Rule-Based Models of Phonology:
Interfaces

Modularity and Derivation at the Syntax-Phonology Interface

Heather Newell, UQAM

Abstract

This chapter investigates some of the nuanced distinctions between the predictions of a cyclic, modular, Rule-Based Phonological account of the Morphosyntax-Phonology Interface, and those of a cyclic, modular, Constraint-Based account (Stratal Optimality Theory). The focus here is on the theoretical distinctions between these two proposed systems that pertain to the construction of a general theory of linguistic computation. The discussion is centred around questions of modularity and derivation/cyclicity. Specific topics include (i) investigating the necessity of postulating both derivational and representational accounts of phonological domains, (ii) detailing how the two theories differ regarding how cycles are triggered, and in which module (the syntax or the phonology) they are controlled, and (iii) questioning whether the effects of constraint re-ranking across strata can be captured by a theory of structural underspecification. Data from English, Portuguese, Malayalam, and Ojibwe are analysed, and it is argued that the patterns we see are best accounted for within a Rule-Based system.

1. INTRODUCTION

This chapter focuses on two issues that are important to the construction of an explanatory theory of phonology; modularity and derivation. Modularity encapsulates the proposal that the vocabulary used by each linguistic sub-domain (phonology, syntax, semantics) is module-specific. It is therefore also concerned with how information is passed from one module to another. Here we concentrate on how morphosyntactic information is transferred from the syntax to the phonology. It is argued that syntactic features have no place in the phonological module, and that this is an important factor for distinguishing between theories of phonology, and of the morphosyntax-phonology interface. The discussion of modularity then leads us to the question of derivation, or more precisely, of cyclicity. If morphosyntactic information is illicit in the phonological module then the fact that phonological outputs display evidence of cyclic domains must be due either to properties specific to the phonological module, or to the existence of a derivational engine that sends information to the phonology in pieces. I support the latter view here. How this cycling of the computational system works, and how it affects the phonology is the second topic of the current chapter.

These two issues are integral to constructing a theory of the morphosyntax-phonology interface. They are also two domains of inquiry where traditional, serial, Rule-Based Phonology (RBP) and parallel Optimality Theory (OT), or Constraint-Based Phonology (CBP), have diverged, sometimes significantly. Within OT, which was traditionally entirely parallelist (and still is in many, if not most sub-camps) the re-introduction of cyclicity to the derivational computation has closed the gap between the two frameworks. Serial OT frameworks such as Lexical Phonology and Morphology Optimality Theory (LPM-OT) (Kiparsky 2000) or Stratal Optimality Theory (SOT) (Kiparsky 2007; Bermúdez-Otero 2014) are fundamentally quite

similar to a cyclic, modular, rule-based framework, but there are still some significant differences. Many of these particular differences (ex. strata-internal rule ordering) have been detailed in Vaux (2008) and in the previous two chapters (Vaux, Myler (this volume), Purnell (this volume)), and will therefore not be the focus of the current discussion. The recent explosion of modifications to CBP theories (ex. Stochastic OT, Boersma 1997; Harmonic Serialism, McCarthy 2000; Candidate Chain Theory, McCarthy 2007; in addition to LPM-OT and SOT) makes a general overview of the distinctions between Rule-Based and Constraint-Based theories at the interface beyond the scope of this chapter. I therefore focus here on the argument that an understanding of the link between syntactic and phonological derivations is a crucial precursor to developing the correct theory of purely phonological alternations. I emphasize some pertinent distinctions between RBP and SOT as they are currently presented, as they have similar premises regarding the architecture of the grammar and therefore offer an opportune environment in which to discuss detailed nuances of theory-construction and testing. I offer arguments that a serial, cyclic derivation, where affixes are not assigned to strata-particular constraint rankings best captures the inner-workings of the generative phonological system.

In §2 we will briefly discuss some historical perspectives and theoretical assumptions pertinent to the rest of this chapter. In §3 critical distinguishing issues specific to modularity and derivation germane to the OT-RBT debate are expounded. In these two sections the reader will find extensive references pointing them to more in-depth discussions of the foundational issues. Some relevant current contributions and research will be presented in §4. This main section will discuss aspects of two specific issues relevant to the SOT-RBT debate; (i) whether the delimitation of cycles is accomplished via representational or derivational means, and its link to OT alignment constraints and the Prosodic Hierarchy, and (ii) the relationship, or lack thereof, between the morphological status of affixes and phonological cycles. §5 will then conclude with an eye to future potential research directions, discussing the implications of the data in §4 for theories of phonology below the Prosodic Word, where the interface is not at issue.

2. HISTORICAL PERSPECTIVES

To situate any discussion of the morphosyntax-phonology interface it is necessary to discuss one's foundational assumptions regarding (i) the morphosyntax (and the morphology and syntax separately if they are taken to be separate modules), (ii) the phonology, and (iii) their manner of interacting. These foundational suppositions cannot be separated from the history of linguistic theorizing that they emerge from, leading to their inclusion in the present section. The presentation below is brief, of necessity, and should not be taken as a definitive list of resources or viewpoints pertinent to the debate, but rather as an overview of the theoretical underpinnings assumed in the following sections.

Proposals in the morphosyntactic literature have vacillated over whether the syntax and morphology are one single or two separate generative engines. Originally compounded (Chomsky and Halle 1968), the emergence of investigations into morphological irregularity vs morpho-syntactic regularity inspired their division, instigating the emergence of theories such as Lexical Phonology and Morphology (LPM) (Kiparsky 1982; Mohanan 1986). There it was proposed that a pre-syntactic word-formation module existed wherein affixes and phonological rules were organized into Levels, or Strata (ex. irregular inflection, regular

inflection, various types of derivation, compounding). This was taken to explain the link between certain kinds of phonological phenomena and particular constraints on affix positioning, and is the theoretical precursor to Stratal Optimality Theory, to be discussed in more detail below. Issues with LPM, such as its inability to correctly predict affixal patterning (Fabb 1988), the necessary introduction of a looping mechanism between levels which led to a lack of predictive power (Kaisse & Shaw 1985), and its overlooking of the parallels between word-internal and syntactic configurations (Marantz 1997), among other arguments, led to theories that reunified the two modules. This chapter assumes a particular version of this reunification, namely a realizational theory of morpho-syntax (à la Distributed Morphology (Halle & Marantz 1993, 1994) or Nano-Syntax (Starke 2010)) where the building blocks of the syntactic generative engine are morphemes, and these morphemes consist of abstract feature bundles which are given phonological form post-syntactically.

On the strictly syntactic side, it is a historically robust stance that the derivation proceeds in steps, or cycles (See Boeckx & Grohmann 2007 for a history of the cycle in the syntactic literature.). The current theory of cycles, namely Phases, is assumed here. Developed initially by Chomsky (1999, 2001a) (see also Uriagereka 1999). Phases are sub-structures that are sent to Spell-Out at both Phonological Form (PF) and Logical Form (LF). Phases have been undergoing theoretical modifications since their inception, and recently proposed variations and modifications touch on their size and mutability (Embick 2010, 2014; Marvin 2002; Adger 2006; Newell 2008; Bobaljik & Wurmbrand 2014; Svenonius 2004; Epstein & Seely 2002; Bošković 2014, among others). Understanding the exact size and properties of syntactic cycles is crucial to the development of any theory of the morphosyntax-phonology interface, but will not be investigated here. It is assumed herein that phases may be large (EP (traditionally v*P), CP, DP, and perhaps PP), or small (triggered by category defining derivational heads that project vP, nP and aP). The main focus of this chapter bears on the question of the manner in which the phonological module interfaces with the morphology and syntax at the point of Spell-Out, and what implications this has for current RBP or CBP proposals.

The phonological foundation of the current chapter is one where, in the words of McCarthy (1988: 84), "…if the representations are right, then the rules will follow." It is proposed here that the phonological output is organized both sub- and supra- segmentally into a version of feature geometric and syllabic (or CV) representations, respectively. The exact specifics of the organization of these phonological subcomponents are subject to debate. For discussions of feature geometry see Clements (1985), Sagey (1986), McCarthy (1988), Avery & Rice (1989) and Uffmann (2011, and references therein). For discussions of syllabic organization, or the lack thereof, see Bosch (2011 and references therein), and Scheer (2004, and references therein). An important point of debate that will be discussed herein concerns the relative roles of representation (phonological structure) and derivation (procedural computation) to a theory of phonology. Following Newell & Scheer (2007) and Scheer (2010) the existence of prosodic organization above the foot level is questioned (the Prosodic Hierarchy of Selkirk 1984; Nespor and Vogel 1986), but we will occasionally resort to making use of it below for ease of exposition.

This chapter therefore assumes a completely modular linguistic computational system, where the structure generated by the morphosyntax is interpreted cyclically at the interfaces, and where cycles are governed by purely syntactic means. At the interface with Phonological Form (PF) morphemes are replaced with vocabulary items, and their forms are underlyingly structured at the melodic level. Underspecified segmental structure and supra-segmental

structure are both projected from these phonological underlying representations upon interpretation at PF, and these underlying and surface representations may be subject to the application of phonological rules. Inviolable phonological constraints, in the pre-OT sense (ex. the Obligatory Contour Principle, Leben 1973) may also be active, and are not considered a basic part of Rule-Based phonological models.

3. CRITICAL ISSUES AND TOPICS

This section focuses on the main issues to be discussed in this chapter, namely *modularity* and *derivation*. Some general aspects of these issues are discussed, and in §4 we delve into some specific subjects that will tease apart certain differing predictions of SOT and the RBP supported here.

