

# 4 Underlying representations

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## PREVIEW

### KEY TERMS

*alternation*  
*neutralization*  
*predictability*

This chapter looks deeper into the nature of underlying forms by

- ◆ introducing contrast-neutralizing rules
- ◆ seeing how unpredictable information must be part of the underlying form
- ◆ learning what factors are most important in establishing an underlying representation
- ◆ understanding how underlying forms are different from actually pronounced words

A fundamental characteristic of the rules discussed up to this point is that they have been totally predictable allophonic processes, such as aspiration in English or vowel nasalization in Sundanese. For such rules, the question of the exact underlying form of a word has not been so crucial, and in some cases a clear decision could not be made. We saw that in Sundanese every vowel becomes nasalized after a nasal sound, and every phonetic nasal vowel appears after a nasal. Nasality of vowels can always be predicted by a rule in this language: all nasal vowels appear in one predictable context, and all vowels are predictably nasal in that context. It was therefore not crucial to indicate whether a given vowel is underlyingly nasal or underlyingly oral. If you assume that vowels are underlyingly oral you can write a rule to derive all of the nasal vowels, and if you contrarily assume that vowels are all underlyingly nasal you could write a rule to derive all of the oral vowels. The choice of underlying sound may make a considerable difference in terms of simplicity and elegance of the solution, and this is an important consideration in evaluating a phonological analysis, but it is possible to come up with rules which will grind out the correct forms no matter what one assumes about underlying representations in these cases. This is not always the case.

## 4.1 The importance of correct underlying forms

**Neutralizing** rules, on the other hand, are ones where two or more underlyingly distinct segments have the same phonetic realization in some context because a rule changes one phoneme into another – thus the distinction of sounds is neutralized. This means that if you look at a word in this neutralized context, you cannot tell what the underlying segment is. Such processes force you to pay close attention to maintaining appropriate distinctions in underlying forms.

Consider the following examples of nominative and genitive forms of nouns in Russian, focusing on the final consonant found in the nominative.

(1) <i>Nominative singular</i>	<i>Genitive singular</i>	
vagon	vagona	'wagon'
avtomobil <sup>y</sup>	avtomobil <sup>y</sup> a	'car'
večer	večera	'evening'
muš	muža	'husband'
karandaš	karandaša	'pencil'
glas	glaza	'eye'
golos	golosa	'voice'
ras	raza	'time'
les	lesa	'forest'
porok	poroga	'threshold'
vrak	vraga	'enemy'
urok	uroka	'lesson'
porok	poroka	'vice'
t <sup>s</sup> vet	t <sup>s</sup> veta	'color'

prut	pruda	'pond'
soldat	soldata	'soldier'
zavot	zavoda	'factory'
xlep	xleba	'bread'
grip	griba	'mushroom'
trup	trupa	'corpse'

To give an explanation for the phonological processes at work in these data, you must give a preliminary description of the morphology. While morphological analysis is not part of phonology per se, it is inescapable that a phonologist must do a morphological analysis of a language, to discover the underlying form.

In each of the examples above, the genitive form is nearly the same as the nominative, except that the genitive also has the vowel [a] which is the genitive singular suffix. We will therefore assume as our initial hypothesis that the bare root of the noun is used to form the nominative case, and the combination of a root plus the suffix *-a* forms the genitive. Nothing more needs to be said about examples such as *vagon* ~ *vagona*, *avtomobil*<sup>y</sup> ~ *avtomobil*<sup>y</sup>*a*, or *večer* ~ *večera*, where, as it happens, the root ends with a sonorant consonant. The underlying forms of these noun stems are presumably /vagon/, /avtomobil<sup>y</sup>/ and /večer/: no facts in the data suggest anything else. These underlying forms are thus identical to the nominative form. With the addition of the genitive suffix *-a* this will also give the correct form of the genitive.

There are stems where the part of the word corresponding to the root is the same: *karandaš* ~ *karandaša*, *glas* ~ *golosa*, *les* ~ *lesa*, *urok* ~ *uroka*, *porok* ~ *poroka*, *t<sup>s</sup>vet* ~ *t<sup>s</sup>veta*, *soldat* ~ *soldata* and *trup* ~ *trupa*. However, in some stems, there are differences in the final consonant of the root, depending on whether we are considering the nominative or the genitive. Thus, we find the differences *muš* ~ *muža*, *glas* ~ *glaza*, *porok* ~ *poroga*, *vrak* ~ *vraga*, *prut* ~ *pruda*, and *xlep* ~ *xleba*. Such variation in the phonetic content of a morpheme (such as a root) are known as **alternations**. We can easily recognize the phonetic relation between the consonant found in the nominative and the consonant found in the genitive as involving voicing: the consonant found in the nominative is the voiceless counterpart of the consonant found in the genitive. Not all noun stems have such an alternation, as we can see by pairs such as *karandaš* ~ *karandaša*, *les* ~ *lesa*, *urok* ~ *uroka*, *soldat* ~ *soldata* and *trup* ~ *trupa*. We have now identified a phonological problem to be solved: why does the final consonant of some stems alternate in voicing? And why do we find this alternation with some stems, but not others?

The next two steps in the analysis are intimately connected; we must devise a rule to explain the alternations in voicing, and we must set up appropriate underlying representations for these nouns. In order to determine the correct underlying forms, we will consider two competing hypotheses regarding the underlying form, and in comparing the predictions of those two hypotheses, we will see that one of those hypotheses is clearly wrong.

Suppose, first, that we decide that the form of the noun stem which we see in the nominative is also the underlying form. Such an assumption is reasonable (it is, also, not automatically correct), since the nominative is grammatically speaking a more “basic” form of a noun. In that case, we would assume the underlying stems /glas/ ‘eye,’ /golos/ ‘voice,’ /ras/ ‘time’ and /les/ ‘forest.’ The problem with this hypothesis is that we would have no way to explain the genitive forms *glaza*, *golosa*, *raza* and *lesa*: the combination of the assumed underlying roots plus the genitive suffix *-a* would give us \**glasa*, *golosa*, \**rasa* and *lesa*, so we would be right only about half the time. The important step here is that we test the hypothesis by combining the supposed root and the affix in a very literal-minded way, whereupon we discover that the predicted forms and the actual forms are different.

We could hypothesize that there is also a rule voicing consonants between vowels (a rule like one which we have previously seen in Kipsigis, chapter 3):

(2)  $C \rightarrow \text{voiced} / V \_ V$

While applying this rule to the assumed underlying forms /glas-a/, /golos-a/, /ras-a/, and /les-a/ would give the correct forms *glaza* and *raza*, it would also give incorrect surface forms such as \**goloza* and \**leza*. Thus, not only is our first hypothesis about underlying forms wrong, it also cannot be fixed by positing a rule of consonant voicing.

You may be tempted to posit a rule that applies only in certain words, such as *eye*, *time* and so on, but not *voice*, *forest*, etc. This misconstrues the nature of phonological rules, which are general principles that apply to all words of a particular class – most generally, these classes are defined in terms of phonological properties, such as “obstruent,” “in word-final position.” Rules which are stated as “only applying in the following words” are almost always wrong.

The “nominative is underlying” hypothesis is fundamentally wrong: our failure to come up with an analysis is not because we cannot discern an obscure rule, but lies in the faulty assumption that we start with the nominative. That form has a consistent phonetic property, that any root-final obstruent (which is therefore word-final) is always voiceless, whereas in the genitive form there is no such consistency. If you look at the genitive column, the last consonant of the root portion of the word may be either voiced or voiceless.

We now consider a second hypothesis, where we set up underlying representations for roots which distinguish stems which have a final voiced obstruent in the genitive versus those with a final voiceless obstruent. We may instead assume the following underlying roots.

(3) <i>Final voiced obstruent</i>		<i>Final voiceless obstruent</i>	
/muž/	‘husband’	/karandaš/	‘pencil’
/glaz/	‘eye’	/golos/	‘voice’
/raz/	‘time’	/les/	‘forest’
/porog/	‘threshold’	/porok/	‘vice’

/vrag/	‘enemy’	/urok/	‘lesson’
/prud/	‘pond’	/tsvet/	‘color’
/zavod/	‘factory’	/soldat/	‘soldier’
/grib/	‘mushroom’	/trup/	‘corpse’
/xleb/	‘bread’		

Under this hypothesis, the genitive form can be derived easily. The genitive form is the stem hypothesized in (3) followed by the suffix *-a*. No rule is required to derive voiced versus voiceless consonants in the genitive. That issue has been resolved by our choice of underlying representations where some stems end in voiced consonants and others end in voiceless consonants. By our hypothesis, the nominative form is simply the underlying form of the noun stem, with no suffix.

However, a phonological rule must apply to the nominative form, in order to derive the correct phonetic output. We have noted that no word in Russian ends phonetically with a voiced obstruent. This regular fact allows us to posit the following rule, which devoices any word-final obstruent.

- (4) *Final devoicing*  
obstruent → voiceless / \_#

By this rule, an obstruent is devoiced at the end of the word. As this example has shown, an important first step in doing a phonological analysis for phenomena such as word-final devoicing in Russian is to establish the correct underlying representations, which encode unpredictable information.

