

Chapter 21

Phonology and Sociolinguistics

Naomi Nagy

Since the 1960s, there has been a transition in the target of linguistic description, from intuitive representations of the “ideal speaker/listener” (Chomsky 1965) to naturalistic data whose gradience is quantified. The transition is captured by Pierrehumbert:

[L]anguage exhibits variability at all levels of representation, from phonetics to phonology and syntax, right through to pragmatics. Thus the issue is how variation fits into our scientific understanding of language. . . . [V]ariation penetrates further into the core of the theory than generally supposed, and that variation should be exploited rather than disregarded in investigating language. (1994: 233–234)

Related to this are changing views in how human memory, and cognition more generally, work. The present chapter surveys effects of these two developments on the fields of phonology and sociolinguistics, focusing on examples that bring their domains closer. We see resulting developments in more accurate descriptions and robust theoretical models. This chapter reviews instances in which data organized by variationists have served to further develop Lexical Phonology (LP), Optimality Theory (OT), and Exemplar Theory (ET). This transition requires reexamining certain fundamental assumptions of traditional models of generative phonology. We will consider ways in which these developments have influenced sociolinguistic research design and interpretation, particularly regarding which gradient aspects are relevant to social perception and categorization. One goal of this chapter is to provide the groundwork for a unified linguistic model to be developed by collaboration across sociolinguistics, phonology, and other fields. This will allow us to better understand

language within the broader context of cognition, to take into account linguistic and non-linguistic factors in an integrated fashion, and to develop formal models of observed patterns.

Phonology and Sociolinguistics: Their Divided Past

The programs of study outlined for many linguistics departments, the tables of contents of textbooks introducing the field of linguistics, and general linguistics conference programs suggest that the fields of phonology and sociolinguistics are separate. Separate faculty, different course requirements, stand-alone chapters, and parallel competing sessions exist for these fields, with little suggestion of any connection between them. Early differences between the two fields may be summarized as follows.

The goals of early mainstream American Generative Phonology were to develop a formal theory of how phonological knowledge is represented, to account for the commonalities of language, as well as the variability observed across languages, within a single formal model. Other modules of grammar were considered only to the extent that they interacted with the phonological system. A guiding principle in developing these theories was that “redundancies and variation are extracted from the signal and code and discarded rather than stored in memory” (Bybee 2010: 14–15).

The goals of traditional variationist sociolinguistics were to understand which parts of grammar are variable and what factors correlate with the variation and to understand the connections between synchronic and diachronic variation. Sociolinguists sought to understand how language change starts, progresses, and finishes (Weinreich et al. 1968). Early quantitative work examined both phonology (cf. Labov 1963, 1972) and morphosyntax (cf. Sankoff 1980). Another difference is that while formal theoreticians “have typically focused on standard varieties, [. . .] variationists have normally dealt with nonstandard varieties” (Mufwene 1994: 208).

There were also contrasts among some of the crucial assumptions in the two fields. Traditional Generative Phonology assumed that language universals could be observed in synchronic patterns, while sociolinguistics considered the links between diachrony and synchrony. In phonology, language units have traditionally been qualitatively distinguished and categorically distinct. The rules or constraints affecting them are categorical. Rule exceptions and variability are problematic. In contrast, sociolinguistic operations (rules or constraints) have always been probabilistic. Variation is inherent to the system (Labov 1972: 274). Multiple types of contexts, linguistic, social, and stylistic, are considered in analyzing sociolinguistic variation, while the linguistic context has privileged status in phonology.

What constituted data in the two fields also differed. In phonology, transcriptions of sounds and intuitions concerning phonological patterns were traditionally based on impressions. When the target of research was a nonnative language, the phonologist generally relied on the original fieldworker's impressionistic transcriptions, assumptions about the phonemic status of the sounds being transcribed, and so forth. A single observed utterance could serve as evidence or be dismissed as a "speech error" or a "slip of the tongue" and not contribute to the model. Sociolinguistic data come from recording a variety of speakers representing a community, focusing on "natural conversation," as well as word lists and speakers' comments about their attitudes to the community and/or language.

