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**PHONOLOGY.** [This entry is concerned with the ways in which sounds are used in human language. It comprises four articles:

An Overview

American Structuralist Phonology

European Structuralist Phonology

External Validation

For related topics, see also Acquisition of Language, article on Phonology; Autosegmental Phonology; Borrowing, article on Loanword Phonology; Generative Phonology; Juncture and Boundary; Lexical Phonology; Markedness, article on Markedness in Phonology; Metrical Phonology; Morphophonemics; Natural Phonology; Phonemic Systems; Phonetics; Phonological Change; Phonological Features; Prosodic Phonology; Rule-Ordering in Phonology; Segments; and Syllables.]

### An Overview

Phonology is the study of the sound structure of language. Within linguistics as a whole, it has closest connections with morphology and syntax on the one hand, and with phonetics on the other. (For general reference, see Sommerstein 1977, Kenstowicz & Kisseberth 1979, Dell 1980, Van der Hulst & Smith 1982, Lass 1984, and Anderson 1985.)

**1. Early history.** Although the emergence of phonology as a distinct discipline is relatively recent, its practice is actually quite ancient. The discovery of alphabetic writing in the ancient Near East required significant understanding of sound structure; the SEGMENT and the PHONEME, two basic results of phonological analysis, are prerequisites to the alphabet.

A concern with the proper transmission of sacred texts led to very detailed study of the phonology of Sanskrit by the grammarian Pāṇini (5th c. BCE). [See History of Linguistics, article on Ancient India.] Pāṇini is generally credited with constructing the first generative phonology,

in which explicit rules relate an abstract representation of words to their actual pronunciation. This aspect of Pāṇini's work had a considerable impact on modern linguists, particularly Leonard Bloomfield [*q.v.*]. For similar reasons of textual study, the phonological structures of Arabic and Hebrew were later investigated by scholars in the Middle East, North Africa, and Europe.

**2. Structuralism.** During the first half of the 20th century, the most significant intellectual developments in the field were the emergence of American and European STRUCTURALISM as the basis for nearly all phonological research. [See History of Linguistics, *articles on American Structuralism and The Prague School.*] Particularly influential figures of this period were Bloomfield and Edward Sapir in the United States, and Roman Jakobson and Nikolai S. Trubetzkoy in Europe. [See Sapir, Edward; Jakobson, Roman.]

The greatest single contribution of structuralism to phonology was the recognition of the phoneme as the fundamental unit of the organization of sound systems. This unit is a contrastive element by which two words can be distinguished. The phoneme abstracts away from detailed rules of pronunciation to provide a representation of language from which the fully predictable aspects of phonological structure are absent. For example, the *p*'s of Eng. *pit* and *spit* differ in aspiration, the puff of air that immediately follows the release of the closure at the lips. If we transcribe aspirated *p* as [p<sup>h</sup>], then we can represent these two words phonetically as [p<sup>h</sup>it] and [spit]. From a phonological standpoint, however, the phonetically distinct *p*'s of these two words are not in contrast: whether *p* is aspirated is entirely predictable by a rule of pronunciation, i.e. 'Aspirate *p* when it begins a syllable.' The phoneme written as /p/ is expressed as one of its two ALLOPHONES [p] or [p<sup>h</sup>], by this rule of pronunciation. [See also Phonological Features.]

The discovery of the phoneme led to a number of important results. Not only did it account for exceptionless aspects of pronunciation; it also provided a way of representing the lexicon of a language in terms of the units by which different lexical items are distinguished. The possibility was also opened of studying the PHONEMIC SYSTEMS [*q.v.*] of languages, which revealed the systematic patterning of phonological oppositions. Thus, for each of the Eng. voiceless stop phonemes /p t k/, there is a contrasting voiced stop phoneme /b d g/. The important paper of Sapir 1933 showed that phonemes are a part of speakers' mental representation of their language, rather than a mere analytic construct.

**3. Generative phonology.** Contemporary phonology begins with the watershed work of Chomsky & Halle 1968, *The sound pattern of English (SPE)*. The title alludes to a paper by Sapir; the analysis contains a subtle reference to Pāṇini. This book is both a synthesis of the results of earlier research, and a record of major innovations. It describes a theory of sound structure that is known as GENERATIVE PHONOLOGY [*q.v.*], and applies it to a detailed analysis of English. The most influential themes of this work are as follows:

**3.1.** The theory is generative in the sense that it requires explicit formulation of the rules that relate the underlying representations of the lexicon to the surface representations of actual pronunciation. This permits exact evaluation of competing analyses of the same phenomenon.