Modularity speaks to *what kind of information* is processed in each of the morpho-syntactic, semantic, and phonological computational systems. Within a strictly modular framework, the morpho-syntactic and phonological systems are non-overlapping. Morpho-syntactic information must undergo translation into phonological primes before the phonological system can act upon it. In other words, the syntax manipulates strictly syntactic features and representations, while the phonology manipulates strictly phonological features and representations (Zwicky & Pullum 1986). This entails that syntactic information such as *3rd person* or *XP* is invisible to, or rather, non-existent in the phonological domain, while a phonological element such as *nasal* or *onset* can play no part in the syntactic domain. This entailment holds universally. In no language does a person feature trigger, say, lenition, nor does a phonological feature trigger movement.[i] This notion of modularity bears not only on the distinction between phonological and morpho-syntactic primes, or features, but also on the question of the translation of cyclic domain edges into phonological terms. It is clear that the syntactic derivation effects the size of the domains for phonological rule application, but how this influence is exerted is open to debate. It was proposed in the post-SPE era that the # and + boundary symbols characteristic of early generative derivations were diacritics (not native phonological objects) and therefore had no place in a theory of phonology. This brought about the rise of indirect-reference theories, the most popular and widespread of which is the Prosodic Hierarchy (Selkirk 1984, 2011; Nespor & Vogel 1986). Recently Scheer (2008) has questioned the existence of the Prosodic Hierarchy as a phonological object, and reopened the debate over the existence of diacritics in the phonology, proposing that structures such as the Prosodic Word (PWd) have such a status. This brings us to an overlapping point pertinent to the spheres of modularity and derivation. Cyclicity in the phonology can potentially be determined in two different ways; derivationally or representationally. A detailed discussion of this distinction can be found in Bermúdez-Otero & Luis (2009), Newell & Scheer (2007), and Scheer (2010). In §4.1 we will examine how syntactically-driven cyclic interpretation makes independently verifiable predictions, and will discuss whether the representational cyclicity introduced in the (morpho)phonology via the Prosodic Hierarchy is therefore redundant. Arguments for and against the necessity of both representational and derivational explanations for the cycle are assessed in §4.2. It is argued that a purely derivational phonology is the theoretically cleaner option. This, in turn, calls into question OT constraints like ALIGN that make reference to the Prosodic Hierarchy. It is of note that many current phonological proposals include rules or constraints that make simultaneous reference to both phonological and morpho-syntactic information. This mixed-module approach is common within OT and in RBP,

but is not specific to, or fundamentally required by either. In §3.1 we investigate the issues raised by the mixing of modules, and it is demonstrated that this mixing is problematic for an explanatory theory of phonology. A completely modular theory of phonology is proposed to offer superior explanations.

The discussion of the status of derivation within the phonological module is inextricably entangled with the question of modularity in an additional way. Questions of derivation relate to *when information is processed*, and *what triggers interpretation.* The first central question regarding phonological derivation is to determine whether phonological strings are processed in cycles or in one fell swoop. As mentioned in §2, for the most part, historically and currently, cyclic derivation has been the standard assumption (with the notable, and ongoing, hiatus taken by traditional, parallel Optimality Theory (McCarthy & Prince 1993, 2008; and many of its descendants). RBP has traditionally presupposed cyclicity, along with serial application of phonological rules, and these will be taken as basic operations of phonological computation in this chapter. As mentioned above, phonology being processed in cycles leads to the question of whether these cycles are determined phonologically, morphologically (lexically), or syntactically. This brings us to the second question discussed in this chapter relevant to derivation, central only once one accepts that cyclic interpretation is a property of the grammar; what drives phonological cyclicity? In §3.2 we preview the fundamental questions pertinent to how particular phonological cycles are triggered. In §4.3 we carefully examine the case of cyclic phonology in Ojibwe (Newell & Piggott 2014) and will demonstrate that cycles must be determined in the narrow syntax, without reference to morpho-lexical information.

A central concern of this chapter is therefore a meta discussion of the architecture of the grammar assumed generally by some proponents of rule-based and constraint-based systems. Issues with the underlying assumptions of the theories will be raised, and motivations for the return to a derivational, rule-based phonology will be offered. It is crucial to note, however, that neither modularity nor derivation is incompatible with either RBP or CBP. We will therefore focus on a few instances where the underlying assumptions of current theories differ.

3.1 Modularity: The domain division

One of the most important distinctions between a classical OT conception of linguistic processing and that of RBP is that the former is not strictly a theory of phonology. Regardless of the trend that has emerged, where phonologists are the strongest supporters of constraint-based grammars, a classical OT grammar is a ranking of grammatical constraints that may also include constraints on morphological and syntactic structures and derivations (Legendre et al. 1993, Aissen 1999, Hayes 2000). A property of standard Optimality Theoretic proposals is therefore that the grammar is not necessarily modular. Morphological and syntactic constraints can, in principle, be ranked both higher and lower than phonological constraints. Also, single constraints in the literature refer simultaneously to both phonological and extra-phonological properties, as in the following constraint that references both linear order and semantic scope:

(1) SCOPE: Make scope transparent on s-structure (Jäger 1999)

This non-separation of domains predicts that many non-occurring patterns could emerge; where phonology and syntax are predicted to be able to interact in ways that are unattested. Remember that phonological features never impact whether a verb raises from T to C, for

example, just as no formal syntactic feature influences whether Vowel Harmony may occur. Within a non-modular free ranking of constraints, the restriction of languages to the attested patterns is unexpected. Admittedly, the phonological OT literature makes very little reference to narrow-syntactic configurations or features, and a modular OT at that level is not difficult to conceive. Particularly relevant to this chapter is that a modular OT is, in fact, actively promoted within Stratal Optimality Theory (Bermúdez-Otero 2012). Yet, it is important to note here that the instances where the phonology and morpho-syntax do co-refer are an integral part of the OT phonological system, and do nonetheless bleed over into the SOT framework. The most basic non-modular constraints are those like ALIGN (McCarthy & Prince 1993a,b; McCarthy 2003), WRAP (Truckenbrodt 1999), or MATCH (Selkirk 2011). Consider the following:

(2) Match Phrase (Match (Phrase,φ)) :
A phrase in syntactic constituent structure must be matched by a corresponding prosodic constituent, call it φ, in phonological representation.
(Selkirk 2011)

This constraint is one of three (the others being specific to words and clauses) proposed by Selkirk to govern the interface between the syntax and the phonology. Now, the translation from syntax to phonology must be effected somehow, but the formulation of the class of alignment constraints underpins a more general issue for the computational system, and specifically for the phonology. The above constraint is not part of a subset of translation operations (dubbed the Translator's Office by Scheer), but rather is interleaved with purely phonological constraints in the phonological system, as in (3).

(3) a.

$_{clause}$[[verb [noun]$_{NP}$]$_{VP}$]$_{clause}$	BinMin (φ, ω)	Match (Phrase, φ)
i. $_{ι}$($_{φ}$(verb $_{φ}$(noun)$_{φ}$)$_{φ}$)$_{ι}$	*	
☞ ii. $_{ι}$($_{φ}$(verb noun)$_{φ}$)$_{ι}$		*

b.

$_{clause}$[[verb[noun adj]$_{NP}$]$_{VP}$]$_{clause}$	BinMin (φ, ω)	Match (Phrase, φ)
☞ i. $_{ι}$($_{φ}$(verb $_{φ}$(noun adj)$_{φ}$)$_{φ}$)$_{ι}$		
ii. $_{ι}$($_{φ}$($_{φ}$(verb noun)$_{φ}$ adj)$_{φ}$)$_{ι}$		*

(Selkirk 2011: 447)

The above tableaux demonstrate blatant non-modularity. Not only is the Match Phrase constraint ranked directly in relation to BinMin, a constraint that regulates phonological binarity within a prosodic domain, but also both the input to Gen and the output candidates are a jumble of phonological (φ, ι), morpho-syntactic (verb, noun, adj) and syntactic (clause, NP, VP) information. This mix in formal vocabulary strongly entails the presence of other, non-discussed, constraints never listed in the OT syntax-phonology interface tableaux in the literature, namely those preventing the emergence of syntactic features in the phonological output, such as the following:

(4) a. MAX, CLAUSE: Every instance of CLAUSE in the input must emerge in the output.

b. *CLAUSE: No instance of CLAUSE in the input may emerge in the output.

Richness of the Base, combined with the syntactic features in the underlying structures in (3), implies that the non-emergence of syntactic features in the phonological output must be due to universally undominated constraints such as *CLAUSE (it is unclear what the emergence of the feature CLAUSE in a phonological output would look like). Yet, any time a constraint must be proposed to be universally undominated, or a feature in an input must be excluded from all outputs, we run up against the predictions of the general OT framework, wherein constraint ranking is freely mutable. I suggest here that the fact that constraints like *CLAUSE would be inviolable finds a better solution in a strictly modular grammar. No syntactic and morphological features play a role in the phonology, and therefore the tableau in (3) does not represent any possible derivation within the bounds of Universal Grammar. This has implications for the status of the Prosodic Hierarchy, to be discussed below in §4.1 and §4.2.