Whether a consonant is voiced cannot be predicted in English ([dɛd] *dead*, [tɛd] *Ted*, [dɛt] *debt*), and must be part of the underlying form. Similarly, in Russian since you cannot predict whether a given root ends in a voiced or a voiceless consonant in the genitive, that information must be part of the underlying form of the root. That is information about the root, which cannot always be determined by looking at the surface form of the word itself: it must be discovered by looking at the genitive form of the noun, where the distinction between voiced and voiceless final consonants is not eliminated.

## 4.2 Refining the concept of underlying form

It is important to understand what underlying forms are, and what they are not. The nature of underlying forms can be best appreciated in the context of the overall organization of a grammar, and how a given word is generated in a sentence. The structure of a grammar can be represented in terms of the standard block model.

- (5) Syntax → Morphology → Phonology → Phonetics  
Underlying Surface  
Forms Forms

This model implies that the output of one component forms the input to the next component, so the phonological component starts with whatever the morphological component gives it, and applies its own rules (which are then subject to principles of physical interpretation in the phonetic component). The output of the morphological component, which is the input to the phonology, is by definition the underlying form, so we need to know a little bit about what the morphological component does, to understand what is presented to the phonology.

The function of the morphological component is to assemble words, in the sense of stating how roots and affixes combine to form a particular word. Thus the morphological component is responsible for combining a noun root [dag] and a plural affix [z] in English to give the word *dog-s* (i.e. /dag-z/), or in Russian the morphology combines a noun root [vagon] with an inflectional ending [a] according to rules of inflection for Russian, to give the genitive word *vagon-a*. Each morpheme is assumed to have a single constant phonetically defined shape coming out of the morphology (there are a few exceptions such as the fact that the third-person-singular form of the verb *be* in English is [ɪz] and the first-person-singular form of that verb is [æm]). The phonetic realization of any morpheme is subject to rules of phonology, so while the morphology provides the plural morpheme *z* (spelled <s>), the application of phonological rules will make that that morpheme being pronounced as [s] as in *cats* or [ɪz] as in *bushes*.

It is very important to understand that the grammar does not formally derive one word from another. (Some languages seem to have special morphological processes, which we will not be discussing here, that derive one word from another – clipping such as *Sally* → *Sal* would be an example.) Rather, one word derives from a given abstract root plus whatever affixes are relevant, and a related word derives by adding a different set of affixes to the same abstract root. Accordingly, the plural of a noun in English does not derive from the singular, rather, both the singular *and* the plural forms derive from a common root: no suffix is added to the root in the singular, and the suffix /z/ is added to the root in the plural. The Russian genitive [vagona] also does not derive from the nominative, nor does the nominative derive from the genitive. Rather, both derive from the root /vagon/, where the nominative adds no affix and the genitive adds the affix -a.

The underlying form of a word is whatever comes out of the morphology and is fed into the phonology, before any phonological rules have applied. The underlying form of the word [kæts] is /kæt-z/, since that is what results in the morphology by applying the rule that combines a noun root such as *cat* with the plural suffix. The underlying form of the plural word [kæts] is *not* /kæt/, because the plural word has to have the plural morpheme. However, /kæt/ is the underlying form of the singular word [kæt]. There is no phonological rule which inserts *z* or *s* in order to form a plural. The principles for combining roots and affixes are not part of the phonology, and thus there is no need to include rules such as “insert [z] in the plural.” Be explicit about what you assume about morphology in a language, i.e. that there is a plural suffix -z in English or a genitive suffix -a

in Russian. As for the mechanics of phonological analysis, you should assume, for example, that the plural suffix is already present in the underlying form, and therefore do not write a rule to insert the plural suffix since that rule is part of morphology. A phonological analysis states the underlying forms of morphemes, and describes changes in the phonological shape of the root or suffix.

We have concluded that the underlying form of the Russian word [prut] ‘pond’ is /prud/. In arriving at that conclusion, we saw how important it is to distinguish the phonological concept of an underlying form from the morphological concept “basic form,” where the singular form, or an uninflected nominative form would be the morphological “basic form.” An underlying form is a strictly phonological concept and is not necessarily equivalent to an actually pronounced word (even disregarding the fundamental fact that underlying forms are discrete symbolic representations whereas actually pronounced words are acoustic waveforms). It is a representation that is the foundation for explaining the variety of actual pronunciations found in the morpheme, as determined by phonological context.

The morphologically basic form of the Russian word for pond is the unmarked nominative, [prut], composed of just the root with no inflectional ending. In contrast, the phonological underlying form is /prud/, for as we have seen, if we assume the underlying form to be \*/prut/, we cannot predict the genitive [pruda]. The word \*/prud/, with a voiced consonant at the end of the word, does not appear as such in the language, and thus the supposition that the underlying form is /prud/ is an abstraction, given that [prud] by itself is never found in the language – it must be inferred, in order to explain the actual data. The basis for that inference is the genitive form [pruda], which actually contains the hypothesized underlying form as a subpart. It is important to understand, however, that the underlying form of a root may not actually be directly attested in this way in any single word, and we will discuss this point in section 4.6.

### 4.3 Finding the underlying form

A similar problem arises in explaining the partitive and nominative forms of nouns in Finnish. The first step in understanding the phonological alternation seen here is to do a standard preliminary morphological analysis of the data, which involves identifying which parts of a word correlate with each aspect of word structure (such as root meaning or grammatical case). The following examples illustrate that the nominative singular suffix is  $\emptyset$  (i.e. there is no overt suffix in the nominative singular) and the partitive singular suffix is *-æ*, which alternates with *-a* if there is a back vowel somewhere before it in the word (we will not be concerned with that vowel alternation in the partitive suffix).

(6)	<i>Nominative sg</i>	<i>Partitive sg</i>	
a.	aamu	aamua	‘morning’
	hopea	hopeaa	‘silver’

	katto	kattoa	'roof'
	kello	kelloa	'clock'
	kiryä	kiryää	'book'
	külmä	külmäæ	'cold'
	koulu	koulua	'school'
	lintu	lintua	'bird'
	hällü	hällüæ	'shelf'
	kömpelö	kömpelöæ	'clumsy'
	näkö	näköæ	'appearance'
b.	yoki	yokea	'river'
	kivi	kiveæ	'stone'
	muuri	muuria	'wall'
	naapuri	naapuria	'neighbor'
	nimi	nimeæ	'name'
	kaappi	kaappia	'chest of drawers'
	kaikki	kaikkeæ	'all'
	kiirehti	kiirehtiæ	'hurry'
	lehti	lehteæ	'leaf'
	mäki	mækeæ	'hill'
	ovi	ovea	'door'
	posti	postia	'mail'
	tukki	tukkia	'log'
	æiti	æitiæ	'mother'
	englanti	englantia	'England'
	yärvi	yärveæ	'lake'
	koski	koskea	'waterfall'
	reki	rekeæ	'sledge'
	væki	vækeæ	'people'

We might assume that the underlying form of the root is the same as the nominative (which has no suffix). The problem which these data pose is that in some nouns, the partitive appears to be simply the nominative plus the suffix *-æ ~ -a* (for example *muuri ~ muuria*), but for other nouns the final vowel alternates, with [i] in the nominative and [e] in the partitive (e.g. *yoki ~ yokea*). It is obvious that the nature of the following vowel does not explain this alternation, since the same surface-quality suffix vowel can appear after either *e* or *i* – compare *yokea*, *nimeæ* where [e] appears before both [a] and [æ], versus *muuria*, *kiirehtiæ* where [i] appears before these same vowels. Nor can the preceding consonant be called upon to predict what vowel will appear in the partitive, as shown by pairs such as *tukkia*, *kaikkeæ* versus *lehteæ*, *æitiæ*.

This is an area where there is (potentially) a difference between language-learning pedagogy and a formal linguistic analysis. Faced with the problem of learning the inflectional distinction *muuri ~ muuria* versus *yoki ~ yokea*, a second-language class on Finnish might simply have the student memorize a list of words like *yoki ~ yokea* where the vowel changes in the inflectional paradigm. From the point of view of linguistic analysis



this is the wrong way to look at the question, since it implies that this is not a rule-governed property of the language. However, second-language learning is not the same as linguistic analysis: a class in foreign-language instruction has a different goal from a class in analysis, and some students in a language class may receive greater practical benefit from just memorizing a list of words. Thus it is important to distinguish the teaching method where one learns arbitrary lists, and a theoretically based analysis. One simply cannot predict what vowel will appear in the partitive form if one only considers the pronunciation of the nominative. This means: nominative forms are not the same as underlying forms (something that we also know given the previous Russian example). The underlying representation must in some way contain that information which determines whether there will be a vowel alternation in a given word.

In looking for the phonological basis for this vowel alternation, it is important to realize that the alternation in stem-final vowels is not chaotic, for we find precisely two possibilities, either *i* in the nominative paired with *i* in the partitive, or *i* in the nominative paired with *e* in the partitive – never, for example, *i* paired with *u* or *i* paired with *o*. Moreover, only the vowel *i* enters into such a vowel alternation in Finnish, so there are no nouns with *o* in the nominative which is replaced by *u* in the partitive, nor is *u* in the nominative ever replaced by *o* or any other vowel in the partitive. One final fact about the data in (6) suggests exactly how the right underlying representations can explain this alternation: of the eight vowels of Finnish (*i, ü, e, ö, æ, u, o, a*), all of them appear at the end of the word except the vowel *e*. Now, since the stem of the word for ‘name,’ which appears as *nimi* in the nominative, actually appears on the surface as *nime-* in the partitive, it is not at all unreasonable to assume that the underlying form of the stem is in fact /nime/. It would be a bit bizarre to assume an underlying form such as /nima/, since the vowel [a] never appears in that position in any form of this word: the most natural assumption to make is that the underlying form of a morpheme is actually composed of segments found in some surface manifestation of the morpheme. On the other hand, the stem of the word for ‘wall’ is pronounced *muuri* in both the nominative and the partitive, and therefore there is no reason to assume that it is underlyingly anything other than /muuri/.

