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CHAPTER 1

Theories of Phonology

Phonology is primarily concerned with analyzing the sound patterns of language, along with the interaction of these sound patterns with other aspects of grammar, especially syntax and morphology. In the generative tradition the grammar as a whole describes the (largely implicit) knowledge that a native speaker has about his or her language. *The Sound Pattern of English* (Chomsky & Halle 1968; henceforth *SPE*) is a major landmark both in phonological theory and in the phonological description of English, since it signalled a shift in focus to generative phonology, in contrast to the earlier focus on descriptive phonology. Descriptive (or structuralist) phonology seeks to discover the distinctive or contrastive sounds of a language by finding pairs of words that differ minimally, such as *sip* and *zip*. These words differ only in the voicing of the initial segment, thus demonstrating that voicing is distinctive in these two sounds (and also in many other pairs) and so /s/ and /z/ must be considered distinct sounds or *phonemes* in English. In many ways *SPE* has defined phonological issues ever since its appearance. It resolved many of the inadequacies of the earlier structuralist approaches, but left a number of unresolved issues, many of which are still controversial. We will consider a number of these issues as we proceed.

1.1 Generative Phonology and *SPE*

The descriptive approach to phonology emphasized the determination of the distribution of segments in terms of surface contrast (e.g., Hockett 1942). For example, the segments [tʰ] as in *top* and [t] as in *stop* are in complementary distribution in that they cannot appear in the same surface context and thus never serve to distinguish utterances. We can give a rule that governs the appearance of aspirated stops including [tʰ], which we give as rule (27) in Chapter 5. Generative phonology broadened the scope of phonology to include morphophonemics, since many of the variations in

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the phonetic shape of morphemes are definable in phonological terms. *SPE* (pp. 11–12) discusses the example in (1), where the transcription is ours.

(1)
a. telegraph [ˈtʰɛlɪˌgɹæf]
b. telegraphy [tʰɪˈlɛgɹəfi]
c. telegraphic [ˌtʰɛlɪˈgɹæfɪk]

The stem *telegraph* appears in three different phonetic shapes depending on what suffix, if any, is attached to it. This variation is entirely predictable in terms of the rules of English phonology that we will discuss, in particular stress assignment (Chapter 4) and vowel reduction (Section 7.2.3 of Chapter 7). The vowels [ɛ] and [æ] appear in stressed positions and are replaced by [ɪ] and [ə], respectively, in unstressed positions. The most economical way to treat this is by assuming an underlying representation for *telegraph* that contains only the vowels that appear under stress, as in (2).

(2) /tɛlɛgɹæf/

This underlying representation is somewhat abstract, in that it does not appear unchanged in any of the words in which it appears. See further discussion in Section 2.5 of Chapter 2.

A second example is that of final devoicing in German (3).

(3)

	orthographic	*phonetic*	*underlying*	*gloss*
a.	Bund	[ˈbʊnt]	/bʊnd/	‘union’
b.	Bunde	[ˈbʊndə]	/bʊnd + ə/	‘union (dative)’
c.	bunt	[ˈbʊnt]	/bʊnt/	‘colourful’
d.	bunte	[ˈbʊntə]	/bʊnt + ə/	‘colourful (inflected)’
e.	und	[ʊnt]	/ʊnt/	‘and’

The uninflected forms of ‘union’ and ‘colourful’ are pronounced identically. With an inflectional suffix the pronunciation differs. In generative phonology we assign each morpheme a unique underlying representation, /bʊnd/ for ‘union’ and /bʊnt/ for ‘colourful.’ When these are uninflected, the morpheme-final /d/ or /t/ is also word final. The rule required is Final Devoicing (4), which operates in these cases, giving both *Bund* and *bunt* an identical phonetic representation with a voiceless stop. The symbol # represents the word boundary.

(4) *Final Devoicing (German)*
[–son] → [–voice] / ____ #

With an inflectional suffix, the stop is no longer word final and the underlying voiced or voiceless character of this sound appears phonetically.