**3.2.** The theory must be capable of describing all and only the sound systems and rules that actually occur in languages. This requirement follows from the psychological claims made: a generative phonology is a model of the mental representation by adult native speakers of the sound structure of a language. Phonological theory provides a limited set of possible models, among which a child must choose when learning a language.

**3.3.** The theory of phonological processes is a universal theory of how to express rules in terms of a metalanguage. The metalanguage (usually called the 'notational system' or 'abbreviatory conventions') makes claims about what sorts of phonological rules are possible in any natural language. For example, under certain conditions, stress in Hebrew falls on the final syllable of words ending in a C[onsonant]; however, it falls on the penultimate syllable of words ending in a V[owel]. Two rules are required: a penultimate stress rule,  $V \rightarrow \text{stress} / \text{---}CV\#$ , and a final stress rule,  $V \rightarrow \text{stress} / \text{---}C\#$ . (The symbol # marks the end of a word.) The *SPE* theory requires that these two rules be collapsed or abbreviated as  $V \rightarrow \text{stress} / \text{---}(CV)\#$ , with parentheses demarcating the elements not common to the two rules. The theory also claims that rules abbreviated in this way are subject to a principle of DISJUNCTIVE ORDERING, such that the longer rule applies first and disjunctively with respect to the shorter one. Thus any word that undergoes the longer (penultimate) stress rule will fail to undergo the shorter (final) stress rule. This is correct; CVCV words have penultimate stress without final stress.

Finally, *SPE* develops in considerable detail the idea that phonological rules and representations are charac-

terized in phonetic terms. Every speech sound is composed of a set of two-valued DISTINCTIVE FEATURES—phonetically defined entities that classify sounds and make claims about how they pattern in phonological rules. For example, the English stops /p t k/ are distinguished from /b d g/ by the feature value [–voice] in the former, and [+voice] in the latter. A rule like the voicing assimilation responsible for *five+th* → *fifth* refers to the feature [voice]. An adequate theory of distinctive features expresses, for all possible human languages, the contrasts in their sound systems and the categories on which their phonological rules can operate.

Most of these points were generally accepted after 1968, and continue to influence phonological research today; however, some aspects of the *SPE* program engendered considerable controversy in the years following its publication. The claim that the rules of a phonology are linearly ordered in idiosyncratic ways was much debated [see Rule-Ordering in Phonology], as was the idea that phonological rules can re-apply to successive layers of morphological constituency [see Cycle]. Other aspects of rule application in the *SPE* theory were also discussed. ITERATIVE RULES [q.v.] were proposed as alternatives to the application of a single rule at one time to a potentially unbounded string; and CONSPIRACIES among functionally related but formally distinct rules were observed.

An unusually productive controversy was initiated by Kiparsky 1968; he observed that the *SPE* theory places no limits on the remoteness of the relation between underlying and surface representation. Kiparsky pointed out that certain kinds of abstract analyses, although they account for patterning of data in the language itself, are not supported by external evidence, such as the progress of historical change. [See article on External Validation below; see also Borrowing, article on Loanword Phonology.] The efforts to grapple with this and related questions subsequently led to the development of the theory of LEXICAL PHONOLOGY [q.v.; see also Morphophonemics].

Another area of debate which ultimately led to a greater understanding of phonological structure was the problem of NATURALNESS. Within the *SPE* theory, the naturalness or likelihood of a system of rules was determined by maximally abbreviating the rules by use of the notational conventions, and then measuring the simplicity of the resulting grammar by counting the distinctive features (in terms of an evaluation metric). As Chomsky & Halle note, this approach cannot distinguish a common rule like  $V \rightarrow [+nasal] / \text{---} [+nasal]$  (i.e.,

'Nasalize a vowel before a nasal consonant') from a rare or impossible one like  $V \rightarrow [-nasal] / \text{---} [+nasal]$ .

The *SPE* approach to this problem is to posit a set of universal preferences for certain phonological oppositions or sound sequences, and to use them as part of the procedure for evaluating the naturalness of rules. An example of such a rule of MARKEDNESS would be 'Nasalize vowels before nasal consonants.' [See Markedness, article on Markedness in Phonology.] Other ways of looking at the problem have also been profitably pursued; thus NATURAL PHONOLOGY [q.v.] posits universal processes (like vowel nasalization before nasal consonants) that must be unlearned by speakers of any language that lacks a particular process. PARTICLE PHONOLOGY AND DEPENDENCY PHONOLOGY [q.v.] account for the naturalness of certain rules by building such properties into the units of phonological representation (the features) and the laws for combining them, as do AUTOSEGMENTAL PHONOLOGY [q.v.] and FEATURE GEOMETRY [see Phonological Features].