We will then assume that the underlying vowel at the end of the stem is actually reflected by the partitive form, and thus we would assume underlying representations such as /yoke/, /nime/, /kive/, /lehte/, /ove/ and so on, as well as /muuri/, /naapuri/, /kaappi/, /tukki/ and so on. The underlying form of partitive [yoke-a] would thus be /yoke-a/, that is, no rule at all is required to explain the partitive. Instead, a rule is needed to explain the surface form of the nominative [yoki], which derives from /yoke/. A very simple neutralizing rule can explain the surface form of the nominative: underlying word-final *e* is raised to *i*.

- (7) Final vowel raising  
 $e \rightarrow i / \_ \#$

This is a natural assumption but not an absolute rule, as we see in chapter 9. Underlying forms can contain segments not found in any form of the word. Only when there is strong evidence for departing from this assumption are you justified in setting up underlying forms with such abstract elements.

This rule is neutralizing since the distinction between /i/ and /e/ is neutralized by applying this rule: an underlying /e/ becomes phonetic [i].

Apart from illustrating how important correct underlying forms are, these two examples have also shown that it is dangerous, and incorrect in these two cases, to assume that the “most basic” form of a word according to morphological criteria is also the underlying form of the word. To reiterate: the underlying form of a morpheme is a hypothesis set forth by the analyst, a claim that by assuming such-and-such an underlying form, plus some simple set of rules (which need to be discovered by the analyst), the observed variation in the shape of morphemes can be explained.

**Kerewe.** To better understand the reasoning that leads to correct underlying forms, we investigate other examples. Consider the following data from Kerewe.

(8) <i>Infinitive</i>	<i>1sg habitual</i>	<i>3sg habitual</i>	<i>Imperative</i>	
kupaamba	mpaamba	apaamba	paamba	‘adorn’
kupaanga	mpaanga	apaanga	paanga	‘line up’
kupima	mpima	apima	pima	‘measure’
kupuupa	mpuupa	apuupa	puupa	‘be light’
kupekeča	mpekeča	apekeča	pekeča	‘make fire with stick’
kupiinda	mpiinda	apiinda	piinda	‘be bent’
kuhiiga	mpiiga	ahiiga	hiiga	‘hunt’
kuheeka	mpeeka	aheeka	heeka	‘carry’
kuhaanga	mpaanga	ahaanga	haanga	‘create’
kuheeba	mpeeba	aheeba	heeba	‘guide’
kuhiima	mpiima	ahiima	hiima	‘gasp’
kuhuuha	mpuuha	ahuuha	huuha	‘breath into’

In this example we only have direct evidence for the change after *m*, so it would be possible to restrict our rule to the more specific context “after *m*.” But this would run counter to basic assumptions of science, that we seek the most general explanations possible, not the most restricted ones.

We notice that every infinitive begins with *ku-*, which we surmise is the prefix for the infinitive; the third-singular habitual form has the prefix *a-*, and the first-singular habitual has the prefix *m-*; the imperative involves no prefix. In addition to segmental prefixes, there is a change in the first consonant of the stem in some verbs, in some contexts. The initial consonant of the verb meaning ‘guide’ alternates between [h] and [p], with [p] appearing in the first-singular habitual after [m] and [h] appearing elsewhere. Since this stem appears in two surface variants, [heeba] and [peeba], two plausible hypotheses are immediately possible: the stem is underlyingly /peebe/, or the stem is underlyingly /heebe/. If we assume that the stem is underlyingly /heebe/, we require a rule to explain the divergence between the predicted form of the first-singular habitual form – we would expect \*[mheeba], \*[mhiima], etc. – and the actual form of the verb, [mpeeba], [mpiima] and so on. Since in fact we do not see the sequence /mh/ anywhere in the data, we might assume the following neutralizing rule.

- (9) *Postnasal hardening*  
 $h \rightarrow p / \text{nasal } \_$

If, on the other hand, we assume that the root is underlyingly /peeba/, we would need a rule which changes /p/ into [h] when not preceded by a nasal – in other words, when preceded by a vowel or by nothing. There is no single property which groups together word-initial position and vowels. Thus, the supposed rule changing /p/ to [h] would have to be a disjunction of two separate environments.

$$(10) \quad p \rightarrow h / \left. \begin{array}{l} \# \\ \vee \end{array} \right\} -$$

This suggests that rule (10) is wrong.

More important than the greater complexity of the rule entailed by assuming that the word for ‘guide’ is underlyingly /peeba/, it is empirically wrong: rule (10) implicitly claims that /p/ should always become [h] word initially or after a vowel, but this is falsified by forms such as *kupaamba*, *apaamba*, *paamba* ‘adorn’ and *kupaanga*, *apaanga*, *paanga* ‘line up.’ If we assume the stems uniformly begin with /p/, then we cannot predict whether the imperative or infinitive has [h] (*kuhaanga*) or [p] (*kupaanga*). On the other hand, if we assume an underlying contrast between initial /h/ and initial /p/ – i.e. *haanga* ‘create’, *paanga* ‘arrange’ – then we can correctly distinguish those stems which begin with /h/ from those which begin with /p/ when no nasal precedes, as well as correctly neutralizing that distinction just in case the stem is preceded by a nasal (*mpaanga* ‘I create’; ‘I arrange’).

**English plurals.** A further illustration of how to determine the correct underlying representation comes from English. As the following examples illustrate, the surface form of the plural suffix varies between [s] and [z] (as well as [ɪz], to be discussed later).

(11)	kæps	caps	kæbz	cabs	klæmz	clams
	kæts	cats	kædz	cads	kænz	cans
	kaks	cocks	kagz	cogs	karz	cars
	pruwfs	proofs	huvz	hooves	gəlz	gulls
			fliyz	fleas		
			plæwz	plows		
			pyʔez	purees		

The generalization regarding distribution is straightforward: [s] appears after a voiceless segment, and [z] appears after a voiced one (be it an obstruent, a liquid, nasal or a vowel).

This same alternation can be found in the suffix marking the third singular present-tense form of verbs.

(12)	slæps	slaps	stæbz	stabs	slæmz	slams
	hits	hits	haydz	hides	kænz	cans
	powks	pokes	dɪgz	digs	hæŋz	hangs

læfs	laughs	θrayvz	thrives	hiylz	heals
piθs	piths	beyðz	bathes	hurz	hears
		flayz	flies	viytowz	vetos

If we suppose that the underlying form of the affixes for noun plural and third singular present verbs are /z/, then we would assume the following rule to derive the phonetic variant [s].

(13) obstruent → voiceless / voiceless \_

On the other hand, if we were to assume that these suffixes are underlyingly /s/, we would assume the following rule.

(14) obstruent → voiced / voiced \_

In terms of the simplicity and generality of these two rules, the analyses are comparable. Both formulations require the same number of phonetic specifications to state the rule, and both formulations apply to general and phonetically natural classes. However, the two analyses differ quite significantly in terms of their overall predictions for English. The implicit prediction of the first rule (13) is that there should be no voiced obstruents after voiceless segments in English, since that rule would devoice all such obstruents. This generalization seems to be correct: there are no words like \*[yəkɔd], \*[pɪfz], \*[sdap]. The implicit prediction of the second rule (14) is different: that rule implies that there should be no voiceless segments after any voiced segments. This is manifestly incorrect, as shown by the existence of words such as [hɪs] *hiss*, [pæθ] *path*, [dæns] *dance*, [fals] *false*. We prefer a hypothesis which makes the correct prediction about the phonetic structure of the language as a whole, and thus we select the underlying form /z/ and a rule devoicing obstruents after voiceless segments. Looking for such asymmetries plays an important role in determining which of two hypotheses is the correct one.

The alternation *z* ~ *s* is not limited to the two affixes -*z* 'plural' and -*z* '3sg present tense.' The rule of devoicing can also be seen applying to the possessive suffix -*z*.

(15) <i>Noun</i>	<i>Noun + poss.</i>	
kæt	kæts	cat
slæg	slægz	slug
klæm	klæmz	clam
snow	snowz	snow

Moreover, certain auxiliary verbs such as *has* [hæz] and *is* [ɪs] undergo a reduction in casual speech, so that they appear simply as [s] or [z], the choice between these two being determined by the devoicing rule which we have motivated.

(16) <i>Noun + has</i>	<i>Reduced</i>	<i>Noun + is</i>	<i>Reduced</i>	
ʃæk hæz iyʔŋ	ʃæks iyʔŋ	ʃæk ɪz iyʔŋ	ʃæks iyʔŋ	Jack
pæt hæz iyʔŋ	pæts iyʔŋ	pæt ɪz iyʔŋ	pæts iyʔŋ	Pat

ʃɛn hæz iyʔŋ	ʃɛnz iyʔŋ	ʃɛn ɪz iyɗɪŋ	ʃɛnz iyɗɪŋ	Jen
bab hæz iyʔŋ	babz iyʔŋ	bab ɪz iyɗɪŋ	babz iyɗɪŋ	Bob
ʃow hæz iyʔŋ	ʃowz iyʔŋ	ʃow ɪz iyɗɪŋ	ʃowz iyɗɪŋ	Joe

The devoicing rule (13) automatically explains the alternation in the surface shape of the consonant here as well.