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The word for 'and' has no alternations and so its underlying representation is the same as its phonetic representation (despite the spelling, which shows *historical* voicing). A theory of phonology that confines itself to describing contrast and distribution of variants is unable to capture final devoicing as a phonological generalization, despite its phonologically exceptionless nature. The sounds [t] and [d] must be distinct phonemes since they contrast in words like *Bunde* and *bunte*, and they contrast also in other positions of the word as in the initial position of *Draht* [draːt] 'wire' and *trat* [traːt] 'stepped.' Thus the words *Bund* and *bunt* must be analyzed as *phonemically* identical according to structuralist principles, and hence the alternation between [bʊnt] and [bʊnd] for 'union' must be analyzed as a matter of *morphology* rather than phonology. This implies that these two phonemic forms must be set up as distinct *allomorphs* of the morpheme for 'union.'[1] This is a very uneconomical description, since literally hundreds of morphemes would require a similar pair of allomorphs that differ just in the voicing of their final obstruent. It has the further disadvantage that it fails to distinguish these phonologically predictable variants of a morpheme from completely suppletive forms, such as *go* and *went* in English. Generative phonology concedes that *go* and *went* are allomorphs but denies this status to phonologically predictable forms (called *alternants*) like [bʊnt] in *Bund* and [bʊnd] in *Bunde*.

A related problem arises when there are asymmetries in the phonological system. Halle (1959) observes that voicing is generally distinctive (contrastive) in Russian obstruents, as we observed in German. This is shown in (5).

(5)

[paˈkɑ]	'while'	[baˈkɑ]	'sides'
[ˈtom]	'volume'	[ˈdom]	'house'
[ˈsloj]	'layer'	[ˈzloj]	'bad'
[ˈʃar]	'sphere'	[ˈʒar]	'heat'
[ˈklup]	'club'	[ˈglup]	'stupid'

But three Russian voiceless obstruents, /x, ʃʃ, ʦ/, have no contrastive voiced counterparts, although the corresponding voiced obstruents, [ɣ, ʤ, ʣ], exist phonetically in Russian. Russian has a rule of voicing assimilation by which an obstruent takes on the voicing of an immediately following obstruent within a phonological phrase. This rule affects all obstruents,

[1] In generative practice, the term 'allomorph' is restricted to variation in morpheme shape that is not phonologically predictable and must be lexically listed or stated by allomorphy rules (Aronoff 1976). Phonologically predictable variants are known as *phonological alternants* and are simply the outcome of regular, general phonological rules.

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regardless of whether they have contrastive voiced counterparts or not, as shown in (6).

(6)

a.	[ˈmok l̥i]	'whether he soaked'	[ˈmoɡ bɨ]	'were he to soak'
b.	[ˈʒɛʧ l̥i]	'whether he burned'	[ˈʒɛʤ bɨ]	'were he to burn'

In the most economical grammar, this assimilation is expressed by a single rule. But in a grammar that insists on a separate level that contains all and only the contrastive segments of the language (e.g., Hockett 1942), the rule would have to be expressed twice: once morphophonemically, to account for (6a), and again phonemically, to account for (6b). This forces a single generalization to be split up into two rules (Halle 1959: 22–23).

In German devoicing and Russian voicing assimilation, the context for the rule is visible in the phonetic output. Sometimes this is not the case, as in the following example discussed by discussed by Malécot (1960) and Chomsky (1964). In many varieties of English, a vowel is nasalized if a nasal consonant immediately follows. In certain cases, a nasal vowel may appear phonetically even if no nasal consonant immediately follows phonetically. Consider the examples in (7).

(7)

a.	pin	[ˈpʰĩn]	f.	hut	[ˈhət]
b.	had	[ˈhæd]	g.	hunt	[ˈhə̃t]
c.	hand	[ˈhæ̃nd]	h.	hit	[ˈhɪt]
d.	cat	[ˈkʰæt]	i.	hint	[ˈhĩt]
e.	can't	[ˈkʰæ̃t]	j.	lip	[ˈlɪp]
			k.	limp	[ˈlĩp]

Since (7d) and (7e) constitute a minimal pair, the nasal vowel [æ̃] must be counted as a phoneme of English, by a strict application of the structuralist principles of contrast and distribution. This seems wrong intuitively, but beyond that, we can observe that this contrast appears only before a voiceless stop. In all other positions, a nasal vowel can appear only before an overt nasal consonant, which itself occurs word finally (7a) or before a voiced consonant (7c), as well as in other positions. This situation, in which a contrast occurs in some environments but not in others, is a sure sign that another rule is involved. Chomsky (1964: 82) points out that a completely general and straightforward analysis involves the interaction of two rules that apply in the order given in (8).[2]

[2] Nasal Consonant Deletion will be slightly revised in Chapter 5, Section 5.3.3. We assume that Vowel Nasalization affects an entire diphthong when that is the nucleus preceding the nasal consonant. Also, Nasal Consonant Deletion applies only when the nasal consonant is homorganic with the following stop; for example, it does not apply in *Fromkin*.

