INTRODUCTION TO MORPHOLOGY

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5 MORPHOLOGY AND PHONOLOGY

In Chapter 1, we touched briefly upon the interaction of morphology and phonology, in particular in the discussion of **allomorphy**. In this chapter, we will explore the interaction of these two components or "modules" of language in somewhat more detail. Particular points of interest include:

the observation that not all affixes behave the same with respect to phonological rules, in the most extreme cases this is true of affixes that appear to be otherwise homophonous

the observation that some phonological rules are sensitive to morphology while others are not

and

the concept of the **cycle** as the explanation for a variety of phonological generalizations.

5.1 Derivations, relatedness and the cycle

We have been careful in the preceding chapters to note that the Word Structure Trees contain, at the bottom, the *morphemes*, which means formally complete lexical entries. Lexical entries, we have seen in Chapter 1, contain phonological Underlying Representations (URs): the surface forms are derived after the morphology by phonological rules.

One example we considered in the discussion of allomorphy was the regular English plural. Recall that there are three phonologically distinct (surface) allomorphs, as shown in (1).

(1)	a.	bus	busses	[bʌs-əz]
	b.	step	steps	[stɛp-s]
	c.	head	heads	[hɛd-z]

We saw in chapter 1 that this is an instance of surface allomorphy as opposed to true allomorphy. In other words, the lexical entry for the (regular) plural has the unique UR /z/, from which the surface forms are derived by phonological rules, specifically those in (2).

(2) a. z → əz / C__ where C = coronal, fricative
b. z → s / C___ where C = -voice

The main argument that the alternation should be part of the phonology and not part of the morphology (or the lexical entry) was the fact that the phonological rules in (2) apply quite generally, in English, in fact with all four distinct "s" morphemes: the regular plural on nouns (*the 39 steps*), the possessive marker (*this step's tread is worn out*), the contracted third person singular auxiliary *be* (*this step's too high*), and the third person singular present tense of the verb (*she steps lightly*). This is illustrated in (3). (With appropriate modification, the rule can alsso be extended to the alternations in the regular past tense "ed" = [əd, t, d], see Chapter 1.)

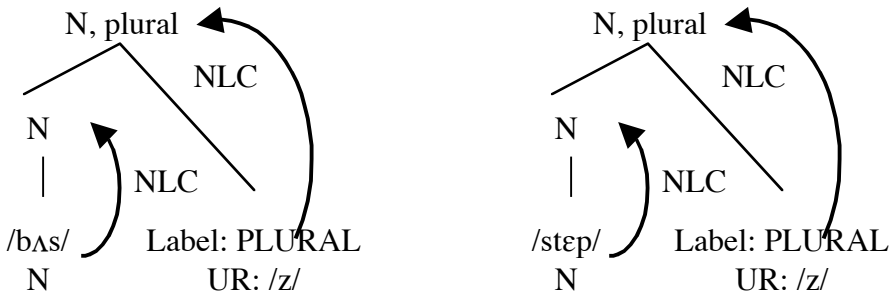
(3)

		plural	possessive	contracted "be"	verb (3 sg present)
a.	bus:	[bʌsəz]	[bʌsəz]	[bʌsəz]	[bʌsəz]
b.	step:	[steps]	[stɛps]	[stɛps]	[stɛps]
c.	head:	[hɛdz]	[hɛdz]	[hɛdz]	[hɛdz]

To list the alternations as allomorphs in each morpheme's lexical entry would miss the generalization that the rules in (2) apply in the same manner to all of these affixes.

The analysis of (1a-b), with slightly abbreviated lexical entries, is given in (4). Note that the two part analysis with a WST and subsequent phonology is what we have been implicitly doing all along, but it is now time to be more explicit about the steps involved.

(4) a. Word Structure Trees (to be revised in Chapter 6)



b.

/bʌs/	+	/z/	/stɛp/	/z/	URs
	bʌs **ə** z			----	(2a)
	-----			stɛp **s**	(2b)
	bʌsəz			stɛps	OUTPUT

The trees in (4a) should be familiar. Note that the lexical entry of the plural morpheme has a unique UR, namely /z/. The step in (4b) schematizes a mapping of the WSTs to a phonological string, namely, the URs of each of the morphemes. This mapping creates the starting point of a

PHONOLOGICAL DERIVATION. The derivation in (4b) is read from top to bottom, and shows the stepwise application of the phonological rules. As we discussed in the allomorphy section, the ordering of the rules is important—if (2b) could apply before (2a), the plural of *bʌs* would be falsely predicted to be **bʌss* (with a long /s/ and only one syllable).

Notice that we have introduced a notational convention in writing derivations: all of the applicable rules are listed on the right, but in comparing two derivations, when a rule is not applicable in a particular derivation, we indicate this with a horizontal line in the appropriate column. The derivations in (4b) indicate that rule (2a) does not apply in the derivation of *steps*, for example.

Now let's move on to a more complex case, involving another rule of English phonology, namely the rule that accounts for the alternations in vowel quality in the pairs of words in (5).

(5)

Orthography	Phonetic Transcription	
divine - divinity	dɪ. **vájn**	dɪ. **vɪ́**. nɪ. tij
serene – serenity	sə. **ríjn**	sə. **rɛ́.** nɪ. tij
profane – profanity	pro. **féjn**	pro . **fǽ** .nɪ .tij
deprave – depravity	dɪ. **préjv**	dɪ. **prǽ.** və. tij
profound – profundity	prə. **fǽwnd**	prə. **fʊ́n.** dɪ. tij
vile – vilify	**vájl**	**vɪ́**. lɪ. faj
clear – clarify	**klíjr**	**klɛ́.** rɪ. faj
rite – ritual	**rájt** / rʌjt	**rɪ́**. tʲu . əl

In all of these pairs, the quality of the stressed vowel alternates (this is sometimes, but not consistently, reflected in the orthography, as in *clear* vs. *clarify*). In the left-hand member of each pair, the vowel is long, i.e. a tense diphthong, whereas in each case on the right, the stressed vowel is short and lax.

