pen nor mother' or *gan vriste, fien agus vaher*, with the same meaning. Mutation cannot take place when the nouns are simply conjoined and not preceded by a preposition. Since such phrases presumably derive from a more remote syntactic structure in which each noun is preceded by the preposition (*gan briste, gan pien, agus gan maher*), the proper pattern of spirantization can be obtained if the mutation rule is applied before the rule of conjunction reduction.

It is perhaps worth noting that in all of the preceding cases it is not necessary to assume that the phonological rule in question is actually APPLIED prior to the syntactic rule(s). Rather, we have shown that the CONDITIONS that determine whether or not a given phonological rule applies are conditions that exist prior to certain syntactic operations. Thus if phonological rules were permitted to operate *on* surface structures only when the surface structure involved had a particular shape at a deeper level, then these examples could be accounted for without actually ordering phonological rules before syntactic rules. (For a detailed discussion of related matters, see Chapter 6.)

Most of the examples discussed in this section have involved phonological rules that have applied because two formatives were contiguous at some point prior to surface structure. Certain syntactic rules causing elements to move (negative morphemes, clitics, etc.) obscure contiguity. These examples suggest, then, that phonological rules must be allowed to operate in terms of structures that exist prior to syntactic movement rules.

There are, obviously, other kinds of syntactic rules that could interact with phonological rules in a similar fashion. Syntactic deletion rules could, for example, destroy the context which invokes the application of a phonological rule. If the phonological rule does apply, then we could say that it is applied in terms of the syntactic structure prior to deletion. The example from Irish involving the interplay of conjunction reduction and spirantization offers one relevant example.

3.0 LEXICAL INFORMATION IN PHONOLOGY

Whether or not a given phonological rule *n* will apply to a particular phonological structure can be shown to be determined by a variety of factors. The most characteristic of these factors is the phonetic nature of the structure itself. A rule will apply to a given structure only if that structure contains a sound appearing in the environment required by the structural description of the rule. A second factor that may limit the applicability of a rule to a given structure is the syntactic/semantic makeup of that structure. Numerous examples illustrating this point were discussed in the preceding section. Another factor (discussed at length in Chapter 6) is the derivational source of the structure. For instance, in Lardil (see Chapter 1) only underlying word-final high vowels are subject to lowering. High vowels that come to stand in word-final position as

the result of the deletion of a consonant do not undergo the lowering rule. This difference in the derivational source of a high vowel (underlying versus derived) can be expressed in the form of rule ordering.

Each of the factors discussed above that restrict the application of a given phonological rule is independently motivated, in the sense that each represents information necessary to the grammar, independently of the formulation of rule *n*. Phonetic information is needed in order to characterize the pronunciation of the structure involved. Syntactic/semantic information is independently required in order to describe the grammatical behavior of the structure. Also, the contrast between whether a segment is basic or derived by a particular rule *x* is information that is independent of whether or not some other rule *n* applies.

However, it is often the case that the phonological behavior of a morpheme cannot be determined solely on the basis of such independently necessary information. In such circumstances it is necessary to provide additional, unpredictable information ad hoc in order to characterize fully the phonological structure of the morpheme. Generative phonologists have taken the position that this information is to be included in the lexicon, whose role is that of the repository of all of the unpredictable, idiosyncratic features determining the phonological (as well as syntactic and semantic) behavior of a morpheme. Despite a fair amount of study of the nature of this unpredictable information, a great many questions remain unanswered. In the remainder of this section we will briefly survey the major types of lexical information that appear to be necessary to phonological theory.

3.1 LEXICAL EXCEPTIONS

Perhaps the simplest kind of situation in which an ad hoc lexical specification is mandatory in order to determine properly the application of a phonological rule involves lexical exceptions. Here we have in mind the situation in which most lexical items that satisfy the phonetic and grammatical requirements of a rule do in fact undergo the rule, although a small number unpredictably do not. Consequently, in order to assign the correct phonetic representation to the morphemes they must be blocked from undergoing the rule. This seems to be most properly handled by including in the lexical representation of these morphemes the ad hoc information that they are exceptions to the rule.

We will begin a brief discussion of how this is to be accomplished by examining what seems to us the strongest possible position that can be taken on the treatment of exceptions (short of denying that there are exceptions!). This is the position proposed in *SPE* where each morpheme in the lexicon is to be assigned a feature [α rule n], where α is a variable ranging over the values + and −, for each of the phonological rules in the language. In the unmarked, regular case each lexical item is specified the value $\alpha = +$; in the irregular case of exceptions, $\alpha = -$. Then, by general convention, the specification α is assigned

to each segment in the morpheme. *SPE* then proposes that given any phonological rule of the form *n*:

(72) $$(n)\ A \longrightarrow B/X\_\_\_Y$$

this rule will apply to a string X′A′Y′ (where X′A′Y′ are not distinct from X, A, and Y, respectively), only when A′ contains the specification [+rule n]. If a segment has been assigned the specification [−rule n], by virtue of appearing in a morpheme that has been marked in the lexicon as an exception to rule *n*, *n* will not apply to that segment.

For example, in Ukrainian there is a rule that deletes the dental stops *t* and *d* before the past tense suffix *-l*. This accounts for the varying shapes of the morpheme /krad-/ 'steal' in *krad-u* 'I steal' and *kra-l-a* 'she stole'. The morpheme /zblid-/ 'turn pale' is an exception to this rule: *zblid-l-a* 'she turned pale'. Given the system developed above, the morpheme /krad-/ would be assigned the feature [+dental stop deletion], while /zblid-/ would be marked [−dental stop deletion] in the lexicon of Ukrainian. By general convention the specifications of + and − would be assigned to each segment of the morpheme. Dental stop deletion would not then apply to the *d* of /#zblid-l-a#/, since it is marked as [−DSD]. But the rule would apply to the *d* of /#krad-l-a#/ since it is specified [+DSD].