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(8) a. *Vowel Nasalization*

$$V \rightarrow [+\text{nasal}] \; / \; \_\_\_\_ \begin{bmatrix} C \\ +\text{nasal} \end{bmatrix}$$

b. *Nasal Consonant Deletion*

$$\begin{bmatrix} C \\ +\text{nasal} \end{bmatrix} \rightarrow \emptyset \; / \; V\_\_\_\_ \begin{bmatrix} C \\ -\text{voice} \end{bmatrix}$$

These rules presuppose the underlying representations in (9) for the words of (7). We use the term *underlying representation* rather than *phonemic representation* when the discussion concerns generative phonology. Notice that the underlying representation of *can't* cannot be determined by application of phonemic procedures. In fact, it is determined implicitly by using grammatical information, its relation to *can*, in violation of strict phonemic orthodoxy, as for example Hockett's (1942: 20–21) statement that "[t]here must be no circularity: phonological analysis is assumed for grammatical analysis, and so must not assume any part of the latter. The line of demarcation between the two must be sharp."[3].

(9)

a.	pin	/pɪn/
b.	had	/hæd/
c.	hand	/hænd/
d.	cat	/kæt/
e.	can't	/kænt/

The derivations in (10) illustrate the operation of the rules in (8) on the underlying representations of (9). Note that the rules must apply in the order given. According to *SPE* (p. 342), "[t]he hypothesis that rules are ordered. . .seems to us to be one of the best-supported assumptions of linguistic theory." The output [kʰæ̃t] from the input /kænt/ is a case of *opacity*, since the nasal vowel in the output is not in the context of nasalization in the output, because this context was destroyed by the application of Nasal Consonant Deletion. We will encounter many examples of opacity in the course of our investigation into the phonology of English.

(10)

Underlying representations	/pɪn/	/hæd/	/hænd/	/kæt/	/kænt/
Vowel Nasalization (8a)	ĩ	——	æ̃	——	æ̃
Nasal Consonant Deletion (8b)	——	——	——	——	Ø
Phonetic representations	[ˈpĩn]	[ˈhæd]	[ˈhæ̃nd]	[ˈkʰæt]	[ˈkʰæ̃t]

[3] An important exception to this statement is Pike (1947), who argued that grammatical information is necessary for phonemic analysis.

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In this way, generative phonology resolves the contradiction in phonemic theory noted above, by an appeal to *ordered rules*. Rather than assuming that all the rules apply to the phonemic representation, as in phonemic theory, generative phonology provides a series of rules such that the first rule applies to the underlying representation, the next rule applies to the output of the first rule, and so on until the last rule is reached, the output of which is the phonetic representation. This picture is somewhat complicated by the necessity of applying some rules cyclically, that is repeatedly to increasingly larger units (see Chapter 6), but the basic principle remains the same.

Consider a second example of the need for rules to be ordered. In most North American varieties of English, the alveolar stops /t/ and /d/ are realized as a flap [ɾ] in various contexts, one of which is between vowels (including diphthongs) where the second vowel is unstressed.[4] We will call this rule *Flapping*. This is an example of *neutralization*: the distinction between these two sounds is lost, or *neutralized*, in particular contexts. In the same dialects, the diphthong /ɑɪ̯/ has two realizations: [ɑ̝ɪ̯] or [əɪ̯], where the latter appears before a voiceless consonant (Chambers 1973). We will call this rule *Diphthong Shortening*.[5] This rule is responsible for the difference in the diphthong in words like *write* and *ride*, as in (11).

(11) a. write [ˈɹəɪ̯t]
b. ride [ˈɹɑ̝ɪ̯d]

Like nasalized vowels, the raised diphthong sometimes appears phonetically in the 'wrong' environment, i.e., before a phonetically voiced consonant, but only when that consonant is a flap. This is shown in (12).

(12) a. writer [ˈɹəɪ̯ɾəɹ]
b. rider [ˈɹɑ̝ɪ̯ɾəɹ]

Because the raised diphthong [əɪ̯] contrasts with [ɑ̝ɪ̯] in this context, phonemic theory would be forced to regard these diphthongs as separate phonemes.[6] However, the only case where the raised diphthong appears

[4] For a more complete discussion of this rule see Section 5.3.8 of Chapter 5.
[5] This rule is sometimes called Canadian Raising. Geographically it is much more widespread, appearing at least in much of the Northeastern United States. In Canada it also affects the diphthong /ɑ̝ʊ̯/, and pronunciations like [həʊ̯s] for 'house' are something of a shibboleth for Canadian English. We abstract away from this variation in the present discussion.
[6] It might be objected that the real difference is between [ə] and [ɑ̝], which contrast elsewhere as in *sum*, *psalm*. However, the argument still holds, because there is a context where they do not contrast, namely before [ɪ̯] plus a consonant, unless that consonant is [ɾ].