**Jita tone.** It is important to look for correlations which may lead to causal explanations, in analyzing data. Consider the following data from Jita, concentrating on the tones of morphemes (H or high tone is marked with acute accent, L or low-toned syllables are unmarked).

(17) a.	okuβuma	‘to hit’	okusiβa	‘to block’
	okuβumira	‘to hit for’	okusiβira	‘to block for’
	okuβumana	‘to hit e.o.’	okusiβana	‘to block e.o.’
	okuβumirana	‘to hit for e.o.’	okusiβirana	‘to block for e.o.’
b.	okulúma	‘to bite’	okukúβa	‘to fold’
	okulumíra	‘to bite for’	okukúβíra	‘to fold for’
	okulumána	‘to bite e.o.’	okukúβána	‘to fold e.o.’
	okulumírana	‘to bite for e.o.’	okukúβírana	‘to fold for e.o.’

We can conclude that there is a prefix *oku-* perhaps marking the infinitive, a suffix *-a* appearing at the end of every verb, and two suffixes *-ir-* ‘for’ and *-an-* ‘each other.’ There are also root morphemes: *-βum-* ‘hit,’ *-siβ-* ‘block,’ as well as *-lúm-* ‘bite’ and *-kúβ-* ‘fold.’ We decide that ‘bite’ and ‘fold’ underlyingly have H tones in part based on the fact that there actually is an H tone on the vowels of these roots in the simplest verb forms.

In addition, we observe that the suffixes *-ir-* and *-an-* have H tone when they come immediately after these verb roots. The suffixes do not have H tone after the first set of roots: appearance of H on the suffix is correlated with which morpheme immediately precedes the suffix. Since this unpredictable property is correlated with the preceding root morpheme, it must therefore be an aspect of the underlying form of the preceding morpheme.

We thus explain the H tone on these suffix morphemes by positing that [oku-lum-án-a] derives from underlying /oku-lúm-an-a/, by applying a rule of tone shift which shifts a H tone rightward to the following syllable, as long as the syllable is not word-final. Because of the restriction that H does not shift to a final syllable, the underlying H surfaces unchanged in [okulúma].

Now consider the following data.

(18)	okumuβúma	‘to hit him/her’	okumusíβa	‘to block him/her’
	okumuβúmira	‘to hit for him/her’	okumusíβira	‘to block for him/her’
	okučǐβúma	‘to hit it’	okučǐsíβa	‘to block it’
	okučǐβúmira	‘to hit for it’	okučǐsíβira	‘to block for it’

When the L-toned roots of (17a) stand after the object prefixes *-mu-* ‘him/her’ and *-čí-* ‘it,’ they have an H tone at the beginning of the root. Again, since the presence of the H is correlated unpredictably with the prefixes *-mu-* and *-čí-*, we hypothesize that the tones are *part* of the underlying representation of the prefixes – the prefixes are /mú/ and /čí/, and the H tone shifts to the right by the tone shift rule which we have already posited.

## 4.4 Practice at problem solving

You should now be able to apply this reasoning to data which pose analogous problems; a series of examples are given in this section for practice.

**Chamorro vowel alternations.** There are alternations in the quality of vowels in initial syllables in some contexts seen in the following data from Chamorro.

(19)	gwíhən	‘fish’	i gwíhən	‘the fish’
	gúməʔ	‘house’	i gíməʔ	‘the house’
	kátta	‘letter’	yoʔ kátta	‘a letter (object)’
			i kátta	‘the letter’
	t <sup>s</sup> úpa	‘cigarettes’	i t <sup>s</sup> ípa	‘the cigarettes’
	finoʔ	‘talk’	mi finoʔ	‘lots of talk’
	tínuʔ	‘to know’	en tínuʔ	‘you know’
	t <sup>s</sup> úgoʔ	‘juice’	mi t <sup>s</sup> ígoʔ	‘lots of juice’
	sónsuŋ	‘village’	i séŋsuŋ	‘the village’
	húluʔ	‘up’	sæn húluʔ	‘upward’
	pét <sup>s</sup> u	‘chest’	i pét <sup>s</sup> u	‘the chest’
	tómu	‘knee’	i tému	‘the knee’
	ótdut	‘ant’	mi étdut	‘lots of ants’
	óksuʔ	‘hill’	gi éksuʔ	‘at the hill’
	dáŋkulu	‘big one’	i dáŋkulu	‘the big one’
	láhi	‘male’	i láhi	‘the male’
	lágu	‘north’	sæn lágu	‘toward north’
	pulónnun	‘trigger fish’	i pulónnun	‘the trigger fish’
	mundónŋu	‘cow’s stomach’	i mundónŋu	‘the cow’s stomach’
	putamonéda	‘wallet’	i putamonéda	‘the wallet’

What underlying representations, and what rule or rules, are required to account for these data? When you answer this question, you should consider two hypotheses which differ in particular about what form is taken to be underlying – what are the two most obvious ways of treating these alternations? One of these hypotheses is clearly wrong; the other is the correct hypothesis.

**Korean.** Now consider the following data from Korean. The first column, the imperative, seems to involve a vowel suffix. One reason to think that there is an imperative suffix is that every imperative ends either in the

vowel *a* or in *ə* (the choice between *a* versus *ə* is based on the vowel which precedes that suffix, /*a*/ or /*o*/ versus other vowels, and can be ignored here). A second reason comes from comparing the imperative and the plain present forms. Comparing *ana* and *anninta*, or *kama* and *kamninta*, we can see that for each verb, the portions common to both the imperative and the plain present are respectively *an-* and *kam-*. From this we deduce that there must be a suffix, either *-a* or *-ə*, which marks the imperative, and another suffix *-ninta* which marks the plain present.

(20)	<i>Imperative</i>	<i>Plain present</i>	
	<i>ana</i>	<i>anninta</i>	‘hug’
	<i>kama</i>	<i>kamninta</i>	‘wind’
	<i>sinə</i>	<i>sinninta</i>	‘wear shoes’
	<i>t’atimə</i>	<i>t’atimninta</i>	‘trim’
	<i>nəmə</i>	<i>nəmninta</i>	‘overflow’
	<i>nama</i>	<i>namninta</i>	‘remain’
	<i>č<sup>h</sup>ama</i>	<i>č<sup>h</sup>amninta</i>	‘endure’
	<i>ipə</i>	<i>imninta</i>	‘put on’
	<i>kupə</i>	<i>kumninta</i>	‘bend’
	<i>čəpə</i>	<i>čəmninta</i>	‘fold’
	<i>tatə</i>	<i>tanninta</i>	‘close’
	<i>put<sup>h</sup>ə</i>	<i>punninta</i>	‘adhere’
	<i>čoč<sup>h</sup>a</i>	<i>čonninta</i>	‘follow’
	<i>məkə</i>	<i>məɲninta</i>	‘eat’
	<i>sək’ə</i>	<i>səɲninta</i>	‘mix’
	<i>tak’a</i>	<i>taɲninta</i>	‘polish’
	<i>čukə</i>	<i>čuɲninta</i>	‘die’
	<i>ikə</i>	<i>iɲninta</i>	‘ripen’

What is the underlying form of these verb stems, and what phonological rule or rules are required to account for the variations that are seen in the surface shape of the various stems?

**Koasati.** What is the underlying form of the first-singular possessive pre-fix in Koasati, and what phonological rule applies in these examples?

(21)	<i>Noun</i>	<i>My N</i>	
	<i>apahčá</i>	<i>amapahčá</i>	‘shadow’
	<i>asikčí</i>	<i>amasikčí</i>	‘muscle’
	<i>ilkanó</i>	<i>amilkanó</i>	‘right side’
	<i>ifá</i>	<i>amifá</i>	‘dog’
	<i>a:pó</i>	<i>ama:pó</i>	‘grandmother’
	<i>iskí</i>	<i>amiskí</i>	‘mother’
	<i>pačokkó:ka</i>	<i>ampačokkó:ka</i>	‘chair’
	<i>towá</i>	<i>antowá</i>	‘onion’
	<i>kastó</i>	<i>aɲkastó</i>	‘flea’
	<i>bayá:na</i>	<i>ambayá:na</i>	‘stomach’
	<i>tá:ta</i>	<i>antá:ta</i>	‘father’

čofkoní	aňčofkoní	'bone'
kitiřká	aňkitiřká	'hair bangs'
toní	antoní	'hip'

**Kimatuumbi.** What phonological rules pertaining to consonants operate in the following examples from Kimatuumbi. What are the underlying forms of the stems of the words for 'rope,' 'palm,' 'tongue,' 'piece of wood,' 'pole' and 'covered'? Ignore tonal changes.

