Phonology: An Overview

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1 Key Points/Objectives

- Phonology is the branch of linguistics that investigates the mental representation of speech sounds and the cross-linguistic typology of sound systems.
- Phonological theories deal in various kinds of abstract representations, such as features, syllables, and metrical feet, and often posit that words are represented in the mind in a form quite different from how they are pronounced.
- Phonological theories differ on their explanations for phonological language universals and the extent to which they assume innateness as part of phonological grammars.
- Phonology interfaces with many areas of linguistics, chief among them morphosyntax and phonetics.

2 Introduction

Phonology is the branch of linguistics that studies the structure of speech sounds and sign language gestures—the discrete parts of the linguistic signal that lack a meaning or a grammatical function. The main questions in phonology concern the nature of phonological grammars and phonological typology: how are sound systems represented mentally, and what is the range of variation between the sound systems across languages. Unlike phonetics, which studies the physical nature of sounds (articulation, acoustics, perception), phonology focuses on the mental, symbolic representations of sounds and the unconscious rules that govern their distribution.

3 Natural classes and features

In phonology as practiced today, sounds are assumed to be mentally represented in terms of *features*. Features usually describe some phonetic properties of sounds: for example, *nasal* sounds [m, n] are articulated with nasal airflow. But more importantly, features are used to cross-classify sounds and group them into natural classes based on shared attributes. An individual sound is merely a specific combination of features, which cross-linguistically appears to be limited (around 30 features appear to be sufficient to describe all known sound systems; see Hayes 2009:ch.4).

Features displaced an eariler view, common in American structuralist linguistics, whereby sounds were mentally represented as *phonemes* (see Sapir 1963). Structuralism distinguished between phonemic and allophonic levels, according them different representational status. Halle (1959) was the first proposal to develop a phonological theory that used features for both underlying (mental) and surface (phonetic) representations. While proposals for specific sets of features have varied over the years (Jakobson et al. 1952, Chomsky and Halle 1968, Sagey 1986, and others), the idea that features are the basic atomic unit

of representation is still a mainstay in phonology. Even theories that eschew features in favor of more phonetic categories, such as Articulatory Phonology (Browman and Goldstein 1986), can be linked to developments in theories of featural representation. Notably, work on phonological features has influenced theorizing in other areas of linguistics, such as morphology (Jakobson 1958; Harley and Ritter 2002).

The feature proposal in the **Sound Pattern of English** (known as the SPE, Chomsky and Halle, 1968) has been widely influential. The main modification to it arrived in the 1980's, in the work on Nonlinear Phonology (e.g., Sagey 1986), which contributed the idea that features were not mere attributes of sounds but autonomous representational entities, organized into "Feature Geometry" hierarchies. As in other areas of linguistics, the evidence for hierarchical structure comes from joint patterning in rules: for example, features that denote place of articulation (labial, coronal, dorsal, etc.) are restricted in similar ways, as are laryngeal features.

4 Phonological Reasoning and Abstraction

Most phonological theorizing involves some abstraction. While features and natural classes are inspired by phonetic properties of sounds, it is impossible to reduce all necessary classes to phonetics: thus, sonorants such as [n, l, r, w] are diverse articulatorily, and stridents such as [tʃ] (as in "church") and [z] are quite different acoustically. The phonological view of such classes is that they are abstract objects in the mental grammar. The phonological grammar has been argued to include various other kinds of abstract representations, as well as derivational stages and levels.

4.1 Abstract representations

Syllables, feet, and other units of the Prosodic Hierarchy. Syllables are psychologically salient units of linguistic rhythm, common to both spoken and signed languages (see Wilbur 2011). English speakers easily identify four syllables in "America", three in "Canada", and two in "Britain". Despite being salient, syllables have proven difficult to relate to straightforward phonetic events (see Bosch 2011). The evidence for syllable structure and boundaries relies instead on phonological reasoning. For example, in Misantla Totonac (see (1)), syllables can begin in two consonants (e.g., [ʃtiniːtaː] 'ugly'), but word-medial consonant clusters must be in separate syllables: [ìʃ.táː.ta], not *[ì.ʃtáː.ta]. Supporting this analysis is the stress pattern: if the syllabification is as shown, stress can be easily described (stress the last syllable if it ends in a long vowel or a consonant (is *heavy*), else stress the penult, and stress every heavy syllable to the left of the main stress). Without syllable structure, stress is hard to describe.

(1) Misantla Totonac (MacKay 1991): stress depends on syllable structure

a.	kís.pa	'corn kernel'	f.	ʃti.nìː.táː	'ugly'
b.	sná.pu	'gnat'	g.	ɬu.kúk	'pierced'
c.	tá.ku	'woman'	h.	tʃìʃ.kùʃ.kán	'her son'
d.	tʃu.kúŋ.ku	'cold'	i.	sə.páp	'warm'
e.	sla.pɔ́χ	'soft'	j.	ìʃ.táː.ta	'her father'

For similar reasons, phonologists posit abstract representations to characterize **prosody** (rhythmic and tonal structure): feet, similar to those in poetic metrics (see Hayes 1995); phonological/prosodic words; phonological and intonational phrases (Selkirk 1978 et seq.). These units of structure are posited to delimit the domain of certain systematic rules (such as word-final consonant devoicing) and to explain the distribution of lengthening, tones, and other prominences. One of the conclusions of research on prosody is that it should not be represented as features on the sounds that express prominence, as in the Sound

Pattern of English. Rather, prominence is the expression of hierarchical, relational structure, such as feet or metrical grids (Prince 1983; Hayes 1995).