In primary school, you probably learned to write these vowel pairs as "long" and "short" versions of the same vowel, such as : ī, ĭ; ē, ĕ, etc. In reality, these alternations are much more complex, and involve various historical considerations, but they are nevertheless systematic. The main pairings of long and short (or tense and lax) alternations in English are the following:

(6)

orthography	tense	lax	orthography	tense	lax
i	aj	ɪ	(o)u	æw	ʊ
e(a)	ij	ɛ	o	ow	a,ɑ
a	ej	æ			

Luckily, we need not work through the complex history of these pairings for the points we need to understand here, and it will suffice simply to recognize that English vowels come in alternating pairs, as listed here.

Now that we know this, we can describe all the alternations in (5) with a single rule, which states that long (tense) vowels correspond to short (lax) vowels in certain environments. Let's assume that the relevant environment is: three syllables from the right edge of certain words. We may call this the *Tri-Syllabic Laxing* rule (TSL) and it is one of a number of laxing rules in English. A slightly simplified version of the rule is given in (7).

(7) TRI-SYLLABIC LAXING: V → [lax] / ___ . □ . □ . #

(Note that we don't take [lasx] and [tense] to be a real phonological features, they are simply convenient abbreviations for whatever underlies the alternations noted above. Also, speakers of English might note immediately that there are counter-examples to this rule, and we will return to this below. First, we need to see how the overall system works when the rule applies.)

In each of the pairs of words in (5), the stressed syllable falls under the structural description of the TSL—and hence undergoes laxing—only in the second member of each pair. In the first member, the syllable is either the last one (ultimate) or the second last (penultimate) and hence the TSL does not apply.

Now consider what happens when the last three pairs of words are expanded to include further derivational affixes:

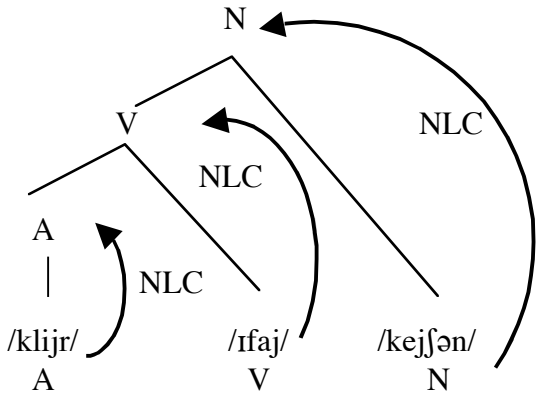
(8)

clear – clarify - clarification	**klíjr**	**klɛ́.** rɪ. **faj**	**klɛ.** rɪ. **fɪ**. kéj. ʃən
vile – vilify - vilification	**vájl**	**vɪ́**. lɪ. faj	**vɪl.** rɪ. **fɪ**. kéj. ʃən
rite – ritual - ritualize	**rájt** / rʌjt	**rɪ́**. tʲu . əl	**rɪ́**. tʲu . ə. lajz

Note that in the longer words, the first syllables are lax, even though they no longer meet the description of the TSL. In the word *clarification*, the syllable that is three from the right edge **does** undergo laxing. It is [faj] in *clarify*, but [fɪ] in *clarification*, as expected. But why don't we say *clearification* [klijrɪfɪkejʃən]?

Let's look explicitly at what appears to go wrong. For the sake of simplicity, we will treat the string *-kejʃən* as a single morpheme, with category N and subcategorization [V__].

(9) a.



b. □ □ □

/klijr/	+	/ɪfaj/	+	/kejʃən/	URs
k l i j r ɪ f a j k e j ʃ ə n					
k l i j r ɪ f ɪ k e j ʃ ə n					TSL
* k l i j r ɪ f ɪ k e j ʃ ə n					OUTPUT - INCORRECT

In (9), we have collected all of the URs together at the beginning of the phonological derivation. This approach correctly predicts that TSL will apply to the middle syllable, but incorrectly leaves the first syllable in its underlying form, surfacing as a tense vowel.

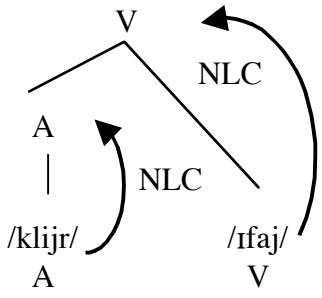
The source of the problem lies in treating the string of URs as one long sequence for the purposes of phonological rules. In a sense, this undoes (or ignores) the hierarchical structure that our WSTs were designed to capture.

So, what would happen if we applied phonological rules in a stepwise fashion, at each node in the tree, in the same way that our morphological principles are calculated on intermediate nodes and among sisters?

Consider what the derivation of *clarification* would look like on this approach. We'll skip the first step (the root) for reasons that will become clear below, though you should be able to see that this doesn't matter.

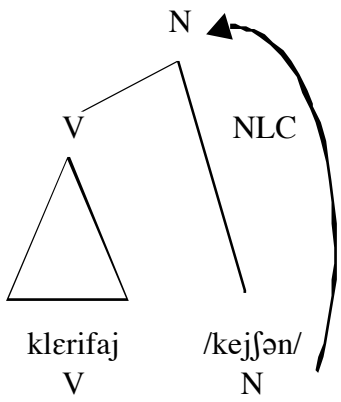
(10) STEP 1

root *clear* plus suffix *–ify*



STEP 2

output of Step 1 *klɛrifaj* plus suffix *kejʃən*



b.

