11 The Phoneme

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1 Introduction

The concept of the phoneme was central to the development of phonological theory. In the early twentieth century, phonological theory was all about the phoneme: how to define it, how to recognize it, how to discover it (see, for example, the articles selected for inclusion in Joos 1957 and Makkai 1972). The American structuralist term for phonology, phonemics, indicates to what extent the field was considered to be about the phoneme.

Things have now changed. The phoneme, to all appearances, no longer holds a central place in phonological theory. Two recent and voluminous handbooks devoted to phonology, edited by Goldsmith (1995) and by de Lacy (2007), have no chapter on the phoneme. It is barely mentioned in the indexes. This does not mean that the phoneme plays no role in modern phonology; closer inspection reveals that the phoneme is far from dead. However, it is not much talked about, and when it is, it is more often to dispute its existence than to affirm it.

Such a dramatic change in fortunes for a concept bears some looking into, and this chapter will be devoted to trying to understand what has happened to the phoneme in its journey into the twenty-first century, and what its prospects are for the future.

2 Origins of the term

S. R. Anderson (1985: 38) cites Godel (1957) and Jakobson (1971) as locating the origin of the term *phoneme* in the French word *phonème*, coined in the early 1870s by the French linguist Dufriche-Desgenettes. He proposed the term to substitute for the German *Sprachlaut* ("speech sound"), so it did not have the modern sense of phoneme, but rather corresponded to what we would now call "speech sound" or "phone." The term was taken up by Saussure (1879), who used it in yet a different sense, and from Saussure it was taken up by the Polish Kazan school linguists Jan Baudouin de Courtenay and Mikołaj Kruszewski.

S. R. Anderson (1985: 60–68) traces how the meaning of the term evolved from Saussure's use to the one that ultimately emerged from the Kazan school (for detailed accounts of the history of the phoneme see also Krámský 1974; Fischer-Jørgensen 1975). Saussure (1879) used it in his historical work on Indo-European to refer to a hypothesized sound in a proto-language together with its reflexes in the daughter languages, what we might call a "correspondence set." For example, if a sound that is reconstructed as *g in the proto-language has reflexes *g*, *h*, and *k* in three daughter languages, then the set {*g*, *h*, *k*} would constitute a "*phonème*" for Saussure.

Kruszewski recast the notion in synchronic terms to refer to a set of alternating elements; for example, if the same morpheme has a final [g] before suffixes beginning with a back vowel, a palatalized [g^j] before suffixes beginning with a front vowel, and a [k] when it is word-final, the alternation "[g] before a back vowel, [g^j] before a front vowel, and [k] when final" would constitute a "phoneme." Subsequently, Baudouin reinterpreted the term "phonemes" as referring to the abstract, invariant psychophonetic elements that alternate; in the above example, one could posit a phoneme /g/ that participates in the alternations that cause it to be realized as [g], [g^j], or [k], depending on the context.

In a final step, the term was extended also to sounds that do not alternate, thereby arriving at a conception of the phoneme as "the psychological equivalent of a speech sound" (Baudouin de Courtenay 1972: 152). It is in this sense that the phoneme entered phonological theory in Europe and North America.

3 General concept of the phoneme

The general concept of the phoneme preceded the term or its exact definition, which is a more difficult enterprise. The basic concept is that of the unity of sounds that are objectively different but in some sense functionally the same. As Twaddell (1935: 55) observes, this concept is not new: if a special term was not needed before the late nineteenth century, it is because in the absence of close phonetic observation, it is not necessary to distinguish between "phoneme" and "speech sound." Alphabetic writing systems tend to have separate letters only for sounds that have a distinctive function, though deviations from this principle occur (Krámský 1974: 10; Fischer-Jørgensen 1975: 4). In ordinary parlance one talks of the sound "d" or "k" as if each of these represents a single sound, rather than, as is the case, a range of sounds.

Parallel to the development of the phonemic concept as part of phonological theory mentioned above, British and French phoneticians who laid the foundations for what became the International Phonetic Association (IPA) arrived at a similar notion motivated by more practical concerns. According to Jones (1967: 256), Henry Sweet (1877) was the first to draw a distinction between "narrow" and "broad" transcription: narrow transcription aims (in principle) to record sounds in as much detail as possible, whereas broad transcription records only distinctive differences in sound. It was recognized early on that the goal of assigning a unique symbol to every sound in every language, even if it could be realized, would lead to transcriptions for particular languages that would be impractical and virtually illegible. Therefore, Paul Passy insisted in 1888 that only distinctive differences should be recorded, and called this principle *une règle d'or* ("a golden rule") from which one should never depart (cited in Jones 1967: 256). Thus, while the IPA is popularly known for developing a universal phonetic alphabet that is associated with phonetic ("narrow") transcription, its founders insisted on "broad" (i.e. phonemic) transcription for purely practical reasons. The practical strain remained influential in phonological theory, as attested by the subtitle of Pike's (1947) *Phonemics: A technique for reducing languages to writing*.

It is hard to imagine what linguistic description would be like without a phoneme concept of some sort. To take one entirely typical example, the Australian language Pitta-Pitta (Pama-Nyungan) is said to have three vowels, *i*, *a*, and *u* (Blake 1979: 187). In describing their pronunciation, Blake writes that they "are similar to the vowels of 'been', 'balm', and 'boot' respectively" (presumably [i], [ɑ], and [u]). Further reading reveals that this is only true in open syllables, and when stressed, and when near certain consonants. In a closed syllable, "they are similar to the vowels of 'bin', 'bun', and 'put' " ([ɪ], [ʌ], and [ʊ]). Further, the vowel *a* is pronounced [æ] in the vicinity of a palatal consonant, and unstressed *a* has a schwa-like pronunciation, [ɐ]. Objectively, then, Pitta-Pitta has at least eight different vowel sounds, and probably many more if we were to attend to further distinctions in different segmental and prosodic contexts, and in different situations and for different speakers.

This variation does not detract from the fact that there is an important sense in which this language has three vowels. In the distribution given above, we recognize that the variation is a consequence of the influence of context, and has no contrastive function: [i] and [ɪ] are variants of a phoneme we can designate as /i/, [u] and [ʊ] are variants of /u/, and [ɑ], [ʌ], [æ], and [ɐ] are variants of /a/. Put differently, in every slot where a vowel belongs we have only three choices in this language. If we are told that a word begins with the sequence *m*-vowel-*rr*-, we know that the vowel must be one of the variants of /a/ (e.g. *marra* 'open'), /i/ (e.g. *mirri* 'little girl'), or /u/ (e.g. *murra* 'stick').

4 Defining the phoneme

In the 1930s many linguists came to share the intuition that a concept like the phoneme is needed in phonological description.[1] Pinning down the definition of this concept proved to be difficult. Like other linguistic notions, such as "sentence," "syllable," and "topic," what starts out as a relatively unproblematic intuitive concept inevitably gets caught up in theory-internal considerations. In the case of the phoneme, three issues have been particularly contentious: (i) what sort of entity is the phoneme (physical, psychological, other); (ii) what is the content of the phoneme; and (iii) how does one identify phonemes?

4.1 What type of entity is the phoneme?

Twaddell (1935) surveyed the various definitions of the phoneme that were then in circulation, and classified them as being of two main types. One type assumes that the phoneme is a physical reality, and the other assumes that it is a psychological notion.

[1] Acceptance of the phonemic principle was by no means universal, however, particularly among traditional grammarians and writers of historical grammars. The phoneme does not appear in Campbell's (1959) *Old English grammar*, to the general applause of reviewers (see Dresher 1993 for discussion); its first appearance in a traditional-style Old English grammar is Hogg (1992).