From the mid-1970s to the present, phonological research has been directed largely toward the elucidation of particular phenomena. Many of the most significant results have been achieved in empirical domains that are scarcely touched on in *SPE*—primarily in prosody. No synthesis of these various approaches has yet emerged, or is likely in the near future. Nevertheless, they are often grouped together under the term 'non-linear phonology'.

The study of stress led to the development of the theory of METRICAL PHONOLOGY [q.v.]. Here stress is seen as a relation between syllables, rather than an intrinsic property of them. This syntagmatic view of stress has yielded a nearly comprehensive cross-linguistic typology of stress systems, as well as an excellent understanding of how rhythmic factors contribute to lexical and sentential stress.

Investigations of TONE were the basis of the development of the theory of Autosegmental Phonology, in which the distinctive features that make up speech sounds are decomposed into separate levels of representation, called TIERS. Principles of the theory provide a kind of orchestration of the gestures on the different tiers, with a single unit of one tier possibly corresponding to several units of another. Autosegmental phonology has also been applied with success to non-concatenative morphology, to vowel and consonant harmony, and indeed to assimilatory phenomena in general. [See Intonation; Prosodic Phonology; Tone; Vowel Harmony and Consonant Harmony.]

The SYLLABLE has also been the focus of close scrutiny. [See Syllables.] Although the initial impetus for studying syllables was to account for distributional regularities, such as MORPHEME-STRUCTURE CONSTRAINTS [q.v.], it soon became apparent that syllable structure plays a role in stress, in non-concatenative or reduplicative morphology, in COMPENSATORY LENGTHENING [q.v.], and in the application of phonological rules like epenthesis and syncope. One result that has emerged from including the study of the syllable in Autosegmental Phonology is the notion of a SKELETON, i.e. a level of representation that consists of a schematic prosodic representation of words, devoid of substantive featural content.

Finally, we turn to the place of phonology in linguistics as a whole. Although the proper relation between phonology and syntax seems secure [see Intonation; Sandhi], the connections between phonology and the closely adjoining fields of morphology and phonetics are not. [See Morphology, article on Morphology and Phonology.] Work on Lexical Phonology and on non-concatenative morphology has established firm correlations between phonological and morphological structure; at the same time, it is unclear in the limiting case whether a particular phenomenon is to be analyzed phonologically or morphologically. The trade-off between phonetics and phonology is similarly unclear, although some recent research at the interface of these two fields gives initial promise of significant progress.

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### American Structuralist Phonology

American structuralist phonology was concerned primarily with formalizing the notion of the PHONEME, and with elaborating a framework for the phonemic analysis of languages. By the early 20th century, phonetic science had revealed that languages often had more sounds in their phonetic inventories than had originally been suspected. For example, Eng. *p[ɰ]ease* has the voiceless liquid also found in Welsh; the final sound in *ma[tʔ]* resembles the glottalized stop of many Amerindian languages. While phonetically accurate, these transcriptions are linguistically misleading: [ɰ] and [tʔ] are of quite different status in English than in these other languages. Understanding the nature of this difference was taken to define the field of phonology.

In the 1920s, Edward Sapir and Leonard Bloomfield initiated two different approaches to the problem. For Sapir, a language's phonetic inventory is but a distorted manifestation of its inner system of phonemes. The phonemic structure is a conceptual system—an inventory of 'ideal sounds', in terms of which the phonetic segments of speech are perceived and articulated. Sapir 1925 shows how the same phonetic sound can have a quite different status in languages with different phonemic systems. For example, in some languages voiced and voiceless laterals, or plain and glottalized stops, constitute separate phonemes. However, English has only one lateral [l], and only one [t], in its phonemic system; [ɰ] and [tʔ] are 'inorganic variants' of the phonemes /l/ and /t/, which arise from largely unconscious, mechanical phonetic processes. The phonemic/phonetic disparity may also go in the opposite direction: two languages may have the same phonemic system, but differing phonetic realizations, depending on the presence or absence of particular phonetic processes. This is a principal source of dialect differences: e.g., intervocalic /t/ is realized as a flap in American dialects, but