/klijr/	+	/ɪfaj/			URs
k l i j r ɪ f a j					STEP 1
k l ɛ r ɪ f a j					TSL
k l ɛ r ɪ f a j					Output Step 1
k l ɛ r ɪ f a j			+	/kejʃən/	
			k l ɛ r ɪ f a j k e j ʃ ə n		STEP 2
			k l ɛ r ɪ f ɪ k e j ʃ ə n		TSL
			k l ɛ r ɪ f ɪ k e j ʃ ə n		Output Step 2

As the derivation in (10) shows, the correct results are obtained if phonology is allowed to apply in a stepwise fashion, in tandem with the construction of the WST. The TSL rule applies correctly at the intermediate node created by adding the suffix *–ify* to the root *clear*—at this stage the structural description is met. The TSL applies again at the next step of the derivation, when the remaining suffixal material is added.

The formal name given to each step in such a derivation is a **CYCLE**, and a derivation which proceeds in this manner is said to be a **CYCLIC** derivation.

The concept of cyclic rule application leads to some interesting (and currently hotly debated) expectations about the way morphologically related words will cluster together in terms of their phonological behaviour. For example, consider the pair in (11).

(11) a. lightning [lajt.niŋ] (e.g., during a thunderstorm)
b. lightening [laj.tə.niŋ] (e.g., becoming lighter)

Cross-linguistically, alternations between a schwa and zero are often due to considerations of syllabification in phonology. If we assume that the schwa in (11b) is the result of a phonological rule, then it raises the question of why there is no corresponding schwa in (11a).

The cycle provides an answer. We may think of (11a) as the basic syllabification that is expected of the underlying string /lajtniŋ/—the /n/ forms the onset of the second syllable and the /t/ is assigned to the coda of the first syllable. If (11b) were syllabified in one step on the surface, it should end up the same as (11a). But, the word in (11b) is morphologically complex, and in particular is derived from the adjective *light* via the verb *lighten*. At the intermediate step *lighten*, the schwa is motivated—the cluster *tn#* is an impossible coda in English and the schwa is inserted. By the time the suffix *–ing* is added, the schwa is already present. As *lightning* does not undergo the same derivation, there is no intermediate stage at which schwa epenthesis is triggered.

Another example can be taken from the stress pattern of English. English stress is quite complex and has been the subject of various book-length studies. This is not the place to pursue the many intricacies of these discussions, but we may identify here some basic properties.

First, primary stress (which we indicate with an acute accent) in English typically falls on the penultimate syllable if it is heavy (a long vowel or a closed syllable) otherwise on the antepenultimate syllable. The stress contrasts between the words in (12a) and those in (12b) illustrate the basic pattern.

(12) a. a.gén.da con.sís.tent sta.lág.mite e.léc.trode
b. a.mé.ri.ca cóm.pe.tent má.la.chite plá.ti.node

In addition to primary stress, long English words have secondary stresses. Laying aside fine distinctions among various degrees of secondary stress, we may observe that secondary stress in long monomorphemic words (such as place names) occur on the first syllable and alternating syllables thereafter, up to the main stress. There is also a ban on stress clash (two adjacent stresses syllables), which means that secondary stress is not assigned to the syllable immediately preceding the primary stress. Examples illustrating the combination of primary and secondary stress are given in (13).

(13) àppalàchicóla tàtamagóuchi hàmmamèlidánthmum

Consider now the words in (14).

(14) solìdificátion orìginálity

The words in (14) conform to the basic primary stress pattern. In each case, the penult is light and primary stress falls on the antepenultimate syllable. However, the placement of the secondary stresses is unexpected from the perspective of the discussion of (13). The word *solidification* has the same number of syllables before the main stress as *Appalachicola*, and the secondary stress pattern described above predicts (incorrectly) **sòlidìficátion*. Likewise, the stress pattern of *Tatamagouchi* leads us to expect (again incorrectly) the pattern **òriginálity*.

Once again, the cycle provides an answer. The words in (14) are morphologically complex. Specifically, *solidification* is derived from *solidify* and *originality* is derived from *original*, by the addition of one suffix in each case. Now, the words *solídify* and *oríginal* are unexceptional from the perspective of stress. In each word, the penult is light and main stress correctly falls on

the antepenult. The ban on stress clash correctly precludes secondary stress on the initial syllables of each word. The stress patterns observed in (14) are explained if stress is assigned cyclically in English. Stress is first assigned to the words *solidify* and *original*; these stresses are maintained in the next cycle and an additional stress is assigned to the appropriate syllable on that later cycle. Stresses from previous cycles are demoted to secondary stress, but no secondary stresses will be assigned to the first syllables due to the ban on clash.

Once again, we see the effects of the cycle: stress is first calculated at an intermediate node in the complex words in (14) but there is no intermediate node in the monomorphemic words in (13). The cycle thus provides the basis for an account of the stress differences between the two classes of words.

In sum, the cycle leads us to expect that differences in morphological structure may correlate with differences in phonological structure. Moreover, the cycle makes predictions about how the morphological structure and the phonological structure will correlate—surface optimality effects will be suspended in a complex surface form, if phonological processes have applied on a prior cycle.

NON-ENGLISH EXAMPLES

5.2 Two kinds of affixes

Consider now the following examples, which illustrate cases in which the TSL rule discussed above fails to apply.

(15)

Orthography	Phonetic Transcription	
nightingale	**nʌ́j.** tɪn. gejl	* **nɪ́.** tɪn. gejl
ivory	**áj.** və. rij	* **ɪ́.** və. rij
stevedore	**stíj.** və. dowr	* **stɛ́.** və. dowr

Although these words have long/tense vowels three syllables from the right edge, thus meeting the description of the TSL the vowels don't shorten. In order to understand these examples, we need to make two assumptions, as given in (16)—these introduce some terminology which we will explain presently.

(16) a. Phonological rules (such as TSL) may be specified as **cyclic** or **non-cyclic**

b. Cyclic rules apply only at **cyclic nodes**.

c. Root nodes are not cyclic nodes.