The position we have just outlined makes a very strong claim, in the sense that it is very restrictive: it claims that only a certain limited class of exceptions may occur. This is entirely fitting, since, as with so many other aspects of theoretical phonology, *SPE* was the first serious attempt to develop a theory of exceptions. And with first attempts, the best policy is to make the strongest, most restrictive claim consistent with the data available. For it throws into relief the kinds of data that could serve as possible counterexamples, and thereby provides a clear guide to future research.

Since the publication of *SPE* further work in the area of exceptions has revealed that the *SPE* position is too strong. In what follows we shall give a brief survey of the kinds of exceptions that have been clearly established, discussing what mechanisms seem to be required in order to deal with them.

The *SPE* position admits just one basic kind of exceptional behavior—this can be referred to as "negative input exceptions"; that is, a segment (actually, the morpheme containing the segment, according to the *SPE* analysis) is specified negatively as failing to undergo a specific phonological rule. There are, of course, other logically possible types of exceptional behavior. For example, a morpheme may fail to CONDITION the application of a phonological rule, even though the morpheme contains the sort of segmental structure that ordinarily requires the rule to apply. Exceptions of this type are in fact rather common.

Chi-Mwi:ni provides a quite straightforward example. There is a morphophonemic rule in Chi-Mwi:ni which affects just the perfective suffix *-i(:)ɬ-*; the *ɬ* of this suffix (*ɬ* is a liquid that contrasts with both *l* and *r*; in articulating *ɬ*,

the tip of the tongue strikes lightly a small area to the front of the alveolar ridge, without lateral contact) is converted to *z* if the preceding verb stem ends in *s*, *sh* (=[š]) *z*, or *ñ*.

(73)	*x-fiɬis-a*	'to go bankrupt'	*fiɬis-i:z-e*	'he went bankrupt'
	x-kos-a	'to make a mistake'	*kos-e:z-e*	'he made a mistake'
	k-a:nz-a	'to begin'	*anz-i:z-e*	'he began'
	x-ṭez-a	'to play'	*ṭez-e:z-e*	'he played'
	ku-ra:sh-a	'to follow'	*rash-i:z-e*	'he followed'
	x-ṭosh-a	'to think'	*ṭosh-e:z-e*	'he thought'
	x-fa:ñ-a	'to do'	*fañ-i:z-e*	'he did'
	x-kakañ-a	'to change'	*kakañ-i:z-e*	'he changed'
But:	*ku-ji:b-a*	'to answer'	*jib-i:ɬ-e*	'he answered'
	x-so:m-a	'to read'	*som-e:ɬ-e*	'he read'
	ku-haḍ-a	'to say'	*haḍ-i:ɬ-e*	'he said'
	x-ṭaraj-a	'to hope'	*ṭaraj-i:ɬ-e*	'he hoped'

Although the change of the perfective *ɬ* to *z* is restricted to one morpheme, the rule appears to be productive; it does apply even in cases where the verb root has been borrowed from Arabic or Somali (the two languages that have affected Chi-Mwi:ni vocabulary most extensively). The root /fiɬis/ in *fiɬis-i:z-e* is an Arabic loan and /ra:sh/ in *rash-i:z-e* is a Somali loan.

There are, however, a handful of exceptional forms.

(74)	*ku-bariz-a*	'to appear'	*bariz-i:ɬ-e*	'he appeared'
	ku-ja:su:s-a	'to spy'	*jasus-i:ɬ-e*	'he spied'
	ku-'a:sis-a	'to found s.t.'	*asis-i:ɬ-e*	'he founded (it)'

Even though the *ɬ* in *bariz-i:ɬ-e* does not undergo the expected change to *z*, it is clearly not the perfective suffix itself that is an exception; rather the root /bariz/ is exceptional in that its final *z* does not trigger the change of the perfective *ɬ* to *z*.

In the *SPE* system, the failure of the *ɬ* in *bariz-i:ɬ-e* to shift to *z* must be accounted for by specifying somehow the *ɬ* as [-rule *ɬ*-to-*z*]. The prefective suffix cannot be assigned this property in the lexicon, otherwise we could not account for why the rule applies in (regular) examples like *fiɬis-i:z-e*, *kos-e:z-e*, *anz-i:z-e*, etc. In the *SPE* analysis it would be necessary to assign to the perfective suffix the property [-rule *ɬ*-to-*z*] when preceded by the morphemes /bariz/, /ja:su:s/, /'a:sis/, etc. Although this would be technically possible, it does seem to miss the point, since in this analysis the morphemes /bariz/, /ja:su:s/, /'a:sis/ are not marked in the lexicon as exceptional in any way. But they are clearly exceptional in that they fail to condition application of the *ɬ*-to-*z* rule. Let us refer to a morpheme like /bariz/ as a "negative environment exception."

If we accept that a morpheme may be exceptional either because it fails to undergo a rule, even though in the appropriate environment, or because it

fails to condition a rule, even though containing the relevant segmental structure, the following question arises: Does a morpheme that exceptionally fails to undergo a rule also necessarily fail to condition that same rule (assuming that the structure of the morpheme is such that it can both undergo the rule and also condition it)? and vice versa? We can depict this range of questions in the following table.

(75)

	undergoes rule *n*	conditions rule *n*
(i)	+	+
(ii)	+	−
(iii)	−	+
(iv)	−	−

The evidence seems to be that all four cases are possible. In the following paragraphs we briefly discuss examples of each of the four types.

The following data from Piro, an Arawakan language of Peru (Matteson, 1965) are especially interesting in this regard. This language has a rule of vowel drop of roughly the following form.

(76) $$V \longrightarrow \emptyset / VC\_\_\_ + CV$$

That is, a morpheme-final vowel deletes in a two-sided open syllable. To illustrate, the nominalizing suffix *-lu* causes the deletion of the final vowel of a preceding verb stem.

