this section, more detail about the structures underlying these derivations is needed before it can be concluded that harmony operates across cycles in the relevant way.

In the (8a,b) examples, the inactive Root's final consonant is copied onto the *-nC* affix; in the (8b,c) examples, the affix is infixed into the inactive Root. More generally, infixation and copying processes could reveal a great deal about how much phonological structure is still active across cyclic boundaries, but no general examination of such effects has yet been undertaken.

In summary, the results of this section show that there are evidently several different types of phonological computation that access and alter the representation of material that is inactive in the cyclic sense.

4 Towards a Revised PIP

The conclusion suggested by sections 2-3 is that PIP as stated in (1) does not hold. The question is how to replace PIP in a way that maintains strong predictions about phase-cyclic domains and phonology. One part of the theory I will propose is the idea that cyclically inactive elements cannot be identified as particular morphemes (section 2). A second part is directed at the types of phonological rules that see or affect inactive representations. These ideas together comprise the revised PIP (rPIP):

(9) **(rPIP)** Material that is phase-cyclically inactive

a. has a visible phonological representation, but cannot be identified as a particular morpheme; and

b. may be seen or altered by non-cyclic or phrasal phonological rules, but not by cyclic phonological rules.

Regarding (9b), something remains to be said about why non-cyclic and cyclic rules should differ with respect to inactive material.

The idea that cyclic phonological rules may not affect inactive material can be approached in a few steps. The driving idea is that PF operates on cyclic domains– i.e., those defined in section 2 above– and that cyclic phonological rules are triggered by particular morphemes within those domains. Inactive material from earlier cycles is not present when this happens, and therefore cannot be affected by cyclic phonological rules. The details of this proposal can be illustrated with (10); x, y are phase-cyclic, and W is not:

(10) $[[[\sqrt{\text{ROOT}}\ x]\ W\ ]\ y]$

According to the theory outlined in section 2, when y is merged, a cyclic domain centered on x– $[[\sqrt{\text{ROOT}}\ x]\ W]$– is sent to the interfaces to be spelled out. This object is linearized, and then Vocabulary Insertion takes place at the individual morphemes from the inside-out. When Vocabulary Insertion occurs at the x morpheme, a phonological cycle applies if this morpheme (or its exponent) are cyclic. Then Vocabulary Insertion applies at W, and, again, there is a pass

through the cyclic phonology if this morpheme or its exponent triggers cyclic phonology, otherwise there is not. (For the assumption that both phase cyclic heads like x, and non-phase-cyclic heads like W can trigger cyclic phonology, see section 5). Since the Root, x, and W are all present and active in this domain, cyclic phonological rules triggered by x or W could in principle affect the Root.[8]

When later structure triggers spell out of the domain centered on phase-cyclic y, the Root is (by the ACTIVITY COROLLARY) inactive. A strong hypothesis is that the PF cycle centered on y contains only the active objects: in this example, x and W (which have already undergone Vocabulary Insertion), along with y itself. The phonological representation Φ of the inactive material– the Root in this example– is placed in a buffer that is accessed when the phonological contents of the entire M-Word is integrated.[9] Since inactive Φ-representations are linearized with respect to outer morphemes, the Φ that is buffered also possesses a link $\triangleright$ that indicates where it is to appear linearly; for convenience, this is shown with respect to the linearly adjacent active morpheme as $\Phi \triangleright x$ or $x \triangleright \Phi$.

It can be seen that (9b) derives from the assumption that cyclic domains contain only active morphemes, along with the assumption that the cyclic phonology applies in such cyclic domains. In terms of (10), the idea is that cyclic phonological rules triggered by y occur in a phase-cycle in which the only other active elements are x and W. Thus, only phonological material of x or W could be affected by cyclic phonological rules in the y-cycle. In this way, inactive material (like the Root in (10)) is precluded from being changed by cyclic rules.

This leaves non-cyclic (and phrasal) rules, which can affect inactive material. Concentrating on the former, in a theory with cyclic and non-cyclic rules, a natural idea is that the non-cyclic rule block applies to structural objects that are entire complex heads: i.e., the *M-Word* in the sense of Embick and Noyer (2001) and related work (cf. Embick 2010b, 2012a). The rules in the non-cyclic block apply across-the-board. This means that they may affect embedded or cyclically inactive phonological representations. The idea that non-cyclic rules can affect the phonology of embedded morphemes is not novel; it is an important component of the theory of morphophonology that has been applied to a wide range of phenomena (see Halle and Nevins (2009) for a recent discussion). What (9) adds to the picture is the observation that the across-the-board application of M-word-level non-cyclic rules may affect inactive material.[10]

[8] I say "in principle" here because whether or not a rule in a phonological cycle triggered at W could affect the Root depends on some further assumptions about Strict Cyclicity (Mascaró (1976) and others) and related notions. To a first approximation, the proposal in (9b) derives part– not all– of what is typically associated with Strict Cyclicity, but it is beyond the scope of the present discussion to look further at this.