Autosegmental Tone and C/V Skeleta. The study of tone was influential in the development of phonological theory for several reasons. In languages that use tone contrastively to distinguish meaning, tone is hypothesized to be representationally independent of the consonants and vowels that express it. This property was encoded in the Autosegmental theory of tone (Goldsmith 1976), which accords tones autonomous representational status. The autosegmental representations for tone inspired the development of nonlinear representations for other features (as in Feature Geometry). A related development was the introduction of C(onsonant) and V(owel) skeleta (McCarthy 1979; Clements and Keyser 1983), which were precursors to one of the most abstract theories of phonological representations, Government Phonology (Kaye et al. 1985 et seq.).

4.2 Abstract derivational levels

A central area of concern in phonology is the content of the mental lexicon. A widespread hypothesis, developed in the SPE, is that the mental lexicon contains *morphemes*: roots, prefixes, suffixes. Morphemes are stored as mental abstractions known as Underlying Representations (URs). In languages like American English, morphemes *alternate*: words like *ba[t]* and *ba[d]* are distinct in isolation, but pronounced the same in *batty, baddy* (with a flap, [ɾ]). In a classical analysis, there is just a single UR for each, and the *batty/baddy* versions are derived by rule. The lexicon stores only the unpredictable aspects of each morpheme's pronunciation (e.g., whether it has [t] or [d] word-finally in English), and the phonological grammar derives all predictable aspects of pronunciation (e.g., the flap between vowels in *ba[ɾ]y*). The main argument in favor of the abstract URs+rules approach is that rules are independently motivated, since speakers apply them to non-alternating forms (like *caddie*) and generalize rules to words that are new to them and which cannot have been memorized. Not storing predictable information maximizes the economy of lexical storage. While widely accepted in much phonological work, abstract URs are rejected in some theories such as Exemplar Theory (Pierrehumbert 2001 et seq.), which hypothesizes that representations are clouds of detailed phonetic representations.

Derivational stages. Related to abstract URs is the idea of derivational stages. If multiple rules apply to the same form, sometimes the results differ depending on which rule applies first. The grammar must specify which order the rules apply in, and grammars can differ in ordering alone. For example, in some North American dialects, words such as *writer* and *rider* are homophonous (neutralized). In others, *writer* has a shortened vowel, just like *write*. The rule-ordering explanation for this is that in neutralizing dialects, the flapping rule applies before the shortening rule, while in non-neutralizing dialects, the shortening rule applies before flapping. This kind of interaction is an argument for abstract levels of representation.

5 Universals: rules and constraints

An insight due to Roman Jakobson (1941) is that many adult languages constrain their sound patterns in similar ways, and these constraints also emerge in child speech. Thus, sounds and sequences that children find easy are near-universal in adult languages, while structures that children struggle with tend to be cross-linguistically rarer. This insight could not be directly captured in rule-based theories of phonology such as the Sound Pattern of English, since phonological grammars in such theories consist of rules whose content is essentially arbitrary. It is just as easy to write a rule that is common in world languages as it is to write a rule that is rare to nonexistent. The SPE includes a metric for evaluating rules based on complexity, but this does not directly correlate with typological universals.

Research throughout the 1970s-1980s identified a number of common constraints that languages appeared to enforce using a variety of rules. Thus, syllable structure is often limited in similar ways across

unrelated languages (Ito 1986). Stress assignment can be decomposed into several simple parameters, which interact in limited ways (Hayes 1995). There are also recurrent themes in how certain segmental contrasts are handled. As the evidence continued to accumulate for these patterns, there was an attempt to formulate them in a sufficiently general way that worked for all languages, but it was also clear that they could not hold as inviolable requirements in every language, since there does not appear to be any single rule that every language has. While the intuitions about constraints were commonplace, it was difficult to connect them to rules that enforced them in the theory (Kisseberth 1970).

Constraint Grammars. The most systematic efforts to explain typological universals were undertaken in Optimality Theory (OT): a framework for grammars that decoupled phonological operations from the constraints that drove them (Prince and Smolensky 1993/2004; McCarthy and Prince 1993b,a, 1994, 1995a). In OT, rather than providing instructions for modifying the URs in arbitrary ways, the grammar generates pronunciations freely but filters out all and only the possible forms allowed in any given language. The filtering is done by a ranked hierarchy of violable constraints. The constraints are universal in the classic theory: if a language shows no evidence of a constraint's activity, it means that other, higher-ranked constraints override its effects. Every constraint ranking is predicted to yield a plausible grammar; the goal of an OT phonology is to identify constraints that generate the right typology. While OT and rule-based grammars often converge on describing the same phenomena adequately, there are some types of interactions OT cannot generate without significant modifications to the theory's architecture.