The first assumption in (16) allows for the possibility that some phonological rules are sensitive to morphological structure, while others are not. We'll consider more evidence for this division below. The TSL rule we have been discussing is specified to be a cyclic rule, since whether or not it applies is in part determined by the morphological, and not just the phonological

environment—TSL applies only in morphologically complex words, and not in monomorphemic words like (15).

Assumptions (16b) introduces the term *cyclic node* to refer to those nodes in the tree which correspond to the domain in which cyclic phonological rules apply.

Finally, assumption (16c) (sometimes called the *derived environment condition*) asserts that cyclic rules such as TSL will not apply in words that consist of only a root node.

Together, these assumptions account for the failure of TSL to apply in the examples in (15).

We introduced the assumptions in (16) to account for the failure of TSL in a handful of monomorphemic words in English meeting the structural description of the rule. At this point, a good move would be to look for independent evidence for these assumptions.

Let's look first at (16b). For the examples in (15), this assumption does very little work. By keeping assumptions (16b) and (16c) distinct, we are tacitly acknowledging that we expect to find that the distinction between cyclic and non-cyclic nodes will have more content than just distinguishing root nodes from all other nodes. This is indeed the case. The following examples show that the TSL rule is not only sensitive to the distinction between simple and complex words, but is also sensitive to the particular choice of affix involved in creating the environment. Addition of the suffixes *–able, –ness*, *-ing*, and *–ry* can create derived words which meet the Structural Description of the TSL rule (7), but the rule (still) fails to apply:

(17)

Orthography		Phonetic Transcription (of righthand word)	
righteous - righteousness		**ráj.** čəs. nəs	* **rí.** čəs. nəs
	CDN	**rʌ́j.** čəs. nəs	
brave - bravery		**bréj.** və. rij	* **brǽ.** və. rij
profound – profoundnesses		prə. **fǽwnd.** nəs	* prə. **fʊ́nd.** nə. səz
clear – clearable		**klíj.** rə. bəl	* **klɛ́.** rə. bəl

Although these words are complex words, and although the affixation creates an environment in which the long vowels end up three syllables from the right edge, the vowels in the stressed syllables do not undergo laxing.

Note that in the (admittedly artificial) word *profoundnesses* (the plural of *profoundness*, or the possessive, as in *the article about profoundess's author…*), the vowel fails to undergo laxing, even though the same vowel in the same root does undergo laxing in the word *profundity* in (5). A clearer example is the root *clear* which undergoes TSL in *clarity, clarify*, but not in *clearable*.

We must therefore recognize that, like phonological rules, individual affixes may be either cyclic or non-cyclic. In the cases that we have seen thus far, the suffixes *–ity, -ify,* and *–(c)ation* are cyclic—they trigger the TSL rule, while the suffixes *–able, –ness*, *-ing* may create the right

segmental environments, but they are not cyclic and thus do not trigger the TSL. The following provides a basic list of common cyclic and non-cyclic suffixes in English.

(18) Classification of English suffixes:

a. "CYCLIC" AFFIXES Those affixes which trigger cyclic rules;

"Class 1" -ity, -ify, -ual, -ial, -ous, -ize, -(at)ion, -ic, $-y^{X \rightarrow N}$

b. "NON-CYCLIC" AFFIXES Those affixes which do not trigger cyclic rules.

"Class 2" -ness, -less, -ful, -ly, -er, -ish, -ing, -ry, $-y^{N \rightarrow Adj}$

We may now return to assumption (16b) and state the following condition for determining whether or not a node is cyclic.

(19) A node is cyclic if it immediately dominates a cyclic affix

[As a thought question, consider the implications of strengthening (19) to a bi-conditional. For example, what implications would this have for compounding?]

We illustrate now with the derivations of *clarity* and *clearable*. We omit the WSTs, and consider only the phonological part of the derivations involved.

(20)

a. *clarity*	b. *clearable*	
/klijr/	/klijr/	ROOTs No Cyclic Rules apply (by (16c))
klijr + /ity/	klijr + /ʌbəl/	AFFIXES
kl ɛ r + /ity/	n/a (19)	TSL (Cyclic Rule)
klɛrity	klijrʌbəl	OUTPUT

The suffix *–ity* is a cyclic affix, therefore, addition of this affix to the root *clear* makes the immediately dominating node cyclic. Cyclic phonological rules are therefore triggered, the relevant rule here being TSL. The suffix *–able* however is not cyclic. The node dominating the combination *clear+able* is thus not a cyclic node (by (19)) and thus TSL is not applied. We'll return to considering some further implications of this distinction below, but the conclusion we draw at this point is that two things are necessary in order for a cyclic phonological rule to apply. First, there must be a derived environment (i.e., a morphologically complex word) and second, the affix which creates the derived environment must itself be cyclic.

5.2.1 German.

Consider now the following German data. (In the transcriptions, we'll ignore some phonetic detail about the "r" segments, which is not relevant to the points being made.) German has a class of adjective stems which end in a syllabic nasal. This is illustrated by the word *trocken*

'dry', which is pronounced as two syllables. For convenience, we will indicate the syllabic nasal in the second syllable as a schwa+nasal sequence: /trɔkən/.

This root may serve as the basis for affixation. For example, the plural and comparative forms of the adjective are given in (21).

(21)	trɔkən	+ ən	→	trɔkənən	'dry (of plural objects)'
		+ ən	→	trɔkənər	'drier' (i.e. more dry)

Basic segmentation allows us to correctly identify two suffixes here, the plural suffix /*-ən*/ and the comparative suffix /*-ər*/ (the latter is cognate with English). The resulting words have three syllables each.

Now, German has two other suffixes with which the root *trɔkən* may combine. These are the infinitive suffix /*-ən*/ yielding a verb meaning 'to dry' and the "agentive" suffix /*-ər*/, which, like English, means "one who or that which does V". This is shown in (22).