Note that the above criticism cannot be restricted to CBP derivations, but that a rule in an RBP framework like the one assumed herein must also apply to a phonological string or structure after the translation of syntactic structure into phonological vocabulary has occurred. In other words, the translation of syntactic domains into phonological domains like PWd and PPh (if they are indeed phonological objects) is not considered to be part of the phonology proper in a radically modular theory (Scheer 2012). At the point where phonological rules are applied, reference to the syntax is impossible. Whether this radical stance is correct has implications for any theory of phonology. It is, however, simpler mechanically to eliminate reference to morpho-syntax from an RBT theory than from an OT framework where constraints like ALIGN (along with faithfulness and markedness constraints) form one of the fundamental constraint classes.

3.2 Derivation: The Source of Cyclicity

As stated above in §2, it is assumed in this chapter that cycles in the phonology are parasitic on a cyclic syntactic generative engine. It follows that syntactic features relevant to cyclic Spell-Out will determine the size and number of phonological domains. A word like *ungrammaticality* in such a system is computed in four cycles, indicated in (5).

(5) $[[\text{un}]_3[[\text{grammatical}]_1\text{ity}]_2]_4$

The status of *un-* as separate phonologically from its base will be discussed further in §4.1, but it is clear from the lack of nasal assimilation evidenced, and its status as a separate (secondary) stress domain that the phonology has a means to keep this affix separate from its base; *grammaticality*. In Phase-based terms, the set of morphemes {*un-*} comprises a separately processed subset of lexical items in the derivation (a numeration) and therefore constitutes an independent Spell-Out domain. Then, we have evidence that *grammaticality* is processed in 2 cycles, as indicated by the fact that the stress on *grammatical* from cycle 1 carries over into cycle 2. The stress pattern of *grammàticálity* is distinguished from the stress on monomorphemic, single cycle, long words in English like *Lòllapalóoza,* where secondary stress generally falls on the first syllable (Pater 2000). We then must postulate a cycle where *un-* and *grammaticality* are linearized, giving us the four cycles in (5).

Within a LPM-OT or SOT account, it is postulated that there are only three possible strata; stem, word, and phrase. As we will limit our discussion in this chapter to elements that are considered to be words we will restrict our discussion to the first two strata. This adherence to a limited number of strata does not preclude a four-cycle analysis of (5), where the stem stratum may iterate (cycles 1 and 2) as may the word (cycles 3 and 4), but this adherence does coincide with two other pertinent propositions (But see §3.4 for a discussion of the proposal in Bermúdez-Otero (2012) that word-level phonology cannot be subject to cyclic reapplication). The first is the proposal that the particular stratum that a phonological string is submitted to is determined by the particular affix(es) added during a cycle. As with its predecessor, LPM, affixes in SOT are affiliated with strata, and this proposal is therefore subject to many of the arguments against LPM in the literature (see references in §2, and the discussion below in §4.3). Yet, an advantage of the proposal that phonological cycles are morphologically determined is that it accounts easily for the re-application of stem-level rules, like the main stress rule, in (5) in a way that a phase-based system like the one assumed here appears to have trouble explaining. In a phase-based system without morphological affiliation we expect that only the morphemes present in the first, innermost, phase will affect the phonological domain of the root (here *grammar*) (Marantz 2001). Cycle 1 should therefore delimit the domain for main-stress assignment, contrary to the attested output (cf. the less common [[*grammátical*]$_1$*ness*]$_2$). That this is not the case is clearly caused by an idiosyncratic property of the affix –*ity*; regardless of the morphosyntactic makeup of the structure to which it attaches it will be interpreted as part of the main stress domain. Within an SOT framework this falls out directly. In a Phase-based RBP account an extra, lexically-sensitive, process must be posited that may insert an affix into a previously interpreted phonological domain to account for these facts (Lowenstamm 2010). Fortunately, a possible solution to this problem can be proposed, and an independently motivated class of operations (which may be morphologically or phonologically motivated), dubbed Phonological Merger in Newell & Piggott (2014: 353), may be co-opted to account for this behaviour.

(6) *Phonological Merger*
[X [.....$_{PWd}$]] → [~~X~~ [.. X....$_{PWd}$]], where X is an affix.

This operation causes an outer affix to incorporate into the phonological domain built on a previous cycle. Two of the clearest cross-linguistic manifestations of this type of operation are infixation (7a), or Selkirk's (1996:207) internal clitics (7b), where the clitic, which is syntactically separate from the noun to which it cliticizes, emerges as internal to the stress domain that includes the noun.

(7) a. abso*bloody*lutely
b. ù graad 'to the city' (Serbo-Croation)

Phonological Merger, as seen in (7b) is not restricted to operations that modify linear order, as will be seen again below in the discussion of Ojibwe. The stem-level affiliation of –*ity* in (5) may therefore be ascribed to its phonological (dis)position, rather than its morphosyntactic features. Here it would be the case that affixes like –*ity* target the sub-foot structure in the base they attach to, triggering some necessary re-syllabification which would affect the position of stress.[ii] In comparison with the behaviour of affixes like -*ity*, §4.3 demonstrates that a single

affix in many languages may have multiple phonological behaviours. It will be argued that the behaviour of these 'multi-stratal' affixes is best determined syntactically, rather than morpho-lexically. The notion that morphemes belong to particular strata is therefore not the deciding factor in their phonological behaviour.

This is in part due to the second issue that coincides with the SOT proposal that there are a limited number of phonological strata, namely that morphosyntactic features that correspond to the notion of 'stem' or 'word' do not exist. Volumes such as Julien (2002), Newell et. al. (in press) expound upon the impossibility of determining the status of the term 'word' syntactically. A morphosyntactic notion of 'stem' is even more elusive. As SOT is modular theory, where no morphosyntactic features (besides those picked out by alignment) are permitted in the phonology, the imposition on the syntax to determine stratal affiliation of affixes is theoretically unmanageable. Within a phase-based account, where the only relevant morphosyntactic features determining phonological cycles are those proposed to be independently necessary to determine syntactic cycles, this problem is not encountered. That said, it is nonetheless the case that different phonological cycles have particular characteristics, and this fact does not fall out of any particular syntactic aspect of phases. Potential directions to take in independently motivating cyclic phonological differences have a long history based in notions such as the Strict Cycle Condition (Kean 1974:179). Restrictions on the application of phonological rules and the potential ways in which to determine the phonological behaviour of different cycles will be discussed in §5.

This section has presented an overview of the issues that are critical to the discussion of the particular problems to be presented in §4. We will discuss how the particular behaviour of adjuncts has been used to motivate the necessary presence of the Prosodic Hierarchy in the phonological component, and how a derivational account may eliminate this necessity in §4.1 and §4.2. In §4.3 we will examine multi-cyclic affixes in Malayalam and Ojibwe, and will conclude that the cross-linguistic evidence supports the conclusion that affixes are not lexically affiliated with particular phonological strata. Although the morphosyntax-phonology interface predictions of SOT and the RBP framework presented here agree in many aspects, it will be seen that there are domains wherein their implications are non-overlapping.

4. CURRENT CONTRIBUTIONS AND RESEARCH

Here we will examine particular analyses of phonological phenomena for which RBT premises are argued to offer a simpler, more modular solution than that offered within a theory such as SOT. §4.1 will begin with a discussion of English negative morphemes that has been recurrent in the literature since at least Booij & Rubach (1984). This discussion is pre-empted in Newell (2008), and Scheer (2012), and rests on the proposition that, due to the syntactic governance of cyclicity, words that appear to be structurally indistinct may nonetheless display divergent derivations. This leads in to a discussion in §4.2 of data raised in Bermúdez-Otero & Luis (2009) from European Portuguese (EP). Bermúdez-Otero & Luis contend that the EP data argue definitively for the necessity of a representational distinction at the word-level. A solution along the lines of Newell & Scheer (2007), and Newell (2008) will be argued to account for this data within a derivational model as well, eliminating the need for a solution that appeals to the Prosodic Hierarchy. §4.3 will then discuss the notion of strata or levels in SOT, and discuss how the proposition that morphemes are linked to specific strata does not hold when we look at languages where the same morphemes have divergent phono-syntactic behaviour. We will look

in detail at the proposal in Newell & Piggott (2014) that there is no possible OT account for Hiatus Resolution in Ojibwe. This will lead to a short discussion of affixes whose varying phonological behaviour must be due to modular interface effects rather than to Stratal affiliation. The conclusion to be reached here is that, for the data at hand, determination of strata or cycles is effected without reference to the identity of particular morphemes, but rather through syntactic computational mechanisms.

4.1 The Phonological vs Syntactic Derivation of English *un-/in-*

There is a well-known phonological distinction between the negative prefixes *in-* and *un-* in English. The nasal consonant in the former assimilates phonologically in Place (and Manner, for sonorants) to a following consonant, while the nasal in the latter does not.

(8)

a.		b.	
	i[m]possible		u[n]balanced
	i[n]tolerable		u[n]timely
	i[ŋ]congruous		u[n]kempt
	i[l]licit		u[n]lovable
	i[ɹ]refutable		u[n]rounded

Booij & Rubach (1984) propose, within the framework of Lexical Phonology, that the distinction between the two is representational: *in-* is incorporated into the PWd of its base (It is a Level 1 affix), while *un-* projects its own PWd (Level 2).

(9) a. $[\text{in-possible}]_{\text{PWd}}$ b. $[[\text{un}]_{\text{PWd}}[\text{balanced}]_{\text{PWd}}]$

Assuming that Assimilation occurs only within a PWd, the distinction in (8) is captured.