[9] One way to implement this view would be to treat a Φ as a pointer to a buffered phonological representation. At this point, however, little in the present discussion hinges on the details of a particular implementation, so I will not pursue one here.

[10] Beyond the M-Word, other domains might be relevant for the application of phrasal processes; see Pak (2008) for a concrete proposal in a framework like the one adopted here.

Non-cyclic rules apply to an integrated representation that consists of all of the phonological material in the M-Word. In an M-Word that contains only one cycle, like [[$\sqrt{\text{ROOT}}$ x] Y], all of the morphemes are active when the M-Word boundary triggers the non-cyclic phonology. When there is more than one cyclic domain, as in (10), a step of *linear integration* takes place. Informally, in integration the buffered Φ-representations are put in a single sequence: $\Phi_1 \triangleright \Phi_2 \triangleright ... \Phi_n$. The non-cyclic rules apply across-the-board to representations of this type.[11]

The approach is summarized in the steps in (11-13), with reference to (10):

(11) Spell out of cycle centered on x.

a. Active morphemes: Root, x, W

b. Vocabulary Insertion: applies to these morphemes

c. Cyclic Phonology: triggered by x or W (or their exponents) if that is what those morphemes/exponents are specified to do.

(12) Spell out of cycle centered on y

a. Inactive material: phonological representation of the Root, Φ. Stored with a link to its linear position w.r.t. x.

b. Active morphemes: x, W, y

c. Vocabulary Insertion: applies to y

d. Cyclic Phonology: triggered by y or y's exponent if they are specified as cyclic.

(13) M-Word:

a. *Linear integration:* All material in a single linear representation.

b. Non-Cyclic phonology applies.

The rPIP theory relaxes PIP in a way that allows for limited phonological interactions involving inactive material. It makes some clear predictions for allomorphy and for phonology. For the former, it is predicted that phonologically conditioned suppletive allomorphy at a morpheme $\mathcal{M}$ should not be conditioned by an inactive phonological representation Φ. For the latter, it is predicted that a cyclic rule triggered by $\mathcal{M}$ could not refer to an inactive Φ in its context. I will leave these predictions and other aspects of the revised theory for future work.

Before concluding this section, a few words are in order concerning *why* the strong version of PIP does not hold. In my view, the reason for this is because of parochial concerns of the PF component, which effectively override the cyclic

[11] Since some morphemes are active at the M-Word boundary, the representations that undergo the non-cyclic phonology contain some active morphemes in addition to the Φ's for inactive material. This allows, for example, active morphemes to be triggers or targets for morpheme-specific processes in the non-cyclic domain (see Embick 2012a for some discussion).

part of the theory in a limited way. More specifically, I conjecture that PF overrides phase cycles in certain ways because of the fact that the phonological representations from distinct cyclic domains must be integrated into a single linear representation for the purposes of serial realization in real time. In principle, the phonological representations of different phases Φ_1, Φ_2...Φ_n could be separated from one another, if, for example, the grammar had an external interface that did not require serial realization. However, the nature of the actual PF interface is such that these representations must be linked in a sequence. Running across-the-board phonological rules after the distinct domains have been assembled can be seen as a concomitant of the linear integration requirement.[12,13]

5 Phase Cycles and ϕ-Cycles

The last section notes that cyclic phonological rules are **not** associated exclusively with phase-cyclic morphemes. This point requires further elaboration. In order to avoid confusion in the discussion to come, I will distinguish between the phase-oriented and phonology-oriented notions of cyclicity with the labels *phase-cyclic* for the former and *ϕ-cyclic* for the latter. There are two sub-hypotheses to consider for how these two notions of cycle relate to one another:

(14) Hypotheses connecting ϕ-cycles and phase-cycles

a. All phase-cyclic morphemes are ϕ-cyclic morphemes.

b. All ϕ-cyclic morphemes are phase-cyclic morphemes.

My position is that both hypotheses in (14) are false, and that cyclic phonology is specified on a morpheme- or exponent-specific basis. This means that there are some phase-cyclic morphemes that are not ϕ-cyclic, and some ϕ-cyclic morphemes that are not phase cyclic. I will illustrate each of these points in turn, drawing on conclusions that appear earlier in the phonological literature, and synthesizing them with the phase-cyclic aspects of the theory adopted here.

[12] In addition to linear integration, there is another factor at play in this discussion. In particular, it appears that PF chunks phonological representations into phonological words, which, in the normal case, correspond to M-Word boundaries, as discussed in the main text; this is the domain to which non-cyclic rules apply. There is nothing about the theory of phase-cycles that requires this kind of chunking. It is brought about either because of a property of PF (e.g., perhaps because M-Words are privileged in linearization, as discussed in Embick 2007, although this privilege itself requires explanation); or because of the properties of some other system.