(22)	trɔkən	+ ən	→	trɔknən	'to dry'
		+ ən	→	trɔknər	'dryer' (e.g., a machine)

Note that with these two suffixes, there is a change in the syllable structure. The derived words in (22) are only two syllables—the final "n" of the stem resyllabifies as an onset and the medial schwa is omitted. There are a variety of ways of formalizing this alternation we see in (22), depending on the theory of phonology one chooses to adopt. One simple analysis would invoke the phonological rule in (23).

(23) Desyllabification: ə -> Ø / __nV

Without the classification of affixes into two kinds, cyclic and non-cyclic, we would reach somewhat of a paradox with these facts. The rule in (23) could account for the forms in (22), but would wrongly apply in (21) as well. We could try appealing to different formalizations of the phonology, such as a schwa epenthesis rule, or more sophisticated syllabification algorithms, but they will all face the same potential problem. The affixes in (21) and (22) are homophonous on the segmental level, yet the phonology distinguishes between words formed with one group of affixes and words formed with another.

The German facts thus illustrate the divide into cyclic and non-cyclic affixes even more starkly than the English examples considered above. In the German examples, homophonous affixes may have distinct phonological behaviour. A single phonological rule such as (23) may be triggered by some affixes and not triggered by others, regardless of the segmental phonological properties of those affixes. Examples of this sort thus provide a powerful argument for the morphologically sensitive nature of some phonological rules.

5.2.2 Other cyclic rules of English

Thus far, we have found that the TSL rule in English is sensitive to morphology in two ways. First, it does not apply inside single morphemes (that is, in mono-morphemic words), and second, it only applies when specific affixes (the cyclic affixes) have created the environment that matches the structural description.

If the TSL were the only rule of English to behave in this manner, the most straightforward approach would be to build all of these conditions into the formulation of the rule itself. However, it has long been recognized that phonological rules fall broadly into two classes, and specifically, that there is an array of rules of English that behave in a cyclic fashion, i.e., inapplicable in monomorphemic words and triggered only by cyclic affixes.

The stress-assigning rules of English are at least partly cyclic in this manner. In fact, we saw a hint of this above, where the proper understanding of the stress pattern of *orìginálity* and *solìdificátion*, required calculating stress first on an early cycle and then recalculating it again when later suffixes were added.

Now, if stress rules are cyclic, we expect that only the cyclic affixes will trigger cyclic application of stress rules. In essence, what this means is that the affixes in (18a) have the potential to trigger a stress "shift", while those in (18b) do not. This is largely borne out, as (24) illustrates; the addition of the cyclic affix *–ity* triggers a recalculation of stress, and, in accordance with the rules identified above, main stress is assigned to the antepenult, but as (24b) shows, the addition of the suffix *–ness,* which is non-cyclic, does not trigger a recalculation of stress even though the penult /tɪv/ is closed and should attract stress.

(24)	a.	pro **DÚC** tive	→	pro duc **TÍ** vi ty	-ity → stress shift
	b.		→	pro **DÚC** tive ness	-ness → no stress shift

This example illustrates an important point about the cyclicity hypothesis, not particular to English. The proper account of many phonological alternations requires understanding both that phonological rules fall into two classes (cyclic and non-cyclic) and that affixes fall into two classes (cyclic and non-cyclic). This has long been understood, and is recognized even in theoretical frameworks that reject the notion of the cycle and therefore encode these observations in some other manner.

But the cyclicity hypothesis goes beyond these observations and makes specific predictions about the distribution of the various kinds of "morphological relatedness" discussed in section 5.1. Thus, the derivations of *clarification* and *solidification* illustrate OVERAPPLICATION of phonological rules (TSL and stress assignment), respectively. These words are interesting since phonological rules appear to apply even though their structural description is not met on the surface string. The cycle explains this—the structural description was met at an earlier stage of the derivation, when a cyclic affix was added. Since only cyclic affixes trigger cyclic rules, the cyclicity hypothesis predicts that overapplication effects will be limited to cyclic rules, in the context of cyclic affixes.

By contrast, the stress of (24b) indicates an apparent morphological relatedness effect, but in this case it is one of UNDERAPPLICATION. The main stress rule of English should assign stress to the penultimate syllable in **productívness*, as that syllable is heavy. but instead, the stress contour of the contained word *productive* is retained. Thus, a phonological rule fails to apply when its environment is met on the surface. The cycle again offers an explanation. The suffix *–ness* is non-cyclic and therefore addition of this suffix does not trigger the application of cyclic phonological rules, including stress (which was triggered on an earlier cycle). Thus, the cycle predicts underapplication effects in the context of non-cyclic affixes.

There is an extensive literature in phonology surrounding the issues discussed above, and at the time of writing, a consensus has not yet been reached. Our main purpose, though, is to illustrate the ways in which morphology and phonology interact, and to demonstrate how a theory of this interaction might profitably be constructed, with an eye to understanding the implications of the theory. Being able to see the broad implications (such as the distribution of over and under-application) of narrow hypotheses is important in developing any theory, as it allows the theoretician and the skeptic alike to identify the kinds of data which will bear on hypothesis formation and testing.

In section 5.5, we will consider one particular hypothesis which was set out within the framework identified above, and discuss apparent counter-examples.

5.3 Two kinds of rules

In the preceding section, we saw that some phonological rules care about which affix has created the relevant environment. In other words, some phonological rules are sensitive not only to morphological structure, but also to the identity of the morphemes involved-lexical information.

To see this more clearly, it helps to contrast these rules with phonological rules that are *non-cyclic*. Such rules apply in an Across-the-Board fashion; in other words, they apply on the phonological string as a whole, without regard to morphological structure.

Two such non-cyclic rules in some varieties of English are the Flapping Rule and the Canadian Raising rule. These are illustrated below.

5.3.1 Flapping

In some varieties of North American English, such as Mid-Western dialects of the US, the pairs of words in (25) are homophonous (same sound, different spelling and meaning) on the segmental level, especially when pronounced at a normal, e.g., conversational, rate of speech. (There is a difference in vowel length which correlates with voicing of the following consonant; this difference is preserved even before the surface flap. This is parallel to the raising distinction noted below and we will abstract away from its effects here.)