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before a flap is when the flap is related to an underlying /t/, as in *writer*, not where it is related to an underlying /d/, as in *rider*. This again is a case of opacity, and can be resolved in the same way as the vowel nasalization case, that is with two ordered rules, as in (13).[7]

(13) a. *Diphthong Shortening*

$$V \rightarrow \begin{bmatrix} -\text{low} \\ -\text{ATR} \end{bmatrix} / \_\_\_\_ \text{ [–cons][–voice]}$$

(A low vowel is raised and laxed before a glide and a voiceless consonant.)

b. *Flapping*

$$\begin{bmatrix} +\text{cor} \\ -\text{strid} \\ -\text{cont} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{cont} \\ +\text{son} \\ +\text{voice} \end{bmatrix} / \text{ [–cons] } \_\_\_\_ \begin{bmatrix} \text{V} \\ -\text{stress} \end{bmatrix}$$

(An alveolar stop (/t/ or /d/) becomes a flap [ɾ] if it follows a [–consonantal] segment (vowel or glide) and precedes a stressless vowel.)

The derivations in (14) show how these rules work when applied in this order. Notice that the underlying representations required cannot be inferred by phonemic methods, both because they require disregarding the superficial (phonetic) contrast between the diphthongs, and because they involve reference to grammatical information, namely the fact that *writer* and *rider* are derived morphologically from *write* and *ride*, respectively, by the addition of an agentive suffix /+əɹ/.[8] In derivations we write the change effected by each rule just under the corresponding segment(s) of the preceding line; nonapplication of a rule is indicated by a long dash.

(14)

Underlying representations	/ɹɑ̤ɪ̯t + əɹ/	/ɹɑ̤ɪ̯d + əɹ/
Diphthong Shortening	əɪ̯	———
Flapping	ɾ	ɾ
Phonetic representations	[ˈɹəɪ̯ɾəɹ]	[ˈɹɑ̤ɪ̯ɾəɹ]

[7] These rules will be revised in Chapter 5.

[8] The underlying representation of the vowels of the stems is actually more abstract, as will be demonstrated in Chapter 7. We start here with a representation that has already undergone a number of rules. There are also words like *item* in which morphological information plays no role and which follow a derivation just like that of *writer*, showing that these rules are purely phonological in nature.

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The situation where the phonetic representation shows the effect of a rule having applied even though its context is no longer apparent (*overapplication:* McCarthy 1999) is one form of phonological opacity and is extremely common in phonological systems. A second type of opacity occurs when a rule fails to apply even when its context is present phonetically (*underapplication*). The rule Velar Softening, (41) in Chapter 7, converts /k/ to /s/ when a nonlow front vowel or glide follows, as in *medi[s]ine* from the root *medic* with final [k]. However, Velar Softening does not affect *medi[k]ate*, where /k/ is followed by the diphthong /eɪ̯/. Again the explanation lies in another rule, in this case Vowel Shift (Section 1.1.1), which among other effects converts underlying /æ̣/ to /e/ and which is ordered after Velar Softening. The suffix *-ate* has the underlying representation /æ̣t/ which contains a low vowel which cannot trigger Velar Softening. Both forms of opacity have proved to be major obstacles for theories of phonology that reject rule ordering, both structuralist (Hockett 1942) and more recently Optimality Theory (e.g., McCarthy 1999).

1.1.1 *Principles of Generative Phonology*

The basic principles governing generative phonology are those in (15).

(15)
a. *Morphological uniqueness:* Except in cases of suppletion, every morpheme has only one phonological form. Any variation in phonetic shape of a morpheme results from the operation of regular phonological rules. (Cf. the quotation from Bloomfield 1939 on page 9.)

b. *Criterion of predictability:* Underlying phonological representations are chosen in such a way as to maximize predictability of phonetic forms on phonological grounds.

c. *Criterion of naturalness:* Phonological representations are stated in terms of phonetic features. They differ from phonetic representations only to the extent that there is justification for a more abstract representation. Unless some phonological rule intervenes, underlying representations are preserved phonetically. Underlying representations are chosen in such a way that the rules required to produce phonetic forms are maximally natural. (Cf. Postal 1968.)

d. *Criterion of simplicity:* Underlying phonological representations and phonological rules are chosen so that the overall grammar is maximally simple.