[13] Since it is specific to the particular (serial) apparatus available for human speech/sign, the hypothesis that "linear override" can allow inactive elements to be accessed is restricted to PF. Linear override should not take place at LF (although, of course, linear order might play an important role in "meaning" broadly construed, since it plays a role in information structure). However, other types of "LF-specific" relations might override cyclic concerns in their own way; see, in particular, Marantz (2013) for the idea that a kind of "semantic adjacency" at LF plays a role analogous to the role that linear adjacency plays at PF.

The argument against (14a) adapts Halle and Vergnaud's (1987) observations about Level1/2 effects in English. It appears to be the case that different exponents of the same cyclic head can be either cyclic or not. For example, the *-ity* exponent of n triggers cyclic phonology, while *-ness* does not. This kind of behavior goes against (14a), since it appears that some phase-cyclic exponents are ϕ-cyclic, while others are not. This argument relies on the idea that the n morphemes realized as *-ity* and *-ness* (along with every other type of category-defining morpheme that is realized with either Level 1 or Level 2 exponents) are syntactically identical in all relevant respects. If it could be shown that the n's that are realized as "Level II" exponents like *-ness* were attached in different ways, or had different inherent properties, then it would not be necessary to conclude that ϕ-cycles are triggered by particular exponents. It is not clear to me that such a re-analysis could be successfully executed; however, a detailed examination of this point goes beyond the scope of this work.

With *-ity* and *-ness* (and many other examples from English derivational morphology), the instruction to go (or not to go) into the cyclic phonology is associated with an exponent. Whether or not morphemes (i.e., conceived of pre-Vocabulary Insertion) can be specified in this way, so that, for instance, a morpheme m triggers cyclic phonology, in a way that is independent of the choice of allomorph for m– is an open question that is worth investigating. Nothing precludes this from happening, but I have no examples of this type.

Points relevant to (14b) have also been examined in the literature, in ways that can be connected with the concerns of this section. For example, Kiparsky (1982:146) suggests that lexical rules, which apply cyclically, might be restricted to domains defined by the lexical category labels N, A, and V. Subsequent investigations in Lexical Phonology, like Booij and Rubach (1984), argue convincingly that restricting cyclic phonology to lexical category morphemes is not possible; they argue that any morpheme could (at least in principle) trigger a pass through the cyclic phonology. The same conclusion is reached in more recent work in this area, such as Halle and Nevins (2009) and Noyer (2013), which implement analyses in which ϕ-cycles are triggered by different morphemes that are not phase-cyclic. The general conclusion to be drawn from this line of work is clear: ϕ-cycles can be associated with morphemes that are not phase-cyclic.

To conclude, it appears that whether or not a particular domain is subjected to a pass through the cyclic phonology is determined by exponents (and perhaps morphemes), as a type of go/no-go specification. This means that phase-cyclic morphemes and ϕ-cyclic morphemes are not the same. However, the theory of phases determines which morphemes are active in a given cycle of PF, in a way that restricts possible phonological interactions in several ways, as outlined in the last section. Exploring these predictions in connection with other cyclic theories (e.g. stratal theories, Kiparsky 1982a,b and subsequent work; or theories with the Strict Cyclicity Condition) is an important topic for future research.

6 Conclusions

The key observations in Lowenstamm's (2010) analysis of English morphology and phonology are (i) that PIP does not hold in a theory that defines phases along the lines of section 2; and (ii) that phase cycles and phonological cycles are not related in the simplest possible fashion– i.e., identity– for such a theory. My view is that (i-ii) do not call for a reworking of phase-cyclic domains; rather, they indicate that part of phonology broadly construed is determined in ways that directly reflect phase cycles, while other aspects of phonology reflect interactions with PF-concerns, which can override phase-cyclic locality in limited ways.

With reference to phase impenetrability in particular, the primary argument of this paper is that phonological material that is inactive in the phase-cyclic sense can nevertheless be involved in limited phonological computation. In my view, the departure from PIP that is called for results from the way in which grammatical patterns in language reflect the interaction of deep properties like phase cyclic domains, with relatively superficial properties imposed by the particular properties of the PF interface; and those related to representations of linear order in particular. As argued in Embick (2010a), linear representations sometimes restrict possible interactions. For example, in the case of allomorphy, where morphemes that are active in the phase theoretic sense are hypothesized to see each other only when linearly adjacent (concatenated), the PF-specific property (concatenation) narrows down potential interactions within a cyclic domain. For another part of PF– the aspects of phonology touched on in the core of this paper– I conjectured above that linear representations allow more interactions than would be expected from a phase theory alone. Specifically, I suggested that it is the fact that phonological representations from different cyclic domains must be integrated into a single serial representation that is responsible for the phonological visibility of cyclically inactive material.

Many details of the current approach could be revised and reworked in different ways that could be explored empirically. However, the idea that grammatical patterns arise from the interaction of different ("deep" and "superficial") systems is indispensable to this line of research; and the question of exactly which linear relations are employed in different parts of PF, and how they interact with syntactic and phase-cyclic concerns, is of central importance for this part of the theory of grammar.

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