(25) a. ladder - latter [læDər]

b. rider - writer [rajDər][1]

The reason for this is that the difference between /t/ and /d/ disappears between vowels when the first vowel is stressed. The resulting sound called a "flap" (written "D" = IPA [ɾ]) is a voiced sound, produced by tapping the tongue quickly against the roof of the mouth. In other words, North American English contains the phonological rule in (26).

(26) /{t,d}/ → [D] / V́___V

To see the relevance of stress, compare the word *atom*, which has initial stress and triggers the flapping rule: [æDəm], to the related word *atomic* which has stress on the second syllable, and thus does not undergo flapping: [ʌt^{h}amɪk].

The flapping rule is automatic, applying whenever its environment is met, that is, whenever an underlying /t/ or /d/ falls between two vowels, the first of which is stressed. It is so automatic that speakers are often not aware they are changing the sound from a *t* or a *d* to a flap (until they take Intro to Linguistics).

Note that the STRUCTURAL DESCRIPTION of this rule (the context part of the statement in (26) makes no reference to morphological structure. This is correct: in (25a) the rule applies in monomorphemic words such as *ladder* and in bimorphemic words such as *rider* where the two vowels in the rule are contained in different morphemes (*rajd-ər).*

Note that the flapping rule even applies across certain word boundaries in connected speech, as in the following sentence, in which the sequence *ride her* contains the environment for flapping:

(27) I'll **ride her** bike tomorrow. [al rayDər bʌyk t^{h}əmarow]

5.3.2 Aspiration and Canadian Raising

Some other examples of ATB rules in English phonology include the aspiration of voiceless stops in certain positions and the rule known as Canadian Raising, both of which we will illustrate here.

There is a difference which you may know from an introductory course in the way voiceless stops such as *p,t* and *k* are pronounced depending on their position within the syllable. Minimal pairs are given in (28).

(28) a. pit vs. spit: [p^{h}ɪt] [spɪt]
cat vs. scat: [k^{h}æt] [skæt]

[1] In Canadian English and some American varieties, the stressed vowels in these words are different and so the words are not homophonous. We'll look at that below.

Voiceless stops are pronounced as aspirated in initial position, but after *s*, the aspiration is absent. You can feel this by putting your hand in front of your mouth when you read the pairs aloud. You should feel a much stronger puff of air with *pit* and *cat* than you do with *spit* and *cat*.

There is nothing universal about this difference, and in some languages the contrast between an aspirated and an unaspirated stop is meaningful—they are distinct **phonemes**. However, in English, there is only one underlying voiceless stop phoneme at each place of articulation, the difference between the two surface realizations is one of **allophony** (cf. the discussion of allomorphy in Chapter B). Like flapping, aspiration is an ATB rule of English phonology, automatically applied in all appropriate contexts and insensitive to morphological structure.

(29) Aspiration of Voiceless Stops:

/p,t,k/ → /p^h, t^h, k^h/ when simple syllable onsets

Many varieties of English also have ATB rules that affect vowels. Among these is the process called Canadian Raising, although it should be noted that there is a good deal of regional variation in this rule, and many speakers from the Northern US have it as well.

Canadian Raising is responsible for the pronunciation of the vowels in *out* and *about* that strike many Americans as amusing. Formally, the rule may be given as follows:

(30) Canadian Raising:

aj -> ʌj / ___ C
æw -> ʌw [-voice]

This rule "raises" certain diphthongs before voiceless consonants. For speakers of Canadian English, then, the vowels are distinct in pairs such as *ride* [rajd] versus *write* [rʌjt] (for speakers without Canadian raising, only the voicing no the final consonant should differ). Similarly, because the final consonant of nouns like *house* and *wife* is voiced in the plural, there is a vowel change in these words in the plural as well in Canadian English (and in the verb *to house*):

(31)	house	[hʌws]	houses [hæwzəz]
	wife	[wʌjf]	wives [wajvz]

Again, this rule is an automatic rule of Canadian English, and as such applies whenever the structural description is met, regardless of morphological structure. The mono-morphemic words *fife* and *five* pattern with *wife* and *wive*[s] respectively, the quality of the vowel determined by the following consonant.

In sum, phonologists recognize the existence of a class of phonological rules which we are calling *non-cyclic* or Across-the-Board (ATB) rules. These rules have the properties in (32):

(32) Some properties of Across The Board Rules:

a. Automatic, exceptionless.

b. Insensitive to morphological structure:

monomorph: ladder [lædər], house [hʌws]

bimorphemic: latter [lædər], pouter [pʌwdər] 'one who pouts'

c. ATB rules can "create" new allophones, e.g.: [D], [p^h], [ʌj]

(None of these occur in underlying representations in English)

The last point is one we have not discussed, but it is useful to know. ATB rules are not "structure preserving", which means that the output of these rules need not conform to the inventory of phonemes in the language. They may introduce sounds or contrasts that are only introduced by phonological rule (for example, the contrast between [p] and [p^h] in English).

Note that these properties are taken to contrast with cyclic rules (property (32b) does by definition). In particular, just as cyclic rules are sensitive to lexical information and the identity of particular morphemes, cyclic rules may also have lexical exceptions.

Thus, in contrast to the examples in (5) we find lexical exceptions to cyclic rules like TSL such as the pair *obese – obesity* where the derived form fails to undergo TSL, and the vowel is pronounced tense: [ob**ij**sɪtij] rather than expected [ob**ɛ**sɪtij] (compare *serene – serenity*).

5.4 Rule Ordering Effects

5.4.1 Rule Ordering

One of the early discoveries of generative phonology was the property of abstractness, in particular, the observation that phonological rules apply in a sequence. For this reason, even if we lay aside the issue of cyclicity, we find that a phonological rule may apply in a word where the structural description is not met.