It is quite simple to translate the above into an SOT framework. Here, a constraint requiring assimilation must be ranked higher than a constraint requiring faithfulness to Place features in the Stem stratum (Level 1), where *in-* is introduced (10), while the opposite ranking must be true at the Word stratum (Level 2), where *un-* is inserted (11).

(10)

in-possible	ASSIMILATE	$\text{FAITH}_{\text{PLACE}}$
inpossible	*	
☞ impossible		*

(11)

un-balanced	$\text{FAITH}_{\text{PLACE}}$	ASSIMILATE
umbalanced	*	
☞ unbalanced		*

The above, like the representational/LP account successfully captures the phonological pattern observed. It does, however, leave some questions unanswered. The first is whether the above (re-)rankings are indicative of a larger, cross-linguistic pattern. It has been observed since the beginning of the generative phonological enterprise that the output of a first cycle

tends to be preserved on a subsequent cycle (ex. Kean 1974). In versions of OT that countenance multiple constraint rankings/levels this has been translated as the proposal that re-ranking across strata can only lead to the promotion of Faithfulness constraints in relation to Markedness constraints.

(12) Constraint typology and the limits of reranking: The core-periphery organization of the lexicon is the consequence of the fact that, in the typical case, reranking is limited to Faithfulness constraints (PARSE and FILL), within an otherwise invariant constraint system.

(Ito & Mester 1995:183)

The above is not, however, assumed in current OT analyses generally. Bermúdez-Otero & Trousdale (2012), alternately, proposes that constraint re-ranking is due to the life cycle of phonetico-phonological processes, leading to the diachronic demotion of Faithfulness constraints in smaller domains. In either case, the distinction between *un-* and *in-* is not linked reliably to a tenet of the OT system.

This brings us to the second question of whether this re-ranking is purely lexico/phonological, or whether the differing levels of faithfulness across cycles is linked to the synchronic morpho-syntactic derivation of particular constructions. In Newell (2005a,b) it is demonstrated that the prefixes *in-* and *un-* not only have distinct phonological behaviour, but also diverge morpho-syntactically.

(13)

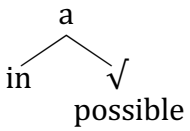
	(a) phonology	(b) morphosyntax: features	(c) morphosyntax: structure
in-	assimilation	projection of adjectival features	no participation in bracketing paradoxes
un-	no assimilation	no projection of features	participation in bracketing paradoxes

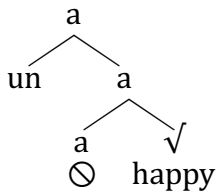
(13a) has already been demonstrated in (8). (13b) is demonstrated by the fact that all words prefixed with *in-* are adjectives, while words prefixed with *un-* may be adjectives, nouns, or verbs.

(14) a. inept, impossible, *intie, *imbirthday
b. unhappy, undo, unbirthday[iii]

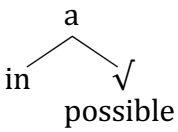
What (14) indicates is a morphosyntactic distinction between the two affixes. Either *in-* selects for an adjectival base, or *in-* is projecting adjectival features. Within a theory such as Distributed Morphology each featureless root morpheme merges (directly or indirectly) with a category-defining head (but see Wiltschko & Déchaine 2010 and Borer 2013 for alternate views of lexicalization and the syntax-phonology interface). This proposal, paired with the fact that *in-* and not *un-* attaches to bound roots (ex. *inept*, with the notable exception of *unkempt*), as well as the fact that *in* emerges in the same phonological domain/cycle as its base, argues for the latter, seen in (15a). The fact that *in-* cannot attach to nouns and verbs indicates that this morpheme may only select for roots or adjectives. As *un-* does not attach to bound roots, and

never affects the category of the base to which it attaches, we can conclude that *un-*, as is characteristic of syntactic adjuncts, projects no category features (15b).

(15) a. 

b. 

Adjuncts, which do not project morphosyntactic features up the tree, have been argued in the syntactic literature (i) to merge a-cyclically, counter to the Extension Condition of Chomsky (2001b) (Lebeaux 1988, Nissenbaum 2000, Stepanov 2001, Ochi 1999), (ii) to be interpreted phonologically prior to their syntactic merger (Uriagereka 1999), and (iii) participate in bracketing paradoxes (Pesetsky 1985, Nissenbaum 2000, Newell 2005a,b, 2008). The divergent syntactic behaviour of adjuncts and non-adjuncts leads to the phonological distinction we see in (8) without calling for additional machinery like prosodic or stratal affiliation in the phonological domain. The derivation for (15a) occurs in one cycle, or phase, *in-* being an adjectival phase head:

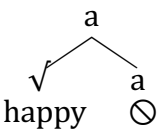
(16) 

→ in-possible

Assuming for the moment that the output of cyclic interpretation to the phonology includes the projection of prosodic structure, the PF output of (15a) will be a single domain. Let us assume this domain to be a Prosodic Word. Place assimilation takes place at PF interpretation.

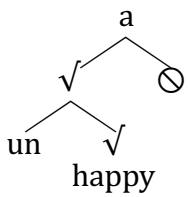
(17) [impossible]$_{PWd}$

The derivation of (15b), however, is computed in three steps, the first two of which, given the adjunct nature of *un-*, may occur in parallel. A null adjectival categorizing head triggers the phase in (18a). In (18b) *un-* is the sole member of its numeration/cycle. (18c) is the structure after the a-cyclic merger of *un-*, which must be interpreted at PF to ensure proper linearization of its pieces.

(18) (a) 

→ [happy]$_{PWd}$

(b) un → [un]$_{PWd}$

(c) 

→ [[un]$_{PWd}$ [happy]$_{PWd}$]$_{PWd}$

As each PF interpretation leads to prosodic projection, the output of (18) will be as follows the arrow in (18c). Note that the Strict-Layer Hypothesis, a tenet of classic Prosodic Phonology (Selkirk 1981, 1984, Nespor and Vogel 1986), has been abandoned and therefore the nested PWd structures seen here are permitted by the theory (following Selkirk 2011, Ito & Mester 2013).

The specifics of the phonological rule responsible for assimilation will be expanded on below. What is important here is that the morpho-syntactic distinctions between the two negative prefixes in English, along with a cyclic account of syntactic interpretation, leads to the distinction in phonological structure seen in (17) and (18c). This is the exact structural distinction that was proposed in Booij & Rubach (1984). The advantage of the present procedural derivation is that the distinction between *in-* and *un-* is non-stipulative. Syntax feeds phonology. Assimilation here applies within a PWd, and the morpho-syntax of *un-* results in its phonological separateness from the base to which it attaches.

Before moving on to the next dataset, it is important to remember the discussion in §3.1, above. The PWd structure assumed in the above derivations is in line with the standardly held view in the phonological literature that the Prosodic Hierarchy is the (indirect) phonological link to syntactic structure. The proposal that the assimilation rule in English is sensitive to this prosodic structure is therefore also standard.

(19) N → [αPLACE] / ___ C$_{[\alpha PLACE]}$ (*N → [αPLACE] / ___]$_{PWd}$ C$_{[\alpha PLACE]}$)

The rule in (19) will not apply if a PWd boundary intervenes between the nasal and the following consonant, as the environment for assimilation (direct linear adjacency) will then not be met. This type of explanation is an illustration of a representational account of the phonological derivation (Newell & Scheer (2007) and Scheer (2010, 2012)). But, the derivations in (16-18) allow for an alternate, purely procedural, account of the manner in which phonological rules are applied. If we assume that the assimilation rule must be applied at the point in the derivation where the nasal consonant is first interpreted, then reference to prosodic structure becomes superfluous. Let us assume that the nasals in both affixes are underspecified for Place. In (16) the nasal is interpreted in the first cycle at PF at the same time as the root *possible* is interpreted. The nasal and the conditioning segment for assimilation are therefore processed in the same cycle, and assimilation may occur. In (18), however, *un-* is first interpreted alone in (18b). As there is no conditioner for assimilation at this point in the derivation, the nasal will emerge with default Place features, here coronal. The proposal here is that these underspecified nasal segments in the input must be fully specified upon interpretation at PF, either by the application of phonological rules, or by default projection of features. At a later point in the derivation assimilation will not apply (18c), as the nasal is no longer underspecified. Given this account of the distinction in assimilation patterns here, then reference to the PWd is not necessary and therefore not the optimal tool to explain the nasal assimilation patterns. If similar procedural accounts of phonological derivations can be

motivated cross-linguistically this will support the proposal of Scheer (2008) that the Prosodic Hierarchy is not the correct way to account for phonological cyclic effects. This type of analysis is discussed further in §5.

The conclusion here is that a Rule-Based, underspecification account of nasal assimilation in English follows from a phase-based, fully modular account of the derivation. This accounts for both the morpho-syntactic and phonological characteristics of these derivations without recourse to either different strata-specific phonologies or diacritic lexical affiliation. A framework like SOT, where Richness-of-the-Base holds only at the input (Bermúdez-Otero 2007), can also account for this, but it is of note that the RBP proposal need not appeal to different constraint rankings/rules to achieve the correct results, making it a simpler account.

