Morpheme structure constraints and blocking in nonderived environments*

Ezer Rasin

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Abstract

In Nonderived Environment Blocking (NDEB), a phonological process applies across morpheme boundaries or morpheme-internally when fed by another phonological process but is otherwise blocked. I present a new theory of NDEB that attributes blocking to an opaque interaction between Morpheme Structure Constraints (which constrain possible URs in the lexicon) and the usual phonological mapping from URs to surface forms. Using several case studies, I claim that this theory is more successful than previous theories of NDEB proposed in the literature, including the Strict Cycle Condition (Mascaró, 1976), Kiparsky's (1993) theory of underspecification, Sequential Faithfulness (Burzio, 2000), Coloured Containment (van Oostendorp, 2007), and Optimal Interleaving with Candidate Chains (Wolf, 2008). This result supports a dual-component architecture of phonology (as in SPE) over the elimination of Morpheme Structure Constraints (the principle of Richness of the Base in Optimality Theory).

1 Introduction

In Nonderived Environment Blocking (NDEB), a phonological process applies across morpheme boundaries or morpheme-internally when fed by another phonological process but is otherwise blocked from applying. A well-known example is Finnish assibilation (Kiparsky 1973, 1993), which turns the stop [t] into the strident [s] before the high vowel [i]. The process applies before the past suffix -i (1-a); morpheme-internally, it applies only when the high vowel is the result of final-vowel raising (which raises [e] to [i] word-finally), as in (1-b); otherwise, assibilation does not apply within morphemes (1-c). The underlying sequence /ti/ is often referred to as a *derived environment* in (1-a) and (1-b) and as a *nonderived environment* in (1-c).[1]

(1) a. Assibilation applies across a morpheme boundary:
halut-a 'want-INFINITIVE' vs. halus-i (/halut-i/) 'want-PAST'

*Acknowledgments: to be added.

[1]There is a debate in the literature regarding the correct analysis of assibilation and final-vowel raising in Finnish. This paper will not contribute to that debate: Finnish is only used here for illustration, as a familiar and simple case that demonstrates two types of NDEB effects. See Wolf (2008) for a summary of the debate and for a list of processes that show NDEB in other languages.

b. Assibilation applies morpheme-internally when fed by final-vowel raising (e → i / __ #):
   vete-nä 'water-ESSIVE.SG.' vs. vesi (/vete/) 'water-NOM.SG.'
c. Otherwise, assibilation is blocked morpheme-internally:
   (i) tila 'room-NOM.SG.'
   (ii) äiti 'mother-NOM.SG.'

NDEB is an instance of under-application opacity that poses a challenge to both rule-based phonology and Optimality Theory (OT; Prince and Smolensky, 1993): in rule-based phonology, a rule of assibilation that turns the stop [t] into the strident [s] before the high vowel [i] would incorrectly apply to nonderived /ti/ sequences if no conditions on its application are posited. Similarly, in OT, the markedness constraint *ti would equally penalize derived and nonderived surface sequences of [ti]. And if *ti is allowed to be repaired by assibilation in derived environments (by appropriately ranking it over faithfulness constraints like IDENT[cont]), assibilation would incorrectly apply in nonderived environments as well. More generally, if P is a process that is blocked in nonderived environments, the challenge in both frameworks is to partition the set of environments of application of P into two subsets – corresponding to derived and nonderived environments – and block the application of P precisely in nonderived environments. Previous works that have tried to address the challenge include Mascaró (1976), Kiparsky (1993), Burzio (2000) Inkelas (2000), Łubowicz (2002), McCarthy (2003) van Oostendorp (2007), Kula (2008), Wolf (2008), and Antilla (2009), among others.

In this paper I defend a new theory of NDEB in which *Morpheme Structure Constraints* (MSCs) play a central role. MSCs, familiar from SPE (Chomsky and Halle, 1968), are grammatical statements that apply to isolated morphemes in the lexicon, before the phonological mapping from URs to surface forms. Take, for example, the generalization that vowels in English are always nasalized in pre-nasal position and never elsewhere. Thus, for example, forms such as gæ̃n and gæd are accidental gaps in English – they are not English words, but they could be – while gæ̃d and gæn are systematic gaps. An account that uses MSCs would combine the constraint in (2) and the rule in (3) to ensure that nasalized vowels are found precisely before nasals.

(2) MORPHEME STRUCTURE CONSTRAINT IN ENGLISH: No nasalized vowels in the lexicon

(3) PHONOLOGICAL RULE IN ENGLISH: Nasalize vowels in pre-nasal position

In contrast to SPE, OT has been guided by the idea that phonological generalizations are captured either on the surface or in the mapping from URs to surface forms, but never in the lexicon. To capture the generalization regarding English nasalized vowels in OT, markedness constraints – as toy examples, *ãd and *an – would penalize nasal non-prenasal vowels and oral prenasal ones. Ranking these constraints higher than the relevant faithfulness constraints would ensure that even URs with inappropriately nasalized vowels will surface correctly, thus correctly ruling out gæ̃d and gæn as systematic gaps. The accidental gaps gæ̃n and gæd, on the other hand, can be added to the lexicon with URs that are identical to the surface forms. OT, then, can capture the generalization regarding nasalized vowels in English without MSCs. This suggests a stronger view – known as *Richness of*

the Base (ROTB) – according to which MSCs are *never* used:

(4) Richness of the Base (Prince and Smolensky 1993, p. 191, Smolensky 1996, p. 3)
   a. All systematic language variation is in the ranking of the constraints.
   b. In particular, there are no language-specific constraints on URs.

Recently, Rasin and Katzir (2014) re-opened the question of whether MSCs are needed in phonological theory and offered an argument from learnability supporting an affirmative answer. This paper shows that MSCs can address the NDEB challenge by creating the desired partitioning of environments into derived and nonderived environments. On this theory, NDEB is not a special phenomenon: it falls out as a by-product of the interaction between MSCs and the input-output mapping, and no special mechanisms are required to account for it. I will show, using several case studies, that more than providing a simple theory of NDEB, this theory is also more successful than previous theories of NDEB proposed in the literature in accounting for known cases of NDEB. If this view of NDEB is correct, it would provide further support for a dual-component architecture of phonology as in SPE and against ROTB.

Here is a schematic demonstration of the idea that will be developed in more detail in section 2. My starting point is Kiparsky's (1993) underspecification theory of NDEB, which I follow in using rules and underspecification (though as discussed later, the proposal is compatible with constraint-based frameworks that reject underspecification, as long as they adopt MSCs). According to Kiparsky, a process which shows NDEB is structure-building and can only apply to underspecified but crucially not to fully specified foci. On this view, Finnish assibilation is a feature-filling rule [T $\rightarrow$ s / __ i] that applies to underspecified [T] but cannot apply to fully specified [t]. My proposal is that the distribution of fully specified /t/, which blocks assibilation, is a predictable property of URs that is regulated by MSCs. An account of Finnish assibilation would combine the MSC in (5) and the rule in (6). The constraint in (5) would ensure that instances of /T/ are unavailable precisely when they precede an underlying tautomorphemic /i/. Assibilation would only apply in environments with foci that escape this constraint, and these would correspond to derived environments.

(5) MORPHEME STRUCTURE CONSTRAINT IN FINNISH: /t/ occurs before /i/; /T/ occurs elsewhere

(6) PHONOLOGICAL RULE IN FINNISH: Assibilate /T/ before /i/

The paper is structured as follows. First, in section 2, I implement an architecture that uses MSCs to regulate the distribution of underspecified and fully-specified structure in the lexicon (2.1) and develop an analysis of Finnish assibilation within this architecture (2.2). Then, in section 3, I use several case studies to compare the MSC-based approach to previous proposals from the literature, starting with Kiparsky (1993) and Inkelas (2000), which can be seen as precursors to the current proposal (3.1). In 3.2, I use Finnish assibilation and Romanian palatalization to show that blocking is determined at the stem level – and crucially not based on morphologically-derived forms – contrary to the predictions of approaches in which 'derived environment' is a theoretical primitive, such as the Strict Cycle Condition and Coloured Containment. In 3.3, I examine reported

cases of NDEB that display blocking in nonderived environments that are fully contained within suffixes. Since MSCs apply to isolated morphemes in the lexicon, they apply to suffixes before morpheme combination and can capture the relevant blocking pattern. I show that cyclic architectures that reject MSCs run into ordering paradoxes in these cases, as they do not include a level of representation in which suffixes are isolated from the rest of the string. Finally, I consider cases of blocking in nonderived environments that are partially predictable, as in Romanian vowel raising, and show that they pose a problem for approaches such as Optimal Interleaving with Candidate Chains (Wolf, 2008) and Sequential Faithfulness (Burzio, 2000) that connect URs to blocking through mechanisms other than MSCs. Section 4 concludes.