4.1.1 The phoneme as physical reality

One class of definitions assumes that the phoneme is a physical reality of some sort. Thus, Jones (1967: 258) considers the phoneme to be a "family" of sounds in a particular language that "count for practical purposes as if they were one and the same." While such a definition ("explanation" is Jones's preferred term) is fine for practical purposes, it leaves unaddressed the essential nature of the phoneme: what is it about certain sounds that cause them to count as part of the same family?

A more ambitious proposal was made by Bloomfield (1933: 77–78). He characterized the phoneme as:

> a minimum unit of distinctive sound-feature . . . The speaker has been trained to make sound-producing movements in such a way that the phoneme features will be present in the sound waves, and he has been trained to respond only to these features.

Such a definition fits well with the behaviorist psychology assumed by Bloomfield, which sees behavior (including language, which is defined as verbal behavior; cf. Skinner 1957) as being shaped by the association of stimuli with responses; if phonemes are crucial to behavior, according to this view, one might expect them to be overtly present in the signal.

Nevertheless, Twaddell (1935: 63) observes that the acoustic constants required by such a theory had not been observed by experimental phoneticians, and he doubts that advances in laboratory technology would reveal them in the future. Twaddell's judgment has turned out to be prescient. In the 1970s and 1980s Blumstein and Stevens tried to identify invariant acoustic correlates for the phonetic features that make up phonemes (Blumstein and Stevens 1981; Stevens and Blumstein 1981). Despite some early successes, a considerable amount of variability was found when different contexts were considered. The emphasis of this line of research ultimately shifted to consider the role of "enhancing" gestures (Stevens *et al.* 1986; Stevens and Keyser 1989) in helping listeners identify features when the primary acoustic cue has been weakened or obliterated (Stevens 2004).[2] Thus it has not been demonstrated that there is some acoustic constant that characterizes every instance of a phoneme or distinctive feature.

4.1.2 The phoneme as a psychological concept

If the phoneme cannot be identified with a physical constant, a natural alternative is that it is a mental or psychological reality. Many early writers on the phoneme thought of it in psychological terms, and Twaddell (1935: 56f.) assembles some characteristic definitions: the phoneme is a constant acoustic and auditory image (Sommerfelt); a thought sound (Beni); a sound idea (Trubetzkoy); a psychological equivalent of an empirical sound (Ułaszyn); and so on. In modern terms, all these definitions amount to the claim that the phoneme is some sort of mental representation.

Twaddell (1935) criticizes these psychological accounts on two grounds. First, he points out, correctly, that such definitions are not particularly helpful in characterizing what phonemes are. His second critique is more sweeping, and arises from his empiricist view of philosophy and psychology: following Bloomfield, Twaddell argues that mentalistic notions have no place in science, because they cannot

[2] I am grateful to James Smith for discussion of this issue.

be empirically tested. While it is no doubt correct that appealing to a vague and unknown "mind" cannot serve as an adequate explanation (*explanans*) of any phenomenon, the cognitive revolution that began in the 1950s has shown the fruitfulness of studying mental representations and processes as things to be explained (*explananda*).

4.1.3 The phoneme as a fiction

The consequence of rejecting both physical and psychological reality for the phoneme is that Twaddell (1935) is forced to conclude that the phoneme, though an "eminently useful" term, is a fictitious unit. There exist philosophies of science in which useful, indeed indispensible, units can be fictions, but most linguists since the 1950s have taken a "realist" view of linguistics (Chomsky 1980: 104–110). From this perspective, a unit that is required to give an adequate account of some phenomenon must be real at some level. Once we abandon empiricist assumptions about science and psychology, there is no obstacle to considering the phoneme to be a psychological entity.

4.2 What is the content of the phoneme?

It is one thing to locate the phoneme as a psychological (or physical) concept; it remains to try to characterize the content of the phoneme. What are phonemes made of? How are they represented? In this section I review some different approaches to these questions.

4.2.1 The phoneme as a set of contrastively underspecified features

Sapir's "point in the pattern." A particularly influential psychological conception of the phoneme was that of Sapir (1925, 1933). For Sapir (1925), each phoneme occupies a particular point in the sound pattern of a language. For example, he proposes that the hypothetical languages he calls C and D have the identical pattern, even though phonetic details differ. What is important is that each consonant in C has a corresponding consonant in D that occupies the same point in the pattern (the inventories in (1) maintain Sapir's arrangement, though I have updated his notation to modern IPA symbols).

(1) *Phonemes with identical patterning* (Sapir 1925)

a. *Pattern of C*

h		w	j	l	m	n
p	t		k	q		
b	d		g	ɢ		
f	s		x	χ		

b. *Pattern of D*

h		v	ʒ	r	m	ŋ
p^h	t^h		k^h	q^h		
β	ð		ɣ	ʁ		
f	ʃ		ç	ħ		

In other terms, Sapir's "point in the pattern" refers to the contrastive status of a phoneme, and the way it relates to other phonemes in the system. Though Sapir did not assume a theory of distinctive features (CHAPTER 17: DISTINCTIVE FEATURES), some such notion appears to be needed to make this notion explicit (Dresher 2009: 38–39). Thus, the series /b d g ɢ/ in language C can be characterized as being contrastively obstruent and voiced, properties it shares with the series /β ð ɣ ʁ/ in language D.

Sapir points out further that the sound pattern of a language is guided by the phonetics but may deviate from it. For example, /ʒ/ in language D is not classified with the voiced obstruents, but rather with the sonorants, corresponding to /j/ in language C. Thus, this sound is physically an obstruent, but psychologically and functionally a sonorant.

Sapir (1933) goes further in characterizing the phoneme as a psychological unit, arguing that "the phonemic attitude is more basic, psychologically speaking, than the more strictly phonetic one," setting off a debate about the psychological reality of phonemes that is still ongoing. He argues that perception in terms of phonemes accounts for difficulties native speakers have in grasping certain phonetic facts about their language, or perceiving "correctly" the objective sounds before them (see §6). Sapir's interpretation of these "errors" has been disputed over the years, but his work did much to establish the phoneme, and the "-emic attitude" more generally, as an important psychological and symbolic unit.

Prague School: Phonemic make-up or content. We observed that an explication of Sapir's notion of "point in the pattern" benefits from thinking of phonemes as possessing contrastive properties. This idea was carried further by phonologists of the Prague School, notably Jakobson and Trubetzkoy. The notion of opposition (or contrast between two phonemes) was central to their conception (CHAPTER 2: CONTRAST). Analysis of the nature of oppositions requires that phonemes be characterized as possessing features. The contrastive features necessary to distinguish a phoneme from others in the same system contribute to the phonemic make-up (Jakobson) or phonemic content (Trubetzkoy) of the phoneme.

Jakobson (1962) cites the observation of Hála that the simple vowels of Slovak are almost identical to the vowels of Standard Czech except for an additional short front vowel, /æ/, that occurs in dialects of Central Slovak (2).

(2) *Czech and Slovak vowel systems* (Jakobson 1962: 224)

a. *Standard Czech*			b. *Standard Slovak*	
i		u	i	u
e		o	e	o
	a		æ	a

Jakobson notes (1962: 224) that the presence of /æ/ in Slovak, though "a mere detail from a phonetic point of view . . . determines the phonemic make-up of all the short vowels." Thus all the short vowels in Standard Slovak come in pairs that contrast in the frontness/backness dimension, so that the vowels /i e æ/ are contrastively front (acute, in terms of Jakobson's features), and /u o a/ are contrastively back (grave). Lip rounding, though present phonetically in /u/ and /o/, is not contrastive and therefore does not enter into the phonemic make-up of these vowels.