(77)

yimaka	'teach'	*yimak-lu*	'teaching'
kakona	'to build a shelter for a hideout in hunting'	*kakon-ru**	'a shelter in which a hunter hides'
kama	'to make'	*kam-lu*	'handicraft'

The addition of the possessive suffix *-ne*, which is used in combination with a pronominal prefix, may also elicit an application of vowel drop to a preceding stem.

(78)

xipalu	'sweet potato'	*n-xipal-ne*	'my sweet potato'
čalu	'fish net'	*n-čal-ne*	'my fish net'
kahli	'clay'	*n-kahli-ne*	'my clay'
xinri	'palm species'	*n-xinri-ne*	'my palm species'

In the last two examples the stem-final vowel does not delete because it is preceded by two consonants, instead of VC. Similarly, all morphemes that begin with a consonant cluster inhibit the deletion of a preceding vowel. The "generalizer" suffix *-kta* illustrates this constraint on the vowel deletion rule: *hiyaho* 'so, then', *hiyah-ni* 'therefore', but *hiyaho-kta-la* 'correctly'. Compare also *hima* 'it is said', *hiya:himni* 'therefore it is said' (from *hiyaho-hima-ni* with

* Upon deletion of the vowel, the *l* shifts to *r* by a general rule that need not concern us.

degemination of the *h-h* cluster resulting from vowel deletion and the compensatory lengthening of the preceding vowel), but *mak-hima-kta* 'but in general it is said'.

Having established VC____ + CV as the context for vowel drop, we now proceed to the matter of interest. The causative suffix *kaka-* is perfectly regular with respect to the rule. It provides the context for the deletion of a preceding vowel (*čokoruha* 'to harpoon', *čokoruh-kaka* 'to cause to harpoon') and will itself lose its final vowel when followed by a CV morpheme: *salwa-kak-lu* 'cause him to visit'. *kaka* is thus a morpheme belonging to case (i) of the table in (75).

Piro also has several suffixes that fail to condition the deletion of a preceding vowel, but that nevertheless delete their vowel when a suffix follows. One such suffix is *-ta*, a verbal theme formative. This suffix occurs in the word *hata-ta* 'to illuminate', which is composed of the root *hata* plus the thematic *-ta*. Note that the final vowel of the root appears in a two-sided open syllable but fails to delete. The failure of the vowel to delete cannot be accounted for by simply marking the root *hata* as an exception to vowel drop, for it deletes its vowel when followed by other suffixes: *hat-nu* 'light, shining' from /hata-nu/, a suffix used to form abstract nouns. The suffix *-ta* is thus exceptional in failing to condition the deletion of a preceding vowel. However, the vowel of *-ta* itself may delete by vowel drop: *yono-t-na-wa* 'to paint oneself', is composed of a root *yono* 'to paint', followed by *-ta*, followed in turn by the reflexive elements *na-wa*. Another suffix having the same properties as *-ta* is the anticipatory suffix *-nu*. It fails to cause deletion of a preceding vowel as shown in words like *heta-nu* 'going to see' from *heta* 'to see' (cf., *het-lu* 'to see it'). But *-nu* loses its vowel before a suffix like *-lu: heta-n-ru* 'going to see him', from /heta-nu-lu/. The suffixes *-ta* and *-nu* belong to the second category of (75). They regularly undergo the rule of vowel drop, but exceptionally fail to condition the rule.

Piro also has a suffix that belongs to the fourth category, *-wa* meaning 'yet, still'. This suffix is doubly exceptional in both failing to undergo and failing to condition the very same rule. Forms like *heta-wa* 'still see' show that this suffix fails to condition vowel drop (cf., *het-lu* 'see it' and *het-ya* 'see there' illustrating that *heta* cannot be simply marked as an exception to vowel drop). Words like *heta-wa-lu* 'to see him yet' and *hišinka-wa-lu* 'to be still thinking about it' indicate that *wa* also fails to undergo vowel drop, since the 3rd person pronominal suffix *-lu* normally conditions the deletion of a preceding vowel, as we have seen from forms like *het-lu* 'see it'.

Slovak provides an example of the third type of exception—a morpheme conditioning a rule but exceptionally failing to undergo. Slovak contains a rule called the rhythmic law (RL), which shortens a vowel after a syllable containing a long vowel. This rule is followed by diphthongization that converts underlying [é, ǎ, ó] to [ie, ia, uo]. (A long vowel in Slovak is marked by an acute accent.) The 3rd pl. ending of the second conjugation, which is an underlying /-ǎ/, is an exception to RL. It is always realized as the diphthong /-ia/, regardless of whether the preceding stem ends in a long or short vowel.

(79)

3rd person singular	3rd person plural	gloss
rob-í	*rob-ia*	'work'
vid-í	*vid-ia*	'see'
kúp-i	*kúp-ia*	'buy'
hlás-i	*hlás-ia*	'announce'

Consequently, the 3rd pl. morpheme must be marked as an exception to RL. It fails to undergo the rule. But when an underlying long vowel follows the 3rd pl. morpheme, it is regularly shortened. This can be shown by present active participles, which are formed by the addition of the suffix *-c* to the 3rd pl. form of the verb plus the "soft stem" gender endings, which are underlying /-í/, /-á/, and /-é/, for masculine, feminine, and neuter, respectively. The underlying length of these gender endings is revealed in adjectives like *cudz-í* 'foreign'. But when added to the participle stem, they regularly are realized as short.

(80)

masculine	feminine	neuter	gloss
cudz-í	*cudz-ia*	*cudz-ie*	'foreign'
robiac-i	*robiac-a*	*robiac-e*	'working'
vidiac-i	*vidiac-a*	*vidiac-e*	'seeing'
kúpiac-i	*kúpiac-a*	*kúpiac-e*	'buying'
hlásiac-i	*hlásiac-a*	*hlásiac-e*	'announcing'

To account for the shortening of the masc. ending in a form like *robiac-i* from /rob-ǻ-c-í/, it seems that we must assume that the 3rd pl. morpheme /-ǻ/ triggers an application of RL.