2 Proposal

2.1 Architecture

This subsection describes the phonological architecture that will be used in 2.2 for an account of NDEB. My claim in this paper is that NDEB supports a component that restricts possible URs in the lexicon. I will have nothing to say about the phonological formalism (e.g., rule-based or constraint-based) or the nature of lexical representations (e.g., underspecified or fully specified). To make the proposal explicit, I will adopt a ruled-based formalism and underspecification, but these choices are arbitrary: the mappings presented in this paper using a rule-based formalism can be reformulated using constraints, and Appendix A presents a variant of the proposal that does not make use of underspecification. The architecture, which I now describe, is schematized in Figure 1.

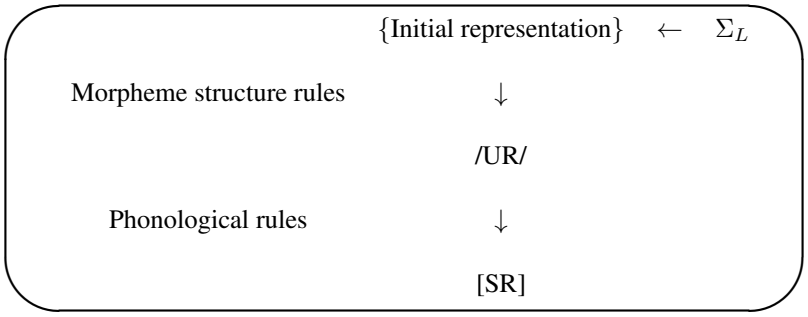


Figure 1: The architecture

A central component of the architecture is the mapping from URs to surface forms, which is implemented here using ordered phonological rules as in SPE. I assume that a phonological grammar includes an alphabet – an inventory of feature bundles Σ – the elements of which can be concatenated. For example, if k, a, t $\in \Sigma$, then {kat} and {takta} are possible concatenations, among many others. I assume that individual languages can restrict Σ to a proper subset, call it Σ_L. For a segment $\sigma \in \Sigma$, we can write $\sigma \notin \Sigma_L$, meaning that σ cannot be used for concatenation in that language. For example, if English rules out /x/ from its alphabet and we

write x $\notin \Sigma_L$, then {bax} is not a possible concatenation in English. Negative statement such as x $\notin \Sigma_L$ are used for convenience and should not be taken to be grammatical constraints per se. What I mean by writing x $\notin \Sigma_L$ is that Σ_L, which could be positively stated in the grammar as a set of segments, does not include x. I will refer to representations created by concatenating elements from Σ_L as *initial representations*, and I will mark them using curly brackets, as in {anta}. Morpheme structure rules map initial representations to URs. For example, if {anta} is a an initial representation and post-nasal voicing (t $\rightarrow$ d / n __) is the only morpheme structure rule in the grammar, the result of applying post-nasal voicing to {anta} is the UR /anda/. Morpheme structure rules have the same format as ordinary rules, but they apply to isolated morphemes in the lexicon before the morphemes are combined. In this framework, then, URs are created in two steps: first, elements from Σ_L are concatenated to form an initial representation. Then, morpheme structure rules apply and map this representation to a UR. Later on, phonological rules map URs to surface forms.

In addition, I assume that lexical representations may be underspecified: segments in Σ (and in Σ_L) may be underspecified for some of their features. See Kiparsky (1982), Archangeli (1988), and Steriade (1995) for relevant discussion. For example, a variant of the voiceless alveolar stop [t] in which the feature [continuant] is not specified may be in Σ. We can refer to this segment as [T] and write T $\in \Sigma$. Underspecified features are filled in either by morpheme structure rules or by phonological rules. Finally, both morpheme structure rules and phonological rules may be *feature filling*. This means that they can target segments underspecified for some feature F and fill in the relevant value but, crucially, without affecting segments that are already specified for F. Example (7) demonstrates the property of feature filling using a version of Finnish assibilation that applies to underspecified [T].

(7) Assibilation: T $\rightarrow$ s / __ i (feature-filling)

a. /Ti/ $\xrightarrow{\text{assibilation}}$ [si]

b. /ti/ $\xrightarrow{\text{assibilation}}$ [ti]

2.2 Analysis

In this subsection I provide an analysis of NDEB using the architecture described in 2.1 and Finnish assibilation as a test case. The basic pattern of Finnish assibilation was presented above in (1-a)-(1-c), and is repeated here as (8-a)-(8-c). Following the convention in the literature, I use the term *morphologically-derived environment* to refer to an environment created through affixation, as in (8-a), and *phonologically-derived environment* to refer to an environment created through the application of a phonological process, as in (8-b).

(8) a. Assibilation applies across a morpheme boundary:
halut-a 'want-INFINITIVE' vs. halus-i 'want-PAST'

b. Assibilation applies morpheme-internally when fed by final-vowel raising (e $\rightarrow$ i / __ #):
vete-nä 'water-ESSIVE.SG.' vs. vesi 'water-NOM.SG.'

c. Otherwise, assibilation is blocked morpheme-internally:
(i) tila 'room-NOM.SG.'
(ii) äiti 'mother-NOM.SG.'

The first ingredient in the analysis is the rule of assibilation (9), which, following Kiparsky (1993), I take to be a feature-filling rule that specifies the voiceless alveolar [T] as [+continuant].[2] The second ingredient is a rule that I refer to as *anti-assibilation* (10). Anti-assibilation is similar to the rule of assibilation: it is a feature-filling rule that applies in the same environment (/Ti/) and fills in a value for the feature [continuant]. The only difference is that anti-assibilation specifies that value as [-continuant] rather than [+continuant]. That is, anti-assibilation specifies [T] as [t].

(9) Assibilation
T → s / __ i (feature-filling)

(10) Anti-assibilation
T → t / __ i (feature-filling)

To see how assibilation and anti-assibilation interact, consider the UR /Ti/ and a hypothetical grammar in which anti-assibilation is ordered before assibilation. The derivation is provided in (11). First, anti-assibilation applies and specifies [T] as [t]. Then, assibilation does not apply since its structural description is not met: the rule is feature filling, but [t] is not underspecified for continuancy. The result is the surface form [ti]. In short, anti-assibilation bleeds assibilation by destroying its environment of application.

(11) Interaction between assibilation and anti-assibilation (hypothetical grammar)

UR	/Ti/
T → t / __ i	ti
T → s / __ i	-
SR	[ti]

My proposal is that in the actual grammar of Finnish, anti-assibilation is a morpheme structure rule that applies to isolated morphemes, whereas assibilation is a phonological rule that is part of the mapping from URs to surface forms. Fully-specified [t] is not part of the Finnish alphabet.

(12) Morpheme structure component:
a. $t \notin \Sigma_L$
b. T → t / __ i

The consequence for the form of URs in Finnish is that /t/ and /T/ are in complementary distribution in the lexicon: /t/ occurs only before /i/ (following the application of anti-assibilation) and /T/ occurs elsewhere. Here are some examples. (13-a) shows the derivation of the UR /tila/. Since $t \notin \Sigma_L$, any instance of /t/ in URs must be derived from /T/. The initial representation is therefore {Tila}, which anti-assibilation maps to /tila/. (13-b) indicates that /lata/ is not a possible UR in Finnish: since $t \notin \Sigma_L$ and the environment for anti-assibilation is not met before /a/, /t/ cannot occur in a a pre-/a/ position.

(13) a. {Tila} → /tila/

[2]For presentational ease, I ignore the feature [strident], which could be filled in by the assibilation rule itself or by a separate rule.

b. */lata/
c. /laTa/, /haluT/

In (13-c), anti-assibilation does not apply, and /T/ remains underspecified. The value for [continuant] will be filled in by the mapping from URs to surface forms: the rule of assibilation turns /T/ into [s] before [i]; otherwise – that is, whenever assibilation does not apply – /T/ is specified as /t/ through the default rule T $\rightarrow$ t.

(14) Phonological rules:
a. T $\rightarrow$ s / __ i
b. T $\rightarrow$ t

Example (16) demonstrates the application of phonological rules in the derivation of the alternants in (15), assuming the UR /haluT/ for the stem.