In Czech the low vowel /a/ is not opposed to another low vowel. Therefore, even though it is almost identical to the Slovak /a/, Jakobson considers it to be neutral with respect to tonality, having no contrastive value except for its height.

Trubetzkoy (1969: 66–67) uses the term "phonemic content" to refer, like Jakobson, to those contrastive properties that characterize phonemes:

> By phonemic content we understand all phonologically distinctive properties of a phoneme, that is, those properties which are common to all variants of a phoneme and which distinguish it from all other phonemes of the same language, especially from those that are most closely related . . . The definition of the content of a phoneme depends on what position this phoneme takes in the given phonemic system, that is, in final analysis, with which other phonemes it is in opposition . . . Each phoneme has a definable phonemic content only because the system of distinctive oppositions shows a definite order or structure.

This concept can be illustrated with respect to the phoneme /r/ in three different languages. German has two liquids, /r/ and /l/, which are set apart from all other consonants by being liquids (3a). Trubetzkoy (1969: 73) observes that the phonemic content of German /r/ is "very poor, actually purely negative: it is not a vowel, not a specific obstruent, not a nasal, nor an *l*. Consequently, it also varies greatly with respect to its realization" (see also CHAPTER 30: THE REPRESENTATION OF RHOTICS). By "purely negative," Trubetzkoy means that the contrastive specifications of /r/ are all the unmarked members of their respective contrasts. He proposes that because /r/ is not contrastively specified for place or specific manner of articulation, some speakers pronounce it as a dental vibrant, some as a uvular vibrant, some as a noiseless guttural spirant, and it varies a great deal in different contexts as well. By contrast, "Czech /r/ has a much richer phonemic content," because it stands in a relation not only to /l/ but to /r̝/ (3b): /r/ is distinguished from /r̝/ in that it is not an obstruent but a liquid, and from /l/ in that it is a vibrant. "For this reason, Czech *r* is always, and in all positions, pronounced as a clear and energetically trilled sonorant."[3] In Gilyak (also called Nivkh, a language isolate spoken in Russia along the Amur River and on Sakhalin Island) (3c), /r/ is opposed to a voiceless spirant, and the two fall into place as the dental members of a series of oppositions between voiced and voiceless spirants, from which it follows that Gilyak /r/ is always dental (the Gilyak phonemes are listed as in Gruzdeva 1998: 10).

(3) /r/ *in different languages* (Trubetzkoy 1969)

Phonemic content of /r/

a. *German*
r – l — not a vowel or obstruent or nasal or lateral

b. *Czech*
r – l — liquid, vibrant, and alveolar
|
r̝

c. *Gilyak*
v – r – z – ɣ – ʁ — dental and voiced spirant
| | | | |
f r̝̊ s x χ

[3] Daniel Currie Hall (personal communication) observes that the opposition between /r/ and /r̝/ parallels many other oppositions in Czech between a dental or alveolar and a palatal or postalveolar consonant: /t/~/c/, /ts/~/ʧ/, /z/~/ʒ/, /n/~/ɲ/, etc. (see D. C. Hall 2007: 38). Thus, the /r/~/r̝/ contrast further identifies Czech /r/ as alveolar.

Representing the underspecified phoneme. The remarks concerning Sapir, Jakobson, and Trubetzkoy above suggest a view of the phoneme as having a single representation, from which other variants, or allophones, are derived. Moreover, if the interpretation of these proposals given above is correct, it would appear that this one representation of the phoneme is *underspecified*, in the sense that it consists only of contrastive properties (CHAPTER 7: FEATURE SPECIFICATION AND UNDERSPECIFICATION). Underspecified phonemic representations were proposed by Jakobson and his colleagues (see, among others, Jakobson *et al.* 1952 and Jakobson and Halle 1956). They proposed that contrastive features are assigned by successively dividing up an inventory until each phoneme has been assigned a unique representation. This theory has been taken up within generative phonology under the name Modified Contrastive Specification (MCS; Dresher *et al.* 1994; D. C. Hall 2007; Dresher 2009).

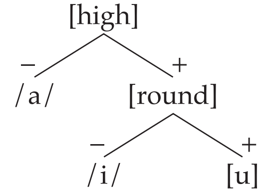
We can illustrate this approach with the vowels of Pitta-Pitta, discussed above in §3. There are three vowel phonemes, therefore two features are required to distinguish them. In MCS it is assumed that only contrastive features are computed by the phonology (the Contrastivist Hypothesis; D. C. Hall 2007: 20); consequently, if features are found to be active in the phonology, by hypothesis it can be supposed that they are contrastive. Lacking any obvious evidence of feature activity in Pitta-Pitta vowels, we can appeal to the phonetic variation of the vowel allophones and universal tendencies in vowel systems. Thus we observe that all the allophones of /i/ and /u/ are [+high], while the allophones of /a/ are not all [+low], but are correctly characterized by [–high]. By Trubetzkoy's criteria for phonemic content, we should choose [high] as one of the contrastive features.

Which feature we choose to distinguish between /i/ and /u/ does not appear to be crucial in terms of the patterning of Pitta-Pitta vowels; I will choose [round] rather than [back], because all the allophones of /u/ are round, whereas the allophones of /a/ may be front or back, but never [round]. Given these features, ordering [high] over [round] conforms to Jakobson and Halle's (1956) hypothesis that the first split in a vowel system is usually a horizontal one, as shown by the tree in (4a).[4]

These contrastive features yield the underlying lexical representations of the three vowel phonemes in (4b), where capital letters represent vowels that are specified only for minimally contrastive features. Remaining features required for pronunciation are supplied by a set of phonetic realization rules as in (4c); sample derivations are shown in (4d).

(4) *Pitta-Pitta vowels: Underspecified phonemes*

a. *Contrastive features*



[4] More information about the phonological patterning of Pitta-Pitta could result in changes to the choice and ordering of features.

b. *Underlying representations*

$$\begin{array}{ccc} /\mathrm{I}/ & /\mathrm{A}/ & /\mathrm{U}/ \\ \begin{bmatrix}\text{+high}\\ \text{–round}\end{bmatrix} & [\text{–high}] & \begin{bmatrix}\text{+high}\\ \text{+round}\end{bmatrix} \end{array}$$

c. *Some realization rules*

i. $[\ \ ] \rightarrow [\text{+tense}]$ / __ in an open syllable

ii. $[\ \ ] \rightarrow [\text{–tense}]$ / __ in a closed syllable

iii. $\begin{bmatrix}\text{–high}\\ \alpha\text{tense}\end{bmatrix} \rightarrow \begin{bmatrix}\alpha\text{low}\\ \text{+back}\\ \text{–round}\end{bmatrix}$

iv. $\begin{bmatrix}\text{+high}\\ \alpha\text{round}\end{bmatrix} \rightarrow [\alpha\text{back}]$

v. $\begin{bmatrix}\text{–high}\\ \text{–stress}\end{bmatrix} \rightarrow$ ɐ

d. *Sample derivations*

	'open'	'little girl'	'stick'
Underlying	/mAr.rA/	/mIr.rI/	/mUr.rA/
Stress	ˈmAr.rA	ˈmIr.rI	ˈmUr.rA
Rules (i)–(v)	ˈmʌr.rɐ	ˈmɪr.ri	ˈmʊr.rɐ

Other versions of underspecification theory have been proposed within generative grammar. In the 1980s, the most notable were Radical Underspecification (Kiparsky 1982, 1985; Archangeli 1984; Pulleyblank 1986) and Contrastive Specification (Steriade 1987). In the 2000s, a number of theories were proposed in which notions of contrast and phonological activity play key roles. Besides MCS, these include the minimalist theories of phonological representation of Hyman (2001a, 2001b, 2003) and Morén (2003, 2006), the theory of feature economy of Clements (2001, 2003, 2009), and the representational economy and underspecification proposal for laryngeal systems of Avery and Idsardi (2001). Other versions of phonological minimalism can be found in Dependency Phonology (Anderson and Ewen 1987; J. M. Anderson 2005; some of the papers in Carr *et al.* 2005) and Radical CV Phonology (van der Hulst 1995, 1996, 2005).