4.2 European Portuguese and Diminutive Adjunction

In the above section we managed to eliminate the need to appeal to the Prosodic Hierarchy in our phonological rules while capturing the apparent level-distinctions between two prefixes. Bermúdez-Otero & Luis (2009), working with an SOT framework, argues that the phonological cycles in European Portuguese not only support a stratal account of the phono-syntactic derivation, but also offer crucial evidence for the existence of the Prosodic Hierarchy. It is of note here that these authors are explicitly aware of the potential duplication of explanations, representational vs procedural, exemplified by the discussion of the negative prefixes above and that they attempt to push the possibility of a procedural account as far as possible within the boundaries of SOT. Within SOT, remember, there are a finite number of levels countenanced; Stem, Word, and Phrase (as opposed to the Word, Phrase, and Clause domains of Match Theory (Selkirk 2011)). In this section we offer an alternative account that again appeals to syntactic adjunction and supports an account of the data that need not take recourse to representational domain distinctions.

Interestingly, Bermúdez-Otero & Luis show European Portuguese affixes/clitics to have (at least) 4 different behavioural patterns. Characteristic behaviour of suffixes in EP is that they form a single domain for stress assignment with the root, and, if a suffix begins with a high front segment, it will trigger lenition of certain root-final /t/, /k/, or /g/s. Suffixes are therefore clearly stem-level affixes according to Bermúdez-Otero & Luis, or first-Phase affixes within a cyclic RBP account. Proclitics in EP can be separated from the verb by other words, and can scope over conjoined verb phrases. They are clearly separate words from the verb, as opposed to prefixes, and therefore must be introduced at the phrasal stratum within an SOT framework. Enclitics, on the other hand, are not separable from the verb and cannot scope over coordination, so are clearly affixal. But, enclitics never affect the position of main stress in the word, and never trigger root-final lenition. It therefore appears that these enclitics are members of the word stratum. The problem here is the behaviour of the diminutive suffixes *–inho* and *–ito*, which falls between that of the proposed stem and word level morphemes. The diminutive affixes may be stressed, like stem-level affixes, but do not trigger lenition, like enclitics.

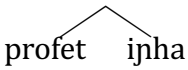
(20) a. profet-ia → profecía (c.f. proféta)
'prophecy'

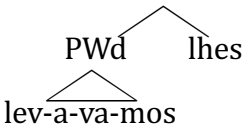
b. profet-inha → profet-ínha
'little prophet'

It is therefore not possible for the above patterns to emerge within a purely procedural SOT system.

(21) a. [proclitics [[[root-suffixes] diminutives] enclitics]]
[phrase [[[stem] word?] word?]]
(Bermúdez-Otero & Luis 2009)

If SOT only allows for 3 strata, then how can the 4-way distinction in affix/clitic behaviour be accounted for? The solution proposed by Bermúdez-Otero & Luis is that diminutive morphemes in the language are representationally distinct from enclitics. Both diminutives and enclitics are introduced at the word stratum, but while the diminutives form part of the PWd with the stem affixes, the enclitics are phonologically adjoined to the PWd.

(22) a. 

b. 

The authors therefore conclude that the Prosodic Hierarchy is empirically motivated, as it is the sole way in which to capture this 4-way distinction in phonological behaviour within a single language. In other words, their conclusion is that the phonology-syntax interface must be moderated both procedurally (stratally) and representationally (prosodically). The authors admit that this conclusion is linked to the SOT proposal that the strata be limited in number to three. If 4 levels were allowed for, we would not need to propose a representational distinction between the diminutives and the enclitics, allowing for a purely procedural account of the interface.

Each of these proposals, where SOT is either augmented representationally (by the Prosodic Hierarchy) or procedurally (by adding an extra stratum) is, however, equally stipulative. A fourth stratum, like the representational distinction in (22) is motivated only by the need to account for the 4-way distinction in (21). Bermúdez-Otero & Luis, and proponents of SOT in general limit the number of strata to 3 in order to constrain the predictive power of the theory (among other motivations). It is unclear, however, how allowing for lexically-specified distinctions in representational prosodic structure does not proliferate the number of cycles in exactly the way restricting SOT to three levels is meant to prevent. But, if a proliferation of strata were to be allowed instead, we would be faced with the problem that plagued SOT's theoretical predecessor, Lexical Phonology and Morphology (LMP), discussed in §3. LMP had to resort to adding levels, and loops between levels, to explain the many phonological distinctions that needed to be accounted for, both within and across languages (Kiparsky 1982, Mohanan 1986). These issues lead us to look for a deeper explanation of the distinctions seen. The data in European Portuguese are indicative of a distinction that is real, just like in the case of the English negative prefixes. We can therefore ask ourselves if there is an analogous phono-syntactic account of the affixal divisions in (21).

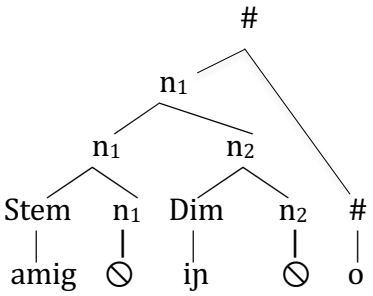
To this end, consider the analysis of the morpho-syntax of the diminutive affixes in Brazilian Portuguese. It is argued in Bachrach and Wagner (2007) that the effect diminutives have on the position of stress in a word differs from that of other derivational affixes. Bachrach & Wagner propose that diminutive affixes behave like members of co-compounds (dvandva) rather than like derivational affixes. It is argued that they constitute a second domain for stress, rather than constituting part of the stress domain of the root. This is supported by the interaction of diminutive affixation with mid-vowel raising in unstressed positions (as noted and referenced by Bermúdez-Otero & Luis).

(23) a. bɛ́lo → bel-éz-a 'beautiful, beauty'
b. bɔ́la → bɔl -íɲ-a 'ball, (small) ball'
c. bɔ́la → bɔ̀la-zìɲ-a 'ball, (small) ball'

(Bachrach & Wagner 2007: 2)

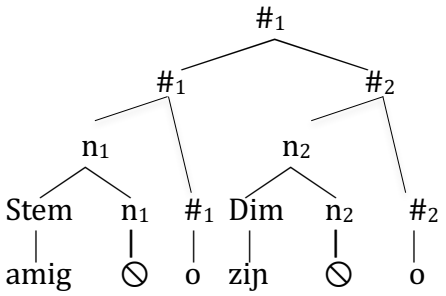
Non-diminutive derivational suffixes shift stress away from the root vowel, leading to its raising (23a). The diminutive affix may cause destressing of the root vowel (23b) or demotion of root stress to secondary (23c). In (23b) the root vowel is argued to have been stressed on a previous cycle, and stress clash has been resolved through deletion. Interestingly, stress clash is not resolved in all dialects (ex. *cafèzínho* Cegalla 2008 :38). In both (23 a & b) it is apparent that the derivation includes two cycles of phonological interpretation, where the root vowels receive stress in the first. Why should these diminutive affixes constitute separate cyclic domains from their hosts? According to Bachrach & Wagner, diminutive affixes generally are adjuncts, and are composed of a diminutive root and a category-defining head. Non-adjunct suffixes are proposed to be, on the other hand, monomorphemic.

(24) a. /iɲ/- Adjunction



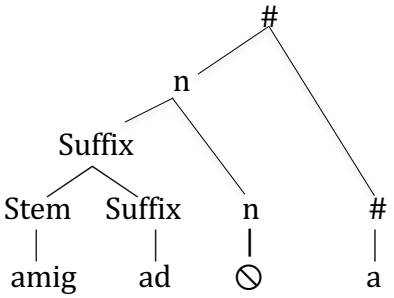
[amigíɲo] 'small friend'

b. /ziɲ/- Adjunction



[amìgozíɲo] 'small friend'

c. Derivational suffix



[amigáda] ‘concubine’

(Bachrach & Wagner 2007: 5)

The positions of adjunction in (24a,b) are argued to explain other agreement and distributional facts regarding the diminutive affixes that would take us too far afield from the discussion at hand. For our purposes it is sufficient to note that the adjunct status of the diminutive affixes brings their derivational status in line with that of *un-*; they will be interpreted phonologically prior to merger with their base. The phonological structure of the words in (24) therefore parallels the structures in (16) and (18c), but now this structure has morpho-syntactic motivation. The distinction here is that, contrary to Bermúdez-Otero & Luis’ analysis, it is the diminutive affixes that are ‘PWd’ adjoiners.

(25) a. $[[\text{amig}]_{\text{PWd}}\,[\text{íɲo}]_{\text{PWd}}]_{\text{PWd}}$
b. $[[\text{amìgo}]_{\text{PWd}}\,[\text{zíɲo}]_{\text{PWd}}]_{\text{PWd}}$
c. $[\text{amigáda}]_{\text{PWd}}$

If the diminutive morphemes are adjuncts to the PWd, as well as being adjuncts in the syntax, then we must ask ourselves what the derivational/phonological properties of the clitics are that cause them to be phonologically farther from their base. The syntax of Portuguese clitics and their relation to phonological spell-out will not be solved here, but will undoubtedly be tied to the functional nature of these morphemes and the resistance functional heads show to bearing stress. In any case, it was the distinction between the two ‘word-level’ suffixes (diminutives and enclitics) that was the motivation for the proposal that the Prosodic Hierarchy is necessary to account for the EP data. Assuming that EP diminutives are adjuncts, as in BP, this entailment no longer holds. Phonological rules apply at PF interpretation, and adjuncts are interpreted prior to their incorporation into the Narrow Syntactic structure. The enclitics, as suffixes, may be interpreted after merger to their base (see (22b). In this type of structure the enclitic will not bring its own stress into the derivation, and stress determined on the first cycle of PF interpretation will persist.