(22) <i>Singular</i>	<i>Plural</i>	
lugói	ηgói	'rope'
lugolóká	ηgolóká	'straight'
lubáu	mbáu	'rib'
lubágalo	mbagálo	'lath'
lujiingyá	ňjiingyá	'entered'
lulaála	ndaála	'pepper'
lulími	ndími	'tongue'
lulndúlá	ndndúlá	'guarded'
lupaláái	mbaláái	'bald head'
lupaálá	mbaálá	'wanted'
lutéelá	ndeelá	'piece of wood'
lukíligo	ηgilígo	'place for initiates'
lukíli	ηgíli	'palm'
luyíma	ňjíma	'pole'
luyóka	ňjóka	'stomach worm'
luyúsi	ňjúsi	'bee'
luyúwé	ňjúwe	'pumpkin plant'
luwikílyá	ηg <sup>w</sup> ikílyá	'covered'

A certain degree of uncertainty regarding the exact underlying form of the plural prefix is expected. However, the underlying form of the stem should be clear, and should be the focus of your analysis.

## 4.5 Underlying forms and sentence-level phonology

In the examples which we have considered so far, we have been comparing morphologically related words, such as a nominative and a genitive, and we have seen that an underlying distinction may be preserved in one word in a particular inflected form (because in that inflected form the conditions for applying the phonological rule are not satisfied), but the difference is neutralized in a related word where the conditions for the rule are present. We now consider two additional cases where underlying distinctions are neutralized depending on context, and the neutralization takes place within one and the same word, depending on where the word appears in a sentence. What this shows is that phonology is not just about variations in pronunciation between words, but also includes variations in the pronunciation of a word in different sentential contexts.



### 4.5.1 Korean final Cs

The first case is a rule of Korean that nasalizes stops before nasal consonants (a rule that we have seen operating within words in the preceding section). The first set of examples shows the word for 'rice' when said alone, or when it is followed by various words which begin with oral consonants and vowels. In these data, the last consonant of the word for 'rice' is pronounced as [p]. In the second set of examples, the word which follows 'rice' begins with a nasal, and in that case the final consonant of the word for 'rice' is pronounced as [m].

- (23) a.      **pap**    'rice'  
           **pap anmækət'a**    'didn't eat rice'  
           rice didn't eat
- pap winmoke tuət'a**    'put rice on the upper floor'  
           rice on-upper-floor put
- pap saməkət'a**    'ate rice at a store'  
           rice ate-at-store
- pap totuki humč<sup>h</sup>əkət'a**    'a thief stole rice'  
           rice thief (subj) stole
- b.        **pam mani məkəla**    'eat rice a lot'  
           rice a lot eat
- pam mək-imyən**    'if eats rice'  
           rice eat-if
- pam nəmu masik'e məkət'a**    'I enjoyed rice quite a lot'  
           rice very deliciously ate
- pam nək<sup>h</sup>o**    'add rice'  
           rice add

Compare those examples with the following examples with the word for 'chestnut'.

- (24) a.      **pam**    'chestnut'  
           **pam anmækət'a**    'didn't eat chestnut'  
           chestnut didn't eat
- pam winmoke tuət'a**    'put chestnut on the upper floor'  
           chestnut on-upper-floor put
- pam saməkət'a**    'ate chestnut at a store'  
           chestnut ate-at-store
- pam totuki humč<sup>h</sup>əkət'a**    'a thief stole chestnut'  
           chestnut thief (subj) stole
- b.        **pam mani məkəla**    'eat chestnut a lot'  
           chestnut a lot eat
- pam mək-imyən**    'if eats chestnut'  
           chestnut eat-if

pam nəmu masak'e məkət'a	'I enjoyed chestnut quite a lot'
chestnut very deliciously ate	
pam nək <sup>h</sup> o	'add chestnut'
chestnut add	

In fact the (b) phrases above are actually ambiguous as to whether the word being pronounced means 'chestnut' or 'rice.'

The last consonant of the word for 'chestnut' is always [m], so we would presume that the underlying form of that word is /pam/. Since the word for 'rice' varies between [pap] and [pam], and since we know that the underlying form cannot be /pam/ (this is the underlying form of 'chestnut,' and 'chestnut' cannot have the same underlying form as 'rice' since they do not behave the same), we conclude that the underlying form of the word for 'rice' is /pap/, and that a nasalization rule changes /p/ (in fact, all stops) to nasals before a nasal. Whether a word undergoes that rule depends on what follows the final consonant. One and the same word can be pronounced differently depending on the properties of the phrase in which it appears.

#### 4.5.2 Kimatuumbi tone

In the Korean case which we just considered, it happens that the underlying form of the word is the same as the way the word is pronounced when it is said alone. This situation does not hold in Kimatuumbi, where one has to know how a word is pronounced when it is *not* at the end of an utterance, in order to determine the underlying form of the word. The words in (25) have an H tone (marked with an acute accent) on the second vowel from the beginning of the word when said alone. When another word follows, they seem to lose that H tone.

(25)

kiwíkulyo	'cover'	nga kiwíkulyo lí	'it isn't a cover'
lubágalo	'lath'	nga lubagalo lí	'it isn't a lath'
mikóta	'sugar canes'	nga mikota lí	'it isn't sugar canes'
nguuṅguni	'bedbug'	nga nguunguni lí	'it isn't a bedbug'
lukólogo	'brewery'	nga lukologo lí	'it isn't a brewery'
mabáando	'thighs'	nga mabaando lí	'it isn't thighs'
kikóloombe	'shell'	nga kikoloombe lí	'it isn't a shell'
lipítanuuṅgu	'rainbow'	nga lipitanuuṅgu lí	'it isn't a rainbow'

In contrast, the words of (26), which also have an H tone on the second vowel from the beginning of the word when the word is said alone, keep their H tone when another word follows.

(26)

lukóṅgobe	'wood'	nga lukóṅgobe lí	'it's not wood'
kitókutuku	'quelea bird'	nga kitókutuku lí	'it's not a quelea'
dííwai	'wine'	nga dííwai lí	'it's not wine'
lukóṅgono	'chicken leg'	nga lukóṅgono lí	'it's not a leg'
lukóṅgowe	'marble'	nga lukóṅgowe lí	'it's not marble'
matógolo	'waterbucks'	nga matógolo lí	'it's not waterbucks'

mivíriingo	‘circles’	nga mivíriingo lí	‘it’s not circles’
kiyógoyo	‘bird (sp)’	nga kiyógoyo lí	‘it’s not a bird’
kikálaango	‘pan’	nga kikálaango lí	‘it’s not a pan’

There are no words in Kimatuumbi which are toneless when said by themselves, thus \**kitekelyo* said by itself is an unattested kind of word. There is a clear contrast in tonal behavior between the words in (25) where the presence of an H tone on the second vowel depends on whether the word is said alone or is followed by another word, and those in (26) where the second vowel always has an H tone. The solution to this puzzle is that the words in (26) have an underlying H tone on their second vowel, and thus nothing happens to that tone; but the words in (25) have no underlying H, and instead get an H at the end of an utterance by a rule that assigns an H tone to the second vowel of a toneless word which comes at the end of an utterance. Thus in the case of Kimatuumbi tone, the contrast between underlyingly toneless words and words with underlying H is best revealed by looking at the word when it appears *not* by itself: it is the citation form of the word that undergoes the neutralization rule, which is the opposite of the situation we just encountered in Korean.

## 4.6 Underlying forms and multiple columns in the paradigm

The following data from Samoan illustrate the very important point that it is wrong to think of deriving underlying forms by chopping off affixes from some single column of data. In the first set of examples, our initial task is to deduce the underlying form of each of the verb roots and the affix for the perfective form.

(27) <i>Simple</i>	<i>Perfective</i>	
olo	oloia	‘rub’
lafo	lafoia	‘cast’
aŋa	aŋaia	‘face’
usu	usuaia	‘get up and go early’
tau	tauia	‘reach a destination’
taui	tauia	‘repay’
sa:ʔili	sa:ʔilia	‘look for’
vajaia	vajaiaia	‘face each other’
paʔi	paʔia	‘touch’
naumati	naumatia	‘be waterless’
sa:uni	sa:unia	‘prepare’
seŋi	seŋia	‘be shy’
lele	lelea	‘fly’
suʔe	suʔea	‘uncover’
taʔe	taʔea	‘smash’
tafe	tafea	‘flow’
ta:upule	ta:upulea	‘confer’
palepale	palepalea	‘hold firm’

Examples such as *oloia*, *aŋaia* and *usuia* suggest that the perfective suffix is *-ia*, and the simple form of the verb reflects the underlying form of the root. Examples such as *seŋi* ~ *seŋia* or *lele* ~ *lelea* suggest a phonological rule, since the combination of the presumed stems *ati* and *lele* with the perfective affix *-ia* would result in the incorrect forms *\*seŋia*, *\*lelea*. However, this problem can be corrected by positing a phonological rule which deletes a front vowel when it is preceded by a front vowel. In the formalization of the rule, we say that the second front vowel is replaced by zero, which means that it is deleted.

(28) *Vowel-cluster reduction*  
 front vowel → Ø / front vowel \_

An alternative hypothesis would be that [i] is inserted between a back vowel and the vowel [a], if we were to presume that the perfective suffix is underlyingly /a/.

(29) Ø → i / back vowel \_ a

This would be quite unlikely on grounds of naturalness. It is common across languages for one of two adjacent vowels to be eliminated, and no language has been found with a rule that inserts a vowel between two other vowels. Additional data to be considered below will show that, in addition, this would just be plain wrong. We abandon the idea of inserting the vowel *i* and conclude that the underlying form of the perfective suffix must be *-ia*, hence there must be a rule deleting a front vowel after a front vowel. We would then conclude that the underlying representation of roots is best revealed in the simple verb, rather than the perfective, since the simple form of the verb shows whether the stem ends with /i/, a vowel which may be deleted in the perfective.