This leads to another importance difference: in traditional Generative Phonology, the goal was to model competence, and variability was considered "just" a matter of performance. Sociolinguists take performance, constituted as multiple tokens found in actual utterances, as the target of analysis, with a preference for those utterances that occur in more naturalistic contexts rather than elicitation. Both fields seek patterns within the variability: categorical patterns in phonology and probabilistic patterns in sociolinguistics. In phonology, these are traditionally organized as phonemes, sets of surface forms that alternate

categorically according to phonological context. In sociolinguistics, the unit is the variable, a set of surface forms that alternate stochastically according to linguistic and social context.

The difference is underscored by differing approaches to frequency: type-based frequencies are traditionally exploited in phonology while token-based frequencies are calculated in variationist sociolinguistics. Type frequencies are how frequently a phoneme occurs in the dictionary of a language. Token frequency is how frequently a phoneme occurs in a particular corpus of speech or text. “Type frequencies [give] information about the structure of a language, whereas token frequency reveals patterns of usage” (Hume & Mailhot 2011: 97-8). Different predictions are made by type versus token frequency statistics (see Munson 2000).

The different types of data implicate differences in methodology.

Sociolinguistics began with smaller corpora than are common now: Labov’s famous department store study uses four tokens from each of 264 speakers (1972: 50), and while his Martha’s Vineyard study analyzed 5000 tokens of two diphthongs, acoustic analysis was reported for only 86 (14–16). Corpora are increasing in size as technology improves for the organization, processing, and storage of larger data sets. From these corpora are culled multiple examples of the variable under examination. Increasingly larger data sets are being deployed to allow for simultaneous analysis of a greater number of variables. Examples of this expanded approach include Raymond et al.’s (2006) study of some 7000 word-internal alveolar stop tokens. They found effects for the linguistic factors of word class (function vs. content word), length, and predictability; syllable position; prominence; preceding and following context; and the speaker-related factors of age, speech rate, and fluency. Similarly, Nagy and Irwin’s (2010) study of more than 11,000 tokens of (r) in Eastern New England examined effects of seven linguistic factors and six social factors.

Because of the range of factors that can be examined, sociolinguistics suffers a lower degree of cross-linguistic comparability. Phonology, in contrast, seeks to identify common and/or differing patterns across languages, and refines its formal models to predict such patterns. However, there is no agreement about how many examples constitute a sufficient base on which to build a model. Indeed in phonology there is often an abstraction away from actual utterances toward an assumed underlying form of the “ideal speaker-hearer.” The contrast in approaches is seen in [table 21.1](#), which compares the number of articles that focus on single languages with those that focus on more than one language, in three representative journals: **INSERT TABLE 21.1 ABOUT HERE**

Chronological trends in these tallies show the fields diverging in this regard: only phonology focuses increasingly on multilingual articles. The languages most often studied (in the same sample) also varies tellingly ([see table 21.2](#)). **INSERT TABLE 21.2 ABOUT HERE**

Phonology and Sociolinguistics Have Acquired Overlaps

In spite of these different starting points, cross-disciplinary approaches arose as each field expanded. A concrete example involves fast speech rules. Subsequent to the establishment of Lexical Phonology (Kiparsky 1982), phonological rules have been proposed that apply within certain stylistic contexts. These rules apply post-lexically and are therefore exceptionless, applying whenever the context of application is met. We can see quantitative variationist approaches as expanding from a small set of explicitly defined, non-overlapping styles, in which a lenition rule categorically either does or does not apply, to a broad range of overlapping definitions of contexts, each with an associated probability of rule application. These probabilistic distributions of stylistic variants mirror the probabilities associated with the rule application in different sectors of the community (Bell 1984), rounding out the sociolinguist’s more nuanced understanding of language variation. This example highlights

an important development in phonology that has contributed to the overlap of the two fields: the distinction between lexical and post-lexical rules and models that allow different types of factors to influence different types of rules (e.g., stylistic differences may influence only post-lexical rules).