The entailment is then that it is the timing of interpretation determined by the syntactic structure that distinguishes the problematic levels seen in (21) that distinguishes the surface stress patterns in EP, and we can again do away with any reference to the Prosodic Hierarchy. EP suffixes will be interpreted at the same time as the root to which they attach, while enclitics merge to a domain that has already been stressed, and syllabified. The final consonants that do not undergo lenition in the presence of enclitics are therefore structurally distinct from the

consonants that do undergo lenition under suffixation, just as in the case of nasal assimilation in English. In the case of diminutives, they themselves constitute separate phases from the base to which they attach. They therefore, as discussed by Bachrach and Wagner, have the phonological behaviour of a kind of compound. Their syntactic structure predicts their phonological differentiation from the enclitics. A fully procedural account is mechanically simpler than the Strata+PH proposal, and accounts for both the morphosyntactic and phonological behaviour of the morphemes involved.

This section has argued that a purely procedural account of phonological domains in EP can be countenanced, leading to a more explanatory account of data that have appeared to require a representational account. It has not been shown, however, that an SOT account cannot account for the data at hand. An SOT framework could be adapted to the account above. The following section, however, elaborates a pattern that has been argued in Newell & Piggott (2014) to be the result of cyclic rule application, and, importantly, to not be derivable in a parallel, CBP framework.

4.3 Multi-Cyclic Affixes

It is not uncommon cross-linguistically for a single affix to display different phonological behaviour depending on the construction in which it emerges. An example of this is the causative morpheme in Malayalam (Michaels 2009). The same morpheme, *-ikk,* marks both low and high (traditionally lexical and syntactic) causative constructions. The low causative morpheme either coalesces with the root-final consonant (26a), or resolves an emergent hiatus by deletion of a vowel (26b), while the high causative morpheme does not coalesce with a root final consonant (27a), and resolves hiatus through epenthesis (27b).

(26)	a.	/aaʈ + ikk/ shake + cause	[aaʈʈ]	‘Y shakes X’
	b.	/nana + ikk/ water + cause	[nanakk]	`Y waters X'
(27)	a.	/paaʈ + ikk/ sing + cause	[paaʈikk]	`Y makes X sing'
	b.	/kaɻa + ikk/ cry + cause	[kaɻajikk]	`Y makes X cry'

This type of pattern is crucially problematic for a non-Stratal Parallelist model such as classic OT, as the input phonological strings in the (a) and (b) examples are indistinguishable in all relevant respects. A non-modular solution to this problem would be to reference the different syntactic structures of (26) and (27) in the constraint ranking (root-attached and non-root-attached causative morphemes, respectively), but this then opens up the issue discussed in §3, where the mixing of syntactic and phonological constraints predicts a sensitivity to the phonology by the syntax that is unattested at the segmental level. To account for the above pattern in SOT, the affix *–ikk* must be permitted to be a member of more than one stratum. This is problematic in that strata are then underdetermined by the morphology, calling into question the premise that strata are morphologically driven (affixes being either stem or word level). Although SOT is a realizational theory of phonology, where cycles are determined in the

syntactic structure, it is nonetheless proposed, as seen above, that a single affix at different positions will trigger the cycle to which it is affiliated, as seen with the behaviour of *–ity* discussed in §3.2. (Bermúdez-Otero 2014, but c.f. Bermúdez-Otero 2015). Take the example of the affix *–al* in English, as discussed by Bermúdez-Otero (2014). *–al* displays stem level, stress-affecting, behaviour regardless of whether it is affixed to a root (28a) or to a word-level affix (28b).[iv]

(28) a. affíxal (c.f áffix)
b. gòvernméntal (c.f. góvernment)

Comparing the behaviours of *–al* and *–ikk,* it is apparent that their different behaviour must have different sources, and therefore cannot both be due to stratal affiliation being linked to particular syntactic positions. That being the case, it is simpler to propose that the different phonological behaviours of the causative morpheme are determined by non-lexical means, and that it is not the morphological affiliation of these affixes that determines their phonological behaviour. Note that the pattern seen in (26) and (27) is not an isolated case. Productive multi-stratal affixes are found cross-linguistically in unrelated languages such as Malagasy, Acholi, Berber, and Ojibwe (Newell 2014). In addition, Bermúdez-Otero (2013: 12) proposes that stem-level phonology is non-analytical and therefore liable to idiosyncratic behaviour, yet it is clearly not the case that all multi-level affixes display quirky behaviour within the first phonological cycle. Storing predictable phonological forms is arguably undesirable (see also Embick & Halle 2005, Myler 2015 for arguments against stem-level storage).

Setting these problems aside for the moment, a technical account of the Malayalam is possible in SOT, if the causative morphemes are treated as accidentally homophonous (A proposition that is also problematic, as homophony of this type is argued to be dispreferred or impossible by Leu 2015.). Although Kilborne-Ceron et al (to appear) argue that both instances of the causative morpheme are heads of an Event Phrase (following Travis 2010) it is possible that these syntactic positions are distinguishable in a way that triggers interpretation at either the stem or word level. Here the domain defined by the low causative morpheme (E_1P) is subject to a Stem-level constraint ranking (29), and the domain defined by the high causative (E_2P) to a Word-level ranking (30).

(29)

nana+ikk(E_1)	*HIATUS	DEP[J]	FAITH$_V$
nanajikk		*	
☞ nanakk			*
nanaikk	*		

(30)

kaɹa-ikk(E_2)	*HIATUS	FAITH$_V$	DEP[J]
☞ kaɹajikk			*
kaɹakk		*	
kaɹaikk	*		

If all multi-stratal affix behaviour could be accounted for in this way, then the question of whether RBP and CBP are equivalently capable of bridging the interface between syntax and phonology would be indeterminate in this sphere.

The following Ojibwe data demonstrate, however, that this equivalency does not universally hold. Newell & Piggott (2014) argue that the Ojibwe facts are underivable in SOT, and therefore we will expand on their presentation here. Hiatus in Ojibwe (Algonquian) is resolved by deletion within the Event Phrase (EP) in a verbal construction (like seen above for Malayalam) or within nP in a nominal construction (31). Between Tense and EP, hiatus is not resolved if the prefix is bi-moraic, and is resolved by epenthesis if the prefix is monomoraic (32). Between a person prefix and its base, hiatus is resolved by epenthesis in verbal and alienable possession constructions (33a,b), but by deletion in inalienable possession constructions (33c).

(31) Hiatus resolution in the EP domain

a. [nigi:[wa:biwe:ʒi:na:na:nig]$_{EP}$]$_{CP}$ ‘we painted them white'
ni-gi:-wa:bi-we:ʒi:-in-a:-ina:ni-Ø-ag
'1-PAST-WHITE-PAINT-FINAL-TS(3 THEME)-1PLURAL-IND-3PLURAL

b. [o[name:miwa:n]$_{nP}$]$_{DP}$ ‘their sturgeon(s)'
o-name:-im-(i)wa:-an
'3-sturgeon-possessive-3plural-obviative’

(32) Hiatus Resolution between Tense and EP

a. [gi:[a:gamose:]$_{EP}$]$_{CP}$ 'he walked in snowshoes'
gi:-a:gam-ose:
'past-snowshoe-walk'

b. [nigà[dá:gamòsè:]$_{EP}$]$_{CP}$ 'I will (probably) walk in snowshoes'
ni-ga-a:gam-ose:-Ø
'1-future-snowshoe-walk-Fin'

(33) Hiatus Resolution between Person Marker and its base

a. [ni[da:gamose:$_{EP}$]$_{CP}$ 'I walk in snowshoes’
ni-a:gam-ose:
'1-snowshoe-walk’

b. [ni[dakwe:m $_{nP}$]$_{DP}$ 'my wife'
ni-akwe:-im
'1-woman-possessive'

c. [no:komis]$_{DP}$ 'my grandmother'
ni-o:komis
'1-grandmother'

Given the fact that the data in (31-33) consist uniquely of words, and not phrases, let us again restrict discussion of an SOT account to 2 strata (stem, word). As the suffixes in (31) emerge in syntactic positions that are closer to the root than the prefixes (inside EP and nP), hiatus resolution by deletion must be effected at the stem level, as seen below for the first cycle of (31b).

(34)

name:-im-(i)wa:-an	*HIATUS	DEP[d]	FAITH$_V$
☞ name:miwa:n			**
name:imiwa:an	**		
name:dimiwa:dan		**	

A re-ranking of constraints at the word-level will give the correct output for non-resolution between the tense morphemes as in (32a), here in (35). An additional restriction on mono-moraic prefixes such as (36a) will force epenthesis in cases like (32b (and 33a,b)), seen in (36b).