A rather different conclusion about arriving at underlying forms would have to be drawn from the following additional Samoan examples.

(30)

<i>Simple</i>	<i>Perfective</i>		<i>Simple</i>	<i>Perfective</i>	
tu:	tu:lia	‘stand’	au	aulia	‘flow on’
tau	taulia	‘cost’	ma:tau	ma:taulia	‘observe’
ʔalo	ʔalofia	‘avoid’	ili	ilifia	‘blow’
oso	osofia	‘jump’	ulu	ulufia	‘enter’
sao	saofia	‘collect’	taŋo	taŋofia	‘take hold’
asu	asuŋia	‘smoke’	soa	soaŋia	‘have a friend’
pole	poleŋia	‘be anxious’	fesili	fesiliŋia	‘question’
ifo	ifoŋia	‘bow down’	ʔote	ʔoteŋia	‘scold’
ula	ulaŋia	‘mock’	tofu	tofuŋia	‘dive’
milo	milosia	‘twist’	laʔa	laʔasia	‘step’
valu	valusia	‘scrape’	taŋi	taŋisia	‘cry’
vela	velasia	‘be cooked’	motu	motusia	‘break’
api	apitia	‘be lodged’	mataʔu	mataʔutia	‘fear’
eʔe	eʔetia	‘be raised’	sau	sautia	‘fall’

lava:	lava:tia	'be able'	oʔo	oʔotia	'arrive'
u:	u:tia	'grip'	ufi	ufitia	'cover'
puni	punitia	'be blocked'	tanu	tanumia	'cover up'
siʔo	siʔomia	'be enclosed'	moʔo	moʔomia	'admire'
ŋalo	ŋalomia	'forget'	tao	taomia	'cover'
sopo	sopoʔia	'go across'	fana	fanaʔia	'shoot'

Here, we see that the perfective form of the verb contains a consonant which is not present in the simple form. That consonant can be any one of *l, f, ŋ, s, t, m* or *ʔ*, given these data. An attempt to predict the nature of that consonant by an insertion rule proves fruitless. We could attempt to insert an appropriate consonant on the basis of the preceding vowel: but while *l* appears after *u*, so do *f* ([ulufia]), *ŋ* ([tofuŋia]) and *s* ([valusia]); and while *f* appears after *o*, so do *ŋ* ([ifonŋia]), *m* ([ŋalomia]), and *s* ([milosia]). In short, it is simply impossible to predict from anything in the environment what the consonant of the perfective is going to be, if we start with the simple form as the underlying form: that consonant must be part of the underlying representation of the root. Thus the underlying forms of this second set of roots would be as follows.

(31)	tu:l	'stand'	aul	'flow on'
	taul	'cost'	ma:taul	'observe'
	ʔalof	'avoid'	ilif	'blow'
	osof	'jump'	uluf	'enter'
	saof	'collect'	taŋof	'take hold'
	asuŋ	'smoke'	soaŋ	'have a friend'
	poleŋ	'be anxious'	fesiliŋ	'question'
	ifoŋ	'bow down'	ʔoteŋ	'scold'
	ulaŋ	'mock'	tofuŋ	'dive'
	milos	'twist'	laʔas	'step'
	valus	'scrape'	taŋis	'cry'
	velas	'be cooked'	motus	'break'
	apit	'be lodged'	mataʔut	'fear'
	eʔet	'be raised'	saut	'fall'
	lava:t	'be able'	oʔot	'arrive'
	u:t	'grip'	ufit	'cover'
	punit	'be blocked'	tanum	'cover up'
	siʔom	'be enclosed'	moʔom	'admire'
	ŋalom	'forget'	taom	'cover'
	sopoʔ	'go across'	fanaʔ	'shoot'

The postulation of underlying consonants at the end of these roots entails the addition of a phonological rule, in order to account for the surface form of the simple verb where there is no final consonant. Noting that no word ends in a consonant phonetically in these examples, we can postulate the following rule of final consonant deletion.

- (32) *Final consonant deletion*  
 $C \rightarrow \emptyset \mid \_ \#$

The underlying forms of these verbs can be heuristically derived by eliminating the perfective affix *-ia* from the perfective form. However, notice that we made a different heuristic assumption for the first group of roots, which underlyingly ended in a vowel. The point is that an underlying representation is whatever is required to correctly predict all of the surface variants of a given morpheme: it does not necessarily derive from any one column in a paradigm.

It is also important to understand the difference between saying that the underlying form *is* the simple form, or *is* the perfective form, and saying that we may best *learn* what the underlying form is by looking at the perfective, or simple form, or some other form. The underlying form of the word for ‘stand’ is */tu:l/*. We learn that this is the underlying form by comparing the simple form *[tu:]* and the perfective *[tu:lia]* and understanding that the perfective form preserves important information about the underlying form that is lost in the simple form. But the perfective form itself is *[tu:lia]* – this is not the underlying form.

**Palauan.** The language Palauan provides a second clear illustration of the point that one cannot always arrive at the correct underlying representation by looking at any single column in the paradigm. In this language, the underlying form of the word does not actually surface as such in any form of a word. Consider the following examples:

(33)	<i>Present middle</i>	<i>Future innovative</i>	<i>Future conservative</i>	
	mədáŋəb	dəŋəbáll	dəŋóbl	‘cover’
	mətéʔəb	təʔəbáll	təʔíbl	‘pull out’
	məŋétəm	ŋətəmáll	ŋətóml	‘lick’
	mətábək	təbəkáll	təbákl	‘patch’
	məʔárəm	ʔərəmáll	ʔeróml	‘taste’
	məsésəb	səsəbáll	səsóbl	‘burn’

The prefix for the present middle is apparently */mə/*, the future suffix (found in the future conservative and the future innovative) is *-l*, and the innovative suffix is *-al*. The position of stress can be predicted by a simple rule: the final syllable is stressed if it ends in two consonants, otherwise the second to last (penultimate) syllable is stressed.

The fundamental problem of Palauan is how to predict vowel quality in the root. Notice that the root meaning of the word for ‘cover’ has three surface realizations: *dáŋəb*, *dəŋəb* and *dəŋóbl*. Looking at all of the data, we notice that the only full vowel in the word is the stressed vowel, which suggests that unstressed vowels are neutralized to schwa.

(34) *Unstressed vowel reduction*  
unstressed V → ə

Note that this rule has no context: it does not matter what precedes or follows the unstressed vowel.

In order to predict that the stressed first vowel in the word for ‘cover’ is *[a]*, that choice of vowel must be part of the underlying representation,

giving the partial solution /daŋVb/. In contrast, the first vowel of the word for ‘pull out’ must be specified as [e], since that is the vowel which appears in this word when the first vowel is stressed, giving /teʔVb/. By the same reasoning, the second vowel of the word for ‘cover’ must be [o], since that is the realization which the vowel has when it is stressed, and the second vowel of the word for ‘pull out’ must be [i]. Thus, the underlying forms of the stems given above would be the following.

(35)	daŋob	‘cover’	teʔib	‘pull out’
	ŋetom	‘lick’	tabak	‘patch’
	ʔarom	‘taste’	sesob	‘burn’

The underlying form of a verb in Palauan is a rather abstract object, something which is never revealed in any single surface form. Rather, it must be deduced by looking at information which is manifested in a number of different morphologically related words derived from a single stem.

**English.** A similar example can be found in English, as the following examples show. We will ignore other alternations and focus only on vowel alternations. Thus for example, alternations such as the one between *k* and *s* can be ignored. There are many idiolectal differences in the pronunciation of certain words such as *economy*, where some people pronounce the word as [iykánəmiy] and others pronounce it as [əkánəmiy]: only attempt to account for the latter pronunciation.

(36)	mánətown	‘monotone’	mənátəniy	‘monotony’
	téləgræf	‘telegraph’	tələgrəfiy	‘telegraphy’
	épəgræf	‘epigraph’	əpigrəfiy	‘epigraphy’
	rélətiv	‘relative’	rələyʃən	‘relation’
	əkánəmiy	‘economy’	əkənámik	‘economic’
	díyfekt	‘defect (noun)’	dəfɛktiv	‘defective’
	déməkræt	‘democrat’	dəməkɹəsiy	‘democracy’
	ítəliy	‘Italy’	ətəlyən	‘Italian’
	hámənum	‘homonym’	həmánəmiy	‘homonymy’
	fənétuks	‘phonetics’	fəwnətíʃən	‘phonetician’
	stətístuks	‘statistics’	stətəstíʃən	‘statistician’
	rəsíprækɫ	‘reciprocal’	rəsəprásətiy	‘reciprocity’
	fənaləʃiy	‘phonology’	fəwnələʃɪkɫ	‘phonological’
	lájik	‘logic’	ləʃíʃn	‘logician’
	sínənum	‘synonym’	sənánəmiy	‘synonymy’
	əristəkræt	‘aristocrat’	ərəstákrəsiy	‘aristocracy’

As in Palauan, there is an alternation between stressed full vowel and unstressed schwa. We assume underlying stems with multiple full vowels, e.g. /manatown/, /telegɹæf/, /ɛpɪgræf/, /dəmækɹæt/, /fəwnələʃ/, etc. But not every unstressed vowel is reduced: cf. for example *rélətiv*, *díyfekt*, *mánətown* where the unstressed vowel is in a closed syllable (followed by one or more consonants within that syllable).