Let's consider the interaction of Flapping and Canadian Raising. As both are non-cyclic rules, the issue of ordering in the cycle is not relevant.

In varieties of English that have Canadian raising, there is a distinction between the vowels in the words *write* and *ride*, as discussed above. The raising rule is sensitive to the voicing of the following consonant. Note that when the suffix *–er* is added to these verbs, the flapping rule is triggered and the coronal consonant is converted to a flap. Now, in varieties without raising, the words *writer* and *rider* are homophonous (see (25b)). But in varieties with raising, the vowels are still distinct, as indicated in (33).

(33)	writer	[rʌjdər]	pouter	[pʌwdər]
	rider	[rajdər]	powder	[pæwdər]

How is this possible? The vowel difference is exactly the distinction that is expected from the application of Canadian Raising, but the voicing distinction which crucially determines whether or not the rule applies has been obliterated by the Flapping rule.

The solution is to have the Canadian Raising rule apply before the Flapping rule. The derivations in (34) illustrate how the correct results are obtained by applying the rules in a specific order.

(34)

writer	*rider*	
/rajt-ər/	/rajd-ər/	Underlying Representations
rʌjtər	-----	Raising
rʌjDər	rajDər	Flapping

If the rules are applied in the other order, the wrong predictions are made, as (35) shows.

(35)

write	*ride*	*writer*	*rider*	
/rajt/	/rajd/	/rajt-ər/	/rajd-ər/	Underlying Representations
----	----	rajDər	rajDər	Flapping
rʌjt	rajd	-----	-----	Raising
[rʌjt]	[rajd]	*[rajDər]	[rajDər]	Output

Note that the reverse-order application in (35) is not the same as the absence of raising, as in American varieties. The absence of raising predicts neutralizations in vowel quality in both the verbs and the derived nouns, while the reverse order application of the rules incorrectly predicts neutralization only when the flapping rule has applied.

<< A parallel argument can be made with lengthening; Kenstowicz p.71 >>

There are various means of capturing the effects of rule ordering. Some modern theories of phonology reject the notion of a rule and cast phonological generalizations in terms of constraints. The effects considered above are no less important, however, and such theories provide an alternate means of stating the same general intuitions. We will continue to present the issues from a rule-based perspective, though in most cases what we say can be straightforwardly translated into a constraint-based approach.

5.4.2 Rule Ordering and post-cyclicity

** to be written **

ATB rules are post-cyclic, i.e., they happen at the end of the derivation

Organization of mapping from phonology to morphology:

Allomorphy / Lexical Insertion

Cyclic Rules triggered each time a cyclic affix is inserted

At end of all insertion: Non-cyclic rules.

THE POST-CYCLIC CONVENTION All ATB rules apply after the cycles (if any) have triggered MS-Rules.

(36) Implication: Derivations always have the following form:

/ root /	Underlying form (e.g., of root) NO RULES HERE
root **+ /affix1/**	Cycle 1 iff affix1 is cyclic Cyclic Rules
root-aff1 **+ /affix2/**	Cycle 2 iff affix2 is cyclic Cyclic Rules Again
… **+ /affix n/**	Cycle *n* iff affix *n* is cyclic Cyclic Rules Again
output of all cyclic rules	**ATB Rules APPLY HERE**
[phonetic form]	Output

5.4.3 The cycle and rule ordering paradoxes

** to be written **

Discussion of either Catalan (cf. Kenstowicz, p. 205) or Icelandic (Anderson)

in which rule ordering paradoxes A> B, B > A are solved by noting that the real order is A>B, but that the addition of a second cyclic affix triggers a second round, hence the order is:

Cycle 1 A>B
Cycle 2 A>B

Thus, even though rule A precedes rule B on any given cycle, the application of "B" on cycle 1 will nevertheless precede the application of rule "A" on cycle 2.

5.5 Level Ordering: A case-study in hypothesis formation and testing

Pairs of words such as those in (37) show that the suffix *–ous* is cyclic. It triggers the TSL rule in (37a) and another cyclic rule, not discussed above, which converts t → č, seen in (37b).

(37) a. omen [ó^{w}mən] ominous [áminəs]

b. right [rajt] righteous [tájčəs]

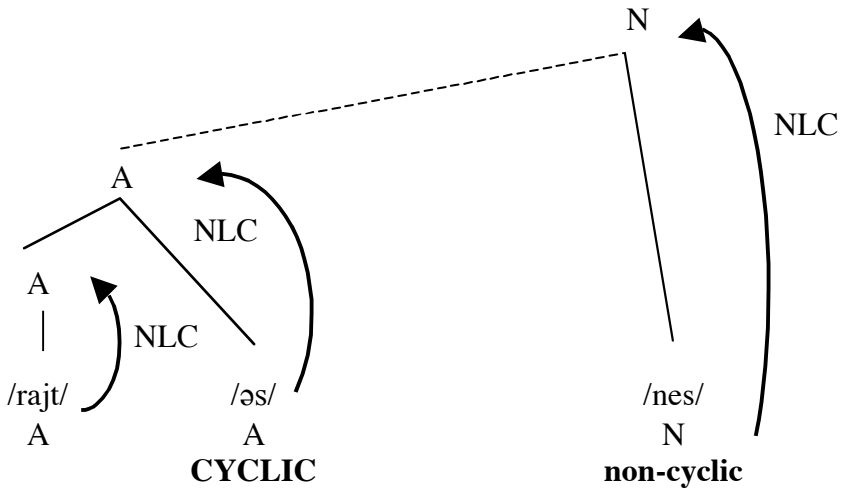
Consider now the word *righteousness*. The first syllable of this word does not undergo TSL, even though it is three syllables from the right edge, and even though the word contains a cyclic affix. The theory we have developed thus far explains the failure of TSL to apply in this word.

Suggestion. Stop reading at this point and provide the entire derivation of the word *righteousness*, including the WST and the phonological derivation, using (10) as a guide.