(35)

gi:-a:gam-ose:	FAITH$_V$	DEP[d]	*HIATUS
☞ gi:a:gamose:			*
gi:gamose:	*		
gi:da:gamose:		*	

(36) a. *HIATUS(μ):

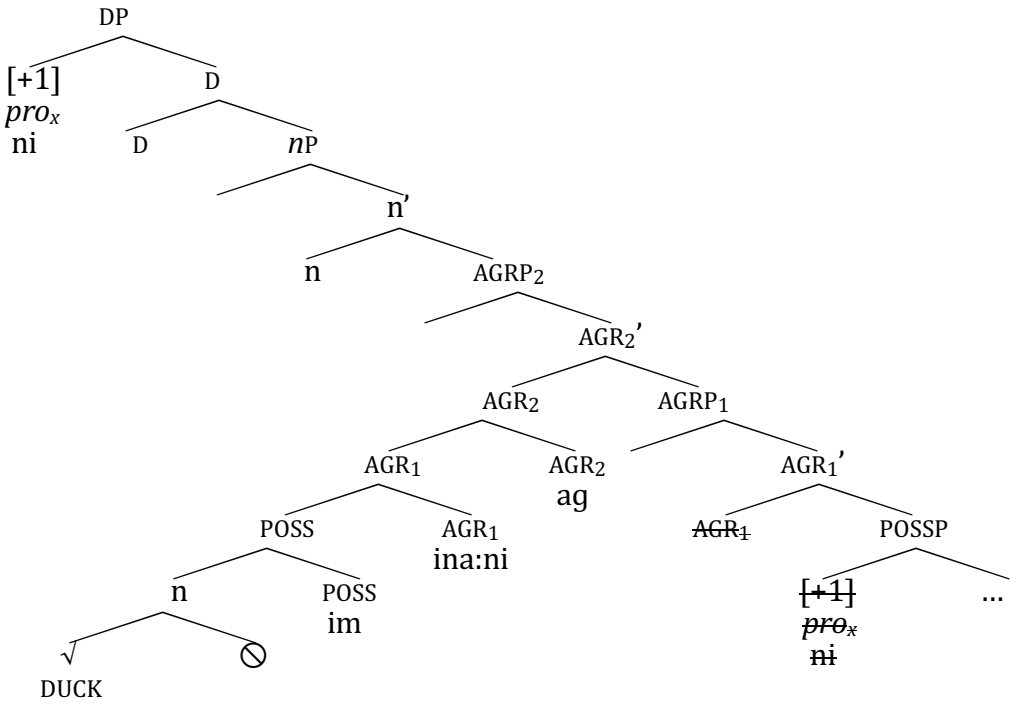
A monomoraic vowel may not be followed by a vowel.

b.

ni-ga-a:gam-ose:	FAITH$_V$	*HIATUS(μ)	DEP[d]	*HIATUS
nigaa:gamose:		*		*
niga:gam-ose:	*			
☞ nigada:gamose:			*	

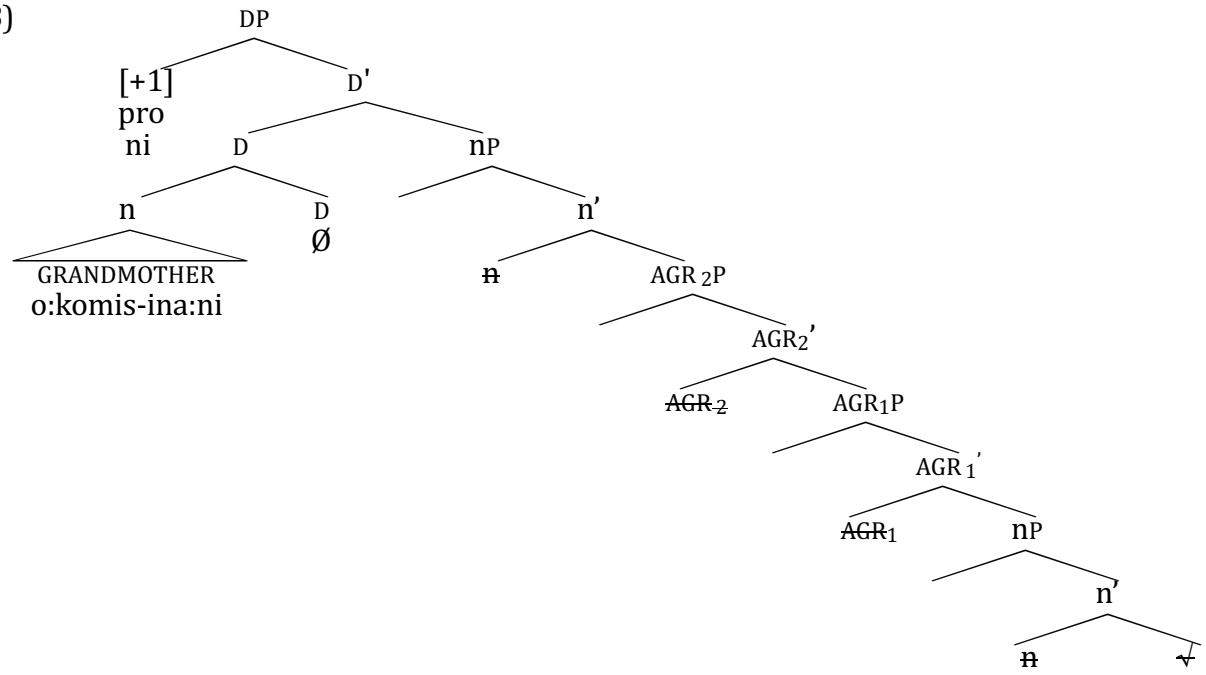
The problem arises when trying to account for the distinct hiatus resolution strategies in (33b) and (33c). Unlike in the case of Malayalam causatives, the person prefixes in the Ojibwe possession constructions cannot be stacked. It is argued in Newell & Piggott (2014) that they emerge in DP; in the identical syntactic position in each construction. Relevant structures for alienable and inalienable derivations are seen in (37) and (38), respectively (strikethroughs indicate elements that have moved).

(37)



(Newell & Piggott 2014: 347)

(38)



(Newell & Piggott 2014: 350)

It is therefore impossible to distinguish the two prefixes based on either their featural or surface distributional properties. Newell & Piggott argue that the derivation in (33c) seen in

(38) has the attested output due to the fact that in inalienable possession construction the root (here *o:komis*) raises to D to check its argument structure features (Inalienable nouns, unlike alienable nouns, are ineffable in Ojibwe without a possessive prefix). The derivation in (37) shows that the root, here *ʒi:fi:b*, does not raise out of nP. The root and its suffixes are therefore interpreted in the first phase (nP), while the prefix is not introduced or interpreted until the second phase (DP), parallel to the EP enclitic derivation in the previous section. In (38) both *ni-* and *o:komis* are interpreted in the same cycle, as they emerge in the same phase (DP). It is this fact, rather than any fact about the particular properties of the person prefix, that determines that hiatus will be resolved through deletion. Note that the person prefixes are not amenable to an account like that for *–al*, as they do not always behave like stem-level affixes (in fact, stem-level behaviour is exceptional for these affixes), nor are they amenable to a multi-level account, as their syntactic positions upon PF interpretation are invariable. The Ojibwe derivations therefore evidence multiple issues for a stratal, constraint-based account. First, as seen above, morphological affiliation to a particular strata cannot account for the behaviour of the person prefix. Secondly, non-analytic listing of stem-level expressions would force the storage of a large number of predictable inflected forms in the language, a proposal that is clearly undesirable.

Furthermore, Ojibwe shows cyclic reapplication of processes that must be considered word-level in SOT, a phenomenon that is proposed to be unattested in Bermúdez-Otero (2012): §3.1. If both the Tense and person prefixes are word-level affixes, and the word-level cannot iterate, this predicts that either word-level phonology will only apply to the innermost word-level affix, or that word-level phonology will apply to both prefixes within one application of the cycle. Neither of these derivations gives the correct result. Newell & Piggott propose that there is a more nuanced explanation for why epenthesis occurs than stated in the constraint in (36a). It is proposed therein that degenerate feet are illicit at the left edge of a PWd. A mono-moraic prefix will therefore move into the PWd to its right to permit the construction of a licit prosodic structure, another instance of Phonological Merger, repeated here.

(39) *Phonological Merger*
[X [.....$_{PWd}$]] → [~~X~~ [.. X....$_{PWd}$]], where X is an affix.

In line with the attempt in this chapter to avoid a dependency on the upper levels of the Prosodic Hierarchy, note that these prefixes cannot project a licit foot. This alone can motivate their incorporation into the domain to their right, erasing the need to reference the PWd in (39). Consider (40); a reiteration of (32b) showing foot structure and a more detailed syntactic bracketing, which contains both a tense and a person prefix:

(40) [(nigà)(dá:)(gamò)(sè:)]$_{PWd}$ 'I will (probably) walk in snowshoes'
[ni[-ga-[a:gam-ose:-Ø]$_{EP}$]$_{TP}$]$_{CP}$
'1-future-snowshoe-walk-Fin'

Two things are pertinent here. First, note that hiatus is resolved by epenthesis between the tense morpheme and the verb. This indicates that Phonological Merger has occurred. Secondly, note that the person prefix and tense morphemes are footed together, as indicated by the secondary stress on *ga-* and not on *ni-*. Ojibwe stress is exhaustive, and degenerate feet are permitted as a last resort, at the right edge of a domain. It follows that the phonology of the word in (40) is computed in three cycles. The first is the PF interpretation of the EP;

[*(a:)(gamo)(se:)*]. If hiatus emerged in this domain it would be resolved by deletion, as in (31). The next cycle of interpretation is the complement of C; TP. Here *ga-*, being monomoraic, undergoes Phonological Merger into the domain projected on cycle 1, giving ~~*ga*~~[*(gada:)(gamo)(se:)*]. Here hiatus is resolved through epenthesis. Note that it cannot be the case that *ni-* and *ga-* are interpreted in the same cycle. If they were, they could be footed together at Spell-Out, and we would predict that they, like the bi-moraic tense prefixes, would neither undergo Phonological Merger nor resolve hiatus, as in (24a). In the final cycle CP is interpreted and *ni-* also undergoes Phonological Merger, giving ~~*ni-gi*~~[*(nigi)(da:)(gamo)(se:)*]. Note that were the tense marker not there, the person prefix would also trigger epenthesis (*nida:gamose:)*. That each of the prefixes prompts the same phonological processes independently leads to the conclusion that there are three phonological cycles within the word, and that two of them are word-level. Therefore, the word-level phonology, in the terms of SOT, may iterate. The particulars of the phonological rule that can account for the distinction between deletion and epenthesis in Ojibwe will be taken up in the following section.