4.2.2 The fully specified basic variant phoneme

The model in (4), with each phoneme represented in the lexicon by a single underspecified representation, is not the only view of phonemic representation. S. R. Anderson (1985) traces it to subsequent interpretations of Saussure's notion that what is important in language is differences. Anderson (1985: 43f.) argues that this view, which he calls the "incompletely specified" theory of the phoneme, is not the only, or even the best, interpretation of what Saussure intended. He presents two alternative views. One is what he calls the "fully specified basic variant" phonemic theory. On this approach, one of the surface allophones of a phoneme is chosen as the basic underlying representation. That is, the representation of a phoneme is a full-fledged segment, with all its properties. A set of rules then changes the basic variant to its allophones in the appropriate contexts. Some theorists associated with Cognitive Grammar (Langacker 1988; Mompeán 2006; Nathan 2006) take a similar view, in which phonemic representations are prototypes or basic level categories abstracted from lexical representations (CHAPTER 1: UNDERLYING REPRESENTATIONS).

A grammar that reflects this view is shown in (5). I have chosen the tense allophones as basic (5a); the other allophones are derived from them by the rules in (5b) (only some are shown). Sample derivations are shown in (5c).

(5) *Pitta-Pitta vowels: Fully specified basic variant phonemes*

a. *Underlying representations*

$$\begin{array}{ccc} /\text{i}/ & /\text{ɑ}/ & /\text{u}/ \\ \begin{bmatrix} \text{+high} \\ \text{–low} \\ \text{–round} \\ \text{–back} \\ \text{+tense} \end{bmatrix} & \begin{bmatrix} \text{–high} \\ \text{+low} \\ \text{–round} \\ \text{+back} \\ \text{+tense} \end{bmatrix} & \begin{bmatrix} \text{+high} \\ \text{–low} \\ \text{+round} \\ \text{+back} \\ \text{+tense} \end{bmatrix} \end{array}$$

b. *Some contextual rules*

i. $[\text{+tense}] \rightarrow \begin{bmatrix} \text{–tense} \\ \text{–low} \end{bmatrix} / \_\_$ in a closed syllable

ii. $\begin{bmatrix} \text{–high} \\ \text{–stress} \end{bmatrix} \rightarrow$ ɐ

c. *Sample derivations*

	'open'	'little girl'	'stick'
Underlying	/mɑr.rɑ/	/mir.ri/	/mur.rɑ/
Stress	ˈmɑr.rɑ	ˈmir.ri	ˈmur.rɑ
Rules (i)–(ii)	ˈmʌr.rɐ	ˈmɪr.ri	ˈmʊr.rɐ

4.2.3 *The phonemic concept without the phoneme*

Both versions of phonemic representation in the preceding sections posit that each phoneme has a single representation, be it underspecified or fully specified. The view that Anderson considers closest to Saussure's intentions is neither of the above, but rather what Anderson calls the "fully specified surface variant" theory. In this version, a phoneme has no single representation. Rather, each surface variant is represented as such, in all its phonetic detail; that a number of such variants constitute a single phoneme is encoded not in representations, but rather in a system of rules that account for the various constraints on where each variant can appear. This proposal recalls Daniel Jones's conception of the phoneme as a family of sounds.

One could question whether the fully specified surface variant theory actually incorporates the phoneme at all. In such a theory there are no representations of phonemes as such. As an example let us consider again the case of Pitta-Pitta: the vowels of *marra*, *mirri*, and *murra* would be represented throughout the grammar as [mʌrrɐ], [mɪrri], and [mʊrrɐ], respectively. The fact that [ʌ ɐ] belong to one phoneme and [ɪ i] to another is not directly indicated by the grammar, but rather must be inferred from the system of rules and/or constraints.

Classical generative phonology did not adopt such a model, but some versions of Optimality Theory (OT; Prince and Smolensky 2004) may be said to instantiate this approach to phonemes. Prince and Smolensky propose that OT places no restrictions on underlying representations, a principle known as Richness of the Base. In Pitta-Pitta, for example, the grammar would be required to derive the correct vowel allophones no matter what input vowels are presented to the grammar. A simplified set of constraints governing the Pitta-Pitta high vowel allophones is given in (6) and a sample evaluation is shown in (7).

(6) *Pitta-Pitta in OT*

Some constraints for high vowels

TnsOpen	Vowels are tense in open syllables.
LaxClosed	Vowels are lax in closed syllables.
Ident[high]	Preserve underlying values of [high].
Ident[round]	Preserve underlying values of [round].
Rd=Bk	The value of [back] must be the same as [round].
Ident[back]	Preserve underlying values of [back].
Ident[tense]	Preserve underlying values of [tense].

(7)

/mɨrrɪ/	TnsOp	LaxCl	Id[hi]	Id[rd]	Rd=Bk	Id[bk]	Id[tns]
a. mɨrrɪ	*!				*		
b. mɨrri					*!		*
c. mʊrri				*!			*
d. mirri		*!				*	**
☞ e. mɪrri						*	*

The input in this example is /mɨrrɪ/, an impossible surface form in which both vowels are "wrong": the first vowel, /ɨ/, is not a possible surface vowel in Pitta-Pitta, according to the description above; the second vowel is possible in a closed syllable, but not in an open one. Therefore, the "faithful" candidate (a), which preserves both input vowels, violates two constraints, one for each vowel. Candidate (b) has a legal vowel in the open syllable but the back unrounded vowel is illicit. Candidate (c) repairs the unattested /ɨ/ by making it correspond to [ʊ], a possible sound in this context, but not in correspondence with an underlying [–round] vowel. Candidate (d) changes both vowels to [+tense], incurring a fatal violation of LaxClosed. Candidate (e) is the winner because it alone respects all the constraints in the highest tier, though violating the two lower-ranking constraints.

In this kind of grammar there is no representation of a phoneme /I/ or /i/, nor is there any statement to the effect that [i] and [ɪ] are allophones of a single phoneme. The latter is a consequence of the constraints and the way they interact, ensuring that any input vowel bearing the feature specifications [+high, –round] will surface as [i] in an open syllable and as [ɪ] in a closed syllable, whatever other specifications they start with.

This view of the phoneme has certain affinities with Exemplar Theory and related proposals (Johnson 1997; Bybee 2001; Pierrehumbert 2001; Välimaa-Blum 2009), whereby multiple copies of lexical items are stored in great detail, forming exemplar "clouds" of remembered episodes of individual experience. On this view, speech sounds, too, are stored in terms of exemplar clouds. Some exemplar theorists posit that there are exemplar clouds of phonemes as well as of words

(Pierrehumbert 2001: 148). Others, such as Välimaa-Blum (2009), argue that there are no separate phonemic representations apart from the exemplar clouds of lexical items. One might think that such a theory dispenses with the phoneme entirely, but Välimaa-Blum (2009: 19) still concludes that "phonemes are indispensable for the overt manifestation of meaningful language."