To be consistent with the preceding data we must provide for at least two types of exception features. Any morpheme will be assigned a value of + or − for the feature F_c, denoting whether or not it conditions a rule. Any morpheme will be assigned a value + or − for another feature F_u specifying whether or not it undergoes a rule. This procedure will then be carried out for each rule of the grammar. A question that arises in this connection is: Given a rule A ⟶ B/X___Y, if a morpheme must be marked as exceptional for one side of the environment, will it also necessarily be an exception to the other side? The examples from Piro discussed earlier are relevant here. The only morphemes that are environmental exceptions to the rule dropping a morpheme-final vowel in the context VC____CV are those which prevent the deletion of a preceding vowel. To our knowledge, there are no morphemes that block the deletion of a following morpheme-final vowel. In other words, the CV portion of the rule has exceptions but the VC portion does not. Consider the problem of characterizing the behavior of a morpheme such as the anticipatory suffix *-nu*, which prevents the deletion of a preceding vowel (*heta-nu*) but itself undergoes the rule (*heta-n-ru*). If *-nu* is marked [$-F_c$] application of the rule will CORRECTLY be blocked in *heta-nu*. But the rule will INCORRECTLY be prevented from applying to /heta-nu-lu/ to yield *heta-n-ru*, the reason being

that the consonant of *-nu* must be permitted to substitute for the consonant in the lefthand environment VC of the rule. But if it is specified [$-F_c$] it cannot. It therefore appears that we must expand our exception feature apparatus further to permit exceptions to different portions of the structural description of a rule. We will forgo doing this here until additional appropriate data can be assembled.

Negative input exceptions and negative environment exceptions represent the two most common types of exceptions. There is a small amount of evidence supporting the claim that two additional types must be recognized: "positive input exceptions" and "positive environment exceptions." The former involves cases where a segment UNDERGOES a rule even though it is not the appropriate segment-type; the latter involves cases where a morpheme CONDITIONS a rule's application even though the morpheme is not of the segmental structure appropriate for conditioning the rule. In other words, both types involve a "mistaken" application of a rule—the rule applies when it ought not to (rather than failing to apply when it should, as in the case of negative exceptions).

Chi-Mwi:ni provides examples that might be considered positive input exceptions. There is a morphophonemic rule in Chi-Mwi:ni that converts stem-final voiceless stops to *s* or *sh* before the perfective suffix *-i(:)ɬ-*.

(81)

ku-ɬap-a	'to swear an oath'	*las-iɬ-e*
ku-gi:ṭ-a	'to pull'	*gi:s-iɬ-e*
ku-ɬo:t-a	'to dream'	*ɬo:s-eɬ-e*
x-pik-a	'to cook'	*pish-iɬ-e*

Stem-final voiced stops are also converted to *z* before the perfective suffix, provided the voiced stop is preceded by a nasal. Otherwise, the voiced stop remains unaffected.

(82)

	ku-ɬo:mb-a	'to beg'	*ɬo:nz-eɬ-e*
	x-ṭi:nḍ-a	'to cut'	*ṭi:nz-iɬ-e*
	x-shi:nd-a	'to win'	*shi:nz-iɬ-e*
	x-fu:ŋg-a	'to close'	*fu:nz-iɬ-e*
But	*ku-ja:rib-a*	'to try'	*jarib-i:ɬ-e*
	ku-re:b-a	'to stop'	*reb-e:ɬ-e*
	ku-ru:ḍ-a	'to return'	*ruḍ-i:ɬ-e*
	ku-ḍo:ḍ-a	'to complain'	*ḍoḍ-e:ɬ-e*
	x-taraj-a	'to hope'	*taraj-i:ɬ-e*
	ku-ja:j-a	'to itch'	*i-jaj-i:ɬ-e*
	x-ṭig-a	'to castrate'	*ṭig-i:ɬ-e*
	ku-ra:g-a	'to be late'	*rag-i:ɬ-e*

(It is perhaps worth pointing out that stems ending in a post-vocalic voiced stop are usually originally of non-Bantu origin, although now thoroughly integrated into the Chi-Mwi:ni phonological and morphological systems.) There is, however, one root in the language that ends in a post-vocalic voiced

stop that does change before the perfective suffix: /big/ 'hit' has the perfective form *bish-ił-e* 'he hit'. The final /g/ of this root changes to /sh/, just as final /k/ of /pik/ does in *pish-ił-e*. One might therefore claim that /big/ is a positive input exception in that it undergoes the change to /sh/ even though it does not end in /k/ (which is the only consonant that regularly changes to /sh/ before the perfective suffix). Instead of recognizing /big/ as a positive input exception, one could simply treat the alternation between /big/ and /bish/ as suppletion. But to do so denies the connection between the occurrence of the /bish/ allomorph preceding the perfective suffix and the existence of a rule that regularly produces /sh/ exactly in this environment.

We have noted that voiced stops, if preceded by a nasal, mutate to *z* before the perfective suffix. The consonant *ɬ* also shifts to *z*.

(83)

ku-mo:ɬ-a	'to shave'	*mo:z-eɬ-e*
x-paɬ-a	'to scrape'	*paz-iɬ-e*
x-pe:ɬ-a	'to sweep'	*pe:z-eɬ-e*
x-kuɬ-a	'to grow'	*kuz-iɬ-e*

No other voiced sounds change (regularly) in the environment of the perfective suffix. The root /law/ 'go out' is, however, exceptional in that its final /w/ mutates to /z/ before the perfective: *laz-iɬ-e*. Stem-final /w/s ordinarily are unaffected—cf., *duguw-i:ɬ-e* 'he limped', *ołow-e:ɬ-e* 'he got wet', *ow-e:ɬ-e* 'he bathed'. Thus the root /law/ could be considered a positive input exception in that its final /w/ undergoes the change to /z/ that is ordinarily restricted just to final /ɬ/ or voiced stops preceded by a nasal. Again, one could claim that the alternation between /law/ and /laz/ is a case of suppletion, but this ignores the fact that the /laz/ alternant is just the kind of shape that is regularly produced before the perfective suffix.