This section has argued that phonological rule application is not governed by a limited number of strata, and that neither morphemes nor particular morpho-syntactic domains can be linked with cycle-specific phonological processes. This is predicted within a computational system where notions like stem or word are not primes in any module. It is therefore arguably simpler here to do away with the notion of strata and to remain with the notion that cyclic Spell-Out is triggered at certain points in the syntactic derivation. Any morpheme situated within a Spell-Out domain will undergo interpretation, leading to the expectation that we may find morphemes that display varying phonological behaviour dependent on their syntactic configuration in a particular derivation; an expectation that is borne out.

5. FUTURE DIRECTIONS

In this chapter we have focused on two notions crucial to any theory of the phonology-morphosyntax interface; modularity and derivation. We have examined two very closely-related theories and seen that the distinctions between them are quite nuanced. We have not delved too deeply, however, into the exact form of rules in a RBP that will give us the kinds of outputs that we see in this chapter and cross-linguistically. A theory like (S)OT has had as one of its foci an investigation of how constraints may rerank across strata and across languages. This is due to the fundamental premise of OT that all constraints are potentially active in the grammar of each language. Rule-based theories, however, as they are not based on the contention that all rules are present in all languages, have been based upon the premise that rules may or may not be active in a particular grammar, or in a particular cycle. Any consistent cyclic effects on the form or output of rules, or patterns in the output forms at different cycles are not derivable from the basic tenets of either OT constraint ranking or rule construction in and of themselves. Each of these theories must therefore work at motivating the patterns we do see. One evident pattern is something like the Strict-Cycle Condition (41), which is akin to the Phase-theoretic notion of Phase Impenetrability (42).

(41) “<an> ...association created in the inner domain cannot be undone in an external domain. » (Kaye 1995:307)

(42) "[the phonological component] is greatly simplified if it can 'forget about' what has been transferred to it at earlier phases; otherwise, the advantages of cyclic computation are lost" (Chomsky 2004: 107)

Both of these formulations are stipulative or descriptive rather than explanatory. The underlying explanation for why it should be the case that cyclic outputs should persist is therefore a domain that needs further investigation. We have seen herein that Both Itô & Mester (1995) and Bermúdez-Otero and Trousdale (2012) have proposed that the different rankings of faithfulness constraints in different parts of the grammar can explain cyclic phonological persistence. These theories take the motivation for these ranking distinctions to be controlled at least partially by extra-phonological elements like restrictions on diachronic change or the existence of co-phonologies. Here I have offered a purely phonology-internal motivation for persistence; structure-building (see Newell 2014, 2015 for further details). Phonological interpretation alters the target of a rule, but will not always eradicate the structural environment for the application of a rule, leading to divergences in rule application (see also Honeybone 2005 for a discussion of how the amount of melodic structure in the representation of a segment affects phonological rule application).

Take the hiatus resolution strategies in Ojibwe; deletion and epenthesis. At the first cycle of interpretation segments may be underspecified, and will not yet have undergone syllabification, nor will they have been organized into feet. Here a ban on hiatus is resolved through a deletion rule (Remember that constraints, or bans, on certain structures are not disallowed in an RBP framework). Breaking down the timeline of, say, the construction of syllables, we are confronted with a point in the derivation where it must be determined which segments in a string have the properties that they could form licit nuclei (e.g. sonority). Therefore, before projection of any syllabic structure, the derivation is cognizant of whether a string contains a VV sequence. At this point, deletion can occur before syllabification, and consequently no suprasegmental information is destroyed by this operation (VV→V). In the case of hiatus resolution across cycles, after Phonological Merger, the sequence of vowels is one where each of the two segments is enveloped in suprasegmental information structure (They have been syllabified). Note that Phonological Merger in Ojibwe only occurs if a prefix cannot project a licit foot. This inability can only be determined after projection of structure at the syllabic level. The sequence (V)σ(V)σ is crucially structurally distinct from the sequence VV, but similar enough in that the constraint against hiatus is still triggered. In order to conserve the previously-built syllabic structure and satisfy *Hiatus, epenthesis is effected. Now, this may appear to be very close to an OT account, where constraints are pitted one against the other. It is contended here, however, that it is not the structure of a rule or a constraint that crucially distinguishes CBPs from RBPs. It is rather that the motivation for the application or non-application of operations in an RBP account must be purely phonological (features, structures), where the overt application of an OT constraint is due to extra-phonological considerations (ranking). As both RBP and CBP frameworks refer to the same phonological primes (features, syllables, etc.) then constraint ranking bears the burden of requiring independent justification. If accounts like the ones herein, where cyclic interpretation paired with structural underspecification can account for the cross-cyclic patterns attested, then this weakens the support for an explanation that calls on constraint re-ranking. Teasing apart the nuances of these types of accounts is a fertile area of investigation.

Other future research directions pertinent to the questions raised in this chapter are the following:

(1) Do we need the Prosodic Hierarchy/representational domain delimitation? Does it perform phonological duties that cannot be subsumed by cyclic, procedural derivation? Relatedly, can SOT function in the absence of Alignment constraints?
(2) What are the restrictions on the destruction/modification of previously computed phonological structure? It is uncontroversial that deletion and feature-changing operations exist. This being the case, what constrains their application?
(3) Is the distinction between rules and constraints the issue here, or are the crucial distinctions between these frameworks in the different assumptions regarding the organization of the grammar? How fundamental are notions of structure-building vs. constraints-on-structure, and what are the distinctions between them?
(4) What are the pertinent cycles that determine the timing of phonological interpretation, and how are they defined?

This is obviously not an exhaustive list of future research directions related to the RBP/CBP debate at the interfaces. These questions can however help guide us to a deeper understanding of the organization of the entire grammatical computational system. Their answers can lead us not only to a better understanding of the phonological module, but also of the syntactic module that underlies it, and of the translation operations between the two. We will finish here with a short list of the advantages of an RBP theory presented in this chapter. First, eliminating reference to the Prosodic Hierarchy is desirable on theoretical grounds. The PH is not fundamental to the RBP toolbox in the same way that ALIGN is claimed to be in CBP. Secondly, phonological cycles are not restricted in number in an RBP. We have seen that once we no longer take recourse to a Prosodic Hierarchy that this proliferation of cycles is unavoidable and, crucially, necessary. The different phonological tendencies at each cycle then need to be governed solely by phonological features and structures. Finally, cycles in an RBP don't make reference to elements that are undefinable in the syntactic component (stem, word, and even phrase in some frameworks). Syntactic and phonological cycles are determined based on identical elements; those which define a syntactic cycle, or Phase.

6. FURTHER READING

Nespor, M. & I. Vogel (1986/2007) "**Prosodic Phonology/ Prosodic phonology: with a new foreword"** This classic work on the Prosodic Hierarchy offers a detailed discussion of the motivations for the theory, as well as a trove of data relevant to the study of the morphosyntax-phonology interface.

Selkirk, E. (2011) "The syntax-phonology interface" This is one of the more recent updates of the Theory of the Prosodic Hierarchy (by the original proponent of the theory) that demonstrates how the view of structure-phonology relations has evolved.

Scheer, T. (2010) "A guide to morphosyntax-phonology interface theories: how extra-phonological information is treated in phonology since Trubetzkoy's Grenzsignale"

This book covers the theoretical path that theories of the interface in generative linguistics have taken in minute detail, and offers an in-depth analysis of the theoretical premises and implications of each advance.

Bermúdez-Otero (to appear) "Stratal Optimality Theory" Currently posted on his website as a library of separate papers, this book will cover the theory of Stratal Optimality Theory, offering a detailed look at the data that support a cyclic account of the morphosyntax-phonology interface.

Newell et al. (to appear) "The Structure of Words at the Interfaces" This is a collection of works, many of which focus on interactions at the morphosyntax-phonology interface with an eye to determining how the elements that we pre-theoretically describe as 'words' emerge at the PF interface.

7. RELATED TOPICS

The two other chapters in the RBP section, the OT section chapter on the interfaces, Charles Reiss' chapter on Substance-Free Phonology, and Bermúdez-Otero, this volume.

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[i] Scheer (2013) notes that this non-communication between the syntax and the phonology may be restricted to melodic primes.

[ii] For a more detailed account of the phonological motivation for Phonological Merger in the case of English affixes see Newell 2016a,b.

[iii] That the adjectival and verbal semantics of *un-* seem to be different but this is arguably due to the semantics of verbs and adjectives, rather than the semantics of *un-*. *un-* implies reversal; of direction of timeflow in the case of verbs, and of positive/negative scale in the case of adjectives. In the case of nouns *un-* indicates the opposite (reversal) of reference (your unbirthday is a day that is not your birthday).

[iv] That the stem-level affiliation of *–al* overrides the word-level affiliation of *–ment* is a separate issue that we will ignore here (but see Newell 2016 a,b). This ability of an outer affix to trigger the reassignment of stress on an interior word-level affix is problematic for CBP and RBP accounts.