4.3 How does one identify phonemes?

The practical question of how one identifies phonemes in any particular language was the subject of much discussion in the first half of the twentieth century. One question that frequently arises is whether a sound is a single phoneme (say, /ts/, /^{n}d/, or /ʃ/) or a sequence of phonemes (/t-s/, /n-d/, or /s-j/). The matter can usually be resolved by looking at the distribution of the sound(s) in question, to see if they pattern with single segments or with clusters.

Chao (1934) famously asked if phonemic solutions are unique. This is part of the more general question of whether speakers can arrive at different grammars based on the same evidence. The answer to this question is highly dependent on the theoretical framework one adopts.

The central issue in phonemic analysis, however, is whether two sounds are members of the same phoneme or of different phonemes.

4.3.1 The commutation test and complementary distribution

The most common criterion for deciding whether or not two sounds are members of the same phoneme is if switching one for another in the same environment results in a different word. For example, changing [p^{h}] in *pin* to [b] results in a different word, *bin*; therefore, the sounds [p^{h}] and [b] belong to different phonemes in English. Substituting an unaspirated [p] for either of these does not result in a new word, but rather in what sounds like an oddly pronounced version of either *pin* or *bin*. We can conclude that [p] does not belong to a third phoneme in English next to /p^{h}/ and /b/, but is an allophone of one of these phonemes.

According to Fischer-Jørgensen (1975), the term "commutation test" was introduced for this procedure by Hjelmslev, though she traces its use at least as far back as the Icelandic twelfth-century First Grammarian. In North America the term "complementary distribution" (Swadesh 1934) has been more commonly used to characterize the usual distribution of allophones. In the above example, [p^{h}] and [p] are in complementary distribution before stressed vowels: [p^{h}] occurs when initial (*pin*), [p] occurs when preceded by [s] (*spin*). Therefore, they are potentially allophones of a single phoneme.

Complementary distribution is rarely sufficient to establish which allophones belong together in a phoneme, because a sound may be in complementary distribution with more than one other sound. For example, English unaspirated [p] is in complementary distribution not only with [p^{h}] but also with [t^{h}] and with [k^{h}]. In this case analysts have appealed to phonetic similarity, or commonality of feature specifications, to classify [p] with [p^{h}] rather than with the other voiceless aspirates (see Harris 1951: 63–78; Chomsky 1964: 92–93).

Unaspirated [p] is equally in complementary distribution with [b] before a stressed vowel (*spin vs. bin*), and this poses a more difficult classification problem. None of the criteria discussed above can resolve this issue, so we need to look for other kinds of evidence. The orthography suggests they are allophones of the voiceless stops – we write *spin*, *stun*, *skin*, not **sbin*, **sdun*, **sgin* – and this has been commonly assumed in analyses that consider voicing to be the decisive criterion (Swadesh 1934; Hockett 1942; Harris 1951). On the other hand, if aspiration is taken to be the main contrastive feature that distinguishes /p^h/ from /b/ (Avery and Idsardi 2001), then [p] fits better as an allophone of /b/.[5]

The situation in English is further complicated in word-final position, where both aspirated ([p^h]) and unreleased ([$p^{\urcorner}$]) voiceless stops can occur without changing meaning: *tap* can be pronounced with either type of *p*. Here, aspirated [p^h] and unreleased [$p^{\urcorner}$] are said to be allophones in "free variation"; both are in contrast with /b/ (*tab*).[6]

4.3.2 Allophones that are not in complementary distribution

In phonemic theory nothing is as simple as it looks, and even venerable criteria like the commutation test and complementary distribution may fail in certain circumstances, and pose more difficulties than are first apparent. Simple examples where these tests fail are cases of partial phonemic overlapping. For example, Chukchee (Paleo-Siberian) has a process of vowel harmony whereby the vowels /i u e/ are changed into [e o ɑ], respectively, in a word containing a low vowel /ɛ/, /ɑ/, or /ɔ/ (Kenstowicz and Kisseberth 1979). Since these alternations are predictable given the phonetic environment, it appears straightforward that the phonemes /i e u/ each have two allophones, as shown in (8).

(8) *Chukchee phonemes*

Phonemes		/i/		/e/			/u/	
Allophones	[i]		[e]		[ɑ]	[u]		[o]

The phone [e] is an allophone of both /i/ and /e/; therefore, [i] is not in complementary distribution with [e], and so, by strict application of the criterion, the sounds [i] and [e] may not be members of the same phoneme. Similarly, these sounds fail the commutation test: substituting [e] for [i] in a word without low vowels could result in a different word, since /i/ and /e/ are in contrast. Nevertheless, even as strict a phonemicist as Bloch (1941) allows that this kind of overlapping should be permitted, because it is always evident from the phonetic context which phoneme a token of [e] belongs to: /e/ in words without low vowels, /i/ in words with low vowels.

Other cases of overlapping allophones have been more controversial, particularly when more information is required to recover what phoneme an allophone belongs to. In Mercian Old English the short diphthongs written *ea* ([æə]), *eo* ([eə]), and *io* ([iə]) derive historically from the short front vowels *æ*, *e*, and *i*, respectively, in a number of contexts.[7] One of the rules that historically derived short diphthongs

[5] Twaddell (1935) argues that it is "arbitrary" to assign [p] in *spin* to either /p^h/ or /b/ and proposes that it be assigned to a third phoneme /p/.

[6] Though it is clear in this position which allophones go together, the nature of the contrast between voiceless and voiced consonants is controversial. It has frequently been observed that the main cue to distinguishing between them is not voicing but the preceding vowel length (Bybee 2001: 43–44): the vowel is longer before voiced consonants (*tap vs. tab*).

[7] I follow Brunner (1953) in interpreting orthographic *ea* as [æə], *eo* as [eə] and *io* as [iə].

is back mutation (also known as back umlaut), stated informally in (9). This rule creates many alternations, such as the ones shown in (10); forms are drawn from the *Vespasian Psalter* (Kuhn 1965), a major Mercian text.

(9) *Back mutation*

Insert [ə] after a stressed short front vowel in an open syllable when a back vowel follows in the next syllable.

(10) *Alternations created by back mutation*

a. *Non-mutation contexts*		b. *Back mutation*	
w[e]*r*	'man (NOM SG)'	*w*[eə]*ras*	(NOM PL)
g[e]*fe*	'grace (ACC SG)'	*g*[eə]*fu*	(NOM SG)

In the forms in (10), [e] and [eə] are in complementary distribution, and there is no obstacle to considering them to be allophones of a single phoneme. The alternation of [e] and [eə] within morphemes strengthens the connection between these vowels.

Back mutation also applies within morphemes without creating alternations, for example in disyllabic stems such as in (11). In these examples, the context for back mutation is supplied by a stem vowel rather than by an inflectional vowel, and so back mutation applies to all members of the paradigm.

(11) *Back mutation in stems, no alternations*

h[eə]*rut*	'hart (NOM SG)'	*h*[eə]*rutes*	(GEN SG)
oferg[eə]*tul*	'forgetful (NOM SG MASC)'	*oferg*[eə]*tule*	(NOM PL MASC)

Up to now [e] and [eə] have been in strict complementary distribution; if this were so throughout the language, most phonologists would analyze [eə] as an allophone of /e/ in (11), despite the lack of alternations (and similarly [æə] would be analyzed as an allophone of /æ/, and [iə] as an allophone of /i/). However, there are contexts in which we do not find the expected surface distribution of these vowels. An example is shown in (12). These forms show back mutation even though they are not followed by a back vowel on the surface. Dresher (1985: 56–58) argues that the underlying forms of the stems in (12a) are /hefun/ and /sefun/; the underlying /u/ is reduced to *e* (perhaps here representing [ə]) by the rule in (12b).