(15) halut-a 'want-INFINITIVE' halus-i 'want-PAST'

(16)

UR	/haluT-i/	/haluT-a/
T $\rightarrow$ s / __ i	halusi	-
T $\rightarrow$ t	-	haluta
SR	[halusi]	[haluta]

This is the grammar of Finnish we have so far:

(17) a. Morpheme structure component:
(i) t $\notin \Sigma_L$
(ii) T $\rightarrow$ t / __ i
b. Phonological rules:
(i) T $\rightarrow$ s / __ i
(ii) T $\rightarrow$ t

I will now show why this grammar applies assibilation in morphologically-derived environments but not in nonderived environments. Consider the derivation of [tilas-i], which alternates with [tilat-a] and includes two potential environments for the application of assibilation: the first is morpheme-internal, and the second spans the morpheme boundary. Assibilation only applies in the latter.

(18) tilat-a 'order-INFINITIVE' vs. tilas-i 'order-PAST'

First, morpheme structure rules apply to each morpheme individually (19-a). Since t $\notin \Sigma_L$, the initial representation of the stem must be {TilaT}. Anti-assibilation applies to the first instance of [T], but not to the second: at this stage of the derivation, the second [T] is stem-final and the environment for anti-assibilation is not met. The result is the UR /tilaT/, where only the second [T] remains underspecified for continuancy. In the mapping from URs to surface forms (19-b), assibilation successfully applies to the sequence /T-i/ which was created through affixation. It does not apply to the stem-initial /ti/, which at this point is already fully specified. The final surface form is [tilasi].

(19) Derivation of [tilas-i] (infinitive: [tilat-a])
a. Morpheme structure rules apply to each morpheme individually:
(i) {TilaT} $\rightarrow$ /tilaT/

(ii) {i} → /i/

b. Phonological rules apply:

UR	/tilaT-i/
T → s / __ i	tilas-i
T → t	-
SR	[tilasi]

The next step is to show why assibilation applies in phonologically-derived environments. Recall that final-vowel raising (20) raises a word-final [e] to [i] (21-a). Assibilation may apply morpheme-internally when fed by final-vowel raising (21-b).

(20) e → i / __ #

(21) a. joke-nä 'river-ESSIVE.SG.' vs. joki 'river-NOM.SG.'
b. vete-nä 'water-ESSIVE.SG.' vs. vesi 'water-NOM.SG.'

Here, nothing further has to be said. Final-vowel raising is ordered before assibilation (22). In words like [vesi], alternating /T/ precedes /e/ in the UR, so anti-assibilation does not get to apply. /T/ remains underspecified, which means that assibilation will get to apply after affixation. The full derivation is provided in (23).

(22) a. Morpheme structure component:
(i) $t \notin \Sigma_L$
(ii) T → t / __ i
b. Phonological rules:
(i) e → i / __ #
(ii) T → s / __ i
(iii) T → t

(23) Derivation of [vesi]

a. Morpheme structure rules apply (vacuously):
{veTe} → /veTe/

b. Phonological rules apply:

UR	/veTe#/
e → i / __ #	veTi#
T → s / __ i	vesi#
T → t	-
SR	[vesi]

In sum, a process P that is blocked in nonderived environments applies unless its focus is made immune in an earlier stage of the derivation. Foci can be made immune by a feature-filling rule *anti-P* that shares its structural description with P and can apply to isolated morphemes in the lexicon. *Anti-P* thus induces the following partition on the set of environment of P:

(24) Partition into nonderived and derived environments

a. Environments present when *anti-P* applies (correspond to nonderived environments)
b. All other environments (correspond to derived environments)

Rules of the form *anti-P* are unusual rules. Their formulation seems arbitrary and

their environment duplicates the environment of P, and at present I have nothing to say about these issues. In what follows, I will assume that such rules are available without trying to derive their existence from deeper principles. Instead, I will focus on the picture of NDEB that arises from (24) and evaluate the success of the MSC-based theory in accounting for known cases of NDEB compared to previous proposals.

3 Case studies and comparison with previous proposals

In this section I use several case studies to take a critical look at alternative approaches to NDEB. Competing approaches proposed in the literature include Mascaró (1976), Kiparsky (1993), Burzio (2000) Inkelas (2000), Łubowicz (2002), McCarthy (2003) van Oostendorp (2007), Kula (2008), Wolf (2008), and Antilla (2009), among others. As the literature on NDEB is quite vast, I will not be able to do justice to all of the relevant approaches. Instead, I will discuss what I take to be a representative sample of the literature and refer the reader to critical reviews of approaches not discussed here directly. See, in particular, Kiparsky (1993) for a review of the literature prior to 1993, Inkelas (2000) for a review of the early OT literature (1993-2000), and Wolf (2008) for a more comprehensive critical review of the literature, including the literature following Inkelas (2000).

3.1 Finnish assibilation: underspecification is not enough

3.1.1 Kiparsky (1993): prespecification

The MSC-based theory relied on the distinction between underspecification and full specification to block P in nonderived environments: P applied to underspecified segments but could not apply to fully-specified segments. This distinction is central to Kiparsky's (1993) proposal: the mapping from URs to SRs is the same as in the MSC-based account, but the morpheme structure component is absent. To see how Finnish assibilation would work in Kiparsky's theory, a fragment of the grammar and a sample derivation are provided in (25)-(26).

(25) Finnish assibilation grammar under Kiparsky's proposal

a. T → s / __ i
b. T → t

(26) Derivation of [tilasi]

UR	/tilaT-i/
T → s / __ i	tilas-i
T → t	-
SR	[tilasi]

For Kiparsky, assibilation does not apply to the first [t] in [tilasi] since this instance of [t] is fully specified in the UR, but it applies to the underspecified [T] since alternating features are missing from the lexicon. As noted by Burzio (2000), this proposal leaves the underlying distribution of underspecified [T] and fully-specified [t] as an accident of the Finnish lexicon: nothing prevents fully-specified [t] from

occurring stem-finally and incorrectly blocking assibilation before a suffix-initial [i]. The grammar thus generates unattested ungrammatical forms such as *[rat-i] in which assibilation has not applied:

(27)

UR	/rat-i/
T → s / __ i	-
T → t	-
SR	*[rati]

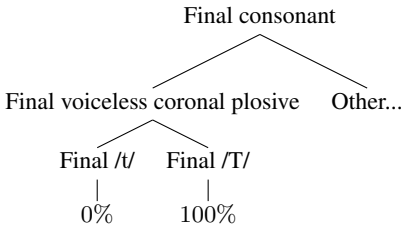
The MSC-based theory rules out /rat/ as a UR since fully-specified [t] can only precede [i] in the lexicon. This restriction is enforced by the morpheme structure component, and it prevents the grammar from incorrectly generating words such as *[rat-i].

3.1.2 Inkelas (2000): lexical typing and analogy

We have seen that Kiparsky's proposal leaves the underlying distribution of underspecified [T] and fully-specified [t] as an accident of the Finnish lexicon. This leads to over-generation, which can be avoided by adopting MSCs. In principle, however, it may be possible to combine Kiparsky's prespecification with a mechanism other than MSCs to rule out undesirable URs like /rat/, where fully-specified [t] (which blocks assibilation) occurs in a position to which assibilation should be able to apply. This is what Inkelas (2000) proposes. In particular, she proposes to extend prespecification with a position-based mechanism of lexical typing and analogy designed to rule out fully-specified [t] from UR-final positions. The mechanism of lexical typing and analogy is left mostly unspecified, but I will show that any position-based mechanism would lead to incorrect predictions.

To see how URs like /rat/ would be ruled out under this proposal, consider the tree in (28), which is supposed to represent the internal organization of the lexicon. The assumption is that the lexicon keeps track of the identity of the final segment, including its probability of occurrence in the lexicon: in the Finnish lexicon, every final voiceless coronal plosive is underspecified for continuancy. To determine the UR of a stem such as [rat], a mechanism of analogy scans the lexicon and finds that final voiceless coronal plosives are always underspecified. As a consequence, /rat/ is never selected as a UR (even though it can be represented in principle), and *[rati] is blocked.

(28)



The position-based mechanism fails once we move from segments in final position to segments in penultimate position. Finnish has a process of vowel deletion that deletes stem-final vowels before another vowel (Kiparsky, 1993). Vowel deletion may feed assibilation, which then targets stem-penultimate segments:

(29) /tunte-i-vat/ → [tunsivat] 'know-PAST-3.PL.'