Let us turn now to some possible examples of positive environment exceptions. Once again, Chi-Mwi:ni provides relevant data. The various examples of perfective verbal forms cited earlier illustrate the operation of a rule of vowel harmony. Various suffixes in Chi-Mwi:ni of the form *-i/u*C- display a pattern of vowel harmony whereby a high vowel appears when the final vowel of the preceding stem is *i(:)*, *u(:)*, or *a(:)*, whereas a mid-vowel appears if the preceding vowel is *e(:)* or *o(:)*.

(84) Perfective suffix -i(:)ɬ-:

ɬim-i:ɬ-e	'he cultivated'	*tetem-e:ɬ-e*	'he shivered'
kun-i:ɬ-e	'he scratched'	*som-e:ɬ-e*	'he read'
gaf-i:ɬ-e	'he made a mistake'		

"Applied" ("prepositional") suffix:

x-ṭi:nḍ-iɬ-a	'to cut for/with'	*ku-pe:l-el-a*	'to sweep for/with'
x-ful-il-a	'to wash for/with'	*x-so:m-eɬ-a*	'to read for/with/to'
x-pak-iɬ-a	'to rub for/with'		

Causative suffix:

ku-miz-ish-a	'to make swallow'	*x-ṭek-esh-a*	'to make laugh'
x-ṭuf-ish-a	'to make spit'	*x-koɬoɬ-esh-a*	'to make cough'
ku-ra:g-ish-a	'to delay someone'		

The alternations illustrated above can most readily be accounted for if we assume that the high vowel variants occur in the underlying representation, and that a rule of vowel harmony operates on these suffixes to lower the basic high vowel to a mid-vowel when a mid-vowel precedes.

The verb /ubl/ 'kill' contains a high vowel and thus would not be expected to trigger vowel harmony, since only mid-vowels cause a following high vowel (in an *-i/u*C- suffix) to lower to mid. Nevertheless, /ubl/ does condition the application of vowel harmony: *ubl-e:l-e* 'he killed', *k-ubl-el-a* 'to kill with' (rather than the expected **ubl-i:l-e* and **k-ubl-il-a*). Thus /ubl/ conditions the application of vowel harmony to a suffix, even though /ubl/ does not contain a mid-vowel and thus should not condition the rule's application. We can consider, then, /ubl/ to be a positive environment exception.

Another possible case of a positive environment exception occurs in Chi-Mwi:ni. Recall the rules of vowel drop and vowel deletion. The former deletes the high vowel of a CV- prefix where C is an obstruent, before a voiceless obstruent: *ku-big-a* 'to hit', *x-pik-a* 'to cook'. The latter deletes the high vowel of a CV- prefix, where C is a sonorant, regardless of the nature of the following consonant: *m-so:m-a* 'one who reads' from /mu-so:m-a/, *m-ṭek-a* 'one who laughs' from /mu-ṭek-a/. Both rules are constrained so as not to delete the prefix vowel when it occurs in the context ____CV#: *ku-f-a* 'to die', *mu-f-a* 'one who dies'; *ku-t-a* 'to grind', *mu-t-a* 'one who grinds'.

There is one morpheme that behaves rather exceptionally with respect to both of these rules. The root /p/ 'give' induces the deletion of a preceding prefix vowel: *x-p-a* 'to give', *m-p-a* 'one who gives'. Since vowel drop and vowel deletion do not ordinarily apply in the environment ____CV#, /p/ is exceptional in triggering the application of these rules. We might therefore consider marking this morpheme as a positive environment exception in the lexicon.

3.2 MAJOR VERSUS MINOR RULES

So far we have dealt with exceptions in which the number of morphemes that fail to undergo a rule is relatively small compared to the number that do undergo the rule. We have proposed to handle these exceptions by including an ad hoc piece of information in their lexical entry, which must be memorized when learning the phonological structure of these morphemes. This proposal is supported by the behavior of language learners, who often extend the rule to exceptional items: For instance, the forms *fishes*, *sheeps*, *mans* are found in

child language. In such situations the language learner has failed to learn (or at least remember) that these morphemes do not undergo regular rules of plural formation. Thus most of the nouns that formed their plurals by umlaut in Old English have joined the regular class of *-s* plurals. Under the treatment we have proposed, this regularization can be interpreted as the loss of an ad hoc piece of information, which is in accordance with the general tendency of linguistic structures to simplify.

However, there are examples in which a phonological rule applies only to a relatively small number of lexical items. The vast majority of morphemes fail to undergo the rule. Lightner (1968) discusses a number of examples like this from Russian. One of them involves a rule of deverbal nominalization that changes the root vowel to *o* in some roots, but not in others.

(85)

root vowel changes		root vowel remains	
vy-bor	'choice', cf. *vy-br-at'* (1st sg. *vy-ber-u*) 'to choose'	*pod-kup*	'bribery', cf. *pod-kup-at'* 'to bribe'
u-boj	'slaughter', cf. *u-bi-t'* 'to kill'	*ob-ed*	'dinner', cf. *ob-ed-at'* 'to dine'
za-por	'lock', cf. *za-per-et'* 'to lock'	*beg*	'running', cf. *beg-at'* 'to run'
pri-tok	'flow, influx', cf. *pri-teč'* (1st sg. *pri-tek-u*) 'to flow'	*na-mek*	'hint', cf. *na-mekat'* 'to hint at'

In order to handle the forms in the first column we require a rule of roughly the following form: V ⟶ *o* in derived nominals. However, it would be incorrect to mark the roots of the second column as exceptions to the rule, for the overwhelming majority of verbal roots in Russian suffer no such vowel change in the derived nominals. The language learner must memorize the few morphemes that do undergo the vowel change. Hence, it is the forms in the first column that must be treated as exceptional and specified with an extra ad hoc piece of information.