**Tonkawa: reaching the analysis step-by-step.** Correct assumptions about underlying forms are crucial in understanding the variations found in the verb stem in Tonkawa, as the following examples will illustrate. The first step in accounting for these data is to provide a morphological analysis of the data, to determine what the morphemes are for the progressive, the present, the first-singular object, and the third-plural object, and to set forth hypotheses about the underlying forms of roots.

(37)	picno?	'he cuts'	picnano?	'he is cutting'
	wepceno?	'he cuts them'	wepcenano?	'he is cutting them'
	kepceno?	'he cuts me'	kepcenano?	'he is cutting me'
	notxo?	'he hoes'	notxono?	'he is hoeing'
	wentoxo?	'he hoes them'	wentoxono?	'he is hoeing them'
	kentoxo?	'he hoes me'	kentoxono?	'he is hoeing me'
	netlo?	'he licks'	netleno?	'he is licking'
	wentalo?	'he licks them'	wentaleno?	'he is licking them'
	kentalo?	'he licks me'	kentaleno?	'he is licking me'
	naxco?	'he makes fire'	naxceno?	'he is making fire'
	wenxaco?	'he makes them fire'	wenxaceno?	'he is making them fire'
	kenxaco?	'he makes me fire'	kenxaceno?	'he is making me fire'
	yamxo?	'he paints a face'	yamxano?	'he is painting a face'
	weymaxo?	'he paints their face'	weymaxano?	'he is painting their face'
	keymaxo?	'he paints my face'	keymaxano?	'he is painting my face'
	nawlo?	'he spreads'	nawleno?	'he is spreading'
	wenwelo?	'he spreads them'	wenweleno?	'he is spreading them'
	kenwelo?	'he spreads me'	kenweleno?	'he is spreading me'

It will be noticed that every word in this set ends with *o?*, and that all of these verb forms have a third-person subject, which suggests that *-o?* is a suffix marking a third-person subject. Comparing the habitual present forms in the first column with the corresponding present progressive form in the second column, it is also obvious that the present progressive is marked by a suffix, *-n-* or *-Vn-*, ordered before the suffix *-o?*. Marking of an object on the verb is accomplished by a prefix, *we-* for third-plural object and *ke-* for first-singular object. What remains is the verb stem.

Two problems now remain: determining whether the suffix for the progressive is *-n-*, or whether there is a vowel which is part of the suffix; and, what the underlying form of the verb root is. To resolve the first question, we look just at the forms of the verb with no object:

(38)	picno?	picnano?
	notxo?	notxono?
	netlo?	netleno?



naxco?	naxceno?
yamxo?	yamxano?
nawlo?	nawleno?

We might think that the vowel before *-n-* is part of the progressive suffix, but if it were part of that suffix, it should have a constant underlying form and all surface variants of that vowel should be derived by some simple rule(s). It is obvious from these examples that the vowel which appears before *n* does not have a single phonetic realization since in these examples it ranges over *a*, *o* and *e*, and that there is no reasonable way to predict (e.g. from surrounding consonants or vowels) what vowel will appear before *n*. Since that information is unpredictable and is governed by which root appears before the suffix, the vowel must actually be part of the underlying form of the verb stem. Thus, we arrive at the following partial answer to the question about the underlying forms of the verb roots:

(39) /picna/	'cut'
/notxo/	'hoe'
/netle/	'lick'
/naxce/	'make a fire'
/yamxa/	'paint a face'
/nawle/	'spread'

The progressive form of the verb can be derived straightforwardly by adding the two affixes *-n-* and *-o?*. The habitual present involves the application of a further phonological process. Based on our hypotheses regarding the underlying forms of the verb stems, we predict the following underlying forms for the habitual forms.

(40) <i>Predicted form</i>	<i>Actual surface form</i>	
picnao?	picno?	'cut'
notxoo?	notxo?	'hoe'
netleo?	netlo?	'lick'
naxceo?	naxco?	'make a fire'
yamxao?	yamxo?	'paint a face'
nawleo?	nawlo?	'spread'

The underlying form is whatever is given by the morphological component, so in this case it would be the root plus progressive suffix, followed by the suffix *-o?*. Our initial hypothesis is that the underlying form should be identical to the surface form until we have evidence that phonological rules change the underlying forms in predictable ways. The difference between the predicted form and the actual surface realization of the verb is that the underlying form has a cluster of vowels which is not found in the surface form. The data do not provide any examples of surface vowel clusters, and this fact allows us to state a very simple rule accounting for the surface form: the first of two consecutive vowels is deleted.

(41) *Vowel cluster reduction*

$$V \rightarrow \emptyset / \_ V$$

Now we turn to the alternations in the shape of the stem that arise between the plain forms of the verb and the verb with an object prefix. Verbs with the prefix *ke-* behave exactly like verbs with the prefix *we-*. Disregarding the suffixes *-n-* and *-o?*, we arrive at the following surface variations in the shape of the stem.

(42) <i>Stem without prefix</i>	<i>Stem with CV prefix</i>	
picna	pcena	'cut'
notxo	ntoxo	'hoe'
netle	ntale	'lick'
naxce	nxace	'make a fire'
yamxa	ymaxa	'paint a face'
nawle	nwele	'spread'

Notice that in the form which lacks a prefix there is a vowel between the first two consonants and none between the second and third consonants. By contrast, in the form with a CV prefix, there is no vowel between the first two consonants but there is a vowel between the second and third consonants. One way to solve this problem would be to assume that this vowel is epenthetic (inserted); the other is to assume that the vowel is part of the underlying vowel of the stem and is deleted in some phonological context. It is also obvious that just as there is no way to predict what vowel will appear between the first and second consonants, it is also impossible to predict what vowel will appear between the second and third consonants, and therefore the vowel cannot be epenthetic. In short, the underlying representation must contain unpredictable vowels after each consonant.

(43) picena	'cut'
notoxo	'hoe'
netale	'lick'
naxace	'make a fire'
yamaxa	'paint a face'
nawele	'spread'

The underlying forms of prefixed and unprefixed forms would thus be as follows (illustrating with the progressive form of the verb).

(44) <i>Unprefixed</i>	<i>Prefixed</i>	
/picenano?/	/kepicenano?/	'cut'
/notoxono?/	/kenotoxono?/	'hoe'
/netaleno?/	/kenetaleno?/	'lick'
/naxaceno?/	/kenaxaceno?/	'make a fire'
/yamaxano?/	/keyamaxano?/	'paint a face'
/naweleno?/	/kenaweleno?/	'spread'

Compare this with the surface form of the verbs:

(45) <i>Unprefixed</i>	<i>Prefixed</i>	
picnano?	kepcenano?	'cut'
notxono?	kentoxono?	'hoe'
netleno?	kentaleno?	'lick'
naxceno?	kenxaceno?	'make a fire'
yamxano?	keymaxano?	'paint a face'
nawleno?	kenweleno?	'spread'

The relation between the underlying forms in (44) and surface forms in (45) is simple. Each is subject to a rule deleting the second vowel of the word.

(46)  $V \rightarrow \emptyset / \# \text{CVC } \_$

Whether the first or second stem vowel is deleted depends on whether a prefix is present.

Apart from illustrating the point that underlying forms of words may not correspond to any single column in a word's paradigm, this discussion of Tonkawa illustrates two important characteristics of a phonological analysis. The first is that one analyzes data by advancing an initial hypothesis, and then refining the hypothesis as it becomes necessary. Thus we began with the hypothesis that the underlying forms were /picna/, /notxo/, /netle/ and so on, and were able to account for a certain amount of data based on that hypothesis, but later modified our hypothesis about underlying forms to be /picena/, /notoxo/, /netale/ and so on. In other words, although our first hypothesis turned out to be wrong, it was close to right, and we were able to identify the source of the problem in our hypothesis and correct it.

The second characteristic of our analysis is that we always seek ways to test the predictions of our hypotheses. The hypothesis that the stems are underlying /picna/, /notxo/, /netle/, etc. makes a prediction that if a vowel were ever to appear between the second and third consonants (for example due to a rule of vowel insertion), it would always be a single consistent and predictable vowel (since we are saying that it is not in the underlying form). The fact that a *different* vowel appears in *wepceno?*, *wentoxo?*, *wentalo?* and *wenxaco?* shows that the prediction of this hypothesis is wrong, and this forced us to consider the alternative hypothesis that the underlying form contains a vowel between the second and third consonants: this hypothesis proved to be correct. The most basic form of hypothesis testing that is done in phonology is combining presumed forms of roots and affixes, and mechanically applying the rules which we assume in the analysis. If the wrong form is produced by this test, something is wrong with the hypothesis – either the underlying forms are wrong, or the rules are stated incorrectly (or the rules are being applied in the wrong order, a point we get to in the next chapter).

## Summary

Establishing the correct underlying representation for a morpheme is the most important first step in giving a phonological analysis of data. A correct underlying representation unifies surface variants of a morpheme, giving recognition of the basic “sameness” of a morpheme, regardless of variations in pronunciation which arise because phonological rules have applied. The underlying form and the system of rules are thus connected: by making the right choice of underlying form, and given the right system of rules, the rules will correctly operate on just those segments which participate in the alternation. The key to making the right decision about underlying forms is to carefully consider different hypotheses: if a segment in a morpheme has two or more surface realisations, it is often necessary to consider two or more possibilities for what is underlying – is variant [a], [b] or [c] the right choice? The main issue relevant to answering this question is knowing which variant preserves important distinctions and which neutralizes distinctions. The underlying form may not even be seen directly in any one pronunciation of a morpheme: it may be a form inferred from considering a number of specific instantiations of the morpheme.