As we saw above, assibilation does not apply morpheme-internally to a /t/ that precedes an underlying /i/, and such /t/'s may occur in penultimate position:

(30) äiti 'mother-NOM.SG.'

The conclusion is that [t]'s in stem-penultimate position may be either fully specified (as in /äiti/) or underspecified (as in /tunTe/, the UR of the stem in [tunsivat]). Crucially, their specification depends on whether they precede an underlying /i/ (as enforced by anti-assibilation) and not on their position within the UR.

3.2 Romanian palatalization: blocking is determined at the stem level

The MSC-based theory determines the alternation status of a feature at the individual morpheme level. Consider again the blocking of Finnish assibilation in morphologically-nonderived environments, using the example [tilas-i] (whose infinitive form is [tilat-a]). For the MSC-based theory, blocking is exclusively determined according to the environment of assibilation-targets in the stem /tilaT/: the first consonant – but not the stem-final consonant – precedes /i/ and therefore becomes immune to assibilation. Other theories of NDEB that privilege the individual morpheme level in determining blocking are Kiparsky (1993) and Burzio (2000a). In contrast to these theories, much of the previous literature on NDEB has followed the idea that NDEB should be understood through a characterization of the set of derived environments. The guiding intuition is that in both types of environments in which P applies – across a morpheme boundary and when part of its environment is the result of another phonological process – part of the environment is "new", or, stated differently, is introduced in the course of the derivation. In the Finnish assibilation case, the environment in /halut-i/ is "new" because it is formed through affixation, and the environment in /veti/ (derived from /vete/ through vowel raising) is "new" because the high vowel is the result of vowel raising. Theories guided by this idea, like the Strict Cycle Condition (Mascaró, 1976) and Coloured Containment (van Oostendorp, 2007), incorporate a notion of "new" or "derived" environments into the grammar and often introduce a licensing condition to allow the application of P only in such environments. I will refer to such theories as *derived-environment* theories.

In derived-environment theories, application is determined based on the morphologically-complex form: for [tilas-i], the relevant representation would be /tilat-i/, the suffixed form before the application of assibilation. Assibilation applies in the second environment (/tila**t-i**/) but not in the first (/**ti**lat-i/) since only the second environment is "derived" and spans a morpheme boundary. Below, I will discuss in more detail some of these approaches and how they enforce application in derived environments. For now, what matters is that they all license application across a morpheme boundary:

(31) *Prediction of derived-environment theories*
Spanning a morpheme boundary is a sufficient condition for licensing.

My goal in this section is to first reconstruct a version of Kiparsky's (1993) argument from Finnish assibilation against (31) and in favor of individual URs as

the level of representation where blocking is determined. I will then discuss a possible confound in the argument, pointed to me by Bill Idsardi. Finally, I will present a stronger version of Kiparsky's argument that avoids the confound, made in unpublished lecture notes by Donca Steriade based on Romanian palatalization.

Kiparsky (1993) notes that the two types of approaches diverge in their predictions in cases like the following. Recall the Finnish process of vowel deletion that deletes stem-final vowels pre-vocalically. Vowel deletion may feed assibilation, but, crucially, only if the stem-final vowel had not been [i]:

(32) a. /tunte-i-vat/ → [tunsivat] 'know-PAST-3.PL.'
b. /vaati-i-vat/ → [vaativat] 'demand-PAST-3.PL.'

For the MSC-based approach, this state of affairs is not surprising: the morpheme structure component captures the distinction between the two verbs at the UR level: the URs are /tunTe/ (with underspecified /T/) and /vaati/ (with fully specified /t/). Assibilation can only apply to the first. For the derived-environment approach, blocking in [vaativat] is unexpected: given vowel deletion, the sequence /t-i/ spans the morpheme boundary, so assibilation should be licensed, incorrectly deriving the SR *[vaasivat]. As pointed to me by Bill Idsardi, a possible response to this example would be to split vowel deletion into two separate processes: if the two adjacent vowels are identical, the second vowel deletes. Otherwise, the first vowel deletes. This would ensure that the /ti/ sequence in /vaati-vat/ is non-derived, blocking assibilation as desired. This move comes at the cost of just a slight complication to the grammar, which perhaps does not warrant rejection of the derived-environment approach. To avoid the confound and make sure that it is the first vowel that deletes, we need to find a case where the deleted stem-final vowel and the suffix-initial vowel are clearly distinct. Romanian palatalization is such a case. The core data presented below in (34)-(37) and the observation regarding the significance of Romanian palatalization to theories of NDEB are due to Donca Steriade (2008).[3]

In Romanian, a palatalization rule turns a velar stop into a palatal before a front vowel or glide:

(33) a. k → tʃ / __ {e, i, j}
b. g → dʒ / __ {e, i, j}

Palatalization applies across morpheme boundaries (34) and is blocked morpheme-internally (35).[4]

(34) mak 'poppy-SG.' matʃ-j 'poppy-PL.'

(35) a. unkj 'uncle-SG.'
b. rokie 'dress-SG.'
c. paket 'package-SG.'

Vowels are deleted before the plural suffix /-i/, which is sometimes realized as a glide (36). The vowel-glide alternation is irrelevant for our current purposes, so

[3] I am grateful to Donca Steriade for her permission to use this material here and for help with the new Romanian data presented in (38).

[4] For presentational ease, I have omitted secondary palatalization from the examples below. The distribution of secondary palatalization is irrelevant for our purposes.

I will leave it as a black box in what follows, assuming that deletion applies pre-vocalically and that a cover rule i → j, which is responsible for the glide-vowel alternation, applies after deletion.

(36) a. metru 'meter-SG.' metr-i 'meter-PL.'
b. bere 'beer-SG.' ber-j 'beer-PL.'
c. popʌ 'priest-SG.' pop-j 'priest-PL.'

Crucially, palatalization is blocked exactly when the deleted vowel had been a palatalization trigger: In (37-a), the final vowel in the singular is a back vowel and palatalization applies in the plural. In (37-b), the final vowel is a front vowel and palatalization in the plural is blocked.

(37) a. minekʌ 'sleeve-SG.' minetʃ-j 'sleeve-PL.'
b. pʌduke 'louse-SG.' pʌdu**k**-j 'louse-PL.'

This contrast is quite general. The following table demonstrates the behavior of palatalization in the plural form of every nominal declension class that takes the plural suffix /-i/: for each class, the two rightmost columns indicate the identity of the stem-final vowel and whether palatalization applies in the plural form.[5]

(38) Palatalization in Romanian nouns that take the plural suffix /-i/

	Noun-SG.	Noun-PL.		Final vowel	Palatalzation applies
MASC					
a.	mak	matʃ-j	'poppy'	/u/	✓
b.	pʌduke	pʌdu**k**-j	'louse'	e	*
c.	dukʌ	dutʃ-j	'duke'	ʌ	✓
d.	flamiŋgo	flamiŋdʒ-j	'flamingo'	o	✓
FEM					
e.	fabrikʌ	fabritʃ-j	'factory'	ʌ	✓
f.	pereke	pere**k**-j	'pair'	e	*

For the sake of concreteness, let us see why the MSC-based theory accounts for this pattern without modification. The grammar, with anti-palatalization (39) as a morpheme structure rule and palatalization as a phonological rule, is given in (40).

(39) Anti-palatalization
K → k / _ {e, i, j}

(40) a. Morpheme structure component:
(i) k ∉ Σ_L
(ii) K → k / __ {e, i, j}
b. Phonological rules:
(i) V → ∅ / __ V
(ii) K → tʃ / __ {e, i, j}
(iii) K → k
(iv) i → j

[5]The range of possible noun-final vowels in Romanian is restricted, perhaps suggesting that the final vowel should be regarded as an idiosyncratic theme vowel specified on a root by root basis. If this is true, a necessary assumption is that the theme vowel is part of the lexical entry, present before the application of anti-palatalization.

Anti-palatalization applies to individual morphemes in the lexicon and specifies K as /k/ in (37-b) but not in (37-a):

(41) Derivation of [pʌduk-j] (singular: [pʌduke])

a. Morpheme structure rules apply:

1. {pʌduKe} → /pʌduke/
2. {i} → /i/

b. Phonological processes apply:

UR	/pʌduke-i/
V → ∅ / __ V	pʌduki
K → tʃ / __ {e, i, j}	-
K → k	-
i → j	pʌdukj
SR	[pʌdukj]

(42) Derivation of [mɨnetʃ-j] (singular: [mɨnekʌ])

a. Morpheme structure rules apply (vacuously):

1. {mɨneKʌ} → /mɨneKʌ/
2. {i} → /i/

b. Phonological processes apply:

UR	/mɨneKʌ-i/
V → ∅ / __ V	mɨneKi
K → tʃ / __ {e, i, j}	mɨnetʃi
K → k	-
i → j	mɨnetʃj
SR	[mɨnetʃj]

Derived-environment theories, on the other hand, are not able to capture the relevant distinction between /mɨnek-i/ (to which palatalization applies) and /pʌduk-i/ (to which it does not).