Your derivation should look like the following.

(38) STEP 1 STEP 2

root *right* plus suffix *–ous* output of Step 1 *rajčəs* plus suffix *nes*



b.

/rajt/ + /əs/			URs
r a j t ə s			STEP 1
------			TSL
r a j č ə s			t → č
r a j č ə s			Output Step 1
r a j č ə s	+	/nəs/	
	r a j č ə s n ə s		STEP 2
			No cyclic rules
	r a j č ə s n ə s		**Output**

The root node is not cyclic, by definition (see (16c)). We know from (37) that the suffix *–ous* is cyclic, therefore, the higher "A" node in (38) is a cyclic node by (19). This triggers a cycle of phonological rules, including TSL and the t → č rule. *Since there are only two syllables at this stage in the phonological derivation*, the structural description for TSL is not met and the rule does not apply. However, the t → č rule applies on this cycle as indicated. The next step in the derivation is the addition or lexical insertion of the affix *–ness*. This affix is non-cyclic (see (24b)). Because the affix is non-cyclic, (19) does not mark the immediately dominating node as cyclic and cyclic rules do not apply. As there is no further affixation, this constitutes the output of the morphology-phonology interaction.

The key points are that when then cyclic affix was added, the structural description for TSL was not met, and when the structural description is eventually met (the third syllable is introduced)

the chance to apply a cyclic rule had passed. The notions developed above thus make quite specific predictions about the interaction of morphology and phonology.

Now, in this example, the cyclic affix is added prior to the addition of a non-cyclic affix. For a period of time in the 1980s, it was suggested that this was not accidental but rather a general principle of grammar, called the *Level Ordering Hypothesis*. There were various formulations of this hypothesis, but the core idea was that all cyclic affixes needed to be added to the word before any non-cyclic affixes were added.

The content of this hypothesis is that various combinations of affixes which meet selectional requirements (see Chapter D) would nevertheless be impossible if the inner affix happened to be non-cyclic and the outer affix cyclic. For example, the suffix *–able* attaches to verbs to make adjectives, and the suffix *–ify* attaches to adjectives.

(39) a.

derive	derivable
rent	rentable
break	breakable

b.

solid	solidify
vile	vilify
humid	humidify

On the basis of categorial selection alone, one would expect to be able to derive words such as those in (40) in which *–able* attaches first, creating an adjective, followed by the attachment of *–ify*. However, this combination of affixes is systematically impossible in English, even though it is fairly clear what the intended meaning might be.

(40) a. *derivabilify ‘to make derivable’
b. *rentabilify ‘to make rentable’

The Level Ordering Hypothesis looked like it would explain the impossibility of this combination: *-ify* is a cyclic affix and is attached outside a non-cyclic affix, *-able*. This explanation is called into question, though, by the fact that other cyclic affixes may follow *–able*, for example *–ity* attaches quite freely to words in *–able* (see discussion of productivity in chapter D).

(41) readability, transferability, advisability, etc.

Another example which involves the affixation of a cyclic affix outside a non-cyclic affix is illustrated by the set of words in (42a). Note that the affix *–ment* does not trigger a stress shift even though the penult *.vern.* is closed and hence heavy. This is because the affix *–ment* is non-cyclic. Yet the suffix *–al* is cyclic, and addition of this suffix does trigger a shift in stress as expected by the application of the cyclic main stress rule. The phonological derivation is given in (42b)-this violates the Level Ordering Hypothesis, but respects the cyclicity hypothesis, with cyclic rules triggered only by the addition of cyclic affixes (by (19)). In order to simplify the analysis somewhat, we will assume that the root *govern* bears a lexically determined stress, as part of the underlying representation.

(42) a. góvern – góvernment – gòvernméntal

b.

/gʌ́vərn/	ROOT
gʌ́vərn + /ment/	NO CYCLE no cyclic rules, no new stress assigned
gʌ́vərnment + /al/	CYCLE
gʌ̀.vərn.mén.tal	Stress Assignment, conversion

These examples are paradoxical for the level ordering hypothesis. level ordering cannot distinguish between **-abil-ify* in (40) and *–abil-ity* in (41). As stated, level ordering should exclude both, incorrectly in the case of (41).

By not subscribing to the Level Ordering Hypothesis, the possibility of the words in (41) is no longer a problem, but now we are left with the question of what excludes the combination **-abil-ify* in (40). It turns out here that the most plausible answer lies in the domain of selection. The suffix *–ify* does not just select for adjectives, it selects specifically for roots. It does not attach outside any other suffix. All words of the form [root – suffix – ify] are unacceptable. Thus, alongside the impossibility of **-abil-ify* in (40), consider also the impossibility of the words in (43).

(43) a. *electr-ic-ify
b. *person-al-ify
c. *destruct-iv-ify …

These examples show that the Level Ordering Hypothesis was not only too restrictive (it excluded possible words), the examples in (43) show that it was not restrictive enough. These words contain a sequence of two cyclic affixes, where category selection is maintained, and thus these impossible words are not excluded by the Level Ordering Hypothesis.

Fabb 1988 provides this important argument—the Level Ordering Hypothesis is both too restrictive and too permissive. The hypothesis is incorrect. Fabb argues that the correct generalization about *–ify* is that this suffix only attaches to roots. Thus, it cannot attach after any other suffix, cyclic or otherwise. In fact, Fabb argues, 28 of 43 common suffixes in English are restricted n this manner, attaching only to roots, and another six attach to roots and only one other suffix. These generalizations, then, are better accounted for in terms of more constrained lexical and structural restrictions on subcategorization.

The LOH thus provides a case study in how a hypothesis can be constructed, and how it can turn out on closer scrutiny, to be incorrect. It is, of course, the formulating of the hypothesis in its strong form which allows us to test it, and which ultimately led to a more accurate understanding of the interplay between phonology and morphology.