6 Innateness and learnability

The introduction of Optimality Theory spurred an interest in phonological acquisition, which received little attention compared to semantic and syntactic acquisition at the time. The OT architecture made it easy to frame the question of how children acquire a grammar: if the constraints are innate, then the acquisition problem can be reduced to discovering their language-specific rankings from available positive evidence (Tesar and Smolensky 2000; Davidson et al. 2004; Tessier 2015). By contrast, rule-based theories struggled with a basic fact about the timecourse of phonological learning, namely, that children apply many more rules in early development than they could have learned from ambient adult phonologies.

OT's innatist view of constraints encounters several challenges. First, while many phenomena in children's speech have counterparts in adult languages, child speech also has unique characteristics such as major place consonant harmony (Tessier 2015, p.216). Second, while adult phonologies display gross typological trends (e.g., consonants usually contrast for voicing in pre-sonorant position, but are voiceless word-finally), there are occasional counterexamples to them (word-final obstruents become voiced in Lezgian, Yu 2004). Third, the goal of identifying a simple set of constraints that derive all and only the attested languages without overprediction has remained elusive, even in relatively constrained empirical domains such as metrical stress typology (see Gordon 2016 for discussion). In less understood domains, such as non-local consonant and vowel interactions, the prospects of a simple universal constraint set are less likely still.

More recent work has suggested that some phonological knowledge can be induced from the data using statistical generalization (Hayes and Wilson 2008 was especially influential; see Jarosz 2019). This research still assumes that the learner has innate *biases* that allow certain kinds of generalizations to be discovered more easily than others—for example, formally simple ones, or generalizations based in the experience with the modality of speech or sign (the so-called channel bias; see Moreton 2008). This work has weakened the innatist stance in phonology: if statistical generalization can explain constraints, there is no reason to posit that they are innate. Conversely, this work has also supplied additional arguments for abstraction. For example, Hayes and Wilson (2008) suggest that in order to navigate the search space of possible constraints, the computational learner needs access to nonlinear featural representations and

metrical grids.

7 Relationship to Other Branches of Linguistics

Phonology interacts with all areas of grammar. Thus, syntactic structure has a major phonological correlate in intonation. In some languages, certain syntactic contrasts are expressed via intonation (e.g., "Mary left." vs. "Mary left?"; see Pierrehumbert 1980). Syntactic boundaries are also the domain of many languages' phonological rules (e.g., sandhi).

The best-studied area where phonology interacts with another grammatical module, however, is morpho-phonology, whose study can be traced as far back as the Prague School and American structuralism (see Anderson 1985 for an overview). Americanist linguists normally distinguished allophonic rules and morpho-phonological rules, which at a basic level differ in generality: allophonic rules apply indiscriminately whenever their context is met (thus, /k/ is aspirated in English quite generally in stressed syllables, [kʰɪt] 'kit', [əkʰɹu] 'accrue'), and morpho-phonological rules apply to an idiosyncratic set of suffixes (/k/ becomes [s] in the *-ic* suffix when followed by *-ity*, *electri[k]* vs. *electri[s]ity*, but not in *finicky*). The main question presented by morpho-phonological rules is whether they are phonology or morphology: are they just general phonological rules applying in limited domains? Or, alternatively, do they require memorized ("lexicalized") stored variants (e.g., both [-ɪk] and [-ɪs] '-ic'), or some special morphological rules that are formally different from phonological rules (SPE's *readjustment rules*)? Many questions in morpho-phonology can be framed in similar terms: for example, whether prosodic generalizations about morpheme shape require special mechanisms or follow from general phonological principles (see McCarthy and Prince 1995b).

Studies of the interface between phonology and phonetics seek to understand which phenomena are controlled by a symbolic phonological grammar, as opposed to concerning the implementation of the categories in articulation and perception. In earlier approaches to phonology and phonetics, the line was usually drawn between categorical and obligatory rules on one hand vs. gradient and optional ones on the other. In-depth research on variation put some of the divisions into question (see Coetzee and Pater 2011 for an overview). Since many phonological rules can be connected to phonetic tendencies, some theories of phonology embrace phonetic grounding as an obligatory feature of any theorizing (see contributions to Hayes et al. 2004). Other theories limit phonology only to those phenomena that cannot be reduced to phonetic explanation. A challenge to phonetically grounded theories comes from patterns that involve phonetically incoherent categories (Mielke 2008, Gallagher 2019).

Finally, phonology as a science has an important historical precursor in philology. It was philologists who discovered systematic patterns of sound change involving natural classes (e.g., Verner's and Grimm's Laws). Systematic differences between the sound systems of dialects are also a concern in sociolinguistics/sociophonetics.

8 Summary

To summarize, phonology investigates the symbolic representations for the units that encode meaning in the communication channel: speech sounds for spoken languages, and gestures for signed ones. As the symbolic representations are not always accessible to speakers' introspection, their precise nature is hypothetical and based on analytic reasoning and typological investigations. Current research in phonology is probing the extent to which phonological grammars can be reduced to general cognitive capabilities, as opposed to being posited as part of an innate language endowment.

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