Is there a way to save derived-environment theories without adopting MSCs? Two possible directions come to mind, but both require undesirable complications. Splitting vowel deletion as in the Finnish case will not work for Romanian, but another splitting strategy may work. We can consider splitting vowel deletion into two rules: one rule deletes non-[e] vowels before [j] and is ordered before palatalization (so palatalization applies in /mɨnek-i/), and a second rule deletes [e] before [j] but applies after palatalization (so palatalization does not apply in /pʌduke-i/, which later becomes [pʌduk-j]). The second direction would be to treat stem-final vowels as idiosyncratic theme vowels specified on a root by root basis. A root like /pʌduk/, and other roots that surface with a final [e] in the singular form, would be listed as a special class in the lexicon, call it THEME-e; roots like /mɨnek/ would be listed as another class, say THEME-ʌ, and so on. These roots would receive their final vowel through class-specific rules:

(43) a. [THEME-e] → add -e
b. [THEME-ʌ] → add -ʌ
c. ...

A special exception rule would be parasitic on these lists and specify THEME-e roots (and only them) as exceptions to palatalization:

(44) [THEME-e] → [-palatalization]

Halle and Nevins (2009) show that exception rules such as (44) that target lists of roots in the lexicon and mark them as exceptions to individual processes are needed, in some form, in every theory of phonology, so the existence of (44) should not be entirely surprising. Both directions (rule-splitting and parasitic exceptions) are reasonable, and with additional support, may turn out to be preferable to the MSC-based analysis of Romanian. Currently, however, the general point is that even the special mechanisms used by derived-environment theories to account for NDEB are insufficient:[6] derived-environment theories are forced to introduce special stipulations to make sense of the blocking patterns found in Finnish and Romanian, whereas these patterns are quite natural from the perspective of the MSC-based theory.

3.3 Blocking within suffixes: cyclicity is not enough

The MSC-based analysis of Finnish assibilation relies on MSCs to restrict the distribution of [t] and [T] in the lexicon: non-alternating [t] occurs before [i], and alternating [T] occurs elsewhere. MSCs apply to each morpheme individually, which makes sure that stems like /tilaT/ have the desired specification before suffixation. The same result could be alternatively achieved in a cyclic architecture where MSCs are replaced with first-cycle evaluation and the distributional restriction applies once, before suffixation. My goal in this section is to discuss the cyclic variant of the MSC-based proposal, which can successfully capture the Finnish assibilation pattern, and show that it faces a challenge in accounting for cases of NDEB where application is blocked not only within stems, but also within suffixes. As we will see, accounting for blocking within suffixes requires a level of representation in which phonological restrictions apply to suffixes in isolation from the rest of the string – a level available in MSC-based architectures but crucially not in cyclic architectures that reject MSCs.

Cyclic architectures allow phonological processes to be interleaved with affixation. Examples of cyclic architectures are Lexical Phonology and Morphology (Kiparsky, 1982 et seq.), its implementation within OT known as Stratal OT (Kiparsky, 2000), and Halle and Vergnaud's (1987) theory of the cycle. I will first show that a cyclic variant of the MSC-based analysis can account for Finnish assibilation without MSCs. In this variant, there are no restrictions on the alphabet, which means that both [t] and [T] can be used in writing URs. Moreover, since anti-assibilation is not an MSC, [t] and [T] may occur anywhere within URs: URs like /rat/ (with fully-specified [t] in final position) and /Tila/ (with underspecified [T] before [i]) can be generated. A cyclic grammar is provided in (45). It contains two rule blocks separated by suffixation. To keep the discussion general and compatible with various cyclic architectures, I will not name the rule blocks and will refer to them simply as Rule block A and Rule block B.[7] Rule block A contains two rules, which mirror the effects of MSCs in the MSC-based analysis. The first rule turns every [t] to [T], which has a similar effect to the constraint t $\notin \Sigma_L$ in

[6] In Appendix B, I discuss the Strict Cycle Condition (Mascaró, 1976) and Coloured Containment (van Oostendorp, 2007) in more detail and explain why they make the wrong predictions for Finnish and Romanian.

[7] The distinction between Rule block A and Rule block B may correspond to the following distinctions made by cyclic approaches: cyclic vs. post-cyclic, stem-level vs. word-level, lexical vs. post-lexical, etc.

banning [t] from initial representations. The second rule is the anti-assibilation rule. The remaining rules, including assibilation, are part of Rule block B.

(45) a. Rule block A:
t → T
T → t / __ i
b. Add the suffix [-i]
c. Rule block B:
T → s / __ i
T → t

The derivation of [tilas-i] (which alternates with [tilat-a]) using this grammar is given in (46). As there are no MSCs, multiple URs for the stem may lead to the same output. To see the rules in working, I have chosen the UR /Tilat/. Notice that the correct output is derived. The analysis straightforwardly extends to phonologically-derived environments if final-vowel raising is placed in Rule Block B.

(46) Cyclic derivation of [tilas-i]

Rule block A	/Tilat/
t → T	TilaT
T → t / __ i	tilaT
Suffixation	/tilaT-i/
Rule block B	/tilaT-i/
T → s / __ i	tilasi
T → t	
	[tilasi]

A cyclic architecture, then, can capture the Finnish assibilation pattern without using MSCs since it can impose the same distributional restriction on the stem before suffixation. More generally, the cyclic architecture succeeds because every nonderived environment is introduced into the derivation before every derived environment. This allows anti-P to be ordered at a stage in the derivation after every nonderived environment has been created and before any derived environment has been created, which, in turn, allows anti-P to apply exclusively to nonderived environments and P to apply later to derived environments.

The two architectures diverge in their predictions when the derivational precedence between nonderived and derived environments required by the cyclic approach breaks down. This may happen when a phonological process that is blocked in nonderived environments is also blocked within suffixes. Cases of such blocking mentioned in the literature are consonant gradation in Finnish (Kiparsky 1993, 2003), spirantization in Luganda (Wolf 2008, citing Odden 1990), and palatalization in Meskwaki (Wier, 2004). The challenge for the cyclic approach from Luganda spirantization is discussed in Wolf (2008, pp. 443-447), and I will present another version of the argument from Finnish consonant gradation.

Finnish consonant gradation (CG) de-geminates a double stop at the onset of a closed syllable and yields alternations as in (47).

(47) tten → ten, ttain → tain

Example (48), taken from Kiparsky (1993), is a single example that contains three

environments for CG. CG is blocked in the first, nonderived, environment (underlined) and applies in the other two, derived, environments (bold). The second geminate (/...to**tt**i.../) and the third geminate (/...**tt**oma.../) undergo CG since they are onsets of closed syllables at some level of representation.[8]

(48) /ho<u>tt</u>ento**tt**i-**t**oma-ta/ → [ho<u>tt</u>ento**t**i-**t**on-ta] 'Hottentotless-PART.SG.'

CG is blocked when its environment is fully contained within the suffix -tten, an allomorph of the genitive plural (49).

(49) maa-i-tten *maa-i-ten 'country-PL.GEN'

Non-application in (49) is not yet a problem for the cyclic analysis: the suffix -tten might be added only after CG gets its last chance to apply. The crucial example is (50-b), where the suffix itself creates an environment for the application of CG to a preceding geminate (/kk/). Notice that in (50-a), with a different allomorph of the genitive plural, CG does not apply (the first consonant of the suffix is deleted and the vowel undergoes glide formation). In (50-b), the plural suffix -i- forms a diphthong with the preceding vowel, and Kiparsky (2003: 121) notes that, generally, in such cases, it is the presence of a following geminate that triggers obligatory CG of the onset of the syllable. This leads to an ordering paradox for the cyclic approach. On the one hand, CG must be able to apply *after* the addition of -tten to make sure that /kk/ undergoes gradation. On the other hand, anti-CG could not have applied to -tten at any prior level of representation, so, paradoxically, CG must not be able apply once -tten is added (otherwise, it would incorrectly apply to -tten).