In order to achieve a state of affairs in which the relatively few forms undergoing the rule are treated as exceptional and require an extra piece of nonphonetic information in the lexicon to trigger their exceptional behavior, Lightner proposes following Lakoff's (1965) treatment of analogous phenomena in syntax by making a distinction between *major rules* and *minor rules*. Major rules apply to the overwhelming majority of morphemes that meet a given structural description. Idiosyncratic exceptions to major rules are handled by adding ad hoc information to their lexical entries: [−rule *n*]. Most of the rules discussed so far are major rules. Minor rules apply to only a small subset of the total number of forms that match a given structural description. The vast majority of morphemes do not undergo minor rules. By general convention all morphemes are assumed to be exceptions to a minor rule. Hence, in order for a minor rule to apply, the morpheme in question must be specified as [+rule *n*] in the lexicon.

To be more precise, we will assume that for each minor rule *n* in the grammar, there is a corresponding lexical redundancy rule of the form: [u rule *n*] ⟶ [−rule *n*], where *u* means "unmarked for rule *n*." Therefore, all regular morphemes (morphemes that, in the case of a minor rule, do not undergo the rule) will be specified by general convention as exceptions to the rule. Those few morphemes that undergo the rule will have to be marked as [+rule *n*], either by an ad hoc listing in the lexicon or perhaps by another redundancy rule.

Applying this treatment to the Russian data discussed earlier, the *V*∼*o* rule will be a minor one. A regular morpheme from the second column such as *kup-* (cf., *pod-kup*) will be [u V∼o] in the lexicon. It will be exempt from the *V*∼*o* rule by virtue of the following redundancy rule: [u V∼o] ⟶ [−V∼o]. On the other hand, an irregular morpheme such as *tek-* 'flow' (cf., *pri-tok*) will be marked as [+V∼o] in its lexical entry. It will not undergo the above redundancy rule and hence *will* undergo *V*∼*o*. Finally, as Lightner observes, for roots that contain a "fleeting" vowel followed by a sonorant such as *ber-* (cf., *vy-br-at'*, *vy-bor*), there is a generalization that can be extracted: Such roots always exhibit an *o*-nominal form. Consequently, roots of this shape may also be [u V ∼ o] in the lexicon. Their [+V ∼ o] specification may be supplied by another redundancy rule.

In the preceding example morphemes had to be specified in the lexicon as (idiosyncratically) undergoing a minor rule. There is evidence that morphemes must also be specified as (idiosyncratically) conditioning a rule. For example, in Polish the velars [k, g, x] shift to the palatals [č, ž, š] preceding the overwhelming majority of derivational suffixes that begin with front vowels.

(86)

mięk	'soft'	*mię*[č-ić]	'to soften'
sług	'servant'	*słu*[ž-ić]	'to serve'
śmie[x]	'laughter'	*śmie*[š-ić]	'to make laugh'
ręk-a	'hand'	*rą*[č-ina]	'little hand'
strug	'plane'	*stru*[ž-iny]	'shavings'
ci[x]	'silent'	*ci*[š-ina]	'silence'
pisk	'squeak'	*pisz*[č-eć]	'to squeak'
drog	'expensive'	*dro*[ž-eć]	'to become expensive'
dy[x-ać]	'to pant'	*dy*[š-eć]	'to pant, puff'

For inflected forms, front-vowel suffixes fall into four types according to their effect on preceding velars. First, there are suffixes such as those in (86); second, there are suffixes that induce the shift of [k, g, x] to [c, dz, š/ś]; third, some suffixes front the velars *k* and *g* (but not *x*) to *k'* and *g'*. Finally, there are front-vowel suffixes which leave a preceding velar unchanged. For instance, in the declension of *a*-stem nouns, the second type of palatalization occurs before the dative and locative singular suffixes *-e*, while the accusative singular *-e* causes no change.

(87)

nominative singular	dative/locative singular	accusative singular	gloss
rękᵃ	*rę*[c-e]	*rę*[k-e]	'hand'
nog-a	*no*[dz-e]	*no*[g-e]	'leg'
mu[x-a]	*mu*[š-e]	*mu*[x-e]	'flea'

Suffixes of the second and third type occur in the declension of "virile" nouns (masculine nouns referring to persons).

(88)

nominative singular	instrumental singular	nominative plural	gloss
urędnik	*urędni*[k'-em]	*urędni*[c-i]	'official'
bóg	*bo*[g'-em]	*bo*[dz-i]	'God'
mni[x]	*mni*[x-em]	*mni*[ś-i]	'monk'

A few of these nouns take the vocative suffix *-e*, in which case the first kind of palatalization occurs (e.g., *bo*[ž-e] 'God!'). Finally, in the inflection of verbs we find front-vowel suffixes of the first and fourth types: *mo*[g-e] 'I can', *mo*[ž-e] 'he can'; *pie*[k-e] 'I bake', *pie*[č-e] 'he bakes'.

As might be expected, there is a historical explanation for the different effects these front-vowel suffixes have. The first type derive from Proto-Slavic front-vowel suffixes, while the others derive from historical back vowels which fronted at different stages in the development of the language. There is, however, little if any evidence that these morphophonemically different but phonetically identical vowels are anything but front vowels in underlying representation and that the differences are not to be handled by lexical markings. Since most front-vowel suffixes cause the first type of palatalization, this would be a major rule. The second and third types of palatalization are elicited by only a handful of suffixes, and hence could be handled by a minor rule. The fourth type, which causes no change, is simply a negative environment exception.

The above data from Polish illustrate the insufficiency of the analysis of minor rules given above earlier. Any noun or verb root ending in a velar will undergo the minor palatalization rules. Thus it would be incorrect to say that these rules are "minor" with respect to the particular morphemes that undergo them. Rather, they are "minor" with respect to the particular morphemes that *condition* their application. It seems, then, necessary to recognize two classes of minor rules: minor input rules and minor environment rules. A minor input rule applies only to morphemes specifically marked as undergoing the rule (all morphemes that are unmarked are predictably specified as failing to undergo the rule). All morphemes will (normally) undergo a minor environment rule, but only if the segments in the environment are specifically marked as conditioning the rule's application; morphemes that are not marked as conditioning the rule will be predictably specified as not conditioning the rule's application.