Later phonological approaches emphasize a need to understand the nature of phonological rules rather than just to stipulate them. Two examples are Grounded Phonology (Archangeli & Pulleyblank 1994), wherein phonological rules and representations are phonetically motivated, and Lab Phonology (cf. Kingston & Beckman 1990), in which phonetic measures are integrated with theoretic accounts. Functional Phonology (Boersma 1998) similarly draws on connections between articulation and perception, as do Hume and Johnson (2001) and Steriade (2009). Interest grew in incorporating probabilistic factors relating to the frequency of phonological and lexical units into phonological accounts (Bod et al. 2003; Boersma & Hayes 2001; Frisch 1996; Hume 2004; Munson 2000; Pierrehumbert 2001a, 2001b; studies summarized in Bybee 2010: 20). Organizing these effects into constraint-based approaches, which focus on the aggregate effects of different rules, has been integral to this expansion. Boersma and Hayes's (2001) approach has been the most explicit regarding the incorporation of frequency effects into the phonological model by establishing probability weights that rank each constraint and change according to the frequency with which certain tokens (favored by that constraint) are encountered during the learning process.

There has been increased interest in accounting for language variation and change in formal models of phonology. For example, Guy (1991) introduced a modification of LP (Kiparsky 1982) to allow probabilistic cyclical rules: a model to predict the stochastic distribution of reduced consonant clusters. Guy and Boberg (1997) introduced the Optional Contrast Principle to further account for the distribution in the same variable, focusing on the role of similarity between adjacent segments.

Anttila (1997) proposed that variation exists where the grammar does not fully determine the output, in particular where certain constraints are not ranked with respect to each other. Nagy and Reynolds (1997: 37) presented Floating Constraints, whereby some particular constraint within a single grammar may be represented as falling anywhere within a designated range in the ranking hierarchy. Thus, two constraints that are unranked with respect to each other “float” around each other, each out-ranking the other half the time (by chance). In a model of post-tonic deletion in Faetar, this model accounts for the stochastic distribution of forms in a sample of over 600 tokens. The data suggest a gradual change in the Floating Constraint’s range over time, given different distributions for older versus younger speakers. Reynolds (1994) showed that Floating Constraints account for quantitative data in other languages. Nagy and Heap (1997) further pursued this model, in morphology, showing how Floating Constraints account for the variable presence of subject pronouns in samples of Faetar and Francoprovençal from different time periods.

Zubritskaya (1997: 1) proposed a model of subsegmental phonology within OT that diverged from standard Autosegmental Phonology both in its limited use of representational distinctions and in the form of the grammar to which the representations are submitted. Capitalizing on the concept of phonological units that are invisible to parsing in certain contexts, such as floating features, she demonstrated that a model that derives the variety of surface phenomena from a single underlying representation can correctly classify the full range of Russian consonant cluster behavior in her sample.

Zubritskaya’s (1994) work highlights the conflict noted in the Pierrehumbert quote cited earlier. She convincingly demonstrates the danger of proposing different (invariant) competing grammars to account for variation by showing the “unwieldy” number of grammars needed to account for “a rather trivial sound change (simple loss of assimilation)” (346–347). This echoes Pierrehumbert’s (1994) generalization that, while

competing grammars might be a valid account for variation between two (or a few more) discrete outcomes, they cannot account for gradient or continuous effects, as these would require “an entire continuum of grammars” (245). This number increases exponentially as we consider the simultaneous variation that occurs across the large number of variables in actual speech production.