(50) a. /ulla<u>kk</u>o-i-ten/ → [ulla<u>kk</u>ojen] 'attic-PL.GEN.'
b. /ulla**kk**o-i-tten/ → [ulla**k**oitten] 'attic-PL.GEN.'

The problem for the cyclic approach is that there is no level of representation in which phonological restrictions apply to suffixes in isolation from the rest of the string. Whenever the nonderived environment in -tten is present in the derivation, a derived environment (the hetero-morphemic closed syllable kko-i-t) is present as well. This is why anti-CG cannot apply to -tten without causing trouble elsewhere. MSCs address this problem directly: if anti-CG applies to individual morphemes in the lexicon before they are combined with other morphemes, it can apply to -tten before any derived environment has been created.

One way out for a cyclic approach without MSCs is to mark the suffix -tten and any other suffixes that involve blocking (including the relevant suffixes in Luganda and Meskwaki) as exceptions. As Wolf (2008) notes, however, marking the Luganda suffix -irir- as an exception to spirantization (r → z / __ i) will not work, since the suffix contains two targets for spirantization (two [r]'s), and it is only the first one, which forms a morpheme-internal environment for spirantization, to which the process cannot apply (the second [r] does become [z] when an [i]-initial suffix follows). To account for blocking within suffixes, then, the cyclic approach will have to mark as exceptions precisely those suffix-internal targets that are a

[8]For the second geminate, the syllable is closed by the third, suffix-initial geminate. For the third geminate, the syllable is closed after deletion of the suffix-final vowel /a/ triggered by the following suffix. In a derivational approach, an explicit analysis could either order vowel deletion before a directional CG rule that applies left-to-right, or (in a cyclic architecture) apply CG after deletion in every cycle. See Kiparsky (1993) for further discussion on CG in an underspecification-based account.

part of underlying morpheme-internal environments. While the number of problematic suffixes is currently quite small, the MSC-based approach avoids arbitrary exception-marking in these cases altogether. Hopefully, further investigation of blocking within suffixes will shed light on the generality of this pattern.

3.4 Blocking in nonderived environments that are partially predictable

3.4.1 Blocking in Romanian and Armenian

The MSC-based approach identifies nonderived environments as environments present at a particular level of representation: the level at which *anti-P* applies. Other approaches in the literature that follow a similar path include Wolf's (2008) Optimal Interleaving with Candidate Chains and Burzio's (2000) Sequential Faithfuless. In these approaches, the presence of an environment at some privileged level leads to blocking, but the relevant level is identified without using MSCs. In Wolf (2008), application to environments present before suffixation may be blocked in suffixed forms due to violation of a precedence constraint. In Burzio (2000), environments present at the UR of individual morphemes are subject to a faithfulness constraint. In this section I discuss a pattern of NDEB in which part of the environment of P is predictable. In particular, the application of P depends on the position of stress, but the distribution of stress is determined by the grammar. Given ROTB, underlying stress can be generated anywhere: output constraints enforce its correct output position. This leads to an over-generation problem for Wolf's and Burzio's approaches: if stress is not in its correct position at the relevant level of representation (the level subject to the blocking constraint), the environment for P is not met at that level, so the blocking constraint is avoided and P incorrectly applies. Examples of such blocking patterns are vowel raising in Romanian (Steriade, 2008) and vowel reduction in Armenian (Khanjian, 2008). I will describe the Romanian case.

In Romanian, unstressed [a] raises to [ə] in suffixed forms (51), but only if [a] is stressed in the unsuffixed form (52).

(51) Raising

a.	bárbə	'beard'	bərb-ós	'bearded-MASC'
b.	fáur	'artisan'	fəur-í́	'to fashion'
c.	isprávə	'brave deed'	ispráv-nik	(nobleman's title)

(52) No raising

a.	mazíl	'deposed official'	mazil-í́	'depose'
b.	kartóf	'potato'	kartof-jór	'potato-DIM'

Stress is predictable: it is penultimate by default, but falls on the final syllable on the surface in words that undergo final-[u] deletion or have stress-attracting suffixes. There is independent distributional evidence for an underlying /u/ in words like [mazíl]: this /u/ surfaces before suffixes, i.e., in some environments where it is not word-final; singular nouns may only end in a surface [u] when this [u] follows an otherwise impermissible complex coda (as in the word [metru]), suggesting that deletion does not apply in these cases; except for those singular nouns that end in a consonant and show a surface [u] elsewhere, singular nouns must end in a vowel. Final stress in consonant-final singular nouns makes sense if penultimate

stress is assigned to the pre-deletion representation. Assuming this description to correctly reflect speakers' grammars, I will now present an MSC-based analysis of Romanian and proceed to show why ROTB leads to an over-generation problem for Wolf's and Burzio's proposals.

3.4.2 An MSC-based account

The challenge posed by the blocking pattern of Romanian raising is that part of the conditioning environment is predictable: the vowel [a] raises if it is unstressed, and stress is assigned by the grammar. For the MSC-based approach, an account of blocking would require the following ingredients. First, a variant of [a] that is underspecified for the feature [low] would be referred to as [A]. Raising would be stated as in (53) and anti-raising as in (54).

(53) Raising: $A_{[\text{-stress}]} \rightarrow$ ə

(54) Anti-raising: $A_{[\text{-stress}]} \rightarrow$ a

If we follow the same recipe as in previous sections, the basic grammar would be (55), with a cover stress rule preceding raising in the phonology.

(55) Grammar for Romanian raising (to be revised below)
- a. Morpheme structure component:
  - (i) a $\notin \Sigma_L$
  - (ii) $A_{[\text{-stress}]} \rightarrow$ a
- b. Phonological rules:
  - (i) STRESS
  - (ii) $A_{[\text{-stress}]} \rightarrow$ ə
  - (iii) A $\rightarrow$ a

The problem with (55) is that anti-raising must be able to protect underlying unstressed [a]'s in the unsuffixed form, but stress is only assigned later: anti-raising cannot make the necessary distinction between stressed and unstressed vowels and thus fails to capture the distinction in (56).

(56)

a.	bárbə	'beard'	bərb-ós	'bearded-MASC'
b.	mazíl	'deposed official'	mazil-í	'depose'

The remedy is clear: stress should be assigned to the unsuffixed form before anti-raising. There are two ways to implement this solution. The first would be to relegate anti-raising to a cyclic phonology and apply stress and anti-raising, in this order, in the first cycle. In the second cycle, stress would apply again, followed by raising. This account, which is consistent with the proposed architecture, would assign a more important role than before to the mapping from URs to surface forms in accounting for blocking, and would leave the morpheme structure component with the minor role of banning [a] from URs. Another way to achieve the same result is to keep anti-raising as a morpheme structure rule and minimally modify (55) so as to assign stress in the morpheme structure component before the application of anti-raising. At present, I am not aware of any good reason to choose between the two variants. For concreteness, I will use the second. Here is the final grammar, followed by derivations of the forms in (56) (for simplicity, I omit vowel-deletion rules from the grammar and drop stem-final vowels when convenient):

(57) Grammar for Romanian raising (final)

a. Morpheme structure component:
   (i) a, $\acute{o} \notin \Sigma_L$
   (ii) STRESS
   (iii) $A_{[\text{-stress}]} \rightarrow$ a

b. Phonological rules:
   (i) STRESS
   (ii) $A_{[\text{-stress}]} \rightarrow$ ə
   (iii) A $\rightarrow$ a

(58) Derivation of [bárbə]

a. Morpheme structure rules apply:
   1. {bArbə} $\rightarrow$ /bÁrbə/

b. Phonological processes apply:

UR	/bÁrbə/
STRESS	-
$A_{[\text{-stress}]} \rightarrow$ ə	-
A $\rightarrow$ a	bárbə
SR	[bárbə]

(59) Derivation of [bərb-ós] (unsuffixed form: [bárbə])

a. Morpheme structure rules apply:
   1. {bArbə} $\rightarrow$ /bÁrbə/
   2. {os} $\rightarrow$ /ós/

b. Phonological processes apply:

UR	/bÁrbə-ós/
STRESS	bArbós
$A_{[\text{-stress}]} \rightarrow$ ə	bərbós
A $\rightarrow$ a	-
SR	[bərbós]

(60) Derivation of [mazíl]

a. Morpheme structure rules apply:
   1. {mAzilu} $\rightarrow$ /mazílu/

b. Phonological processes apply:

UR	/mazílu/
STRESS	-
$A_{[\text{-stress}]} \rightarrow$ ə	-
A $\rightarrow$ a	-
SR	[mazíl]

(61) Derivation of [mazil-í] (unsuffixed form: [mazíl])

a. Morpheme structure rules apply:
   1. {mAzilu} $\rightarrow$ /mazílu/
   2. {i} $\rightarrow$ /í/

b. Phonological processes apply:

UR	/mazílu-í/
STRESS	mazilí
$A_{[\text{-stress}]} \rightarrow$ ə	-
A $\rightarrow$ a	-
SR	[mazilí]

3.4.3 Wolf (2008): Optimal Interleaving with Candidate Chains

Wolf's (2008) architecture is a cyclic implementation of Optimality Theory with Candidate Chains, a serial variant of OT (OT-CC; McCarthy, 2007). Wolf's account of NDEB is guided by the following intuition: P is blocked in some environment if it can apply in this environment before the application of some other process P_0. For morphologically-derived environments, P_0 is set as affixation; for phonologically-derived environments, P_0 is set as the relevant phonological process that precedes P. Blocking is enforced by a precedence constraint that requires P_0 to crucially precede P.

