1 Goals of Cognitive Science

1. Characterize the knowledge that humans possess in various cognitive domains (perception, categorization, language, reasoning, . . .).

   [competence theory]

2. Discover the methods by which knowledge is acquired, including a characterization of innate restrictions on the form and acquisition of knowledge.

   [learning theory]

3. Understand how knowledge is applied in particular behaviors, and what limitations prevent performance from being coextensive with competence. [performance theory]

   In this course we focused exclusively on competence theory.

2 Phonology

Phonological competence refers to the knowledge speakers have regarding the sound pattern of their language. Three major aspects of sound patterns include:

1. Contrasts
2. Phonotactics
3. Alternations

Phonological grammars are “theories” of the sound patterns of particular languages. They can be evaluated in different ways. Grammars which only account for the observed data are observationally adequate. Grammars which treat novel utterances in the same way that real speakers are descriptively adequate. A theory is explanatorily adequate theory if it explains how a descriptively adequate grammar can be obtained from the kind of stimuli that children are exposed to.

It makes sense to also speak of typologically adequate theories, though it is harder to define. Certainly it makes sense to say a theory is typologically adequate if the grammars within the theory are descriptively adequate for all known languages. If not, the theory would
undergenerate. However, it is less clear how to address overgeneration. There is a sense in which a theory which says “anything is possible” ought not to be typologically adequate, even though such a theory would not undergenerate.

3 Phonological Units

1. Speech sounds
2. Allophones
3. Phonemes
4. Features
5. Syllables

Speech sounds and allophones are concrete and observable. Phonemes are abstract, mental representations of sound segments. Phonemes are contrastive.

Phonemes can stand in a variety of oppositions: bilateral, multilateral, proportional, isolated, privative, gradual, equipollent, constant, and neutralizable.

Features are properties of speech sounds, typically described in articulatory or acoustic terms. Theories of features can be either at the observable concrete level, or at the abstract level of the phoneme. Features which distinguish phonemes in a particular language are distinctive in that language.

4 Phonological Processes

Phonological processes can be classified in several ways. There are segmental processes and suprasegmental processes (stress and tone). This class focused on segmental processes and next semester you will study, among other things, suprasegmental processes.

Segmental processes can be classified in terms of whether they are local or long-distance. They can also be classified in terms of whether a sound is substituted, deleted, inserted (epenthesis), or changes position (metathesis). Sound substitutions are further classified into assimilation, dissimilation, or something else.

Phonological processes often have a clear phonetic motivation, but cases exist where the phonetic motivation is hard to divine. A strong hypothesis is that every phonological process is phonetically motivated.

5 Interacting Processes

Phonological processes can interact. These interactions can be classified as transparent (feeding, bleeding) or opaque (counterfeeding, counterbleeding) with respect to particular
inputs. Interactions which are opaque appear unmotivated when viewed from the concrete, surface level. They involve either overapplication (counterbleeding) or underapplication (counterfeeding) of rules.

6 Theories of Phonological Competence

A fundamental principle of phonological analysis holds that each morpheme has a single underlying form. This principle constrains the kinds of allomorphy expected within languages.

Principles useful in establishing underlying forms are predictability, economy, pattern congruity, and phonetic naturalness (plausibility).

Once URs are established and generalizations regarding the processes have been identified, the phonologist has specified aspects of a UR/SR mapping. The remaining task is to formalize these insights by writing a grammar which somehow composes these generalizations into a single UR/SR mapping. In other words, theories of phonological grammars factor the mapping, typically according to the generalizations that have been identified.

\[ F_1 \times F_2 \times \ldots \times F_n = P \]

6.1 Rewrite rules

Each phonological process is associated with a rewrite rule. All else being equal, shorter rewrite rules are to be preferred. Notation should be chosen to ensure that more natural processes are shorter (easier to express) than unnatural ones.

Rules can apply to structural descriptions in a string in many ways: simultaneously, or by parsing the string right-to-left and left-to-right. Some rules, such as syllabification, are said to apply persistently.

Interactions are accounted for by ordering the rules. The output of one rule becomes the input to the next. All types of interaction can be accounted for with rewrite rules.

Rule-ordering is understood to be language-specific, though there was a time when this hotly debated. Certainly intrinsic ordering of rules helps constrain the theory.