(12) a. *Back mutation in stems, no alternations*

h[eə]*fen*	'heaven (NOM SG)'	*h*[eə]*fenes*	(GEN SG)
s[eə]*fen*	'seven'		

b. *Prenasal vowel reduction* (Dresher 1985: 56)
An unstressed vowel is reduced to *e* before a nasal consonant within a stem.

On this analysis, /hefun/ undergoes back mutation to *h*[eə]*fun* before the *u* is reduced to *e* to yield surface *h*[eə]*fen*. In support of this analysis is the fact that there are no examples of unstressed *u* before *n* within a stem. Moreover, positing a /u/ in such forms fills a gap in the pattern of final VC sequences in disyllabic noun stems: we have stems ending in *-el* and *-ul*, and *-er* and *-ur*, but with *n* we find only *-en*, but not *-un*.

In terms of Kiparsky (1973), prenasal vowel reduction makes back mutation *opaque*; that is, the context of back mutation is contradicted at the surface. Hockett (1959) argues that the existence of minimal pairs and near-minimal pairs (e.g. *h*[eə]*fen-* and *s*[eə]*fen-* against *s*[e]*ten-* 'shoot' and *m*[e]*nen-* 'slave', from /seten-/ and /menen-/, respectively) is sufficient to require the short diphthongs to be regarded as independent phonemes. Dresher (1985) argues that a synchronic grammar of Mercian should treat the short diphthongs as allophones of the short monophthongs, because the relevant rules can be recovered, despite their opacity.

Some argue that the choice between separate phonemes or allophones of one phoneme is not a binary one, and that there exist intermediate cases. For example, Scobbie and Stuart-Smith (2008) suggest that Scottish English contains marginal contrasts that are due to "fuzzy" or "quasi-" phonemes; they propose (2008: 87) that such cases show that "contrast must be treated as a gradient phenomenon at the phonological level, with membership of a phonemic inventory being a matter of degree." This approach is taken up by K. C. Hall (2009), who proposes a probabilistic model of phonological relationships, based on the degree of predictability of sounds in any given context (CHAPTER 89: GRADIENCE AND CATEGORICALITY IN PHONOLOGICAL THEORY).

These cases are also bound up with the general issue of how abstract phonology may be with respect to the phonetics, and to what extent morphological and other non-phonetic information may be brought to bear on phonemic analysis. This issue is too big to cover in this review, but we can touch on one aspect of it that played a major role in discussions about the phoneme, and this is the question of linguistic levels.

5 Phonemes and levels

From the earliest days of the phoneme concept there was a considerable ambiguity in the notion that objectively different sounds are in some sense the same. We can apply this idea in a narrow sense to relatively small differences in the phonetic manifestations of sounds, for example, the inter- or intra-speaker variations in the voice onset time of English [p^h], or the changes in the articulation of English /k/ in different environments. But the notion of "same sound" can also be applied more widely, as in the early sense of phoneme to refer to correspondence sets: in this sense, the plural [s] in *cats* is the "same sound" as the plural [z] in *dogs*, and the final [k] of *electric* is the "same sound" as the [s] in *electricity*. What level of the phonology one locates the phoneme at is partly a function of what other levels one considers there to be.

5.1 The phonemic level in post-Bloomfieldian American linguistics

Bloomfield and the American linguists who followed him maintained that a phonetic level corresponding to a narrow transcription cannot be supported as a legitimate linguistic representation, because it is not systematic but arbitrary. In this they followed in the steps of Passy and the founders of the IPA, who argued that only distinctive differences should be transcribed. According to Bloomfield, a transcription that aims to record non-distinctive differences is necessarily dependent on the background and perception of the transcriber: some transcribers will notice and note down certain fine distinctions, but others that are less familiar to them will go unrecorded, particularly as they are not crucial to marking contrastive sounds in the language. Since a linguistic representation must be based on more than just the whims of individual transcribers, Bloomfield concluded that there is no principled level of phonetic representation corresponding to a narrow transcription.

That leaves the phonemic level as the lowest level of sound that speakers can encode into lexical items. Bloch (1941) observed that this fact has important implications for learnability. For example, in English unstressed vowels reduce to schwa [ə] in many contexts, making [ə] an allophone of every English vowel phoneme. It follows that a phonemic representation should include unreduced vowels only; reduction to schwa would then be a rule-governed allophonic variation.

Bloch (1941) argued that while such a system is indeed elegant, it poses problems for a learner (as well as a linguist unfamiliar with the language). What happens when learners come across a schwa whose unreduced version is unknown to them, as in words like *sofa* or *of*? Or even *manager*, if they haven't heard a related form such as *managerial?* If there were a "lower" phonetic level of representation, a learner could at least represent the phonetic form of such words with a schwa, while deferring a decision as to which underlying phoneme to assign it to. But, having rejected a phonetic level, post-Bloomfieldian theory had no recourse to such a level of representation. The consequence is that learners (and linguists) would be unable to assign any phonological representation to such utterances.

Moreover, according to Bloch, the only data relevant to phonemic analysis are "the facts of pronunciation," i.e. the distribution of surface allophones, and not, for example, the existence of morphologically related forms. This assumption severely limits the evidence one can use in arriving at a phonological analysis. It presupposes an analyst who has no access to the fact that the word *manager* is related to *managerial*. Such an analyst would not be in a position to know that the final schwa of the former is related to the stressed vowel of the latter.

Bloch concludes that the phonemic level must be easily accessible to a learner who can evaluate only the phonetic context. This puts severe constraints on the degree to which the phonemic level can depart from the phonetics. To handle the more abstract ways in which sounds are related to each other, such as the fact that schwa alternates with [iː] in *manager* ~ *managerial*, the post-Bloomfieldians posited a morphophonemic level, arriving at a two-level model, as in Figure 11.1.

5.2 The systematic phoneme

Halle and Chomsky made a number of arguments against the model in Figure 11.1, and specifically against the phonemic level. Halle (1959: 22–23) argues that the division into morphophonemic and phonemic components is undesirable, because it prevents capturing generalizations. Russian has a rule of regressive voicing assimilation (RVA) that assimilates all obstruents in a cluster to the voicing of its

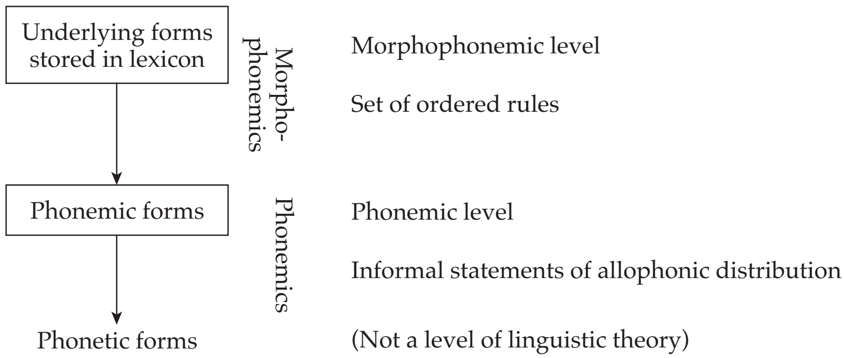


Figure 11.1 Levels in post-Bloomfieldian American structuralist phonology

final obstruent. Voicing is a contrastive feature in Russian that distinguishes pairs of obstruent phonemes: /t/ and /d/ have opposite specifications for the feature [voiced], as do /k/ and /g/, /s/ and /z/, and so on. Since RVA mainly turns one phoneme into another, it must apply in the morphophonemic component:

(13) *Russian regressive voicing assimilation*

a.	*Morphophonemic component*		
	Morphophonemes	//ˈmok bi//	//ˈmok l^{j}i//
	RVA	ˈmog bi	—
	Phonemes	/ˈmog bi/	/ˈmok l^{j}i/
b.	*Allophonic component*		
	Phonemes	/ˈmog bi/	/ˈmok l^{j}i/
	Other rules	ˈmog bɨ	—
	Phonetic form	[ˈmog bɨ]	[ˈmok l^{j}i]
		'were (he) getting wet'	'was (he) getting wet?'