Twenty-First-Century Rapprochement

In the past 10 years, the expansion of both fields into the same territory has made it more difficult to conceive of them as distinct fields. In contrast to the areas of increasing overlap surveyed here, research programs in each field that do not engage with the other field still exist. A key example is Substance Free Phonology, which espouses the view that “phonology consists of a set of formal properties,(e.g., organization into syllables and feet, feature spreading processes) that are modality independent and thus not based on phonetic substance” (Hale & Reiss 2000: 3). Similarly, one needn’t look far to find sociolinguistic analyses that do not engage with phonological theory. This section highlights advances that *do* produce greater overlap.

Following on from the earlier developments in stochastic OT (at which point Anttila [2002] remarked that “it is not the business of grammatical theory to explain the effects of sex, age, style, register and social class” [212]), Bernard et al. (2007) account for inter-speaker variation in forms of post-vocalic (r) in Boston English. They show that implicational hierarchies among constraints restrict the amount and type of variation to be expected in a grammar.

Boersma and Hayes (2001: 45) introduced an important element to stochastic OT approaches: illustrations of learnability of stochastic patterns. In their model, an algorithm directly perturbs constraint rankings in response to stochastic language data. The algorithm is error driven: it changes the ranking of the constraints only when the input data

conflict with its current ranking. It assumes a continuous scale of constraint strictness, rather than discretely ranked constraints, and some noise in the model allows for the production of variable outputs when constraints are ranked close to each other.

Cutillas Espinosa (2004) gives another approach to quantifying the frequency of different forms. It differs from Boersma and Hayes's approach in proposing that each speaker has three discrete grammars rather than a grammar continuum. Each grammar is a set of constraints associated with different probabilities. Grammar 1 is the standard, prestigious variety and Grammar 3 is the local vernacular (or "native") grammar; the model requires the speaker to have access to both of these. Grammar 2 is an individual's "extremely dynamic" grammar, which he designs to convey "different sorts of social and personal meaning" (172). Grammar 2 seems to be as many different settings of the constraints' probabilities as needed to account for the contexts examined.

More constrained means of selecting optimal candidates have since appeared. Coetzee and Pater (2011) provide a concise summary of alternatives and illustrate that a Maximum Entropy Harmonic Grammar model can create an extremely good match to empirical data for consonant cluster simplification patterns.

The preceding studies bring important elements of phonological theory together with accountability to the variable patterns in naturally occurring speech. While the domain of inquiry for phonology has expanded, there is still a focus on synchronic phonological systems and the quest for universal grammar. In contrast, recent sociolinguistics seeks to understand change in a more principled way, developing constraints that account for the unidirectionality of changes and establishing driving forces for linguistic change. Among these are renewed interest in longstanding claims, such as:

- Garde's Principle: "mergers cannot be reversed by linguistic means";
- Herzog's Corollary to this: "mergers expand at the expense of distinctions";

- maximal dispersion (in acoustic space) of the phonemes of a linguistic system (noted by Martinet 1955: 62); and
- principles of chain shifting, such as the direction of shift of vowels along the interior versus peripheral zones of the vowel space (Labov 1994, 2010).

These allow for better understanding, in a phonemic context, of the sound patterns found in large-scale studies such as the *Atlas of North American English* (Labov et al. 2005) and *The World Atlas of Language Structures* (Haspelmath et al. 2005).

An understanding of the differing behaviors of children versus adults in dialect acquisition also better organizes our understanding of the types of changes to expect in different contexts. These are explicitly contrasted to account for the diffusion versus transmission of patterns of vowel shifts and mergers in Labov (2007); for short (a) patterns in New York (Dinkin 2008); and for the diffusion of (r) (the variable surfacing of coda /ɹ/ from Boston into New Hampshire) in contrast to its faithful inter-generational transmission within Boston (Nagy & Irwin 2010).