So far we have examined situations in which the morphemes requiring special lexical markings with respect to a particular phonological rule have been relatively small in number compared to the morphemes requiring no special marking. There are, however, many cases requiring ad hoc lexical categorization in which the number of morphemes failing to undergo the rule is approximately equivalent to the number that do undergo the rule. In these situations it makes no real sense to speak of one class as being "regular" and the other "exceptional". Such situations can be accounted for in essentially the same fashion as before—by ad hoc lexical categorization. The only difference is that we cannot identify one class as being unmarked or regular.

A relatively simple example can be found in Halle's study of Russian accent (1973): There is a general rule that places stress on the inflectional ending of a word whose stem is unaccented. Subsequent to this there is another rule, which Halle calls METATONY, which retracts the stress one syllable from the ending to the stem. In the present tense of verbs this rule operates in all persons but the 1st sg. However, whether or not any given verb undergoes the rule is to a large extent unpredictable. Compare the paradigms of the following verbs.

(89)

	toropít' 'to hurry'	govorít' 'to speak'
singular		
1	*toroplj-ú*	*govor'-ú*
2	*torópiš*	*govor-íš*
3	*torópit*	*govor-ít*
plural		
1	*torópim*	*govor-ím*
2	*torópite*	*govor-íte*
3	*torópʼ-at*	*govor'-át*

Verbs like *toropít'* that undergo the retraction rule include *kupít'* 'to buy', *xodít'* 'to go', *kormít'* 'to feed', *varít'* 'to cook'. Verbs with the stress pattern of *govorít'* include *rešít'* 'to decide', *tvorít'* 'to create', *mutít'* 'to muddle', *žurít'* 'to scold'. Further investigation of these verbs reveals that there is no independent property that makes it possible to predict whether or not they undergo retraction.

In a situation such as the preceding the plus and minus specifications for the metatony rule must be specified ad hoc in the lexicon for the members of both classes of stems, since neither /torop, + metatony/ nor /govor, − metatony/ can be identified as the regular case. In this example, the +/− metatony specifications would have to be considered environmental features, since the metatony rule takes the form of deleting the accent from a suffix, according to Halle's analysis. He assumes that prior to the metatony rule another rule has redundantly specified all syllables preceding the rightmost accented syllable as being redundantly accented. *torópiš* thus derives from

/tóróp-íš/. Metatony yields /tóróp-iš/, and a later rule deletes all but the rightmost accent in a word to yield *toróp-iš*.

As in the previous examples of major and minor rules, the +/− specification for a rule like metatony is sometimes predictable for a given class of morphemes. In the present case there are about sixty Russian verb stems ending in *a* which are unaccented, i.e., which are accented on the inflectional ending in the present tense. All such unaccented verb stems terminating in the vowel *a* undergo the metatony rule. Thus, *pisá-t'* 'to write', *piš-ú*, but *píš-eš* (from /píš-éš/), *píš-et* (from /píš-ét/), and so on. The [+ metatony] specification for these morphemes can be predicted by a redundancy rule.

Rules that have approximately as many exceptions as items that undergo the rule frequently arise as the result of the historical merger of two sounds or sound classes. For example, in Modern Hebrew there is a rather complex morphophonemic rule that spirantizes *p*, *b*, and *k* to *f*, *v*, and *x*, in postvocalic position, although the rule also operates in a number of other (grammatically determined) environments. However, only about half of the *k*'s in Hebrew obey this rule. The roughly 50 percent that do not alternate derive historically from the uvular stop *q*. In the standard Ashkenazi (European) dialect, historical *q* has everywhere merged with *k*. Examples of this process follow.

(90)

	past	present	future	infinitive	gloss
	patar	*poter*	*ji-ftor*	*li-ftor*	'solve'
	bagad	*boged*	*ji-vgod*	*li-vgod*	'betray'
	karat	*koret*	*ji-xrot*	*li-xrot*	'make a covenant'
	palaš	*poleš*	*ji-floš*	*li-floš*	'infiltrate'
	baxan	*boxen*	*ji-vxon*	*li-vxon*	'examine'
	karax	*korex*	*ji-xrox*	*li-xrox*	'bind (a book)'
	paraš	*poreš*	*ji-froš*	*li-froš*	'resign'
	balaš	*boleš*	*ji-vloš*	*li-vloš*	'inspect'
	kavaš	*koveš*	*ji-xboš*	*li-xboš*	'conquer'
but	*kašar*	*košer*	*ji-kšor*	*li-kšor*	'tie'
	kara	*kore*	*ji-kra*	*li-kro*	'read'
	kana	*kone*	*ji-kne*	*li-knot*	'buy'

A number of generative analyses of Hebrew have posited these nonalternating *k*'s as /q/, positing a rule merging /q/ to *k* after the spirantization rule has applied. Barkai (1972) has shown that these analyses cannot be maintained, for there is no evidence in the present day standard dialect that the nonalternating *k*'s should be set up as /q/ rather than any other nonoccurring sound in the inventory of the language, say /č/. In other words, the choice of /q/ is completely arbitrary. It thus differs from the kinds of examples discussed in Chapter 1, where the phonetic makeup of the abstract segment could be pinpointed from other aspects of phonological behavior. As far as the speaker of Modern Standard Hebrew is concerned, *k*'s arbitrarily fall into two classes—those that alternate with *x* and those that do not. This situation is accurately

reflected in a linguistic description which distinguishes the two types of *k*'s by ad hoc lexical markings.