Let us see how this account correctly derives Finnish [tilasi] from /tilat-i/, where there are two potential environments for application. The first step is a precedence constraint that requires affixation to crucially precede assibilation. Informally, the first sequence [ti] (/**ti**lat-i/) is present before affixation: assibilation can apply to this sequence before or after affixation, so it is not crucially preceded by affixation, in violation of the precedence constraint. Application to the second sequence /tila**t-i**/ is not blocked since the process can only apply after affixation. More formally, the derivation starts with an abstract morphosyntactic structure (/ROOT-AF/) and morpheme exponents are inserted in the phonology in violation of the faithfulness constraints INSERT-ROOT and INSERT-AFFIX. Here are the constraints relevant for NDEB:

(62) a. *ti
b. IDENT[cont]
c. PREC(INSERT-AFFIX,IDENT[cont]): assign a violation mark for each time that:
(i) A process that violates IDENT[cont] applies without having been preceded by a process that violates INSERT-AFFIX
(ii) A process that violates IDENT[cont] applies and is followed by a process that violates INSERT-AFFIX

The markedness constraints *ti triggers assibilation, but only when the higher ranked precedence constraint is satisfied:

(63) PREC(INSERT-AFFIX,IDENT[cont]) $\gg$ *ti $\gg$ IDENT[cont]

The tableau in (64) demonstrates the derivation of [tilasi]. A candidate consists of a chain in which each member differs from the preceding member by one atomic change, like a feature change, epenthesis, deletion, affix insertion, and so on. The final member of the chain is the output. Candidate (a) includes the chain that outputs [tilasi]: first the root is inserted, then the affix, then assibilation applies. Whenever multiple distinct chains lead to the same output, they are merged into a single candidate, as in (b), which represents the output candidate [silasi]. Precedence is evaluated based on this merged candidate. In the first chain in (b), assibilation is applied to the first /ti/ sequence after suffixation, but in the second

chain it applies before suffixation. This means that this application of assibilation is not crucially preceded by suffixation, incurring a violation of PREC. To ensure that multiple applications of assibilation are distinguished from one another, precedence is not directly evaluated on the candidates themselves, but rather on tuples of faithfulness violations that the candidates induce, called LUMSeqs (65), and each violation is indexed with respect to the position in the word which is the source of the violation. In both LUMSeqs for (b), the violation ID[cont]$_{@5}$ (which corresponds to the application of assibilation to the fifth segment of the word) follows INSERT-AF (which corresponds to affixation), which means that this instance of assibilation is crucially preceded by affixation and so does not incur a PREC violation. Since candidate (b) violates the highest ranked PREC constraint and candidate (a) does not, candidate (a) is the winner.

(64) Tableau for [tilasi]

	/ROOT-AF/	PREC(INSERT-AF,ID[cont])	*ti	ID[cont]
a. ☞	<tilat-AF, tilati, tilasi>		*	*
b.	<tilat-AF, tilati, silati, silasi> <tilat-AF, silat-AF, silati, silasi>	*!		**

(65) a. LUMSeq: <INSERT-AF, ID[cont]$_{@5}$>
b. LUMSeq: <INSERT-AF, ID[cont]$_{@1}$, ID[cont]$_{@5}$>
LUMSeq: < ID[cont]$_{@1}$, INSERT-AF, ID[cont]$_{@5}$>

Here is how an analysis of Romanian raising would work in this architecture. The ranking, given in (66), is of the following constraints: a cover constraint STRESS stands for whatever constraints enforce correct surface stress in Romanian; the constraint PREC(INSERT-AFFIX,IDENT[low]) requires that raising is crucially preceded by affixation; the markedness constraint *a$_{[\text{-stress}]}$ is responsible of triggering raising, in violation of the faithfulness constraint IDENT[low].

(66) STRESS , PREC(INSERT-AFFIX,IDENT[low]) ≫ *a$_{[\text{-stress}]}$ ≫ IDENT[low]

The tableau in (67) demonstrates the correct derivation of [bərb-ós] assuming the UR /bárbə/ for the root (for simplicity, the tableau ignores the deletion of stem-final [ə]). Notice that, crucially, stress is underlyingly penultimate: [a] is stressed from the outset, so raising cannot apply before suffixation and there is no PREC violation. Hence, raising is (correctly) not blocked.

(67) Correct derivation of [bərb-ós] (assuming the UR /bárbə/)

	/ROOT-AF/	STRESS	PREC(AF,IDENT[low])	*a$_{[\text{-stress}]}$	ID[low]
a. ☞	<bárbə-AF, bárbə-ós, barbə-ós, bərbə-ós>				*
b.	<bárbə-AF, bárbə-ós, barbə-ós>			*!	

Given ROTB, the predictability of stress allows for URs in which stress is placed in arbitrary positions and output constraints enforce surface penultimate stress (68). The problem is that for such URs, the environment for raising is met before or after suffixation, so raising is not crucially preceded by suffixation and is incorrectly blocked (69).

(68) a. /barbá/ → [bárbə]

b. /barbə/ → [bárbə]

(69) a. /barbɔ́-ós/ → *[barb-ós]
b. /barbə-ós/ → *[barb-ós]

The tableau in (70) is a concrete tableau for (69-a), where stress is underlyingly final. The conclusion is that given ROTB, the grammar over-generates pairs of nonderived-derived forms where raising is incorrectly blocked in the derived form.

(70) Incorrect derivation of *[barb-ós] (assuming the UR /barbɔ́/):

	/ROOT-AF/	STRESS	PREC(AF,IDENT[low])	*$a_{[-stress]}$	ID[low]
a.	<barbɔ́-AF, bárbə-ós, barbə-ós, bərbə-ós> <barbɔ́-AF, bərbɔ́-AF, bərbɔ́-ós, bərbə-ós>		*!		*
b. ✕	<barbɔ́-AF, barbɔ́-ós, barbə-ós>			*	

3.4.4 Burzio (2000): Sequential faithfulness

Burzio (2000) proposes a new type of faithfulness constraints to account for NDEB. As opposed to traditional faithfulness constraints which typically protect individual features, Burzio's constraints penalize modifications of sequences or combinations of features. I will refer to these constraints as Sequential Faithfulness constraints. An example of a Sequential Faithfulness constraint is FAITH[ti], which penalizes any output deviation from the input sequence /ti/. Burzio assumes that such constraints do not protect sequences that are separated by morpheme boundaries, presumably because morphemes are not concatenated in the input. This assumption creates a distinction between the two /ti/ sequences in the Finnish /tilat-i/: modifying the first sequence (for instance, by applying assibilation) would incur a violation of FAITH[ti], but modifying the second sequence will not. The following tableau shows how Sequential Faithfulness successfully accounts for the derivation /tilat-i/ → [tilasi]:

(71) Tableau for [tilasi]

	/tilat-i/	FAITH[ti]	*ti	ID[cont]
a.	tilat-i		**!	
b.	silat-i	*!	*	*
c.	silas-i	*!		**
d. ☞	tilas-i		*	*

Burzio's theory shares much of its predictions with the MSC-based theory – if an environment for P is present in the UR of some morpheme, application in this environment will be avoided – but the connection between presence in a UR and blocking is made without MSCs. Blocking in nonderived environments that are partially predictable poses an over-generation problem for Sequential Faithfulness since ROTB allows (given a single morpheme) both for URs in which the environment is present (and is therefore protected by a Sequential Faithfulness constraint) and URs in which it is not (and is therefore not protected). P will incorrectly apply to the latter. The following simplified tableau demonstrates the (correct) derivation of Romanian [bərb-ós], assuming the UR /bárbə/ for the stem: FAITH[$a_{[-stress]}$] is not violated since [a] is stressed in the input.