This brings us to the social side of sociolinguistics. First examined in Labov (1963), analysis of speakers' orientation or attitude has become more complete. Examples include

- interspeaker differences in life-span trajectories of use of the phonological variable (R) in Montreal French (Sankoff & Blondeau 2007);
- the use and interpretation of quotative *be like* in Britain versus the United States (Buchstaller 2006; Dailey-O'Cain 2000);
- quantification of ethnic orientation in studies of English and heritage language usage in Toronto (Hoffman & Walker 2010; Nagy 2011);
- divergence from metropolitan norms in New England (Nagy 2001; Nagy & Irwin 2010; Wood 2010);

- perception of acoustic patterns influenced by orientation (Niedzielski 1999, 2002; Johnson 2006) and social context (Dodsworth 2008); and
- folk linguistics, a subfield in which laypeople's beliefs about language inform linguistic research (Preston & Niedzielski 2009).

Exemplar models can unify such approaches with those that examine the effects of linguistic context by postulating a unified means of acquiring and organizing relevant information of many types, including phonological and social context. Bybee explains,

Exemplar representations are rich memory representations; they contain, at least potentially, all the information a language user can perceive in a linguistic experience. This information consists of phonetic detail, including redundant and variable features, the lexical items and constructions used, the meaning, inferences made from this meaning and from the context, and properties of the social, physical and linguistic context (2010: 14).

This contrasts with earlier approaches in which memory limitations were assumed to require that particular tokens of language use could not be part of permanent memory representations. As Bybee noted, “beliefs about memory limitations fuelled the search for ever simpler types of representation” (15).

Exemplar Theory (ET; Bybee 1994, 2010; Johnson 1997; Pisoni 1997) is a model of the structure of language in which each token is modeled as a constellation of factors. Every encountered token is stored in memory as an exemplar. Category structure is gradient within and across categories, and exemplars are weighted with respect to their contribution to category structure. Abstraction is implied in both acquisition and categorization of the exemplars. Each token's constellation has some features in common with all other token's. ET models the relations among factors by different strengths of connections between elements. There is no a priori assumption of which types of factors, or

links between them, are most important. ET captures the trajectory of experience as tokens are accumulated through exposure to language: exposure to different sets of tokens by different speakers accounts for inter-speaker differences.

ET, with this concept of the interconnectedness of different forms according to various sorts of (phonetic, semantic, social context, etc.) similarities, allows for the incorporation of the concept of indexicality: that linguistic forms acquire layers of association to certain groups of speakers (Kiesling 2010; Silverstein 2003). The connections between this approach and Labov's (1972) *indicator*, *marker*, and *stereotype* division of linguistic variables are neatly explained in Johnstone and Kiesling (2008), using the Pittsburgh English variable (au) to illustrate. This concept has been developed in work by Eckert (2008), Mendoza-Denton (2004) and Podesva (2007). This body of work shows important developments since Lambert and colleagues' development of matched guise studies. There we see evidence of listeners making judgments about speakers depending on which guise or variety the speaker uses (e.g., local vernacular vs. standard; Lambert et al. 1960, 1966). A crucial development in the link between sociolinguistic interest in attitude and the modeling of phonological variation was a series of matched guise studies (e.g., Campbell-Kibler 2009; Labov et al. 2011) where one phonological variable was manipulated while the rest of the recording was held constant. These show that speakers respond (with differing attitude judgments) to particular sounds rather than to the overall dialect or accent. These studies also showed that a single variable, in these cases (ing) or (r), can index a range of social information for different listeners, justifying a model in which variation along numerous linguistic and social dimensions is simultaneously incorporated.

Foulkes (2010) notes that "exemplar theory makes broad predictions about the order of indexical learning, based on (i) the overall contribution of indexical factors to the input, and (ii) the transparency of phonetic cues to the indexed category" (20). His list of

predictions include a chronological sequence for the acquisition of indexical knowledge: first about the maternal voice, then other familiar individuals, then sex and age distinctions and child-directed speech, and later to less familiar individuals and dialects. He calls directly for increased collaboration between the fields of lab phonology and “adjacent fields such as language acquisition, anthropology, dialectology, sociolinguistics, bilingualism, and conversation analysis” (32), to improve our understanding of their intersections.