In (13), the phrase 'were (he) getting wet' is realized as [ˈmog bɨ], where underlying /k/ voices to /g/ before voiced obstruent /b/ (compare [mok l^{j}i] 'was (he) getting wet?', with a /k/ preceding the sonorant /l^{j}/). The rule that changes /k/ to /g/ changes one phoneme to another, and so it must be a morphophonemic rule. This result is forced in any phonemic theory that observes the constraint that allophones of different phonemes may not overlap: in this case, [k] may not be an allophone of both /k/ and /g/.

Halle (1959: 22–23) points out that there are Russian obstruents that do not have voiced counterparts, /ts ʧ x/ (that is, there are no contrasting phonemes /dz ʤ ɣ/). He observes that these phonemes participate in voicing alternations in the same way as other obstruents; in particular, they trigger and undergo RVA (14). Thus, we have [ˈʒeʤ bɨ] 'were one to burn', where [ʤ] is the voiced counterpart of [ʧ] (compare [ˈʒeʧ l^{j}i] 'should one burn?', with voiceless [ʧ] before [l^{j}]). Because [ʤ] is not a phoneme in its own right, but exists only as an allophone of /ʧ/, this application of voicing is an allophonic rule, and must be assigned to the component that maps phonemic forms into phonetic forms.

(14) *Russian regressive voicing assimilation*

a.	*Morphophonemic component*		
	Morphophonemes	//ˈʒetʃ bi//	//ˈʒetʃ lʲi//
	RVA	—	—
	Phonemes	/ˈʒetʃ bi/	/ˈʒetʃ lʲi/
b.	*Allophonic component*		
	Phonemes	/ˈʒetʃ bi/	/ˈʒetʃ lʲi/
	RVA	ˈʒedʒ bi	—
	Other rules	ˈʒedʒ bɨ	ˈʒetʃ lʲi
	Phonetic form	[ˈʒedʒ bɨ]	[ˈʒetʃ lʲi]
		'were one to burn'	'should one burn?'

RVA would have to apply twice: once in the morphophonemic component, where the result is an existing phoneme (13); and again at the phonemic level, to create voiced allophones of the unpaired phonemes /ts tʃ x/ (14). Halle argues that the post-Bloomfieldian phonemic level makes it impossible to capture the generalization that there is one voicing rule at work here, applying equally to all the segments in its purview.

Chomsky (1964) continues the attack on the post-Bloomfieldian phoneme, which he calls the "taxonomic" phoneme, as opposed to the broader "systematic" phoneme that he identifies with the post-Bloomfieldian morphophonemic level. He characterizes the taxonomic phoneme as observing a number of restrictive conditions, and argues that these conditions are not empirically supported (see Dresher 2005 for a fuller account).

We observed above that much of the motivation for the taxonomic phoneme stems from the argument against a systematic phonetic level (an argument that goes back to the founders of the IPA). Chomsky (1964) points out that this argument rests on the assumption that there is no universal theory of phonetic representation. Lacking such a theory, it would appear that a phonetic representation has no principled basis. However, he suggests that a universal feature theory, of the sort initiated by Prague School linguists and developed in works such as Jakobson *et al.* (1952) and Jakobson and Halle (1956), and subsequently revised by Chomsky and Halle (1968), can serve as the basis for a phonetic transcription. The universal set of distinctive features is designed to discriminate all and only those aspects of sounds that are contrastive in the languages of the world. The existence of a universal set of phonetic features constrains what can go into a phonetic representation.

Therefore, the phonological theory of Chomsky and Halle (1968) dispenses with the taxonomic phonemic level and replaces it with a systematic level as diagrammed in Figure 11.2.

Although the model in Figure 11.2 was accepted by many generative phonologists, the phonetic level has never been well defined, and debates continue as to whether there should be a level or levels in between the underlying and surface. One influential proposal is the theory of Lexical Phonology and Morphology (LPM; Pesetsky 1979; Kiparsky 1982, 1985; Kaisse and Shaw 1985; Mohanan 1986). OT versions are proposed by Kiparsky 2000, 2003, forthcoming; Bermúdez-Otero 2003, forthcoming). LPM posits that there is a fundamental distinction between lexical and post-lexical phonology (CHAPTER 94: LEXICAL PHONOLOGY AND THE LEXICAL

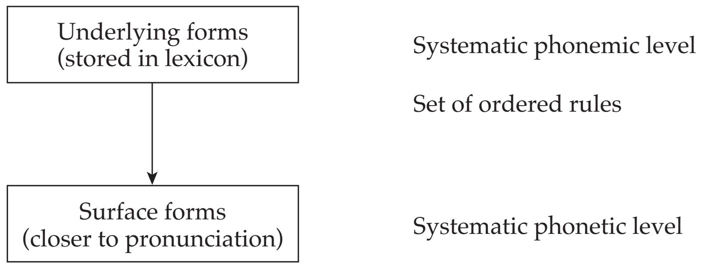


Figure 11.2 Levels in classical generative phonology (Chomsky and Halle 1968)

SYNDROME). Lexical phonology interacts with the morphology and the lexicon, and tends to be restricted to phonemes, somewhat like the old morphophonemic component. Post-lexical phonology follows the lexical phonology and may create new allophones, having properties one would rather associate with "low-level" phonetic rules.

6 Evidence for the phoneme

We have seen that the major motivation for the phoneme is its role as a functional unit that allows one to make concrete the intuition that sounds that are objectively different are functionally "the same" at some level of analysis. If the phoneme is a part of speakers' knowledge of their grammar, it is tempting to suppose that we ought to find other kinds of evidence for its existence. The following sections consider three types of evidence: evidence that native speakers are or can be made aware of phonemes in their language; psycholinguistic and neurolinguistic evidence that speakers can perceive or manipulate phonemes in their language; and evidence from synchronic patterning.

6.1 Evidence for awareness of the phoneme

Early writers on the phoneme assumed that the existence of alphabetic writing developed from intuitively processing language in terms of phonemes, or phoneme-like units (Twaddell 1935; Fischer-Jørgensen 1975). Thus it is natural for English speakers to perceive the word *cat* as consisting of three segments. But some authors have argued that the causality runs in the other direction: English speakers can divide *cat* into three segments because they are familiar with the English spelling. Further, they argue that the supposed naturalness of broad phonemic transcription is itself a consequence of literacy in alphabetic writing systems (Silverman 2006).