## Exercises

### 1 Axininca Campa

Provide underlying representations and a phonological rule which will account for the following alternations:

toniro	‘palm’	notoniroti	‘my palm’
yaarato	‘black bee’	noyaaratoti	‘my black bee’
kanari	‘wild turkey’	noyanariti	‘my wild turkey’
kosiri	‘white monkey’	noyosiriti	‘my white monkey’
pisiro	‘small toucan’	nowisiroti	‘my small toucan’
porita	‘small hen’	noworitati	‘my small hen’

### 2 Kikuyu

What is the underlying form of the infinitive prefix in Kikuyu? Give a rule that explains the nonunderlying pronunciation of the prefix:

γoteŋera	‘to run’	γokuua	‘to carry’
γokoora	‘to root out’	koruɣa	‘to cook’
kooria	‘to ask’	komeɲa	‘to know’
kohɔta	‘to be able’	γočina	‘to burn’
koɣeera	‘to fetch’	kohetoka	‘to pass’
koniina	‘to finish’	koina	‘to dance’
γočuuuka	‘to slander’	γokaya	‘to cut’
koɣaya	‘to divide’		

### 3 Korean

Give the underlying representations of each of the verb stems found below; state what phonological rule applies to these data. (Note: there is a vowel

harmony rule which explains the variation between final *a* and *ə* in the imperative, which you do not need to be concerned with.)

<i>Imperative</i>	<i>Conjunctive</i>	
ipə	ipk'o	'wear'
kupə	kupk'o	'bend'
kap <sup>h</sup> a	kapk'o	'pay back'
čip <sup>h</sup> ə	čipk'o	'feel the pulse'
tata	tatk'o	'close'
put <sup>h</sup> ə	putk'o	'adhere'
məkə	məkk'o	'eat'
čukə	čukk'o	'die'
ikə	ikk'o	'ripen'
tak'a	takk'o	'polish'
k'ak'a	k'akk'o	'reduce expenses'
sək'ə	səkk'o	'mix'

#### 4 Hungarian

Explain what phonological process affects consonants in the following data (a vowel harmony rule makes suffix vowels back after back vowels and front after front vowels, which you do not need to account for). State what the underlying forms are for all morphemes.

<i>Noun</i>	<i>In N</i>	<i>From N</i>	<i>To N</i>	
kalap	kalabban	kalapto:l	kalapnak	'hat'
ku:t	ku:dban	ku:ttö:l	ku:tnak	'well'
ža:k	ža:gban	ža:kto:l	ža:knak	'sack'
re:s	re:zben	re:stö:l	re:snek	'part'
šro:f	šro:vban	šro:ftö:l	šro:fnak	'screw'
laka:š	laka:žban	laka:što:l	laka:šnak	'apartment'
ketret <sup>s</sup>	ketred <sup>s</sup> ben	ketret <sup>s</sup> tö:l	ketret <sup>s</sup> nek	'cage'
test	tezdben	testtö:l	testnek	'body'
rəb	rəbban	rəp <sup>t</sup> to:l	rəbnak	'prisoner'
ka:d	ka:dban	ka:ttö:l	ka:dnak	'tub'
meleg	melegben	melektö:l	melegnek	'warm'
vi:z	vi:zben	vi:stö:l	vi:znek	'water'
vara:ž	vara:žban	vara:što:l	vara:žnak	'magic'
a:g <sup>y</sup>	a:g <sup>y</sup> ban	a:k <sup>y</sup> to:l	a:g <sup>y</sup> nak	'bed'
sem	semben	semtö:l	semnek	'eye'
bün	bünben	büntö:l	bünnek	'crime'
toroň	toroňban	toroňto:l	toroňnak	'tower'
fal	falban	falto:l	falnak	'wall'
ö:r	ö:rben	ö:rtö:l	ö:rnek	'guard'
sa:y	sa:yban	sa:yto:l	sa:y <sup>n</sup> nak	'mouth'

#### 5 Kuria

Provide appropriate underlying representations and phonological rules which will account for the following data:

<i>Verb</i>	<i>Verb for</i>	
suraŋga	suraŋgera	'praise'
taŋgata	taŋgatera	'lead'

baamba	baambɛra	'fit a drum head'
reenda	reendɛra	'guard'
rema	remɛra	'cultivate'
hoora	hoorɛra	'thresh'
roma	romɛra	'bite'
sooka	sookɛra	'respect'
tačora	tačorɛra	'tear'
siika	seekɛra	'close'
tiga	tegera	'leave behind'
ruga	rogɛra	'cook'
suka	sokɛra	'plait'
huuta	hootɛra	'blow'
riiŋga	reɛŋgera	'fold'
siinda	seendɛra	'win'

## 6 Farsi

Give the underlying forms for the following nouns, and say what phonological rule is necessary to explain the following data:

<i>Singular</i>	<i>Plural</i>	
zæn	zænan	'woman'
læb	læban	'lip'
hæsud	hæsudan	'envious'
bæradær	bæradæran	'brother'
bozorg	bozorgan	'big'
mæleke	mælekean	'queen'
valede	valedean	'mother'
kæbire	kæbirean	'big'
ahu	ahuan	'gazelle'
hamele	hamelean	'pregnant'
bačče	baččegan	'child'
setare	setaregan	'star'
bænde	bændegan	'slave'
azade	azadegan	'freeborn'
divane	divanegan	'insane'

## 7 Tibetan

Numbers between 11 and 19 are formed by placing the appropriate digit after the number 10, and multiples of 10 are formed by placing the appropriate multiplier before the number 10. What are the underlying forms of the basic numerals, and what phonological rule is involved in accounting for these data?

ʃu	'10'	ʃig	'1'	ʃugʃig	'11'
ši	'4'	ʃubši	'14'	šiɓʃu	'40'
gu	'9'	ʃurgu	'19'	gubʃu	'90'
ŋa	'5'	ʃuŋa	'15'	ŋabʃu	'50'

## 8 Makonde

Explain what phonological rules apply in the following examples (the acute accent in these example marks stress, whose position is predictable):

<i>Repeated imperative</i>	<i>Past</i>	<i>Imperative</i>	
amán̄ga	amíle	áma	'move'
taván̄ga	tavíle	táva	'wrap'
akán̄ga	akíle	áka	'hunt'
patán̄ga	patíle	póta	'twist'
tatán̄ga	tatíle	tóta	'sew'
dabán̄ga	dabíle	dóba	'get tired'
aván̄ga	avíle	óva	'miss'
amán̄ga	amíle	óma	'pierce'
tapán̄ga	tapíle	tépa	'bend'
patán̄ga	patíle	pépa	'separate'
aván̄ga	avíle	éva	'separate'
babán̄ga	babíle	béba	'hold like a baby'
után̄ga	utíle	úta	'smoke'
lukán̄ga	lukíle	lúka	'plait'
lumán̄ga	lumíle	lúma	'bite'
uŋgán̄ga	uŋgíle	úŋga	'tie'
iván̄ga	ivíle	íva	'steal'
pitán̄ga	pitíle	píta	'pass'
imbán̄ga	imbíle	ímba	'dig'
limán̄ga	limíle	líma	'cultivate'

## 9 North Saami

Posit appropriate underlying forms and any rules needed to explain the following alternations. The emphasis here should be on correctly identifying the underlying form: the exact nature of the changes seen here is a more advanced problem.

<i>Nominative sg.</i>	<i>Essive</i>	
varit	varihin	'2-year-old reindeer buck'
oahpis	oahpisin	'acquaintance'
čoaruš	čoarušin	'antlers, skullcap'
lottaaš	lottaajin	'small bird'
čuoivvat	čuoivvagin	'yellow-brown reindeer'
ahhkut	ahhkubin	'grandchild of woman'
suohkat	suohkaðin	'thick'
heejoš	heejojin	'poor guy'
aaǰjut	aaǰjubin	'grandchild of man'
bissobeahťet	bissobeahťehin	'butt of gun'
čeahťit	čeahťibin	'children of elder brother of man'
yaaʔmin	yaaʔmimin	'death'
čuoivat	čuoivagin	'yellow-grey reindeer'
laageš	laagejin	'mountain birch'
gahpir	gahpirin	'cap'
gaaht̚sis	gaaht̚sin	'8 people'
aaslat	aaslagin	[man's name]
baðoošgaatt̚et	baðoošgaatt̚ebin	'bird type'
ahhkit	ahhkiðin	'boring'
bahaanaalat	bahaanaalagin	'badly behaved'
beštor	beštorin	'bird type'
heevemeahhtun	heevemeahhtunin	'inappropriate'

beeʃot	beeʃohin	'white reindeer'
bissomeahtun	bissomeahtumin	'unstable'
laðas	laðasin	'something jointed'
heaiyusmielat	heaiyusmielagin	'unhappy'
heaŋkkan	heaŋkkanin	'hanger'
yaman	yamanin	'something that makes noise'

(Note: You may find it useful to return to this example after reading chapter 6, and consider the formalization of this process using distinctive features.)

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### Further reading

Inkelas 1994; Kaisse and Shaw 1985; Kenstowicz and Kisseberth 1977; Stanley 1967.