In rewrite-rule grammars, syllabification is handled specially. It is unclear how rewrite-rule grammars address the limits of typological variation. The Principles and Parameters approach helps address the typological issues. Variation in syllabification and stress have been extensively studied in the Principles and Parameters tradition. How do phonological rules interact with principles and parameters.

Rewrite-rule systems did not state some generalizations, in particular, phonotactic ones, directly. I am referring to the duplication and conspiracy problems. Some rules share the same functional purpose, but the rewrite-rule formalism seemed unable to accommodate functional unity. Constraints were introduced which could trigger or block rule application.

Finally, there is some, but not much research, on how phonological rules could be learned.
6.2 Optimality Theory

Standard OT factors every phonological system into the same set of markedness and faithfulness constraints. Phonological processes are obtained by when certain markedness constraints outrank certain faithfulness ones. It embodies the idea that processes exist to repair ill-formed structure. In this way OT addresses the duplication and conspiracy problems.

There are three components to any OT grammar: Gen, Con and Eval. The constraints in Con are ranked. Gen maps an underlying form to a set of candidate surface forms. These forms are evaluated by Eval, which selects the most harmonic one, according to the constraint ranking. The most harmonic candidate is the one which violates the most important constraints the least.

Standard OT is able to describe transparent interactions, but unable to describe common opaque ones. Variants of the theory have been put forward which can capture at least some opaque processes.

OT provides a clear way of modeling typological variation. Every possible ranking of the constraint. Although there are \( n! \) rankings for systems with \( n \), the typologies are typically much, much fewer because many rankings predict the same UR/SR mappings.

Although we did not discuss it, there is a large literature on learning OT grammars. The most-well studied case considers the problem of finding a ranking of the constraints given finitely many (UR,SR) pairs. This problem is solved. There are procedures which can find a ranking consistent with a set of (UR,SR) pairs, if there is one (and tell you if there isn’t one). There is no general solution to the problem of learning the URs and the constraint ranking from SRs, or from SRs paired with meanings.

So despite the problem with opaque patterns, OT provides a unified approach to issues that were handled either separately in rewrite-grammars, or not handled at all. These issues include accounting for processes, interacting processes, syllabification, typology, and learnability.

6.3 Doing a phonological analysis

Identify the generalizations. This can be accomplished without (too much) formal analysis, using the fundamental principles of phonological analysis.

Then formalize the generalizations in one theory or the theory. Ideally, the formal statement of the generalization should match the English prose version in every way.

Justify every decision. Don’t be lazy and skip over justifying the URs because it is obvious to you now. Explain why this choice of UR is better than the alternative because it allows one to make successful predictions (whereas otherwise one couldn’t).

6.4 Computational analysis

Computational analysis reveals that rewrite-rule systems are regular, and so, if they do overgenerate, it is not completely unconstrained. More importantly, computational analysis focuses on the nature of the UR/SR mapping, independent of whether the mapping is
computed with OT or rewrite-rule grammars. What kind of mappings are the phonological ones?

6.5 Summary

Both rewrite rules and OT provide ways of describing descriptively adequate grammars. OT emphasizes phonotactics, whereas rewrite rules emphasize alternations. Neither yet provides an explanatorily adequate theory, though progress in being made.

Standard OT undergenerates because it cannot describe opaque interactions, and in this sense, they are typologically inadequate. Computational analysis has revealed standard OT grammars also overgenerate in the sense that they can describe nonregular UR/SR mappings. Rewrite-rules systems do not undergenerate.

7 Major Questions in Contemporary Phonology

1. Typological generalizations. What primary factors shape the typology and how?
   - phonetic naturalness synchronically
   - phonetic naturalness diachronically
   - processing constraints
   - learning biases

2. Learnability. How can phonological patterns be learned?

3. Phonology in the brain. Is there psycholinguistic evidence for or against abstract phonological units and systems?

4. Categorical vs. gradient distinctions. How best to account for free variation and gradient judgements?

Note that all these issues are very fundamental!

8 Next Semester

1. Suprasegmental processes (stress, tone)

2. Phonological representations
   - Metrical feet (stress)
   - Nonlinear representations of phonological processes (autosegmental phonology)

3. Phonology-morphology interface (the cycle, lexical phonology)
4. ... 

Dresher (2011) describes lexical phonology succinctly as follows: “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.”

9 Reading over winter for those who are interested