Sapir (1933) was the first to argue explicitly that the phoneme is a unit of perception, by showing how phonemic perception could account for a variety of otherwise puzzling "errors" made by his native consultants. In one example, Tony, a native speaker of Southern Paiute being taught to write his language phonetically, transcribed [ˈpaːˌβa^{h}] 'at the water' as [ˈpaːˌpa^{h}]. The error is explained by Sapir's phonemic analysis of Southern Paiute (Sapir 1930), which reveals [β] to be an allophone of /p/, so that the phonemic form of 'at the water' is /paː-paː/ 'water-at'. In another example, Alex Thomas, a Nootka (now called Nuu-chah-nulth) consultant who wrote his language very accurately, transcribed geminates derived from the concatenation of identical consonants with double consonants, but used only a single consonant to represent a geminate that came about by automatic lengthening after a short vowel. Sapir notes that there is no appreciable difference in length between the two types of geminates, so a narrow phonetic transcription should treat them the same. Since the latter type of geminate is not phonemic but a variant of a single consonant, Alex Thomas's transcription was in accord with the phonemic representation.

Sapir's interpretation of these facts was controversial in his own time (see Twaddell 1935) and remains so in ours (Silverman 2006). Some critics point out that the consultants had received phonetic training, so that one could still suspect that literacy is a key to being able to segment words into phonemes, rather than literacy simply being an expression of speakers' (often tacit) internal analysis of sounds.

A direct way of testing which approach is correct is to see if non-literate speakers, or speakers of languages that are not written alphabetically, can segment words into phoneme-like units. This is not as easy to determine as one might suppose. Walsh (2009) reviews the arguments concerning the role of "phonemic awareness" in children learning to read. One of the main questions is whether awareness that words can be analyzed into phonemes is a prerequisite to successful reading or the result of learning to read. Walsh argues that much of the disagreement in the field is the result of unclear definitions. She proposes that one should distinguish between phonemic awareness, the basic knowledge that words are made up of sounds, and phonemic skills, the ability to perform various tasks, such as adding, deleting, or rearranging the sounds in a word. Walsh argues that the former develops as a result of experience with spoken language and is a prerequisite to learning to read, as was proposed by Liberman (1971), Gleitman and Rozin (1977), and Rozin and Gleitman (1977); sophisticated phonemic skills, on the other hand, develop as a consequence of learning to read.

Consistent with this view are the results of Morais *et al.* (1979), who found that literate, but not illiterate, Portuguese adults could add and delete consonants at the beginning of words. Read *et al.* (1986) found that Chinese adults literate only in Chinese characters could not add or delete individual consonants in spoken Chinese words, though a comparable group who were literate in alphabetic spelling as well as characters could successfully perform the same tasks.

It can be observed that these tests may not be getting at the notion of "phoneme" at all, but rather are testing to see if speakers can isolate individual *segments* in a word. The ability to identify segments is a prerequisite to an analysis of segments into phonemes.

6.2 *Psycholinguistic and neurolinguistic evidence for the phoneme*

A somewhat more indirect means of determining if speakers have access to phonemic representations comes from observing unintentional errors in perception or production (CHAPTER 98: SPEECH PERCEPTION AND PHONOLOGY), or the types of manipulations involved in language games.

Sapir's (1933) arguments for the phoneme as a unit of perception are early examples of this type. Fromkin (1971, 1973) argues that slips of the tongue are a window on linguistic representations and processes. Errors like *teep a cape* for *keep a tape* and [fuwt mijving] for *feet moving* show transpositions of individual segments cut out of the speech stream. Fromkin argues that errors where only one segment in a cluster is involved provide further evidence that individual segments are units of speech performance: examples are *fish grotto* > *frish gotto* and *sticky point* > *spicky point*.[8]

Language games exist in many languages and involve manipulations of various kinds of linguistic units (see Sherzer 1982 and Bagemihl 1995 for overviews). Games that pick out individual segments appear to presuppose a linguistic analysis in which such units are represented. For example, some games involve the exchange of segments: Tagalog /ˈdito/ > /ˈdoti/ 'here', or Javanese /satus/ > /tasus/ '100' (cited in Bagemihl 1995: 704). Again, much of this does not specifically show evidence for phonemes as opposed to segments.

Neurolinguistic evidence is becoming increasingly influential in finding out about the sort of representations speakers have. Kazanina *et al.* (2006) report that magneto-encephalographic brain recordings reveal that Russian and Korean speakers react differently to tokens of [d] and [t]. In Russian, these sounds are contrastive, members of different phonemes, /d/ and /t/; in Korean, both sounds exist, but they are not contrastive and map into a single phoneme /T/. Russian speakers showed evidence of separating the sounds into two categories, whereas Korean speakers did not. Kazanina *et al.* (2006) conclude that a speaker's perceptual space is shaped not only by the phonetic distribution of sounds, but also by a more abstract phonemic analysis of speech sounds.

6.3 *Evidence from synchronic and diachronic patterning*

The most pervasive sort of evidence for phonemic representations comes from synchronic and diachronic phonological processes, which typically target individual segments, or classes of segments. It is hard to see how phonology could operate without some representations of the affected units. Of course, whether or not a phonemic representation is required depends on what alternate units are posited. Thus, some processes that apply to initial or final consonants could be recast as applying to syllable onsets or codas (CHAPTER 33: SYLLABLE-INTERNAL STRUCTURE). Even in such cases, it may still be necessary to be able to identify individual phonemes, apart from their positions in syllables. As Idsardi (2010) points out, Russian /ivan/ 'Ivan' and /k ɨvanu/ 'to Ivan' have no syllables in common: 'Ivan' is syllabified /i.van/ and 'to Ivan' is syllabified /kɨ.va.nu/ (cf. Halle and Clements 1983: 149). A representation in which syllables are primitives would have difficulty showing how these words are related.

[8] As mentioned in the previous section, these types of tests are often ambiguous as to whether they target phonemes or just segments. Most of these speech errors show that individual segments can be isolated, but do not necessarily require a phonemic analysis. One interesting example Fromkin (1971: 31) cites is *split pea soup* becoming *plit spea soup*. The fact that *pl* (presumably [pʰl], though Fromkin does not explicitly say) surfaces rather than *bl* when the *s* is transposed could suggest that the speaker groups unaspirated stops following *s* with voiceless stops, rather than with voiced stops.

7 The phoneme in the twenty-first century

As the above survey shows, the phoneme has not disappeared from phonological theory. The fact that recent handbooks of phonology have no chapters devoted to it is not a sign of its demise; rather, it is a function of the development of phonological theory. The time is past when one can attempt to provide an exhaustive definition of the phoneme and its properties apart from elaborating a complete theory of phonology. Many current topics in phonology can be viewed as being about aspects of the phoneme, even though the phoneme is not invoked. For example, the content of the phoneme is studied in distinctive feature theory (CHAPTER 17: DISTINCTIVE FEATURES), feature organization ("geometry"; CHAPTER 27: THE ORGANIZATION OF FEATURES), underspecification (CHAPTER 7: FEATURE SPECIFICATION AND UNDERSPECIFICATION), markedness theory (CHAPTER 4: MARKEDNESS) and notions of contrast (CHAPTER 2: CONTRAST). Constraints on the relations between phonemes and phonetics on one side, and lexical representations on the other, are bound up with the question of the organization of the phonological grammar, whether parallel or derivational, or divided into lexical and post-lexical components, and the relation between lexical storage and production and perception.

When one reads the pioneering works of phonology in the late nineteenth and early twentieth centuries, one is struck at their sense of excitement and revelation when discussing the phoneme. This same feeling continues to exist in introductory courses, where the phoneme retains a central place. That phonological theory has subsumed it into more specialized issues and sub-theories does not detract from the fact that it remains, in the words of Krámský (1974: 7), "one of the most magnificent achievements of linguistic science."

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