So far in this section we have examined situations in which the arbitrary lexical categorization of morphemes has been relevant to only a single rule. In these cases there is no correlation between a morpheme's plus or minus specification for one rule and its behavior with respect to another rule. There are, however, situations in which the arbitrary +/− specification is relevant for more than a single rule and consequently forms some sort of system. In such circumstances it has been customary in generative phonology to subclassify the relevant morphemes in terms of an arbitrary diacritic feature to which the various rules dependent upon the classification may refer. An interesting example in which this kind of treatment is called for is to be found in Pike's (1948) analysis of Mixteco, a language of Mexico. Mixteco morphemes are in general disyllabic. Eight accentual patterns occur in the language (acute and grave accents represent high and low pitch, respectively, while the macron indicates mid pitch).

(91)

1.	*sáná*	'turkey'			
2.	*ñíʔī*	'steam bath'			
3.	*báʔù*	'coyote'			
4.	*kūčí*	'pig'			
5.	*bēʔē*	'house'	perturbed to	*béʔē*	(i.e., pattern 2)
6.	*kūtù*	'nose'	perturbed to	*kūtú*	(i.e., pattern 4)
7.	*sùčí*	'child'	perturbed to	*súčí*	(i.e., pattern 1)
8.	*mìnī*	'puddle'	perturbed to	*mínī*	(i.e., pattern 2)

Morphemes with the tone patterns 5 through 8 take on the alternate tone patterns indicated above when preceded by certain morphemes. Pike calls this process "tone perturbation." However, which morpheme *causes* perturbation is not in general predictable. For example, the noun *ʔīsò* 'rabbit' exhibits pattern 6 when pronounced in isolation. Its shape is altered to ¯´ when preceded by the verb *kēē* meaning 'to eat': *kēē ʔīsó* 'the rabbit will eat'. However, there is a homophonous verb *kēē* meaning 'go away'. When it precedes *ʔīsò*, the noun is not perturbed; it retains its basic shape: *kēē ʔīsò* 'the rabbit will go away'. According to Pike the fact that *kēē* 'eat' perturbs the tonal shape of *ʔisò*, but *kēē* 'go away' does not, cannot be attributed to any phonological or grammatical difference between the verbs in question. This contrast between "perturbing" and "nonperturbing" morphemes is not restricted to isolated examples; it pervades the entire system. Another example: *sùčí* 'child' has underlyingly a low-toned first vowel and a high-toned second vowel; in *tàká sùčí* 'all the children' it retains this basic shape, but in *máá súčí* 'that child' its initial vowel shifts to high tone—cf., *kēē sùčí* 'the child will go away' but *kēē súčí* 'the child will eat'. Examples such as this show that a perturbing morpheme's influence is not restricted to a particular tonal shape in the second morpheme. A morpheme like *kēē* 'eat' will alter each one of the basic patterns 5 through 8 in the manner indicated in the table.

Pike does not present enough data for us to formulate precisely the tone sandhi rules. However, from his discussion it is clear that whether or not a morpheme causes perturbation is to a fair extent unpredictable. This requires us to postulate a diacritic feature, say [±P]. The tonal alternations will then be triggered by a preceding morpheme, specified [+P]. For many morphemes the specification for the feature [P] will simply have to be listed in the lexicon. Undoubtedly the contrast between *kēē* 'eat', a perturbing morpheme, and *kēē* 'go away', a nonperturbing morpheme, will have to be handled in this manner. However, as Pike observes, the assignment of [±P] is not totally unpredictable. Morphemes with the tone patterns high-low (type 3), mid-high (type 4), and low-mid (type 8) never cause perturbation. They are thus [−P]. This value can be predicted by a lexical redundancy rule. Except for possibly one other basic tonal shape, morphemes exhibiting all other basic shapes will have to be marked idiosyncratically as either [+P] or [−P] in the lexicon. The one exception seems to be pattern 1, namely high-high. Except for certain pronouns, morphemes with a high-high underlying shape consistently cause perturbation. It might be possible, then, to treat high-high morphemes as predictably [+P], with the few pronouns in question exceptionally marked [−P] in the lexicon.

With regard to the latter point it is interesting to note that a [−P] morpheme that assumes a high-high pattern as a result of perturbation fails to cause the perturbation of a following morpheme, as illustrated in a phrase such as *tàká sùčí* 'all the children', where *tàká* is [−P]. (If it were [+P] instead, we would expect *sùčí* to be perturbed to *súčí*.) Now consider the phrase *híín táká sùčí* 'with all the children'. Here *híín* has perturbed the following *tàká*, to *táká*, a general property of morphemes whose underlying shape is high-high. But note that [*táká*], also of the pattern high-high, fails to perturb the following *sùčí*. Thus, the redundancy that high-high morphemes are marked [+P] applies only to the basic tone pattern of a morpheme, not to the pattern that results from the perturbation rule.

The Mixteco example thus differs from the Russian and Hebrew ones discussed earlier in that the [+/−P] specification of a morpheme is relevant for four separate tone rules. The use of the diacritic feature [P] represents an attempt to distinguish this kind of systematicity from the earlier examples where the +/− specification described the behavior of a morpheme with respect to just a single rule. The use of diacritic features is perhaps more common for representing the distinct behavior of native versus borrowed lexical items, but many accentual phenomena seem to require such a device as well.

This concludes our survey of the role of grammar and the lexicon in determining phonological structure. The investigation of this topic, at least within generative phonology, is a relatively recent phenomenon, conditioned in large part by the increasing concern for the problems of abstractness discussed in Chapter 1. Hence, a great deal of study remains before we shall be able to assert with any confidence just what syntactic and lexical properties do and do not play a role in determining phonological structure. Also we have not dealt at

all with the important but largely overlooked question of the influence of phonological structure on syntax and morphology. In the coming years consideration of this question along with continuation of the kinds of studies reported in this chapter will constitute one of the most important lines of linguistic research and will strengthen the growing conviction that semantics, syntax, phonology, and the lexicon are much more intimately connected and interdependent than was previously believed.