The role of lexical factors, such as frequency, in accounting for sociolinguistic variation as well as in phonological models constitutes another overlap between the fields. This has been seen since Phillips (1984) noted that “changes affecting the most frequent words first typically involve either vowel reduction and eventual deletion or assimilation,” that is, lenition (322). Supporting this claim, Abramowicz (2007) and Dinkin (2008) show the relevance of lexical frequency to lenition but not other types of changes. Abramowicz examined (ing), finding that it was not a lenition pattern and not subject to lexical frequency effects. Dinkin contrasted short vowel centralization, a form of lenition that exhibits frequency effects, to other non-lenition patterns, such as fronting of diphthongs, which show no frequency effects. Guy (2007), Guy et al. (2008), and Coetzee and Pater (2011) illustrate that (certain) high-frequency words behave differently from lower-frequency words. Hay and Maclagan (2010) show that contexts, both phonological and social, in which reduction of intrusive (r) occurs more frequently also undergo more drastic acoustic reduction.

Through these progressions, the two fields have come to share more assumptions: phonological knowledge is now believed (by some theorists) to contain more than just categorical information, bringing it closer to the starting position of sociolinguistics, and sociolinguistics is making efforts to develop universal generalizations about sound patterns, bringing it closer to the starting position of phonology. Methods have evolved as well, often in parallel. Both fields have increased use of perception experiments, rather than

relying just on production data (cf. Campbell-Kibler 2009 and Hay & Warren 2002 on the sociolinguistic side; and Boersma 1998; Flemming 2002, 2005; Hume 2004; Mielke 2003, 2005; articles collected in Hume & Johnson 2001 and Hayes, Kirchner, & Steriade 2004; and Liljencrants & Lindblom 1972 and Ohala 1993).

Larger corpora and the computational tools to manage them are being increasingly used in both fields as well. Some examples in phonology include Hayes and Cziráky Londe's (2006) analysis of Hungarian vowel harmony that used data automatically harvested via Internet searches, the UCLA Phonetic Segmental Inventory Database (UPSID) developed by Maddieson and Precoda (Reetz 2006), and Mielke's (2007) searchable database of sound patterns in 500 languages. A large-scale perception study is being conducted by Stuart-Smith (2005) and her colleagues to learn about effects of television pronunciations on adolescents.

To summarize, there are a number of crossover contexts in which researchers from one domain use insights from the other. Advances include an understanding of how sounds pattern within and across languages, insight into which patterns tend to occur systematically across languages and which do not, an enriched view of the linguistic factors (phonetic, morphologic, syntactic, etc.) that influence sound patterns, and new formal mechanisms to express generalizations. Contributions from sociolinguistics include an understanding of the range of non-linguistic factors that can influence sound patterns, an analytical approach that starts by treating all factors, linguistic and non-linguistic, as equal in terms of their potential predictive power, stochastic (vs. categorical) models of effects, and an appreciation for the role of experience as a factor influencing language shape and usage.

These changes have led to questioning some crucial assumptions in both fields. The categorical nature of phonological phenomena is challenged by findings reported in Hay and Maclagan (2010) and Pierrehumbert (2003a, esp. fig. 7B, and 2003b). Gradient

information is shown to be relevant to social perception and categorization in work by Docherty and Foulkes (2005) for Tyneside variants of (t); Docherty and Foulkes (2001) for (r); and Currie Hall (2008) for the relationship between categoricity and allophony in Canadian Raising. Probabilistic information has been incorporated into phonological models (e.g., OT, discussed earlier). Probabilistic information has also been incorporated in work such as Jurafsky et al.'s (1998) study of phonetic reduction of function words, Raymond et al.'s (2006) study of word-internal alveolar stop reduction, and ET analyses, such as Hay and Maclagan's (2010) study of intrusive (r) in New Zealand English.