(72) Tableau for [bərb-ós], UR: /bárbə-ós/

		/bárbə-ós/	FAITH[$a_{[\text{-stress}]}$]	*$a_{[\text{-stress}]}$	ID[low]
a.		barb-ós		*!	
b.	☞	bərb-ós			*

Given ROTB, other possible URs for the stem are /barbə/ and /barbə́/. Here vowel raising would incur a violation of FAITH[$a_{[\text{-stress}]}$] since [a] is unstressed in the input. The result is that raising is incorrectly blocked in the derived form:

(73) Tableau for [bərb-ós], UR: /barbə/

		/barbə-ós/	FAITH[$a_{[\text{-stress}]}$]	*$a_{[\text{-stress}]}$	ID[low]
a.	✕	barb-ós		*	
b.		bərb-ós	*!		*

4 Conclusion

OT dispensed with MSCs for reasons of theoretical simplicity: a single-component architecture seemed more appealing than a dual-component one, and output constraints unified MSCs and the input-output mapping. Rasin and Katzir (2014) provided an argument from learnability for MSCs and re-opened the question of the role that MSCs play in phonological theory. In this paper, I examined the implications of MSCs to the phenomenon of NDEB and claimed that it can be characterized as an opaque interaction between MSCs and the input-output mapping. I showed that this characterization provides a simple theory of NDEB that is more successful than alternative theories in both rule-based phonology and OT in accounting for known cases of NDEB, supporting a dual-component architecture of phonology with MSCs over the principle of Richness of the Base.

A Underspecification vs. exception features

The proposal sketched in section 2 makes use of underspecification to distinguish between alternating and non-alternating features: feature-filling rules apply to underspecified but not to specified features. There is no consensus in the literature regarding the availability of underspecification in phonology (see Steriade, 1995 for discussion). Many current theories of phonology reject it, and it will be useful to understand whether the present theory crucially relies on underspecification. My goal in this section is to show that the MSC-based approach is independent of the availability of underspecification. I will do so by presenting a variant of the proposal which does not use underspecification but keeps all other ingredients of the proposal fixed. In particular, the distinction between unspecified and specified features can be replaced with a distinction between plain specified features and specified features alongside an exception diacritic that prevents the feature from being changed by a particular rule. On this variant, every rule is feature-changing and morpheme structure rules are responsible not for filling features in the lexicon but rather for introducing exception diacritics.

The representational differences between the two variants are summarized in table (74). The feature [-assibilation] in $t_{[\text{-assibilation}]}$ indicates that the segment [t]

is immune to the rule of assibilation. A fragment of Finnish under the exception-based variant is given in (75). Here, assibilation is a feature-changing rule that changes every instance of [t] to [s], unless it is marked with the exception feature [-assibilation]. For reasons discussed in section 3.1.1, the distribution of exception features must not remain an accident of the Finnish lexicon: an instance of [t] must be marked with [-assibilation] precisely when it precedes an [i]. This distribution is enforced by the morpheme structure component. The end result is that assibilation applies unless its environment of application is present in the lexicon, as needed.

(74)

Variant	Alternating	Non-alternating
Underspecification	T	t
Exceptions	t	$t_{[\text{-assibilation}]}$

(75) a. Morpheme structure component:
(i) No exception features in Σ_L
(ii) t $\rightarrow$ [-assibilation] / __ i
b. Phonological rules:
t $\rightarrow$ s / __ i

At present, I am not aware of any evidence for choosing one variant over the other. Processes like epenthesis and deletion are not easily characterized using underspecification and may require some additional technical maneuvers from the underspecification variant. The underspecification variant may also be subject to Stanley's (1967) early conceptual objections to underspecified representations. The exception-based variant uses ad-hoc rule-specific features and is less general than the underspecification variant: underspecification of a feature like [continuant] may have consequences for other rules that make reference to [continuant] other than assibilation, and it remains to be seen whether this prediction is borne out. In any case, as both variants are currently equally successful empirically, I conclude that the MSC-based approach is independent of whether underspecification is available.

B Discussion of specific derived-environment theories

B.1 Strict cycle condition

Mascaró (1976) argues that NDEB provides evidence for a phonological analog of Chomsky's Strict Cycle Condition (SCC; Chomsky, 1973). The phonological version is given in (76) below.[9]

(76) **Strict Cycle Condition.** For a cyclic rule R to apply properly in any given cycle j, it must make specific use of information proper to (i.e., introduced by virtue of) cycle j.
This situation obtains if either of the following conditions is met:
1. The rule makes crucial reference to the information in the representation that spans the boundary between the current cycle and the

[9] The presentation of the SCC in this section is based on Kenstowicz, 1994.

preceding one.

2. The rule applies solely within the domain of the previous cycle but crucially refers to information supplied by a rule operating on the current cycle.

Application of a cyclic rule is licensed in morphologically-derived environments by the first condition and in phonologically-derived environments by the second condition. The following table illustrates the analysis of Finnish assibilation using the SCC. Final-vowel raising and assibilation are both assumed to be cyclic rules. Cyclic rules cannot apply in the first cycle by stipulation. A word boundary is inserted in the final cycle. The leftmost column demonstrates application in a morphologically-derived environment, the middle column application in a phonologically-derived environment, and the rightmost column blocking in a non-derived environment. The number of the SCC condition that licenses each rule application is given in brackets next to the outcome of the rule.

(77) Finnish assibilation using the SCC

First cycle	[halut]	[vete]	[tila]
e → i / __ #	-	-	-
t → s / __ i	-	-	blocked
Second cycle	**[#[halut]i#]**	**[#[vete]#]**	**[#[tila]#]**
e → i / __ #	-	veti (1)	-
t → s / __ i	halusi (1)	vesi (2)	blocked
	[halusi]	[vesi]	[tila]

Condition (1) of the SCC dictates that spanning a morpheme boundary is a sufficient property for licensing. This wrongly predicts obligatory application of Finnish assibilation and Romanian palatalization after vowel deletion (78).

(78) a. Finnish [vaat-i-vat] : /vaati-i-vat/ → *[vaasivat]
b. Romanian [pʌduk-j]: /pʌduke-i/ → *[pʌdutʃ-j]

B.2 Coloured Containment

van Oostendorp (2007) proposes an account of NDEB that makes use of a mechanism of morpheme indexing called "colouring". The assumption is that every morpheme is annotated with its own "color" – a morpheme-specific index which is distributed over all segments and other material (features, moras, etc) which make up the morpheme. For example, in the representation of Finnish /tilat-i/, the first morpheme would be associated with the color α and the second morpheme with the color β, as shown in (79) using a simplified linear representation.

(79) /$t_\alpha i_\alpha l_\alpha a_\alpha t_\alpha$-$i_\beta$/

Blocking in nonderived environments arises from a proposed constraint against monochromatic feature spreading, which I have simplified using the following statement (see the original paper for more details about the mechanics of colouring and spreading):

(80) Do not associate a feature and a segment of the same colour.

Finnish assibilation would presumably involve spreading of the feature [continuant] from [i] to [t], but only if [i] and [t] are not of the same color:

(81) a. $t_\alpha i_\alpha \rightarrow t_\alpha i_\alpha$
b. $t_\alpha i_\beta \rightarrow s_\alpha i_\beta$

This account makes the right prediction that /tilat-i/ should become [tilas-i], but it fails for the vowel deletion cases in both Finnish and Romanian, as demonstrated in (82): in both cases spreading is incorrectly licensed across a morpheme boundary.

(82) a. Finnish [vaat-i-vat]:
/$v_\alpha a_\alpha a_\alpha t_\alpha i_\alpha$-$i_\beta$-$v_\gamma a_\gamma t_\gamma$/ $\rightarrow$ $v_\alpha a_\alpha a_\alpha t_\alpha$-$i_\beta$-$v_\gamma a_\gamma t_\gamma$ $\rightarrow$ *[vaasivat]
b. Romanian [pʌduk-j]:
/$p_\alpha \Lambda_\alpha d_\alpha u_\alpha k_\alpha e_\alpha$-$i_\beta$/ $\rightarrow$ $p_\alpha \Lambda_\alpha d_\alpha u_\alpha k_\alpha$-$i_\beta$ $\rightarrow$ *[pʌdutʃ-j]

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