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e. *Preference of phonological solutions:* Phonological solutions are preferred to morphological solutions (e.g., arbitrary lexical markings or suppletion), other things being equal.

Underlying representations can differ from phonetic representations only to the extent required to express certain generalizations. For example, a word like *cat* [kʰæt'] has the underlying representation /kæt/, since the aspiration of the initial /k/ and the glottalization of the final /t/ are predictable aspects of the pronunciation. By the criterion of simplicity this is preferable to including the aspiration of [kʰ] in the underlying representation because this aspiration would need to be included in the underlying representation of hundreds of morphemes beginning with a voiceless stop, which would be more complex. By the criterion of naturalness the underlying representation is expressed in terms of the same phonetic features as the output.

Bloomfield (1939: 58), though normally considered to be among the structuralists, expresses a similar outlook in his discussion of Menomini morphophonemics.

> The process of description leads us to set up each morphological element in a theoretical *basic* form, and then to state the deviations from this basic form which appear when the element is combined with other elements. If one starts with the basic forms and applies our statements. . .in the order in which we give them, one will arrive finally at the forms of words as they are actually spoken.

Bloomfield goes on to caution that "[o]ur basic forms are not ancient forms, say of the Proto-Algonquian parent language, and our statements of internal sandhi are not historical but descriptive, and appear in a purely *descriptive order*." Thus, Bloomfield allows phonological rules to go beyond stating the distribution of sounds per se and to account for morphological alternations as well, just as generative phonology does. A phonology that restricts itself to describing distributions based on phonetic contrasts alone, such as Hockett (1942), cannot do this.

An example of the principles in (15) concerns certain alternations related by the rule of Vowel Shift (fully discussed in Section 7.1 of Chapter 7) together with a number of other rules affecting vowel quality. The examples in (16) are representative. The abbreviation RP ('received pronunciation') indicates a standard southern British pronunciation while NA indicates a North American pronunciation.

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(16)

		underived word		*derived word*	
				u.r. of suffix /+ ɪtɪ/	
	underlying representation of stem	*orthographic*	*phonetic*	*orthographic*	*phonetic*
a.	/sa̤n/	sane	[ˈsẽĩn]	sanity	[ˈsæ̃nɪtɪ] (RP) [ˈsæ̃nɪɾi] (NA)
b.	/sɪɪen/	serene	[sɪˈɹĩĩn]	serenity	[sɪˈɹɛ̃nɪtɪ] (RP) [sɪˈɹɛ̃nɪɾi] (NA)
c.	/səblim/	sublime	[səˈblɑ̃ĩm]	sublimity	[səˈblĩmɪtɪ] (RP) [səˈblĩmɪɾi] (NA)

In order to account for these alternations and similar alternations in many other words, we can set up the underlying representations for the stems given in the first column along with underlying representations of a number of affixes, of which *-ity* is a typical example. If no affix is added, the vowel undergoes a sequence of rules, one of which, Vowel Shift, affects the height of stressed, tense vowels, and which together produce the diphthongs in (16) in the *phonetic* column shown under *underived word*. If the suffix *-ity* is added, the form meets the structural description of a rule that laxes vowels when followed by two additional syllables the first of which is unstressed. This rule is called Trisyllabic Laxing (fully discussed in Section 6.2 of Chapter 6). The lax vowel is not subject to Vowel Shift, and the result is shown under the *phonetic* column under *derived word*. The underlying tense vowel never emerges unchanged in phonetic representations: it is either laxed or vowel shifted. But it is not unreasonable to assume that English speakers relate such pairs as [æ] and [eɪ̯] on the basis of such alternations despite their phonetic distance. It is not likely that sheer conservatism is responsible for the persistence of conventional spelling such as <a> for both these sounds and the practice of some dictionaries to write [ā] for [eɪ̯] 'long a' and [ă] for [æ] 'short a' in their transcriptions. In fact, it takes some phonetic training to realize that these sounds are *not* that close phonetically. This very fact provides an argument for vowel shift as a synchronic process, since a phonological rule relating the phonetic values of the three pairs illustrated in (16) *directly* would be quite complex to state, compared with the rules of laxing and vowel shift. Indeed, there are alternations that show the need for a rule operating in the reverse direction, as shown in (17), where the alternating vowels are shown in boldface.

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