The existence of distinct underlying versus surface representations, and how to map between them, is reconceived in both constraint-based approaches like OT (Prince & Smolensky 1993), in which different surface forms are evaluated by a set of constraints rather than being produced by derivation from an underlying form, and in ET. Cole and Hualde (1998) critique approaches that depend on underlying representations, using arguments based in phonology (lack of ability to encode contrast), psycholinguistics (lack of ability to account for lexical retrieval experimental data), and historical linguistics (inaccurate predictions about language change). However, everything that was developed in traditional generative phonology need not be eliminated: Pierrehumbert (2003b) suggests a “form of scaffolding of abstract labels erected over the exemplar base, with connections retained to map between the two layers of representation.” The transition from entirely lexical to partially abstract information during the acquisition process is explored in Docherty et al. (2006) and Beckman et al. (2007).

Major reconceptions that involve the entire field of linguistics, not just phonology, include: the very existence of the innateness of aspects of language (Mielke 2006 and 2008 question the innateness of phonological features), the concomitant possibility that universals do not in fact exist (Evans & Levinson 2009) and the primacy of synchronic explanation

(Blevins 2004). This latter corresponds to an increase in the use of real-time studies in sociolinguistics, which provide evidence about how language actually changes rather than relying on assumptions that inter- and intra-speaker variability reflect diachronic variation. Such studies include Bailey et al. (1991), which illustrates the mirror images of linguistic patterning (lexical and phonological) in Texas English that come from a comparison of speakers of different ages to data collected at different time points. More recently, real-time studies of phonological change in Montreal (R) have identified life-span changes which suggest that our apparent time estimates underrepresent real time change (Sankoff & Blondeau 2007).

Methods Have Gotten More Similar Too

In sociolinguistics, databases of large corpora are used. Some important sources are the Linguistic Data Consortium (1992), which houses thousands of audio, video, and text files of many languages in many contexts; the International Corpus of English (ICE) project, consisting of one million words from each of about 20 regional varieties of spoken and written English produced post-1989 (Nelson 2010); the Sociolinguistic Archive and Analysis Project at North Carolina State University, “an interactive web-based archive of sociolinguistic recordings,” which integrates playback, annotation, acoustic analysis, and corpus analysis (Kendall 2007, 2008) and the Newcastle Electronic Corpus of Tyneside English (Corrigan 2007).

Another important advance is the development of time-aligned transcription systems, such as ELAN (Max Planck Institute 2008). These allow for transcriptions in which each annotation is time-linked to a segment of the recording of the original speech event (Kendall 2007). Thus, one can search the text, which may be more broadly transcribed, and retrieve any necessary phonetic detail from the recording. This alleviates the need for pre-hoc decisions about the size of the units of analysis, the amount of context that is relevant, and the

type and degree of phonetic detail. The resulting analysis can be more accountable to the original data rather than necessarily reflecting assumptions made prior to analysis (Nagy 2011).

Statistical methods have been part of sociolinguistics since its start. They are increasingly used in phonological studies as well, with probabilistic distributions, rather than just categorical ones, serving as evidence for formal theories. Some examples include statistics derived from the UPSID database and work showing gradient effects of the Obligatory Contour Principle in a variety of languages by Mester (1988), Frisch and Zawaydeh (2001), and Guy (1991).

These innovations illustrate how understanding what structures can undergo change or vary synchronically, and what types of change and variation are possible, improves theoretical models by restricting the types of possible changes (synchronic and diachronic) that should be modeled.

Phonology and Sociolinguistics in the Future: A Unified Approach

We have seen that both phonology and sociolinguistics have broadened in several ways, focusing just on the changes that give the two fields more in common. The domains of inquiry now overlap substantially in terms of what counts as relevant conditioning factors. Many tools and concepts from one field have been adapted in the other. The common core goals are now to understand language within the broader context of human cognition by taking into account both linguistic and non-linguistic factors and to develop a formal model to accurately predict observed patterns. There is a drive to understand the interaction of different types of factors to interpret (as opposed to just report) the data. There has been some success in finding a meeting ground between elegant formal theories and messy data from real speakers.

What remains to be developed is an integrated model that can simultaneously account for the effects of these many types of factors and integrate them into a cognitive model, as proposed by Hume and Nagy (2008). The goal is to develop a formal mechanism for expressing relations among linguistic elements, among the factors influencing the elements, and the interactions among the elements and factors. The relevant factors include at least

- the person's existing phonological system, including information about prosodic structure, sound and feature categories, relations among sounds (allophonic, contrastive), and so on;
- perceptual factors: quality of the acoustic/auditory cues to the identification of sounds influenced by acoustic/auditory similarity;
- production factors: the amount of precision required to produce a given sound or sequence of sounds, influenced by factors such as the complexity of the articulation and the similarity among sounds in a sequence;
- contextual probability: the probability that a linguistic element (feature, sound, contrast, morpheme, word, syllable, etc.) will occur in a particular context, as a function of frequency (type or token) and predictability (including transitional probabilities between sequences of elements);
- lexical factors such as word probability and neighborhood effects;
- cognitive factors such as attention paid to speech, saliency, generalization, and expectation; and
- social factors: the amount of social value accorded a particular sound or sequence and its associations to identity or group membership.

To this model phonology can contribute an understanding of how sounds pattern within and across languages, insight into which patterns tend to occur with systematicity across languages and which ones do not, an enriched view of the linguistic factors that

influence sound patterns, and formal mechanisms to express generalizations about language across languages. An example of this sort of contribution is Currie Hall et al.'s (forthcoming) study of contrast enhancement and epenthesis (see also Hume & Mailhot in press, a study of phonologization which considers the effects of entropy and information content).

Sociolinguistics can contribute an understanding of the range of non-linguistic factors that influence sound patterns, an analytic approach that starts by treating all factors, linguistic and non-linguistic, as of equal potential to predict patterns, a conception of what types of rules are expected to be categorical, how to work with probabilistic distributions, and an appreciation for the role of experience or usage as factors dynamically influencing language's shape. Additionally, it possesses models that allow for interaction among factors. This is important in cases where, for example, phonological factors have a greater effect in one morphological class than another or where certain social factors behave differently in different sectors of society. An appealing model for this purpose is ET.

Research by many scholars, working on many languages and variables in many communities, provides an inventory of effects of various factors. This sets the stage for work toward a generalized predictive theory of the contributions of such factors. Many questions remain to be addressed, however. These include:

- Which factors interact, and why?
- Under what conditions do factors interact?
- What constrains interactions?
- How are factors weighted with respect to one another? To what extent are weightings predictable?

This sort of work necessitates collaboration among researchers from different fields. Phonologists can't do it alone, nor can sociolinguistics.

Acknowledgement

This chapter is based primarily on a paper prepared and delivered with Beth Hume at the 2008 Annual Meeting of the LSA. I am grateful to the participants in that panel and especially to Beth for constructive discussion of these issues, as well as to others, too numerous to list, who provided helpful views on the co-development of the two fields examined here.

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Table 21.1.

Language-specific vs. articles analyzing more than one language in three major journals

	<i>Language Variation and Change</i>	<i>Journal of Sociolinguistics</i>	<i>Phonology</i>
Years surveyed	1989–2007	1997–2008	1990–95, 2005–10
No. of language-specific articles	100	181	41
% articles to analyze >1 language	11%	28%	39%

Table 21.2.

Languages examined in three major journals

Journal	English	Asian	African	Romance	Other
<i>Language Variation and Change</i>	53%	8%	4%	25%	10%
<i>Journal of Sociolinguistics</i>	62%	7%	3%	11%	17%

<i>Phonology</i>	17%	15%	22%	<1%	46%
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