

Laboratory Phonology: Past successes and current questions, challenges, and goals^{1, 2}

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Laboratory Phonology, both as a series of conferences and as a particular approach to the investigation of human sounds and sound systems, has been active for over twenty years. In this paper, I consider the goals and successes of Laboratory Phonology as well as the current challenges. I conclude that the success of Laboratory Phonology is that those issues which at first were defined in the effort to bridge phonology and phonetics are now understood in a richer multidisciplinary way: The central question of understanding the relationship between the cognitive and physical aspects of human speech is now defined as a question of cognitive science. I also explore a series of foundational assumptions and argue that we need to be willing to be critical of our working assumptions. To fully accomplish the work ahead of us, we need to extend our integrated methodologies to truly integrated models. Because the very nature of language is so complex, an adequate model will be complex. The model needs to enable us to accurately model adult grammar, not as epiphenomena, but as a system of knowledge, while also modeling acquisition, language use, and language change.

1. Introduction

What is Laboratory Phonology? Most tangibly, Laboratory Phonology (LabPhon) is a biennial conference.³ More importantly, it has grown into a community of scholars. The strength of Laboratory Phonology is its shared research agenda, achieved through eclecticism, not dogmatism.

The first LabPhon conference took place at The Ohio State University, June 1987. It was co-organized by Mary Beckman and John Kingston with about 40 people in attendance, mainly the presenters, local students, and a few additional scholars. It has taken place roughly every two years since then (with one three-year interval, hence the 10th was 19 years after the first). It has also usually alternated between the United States and Western Europe. The term *Laboratory Phonology* was coined by Janet Pierrehumbert in the planning stages of the first

conference. One of the central goals of the first meeting was to bridge the distinct subfields and subcultures of phonology and phonetics, and crucially both phonologists and phoneticians were in attendance. LabPhon is a very special conference, bringing together a large community of scholars with diverse perspectives but shared interests, addressing the fundamental question of the nature of human speech sounds and sound systems. Its organizational structure – in plenary session, with both papers and commentaries – maximizes the breadth and depth of intellectual exchange.

To understand the nature of Laboratory Phonology, we need to consider what it is beyond a conference. Laboratory Phonology is an approach to investigating human sound systems, taking as foundational the premise that progress will be achieved more successfully through integrated methodologies. This view grows directly out of one of the central questions asked at LabPhon I, as stated in the introduction to the LabPhon I volume (Beckman and Kingston 1990: 3):

Therefore, we ask: how can we use the physical models and experimental paradigms of phonetics to construct more viable surface phonological representations? Conversely, what can we learn about underlying phonetic representations and processes from the formal cognitive models and computational paradigms of phonology? Determining the relationship between the phonological component and the phonetic component demands a *hybrid methodology*. [Emphasis mine.]

While there is some debate, many hold that Laboratory Phonology is not a theory as such. Pierrehumbert, Beckman, and Ladd (2000: 279) state the following:

Frameworks are packages of assumptions about the fundamental nature of language, and the research strategy for empirical investigation is driven by top-down reasoning about the consequences of the framework [...] In contrast, laboratory phonology is not a framework. [...] it is a coalition amongst groups of people, with some working in one or another of the various current frameworks, and others working in no phonological framework at all.

In this paper, I consider the goals and successes of Laboratory Phonology as well as the current challenges. The paper is divided roughly into two parts. In the first (§2), I try to characterize some of what we have accomplished over the past almost two decades. In the second (§3–§5), I turn to the current challenges, suggesting that some refocusing of how we frame our assumptions and models will help us to continue to make headway on the pressing questions that face us.

2. Goals and accomplishments

In this section, I discuss the nature of the enterprise of Laboratory Phonology and consider how Laboratory Phonology has changed how we understand and do phonology and phonetics. I start by giving a brief overview of the evolution of the goals of Laboratory Phonology as I see it. (I do not attempt to highlight individual contributions; this alone would take up more than my allotted space.)

At the outset, the central goal of Laboratory Phonology was, and I believe still is, gaining an understanding of the relationship between the cognitive and physical aspects of human speech. It is important to emphasize that Laboratory Phonology was not the inception of this sort of integrated, hybrid approach to investigating phonology and phonetics. A number of phoneticians and admittedly fewer phonologists were doing this sort of work at the time of the first LabPhon conference. Laboratory Phonology was a codification and naming of this approach.

The first LabPhon conference set out to bridge the gap between phonology and phonetics, to redefine the questions being asked, and to promote more integrated methodologies. For the first several meetings, the questions and methodologies were defined in terms of phonology and phonetics. These included a focus on prosody, segmental structure, and the mapping between phonology and phonetics. This can be seen by reviewing the themes of LabPhon I–IV, listed in Table 1 (including the date, location, conference organizer(s)/volume editor(s), number of attendees, volume title, and themes for each of the LabPhon conferences).

Table 1. LabPhon I–X, date, location, conference organizer(s)/volume editor(s), number of attendees (#), volume title, and themes

Lab Phon	date	location – organizers	#	title – themes
I	'87	OSU – John Kingston – Mary Beckman	40	<i>Between the Grammar and Physics of Speech</i> – suprasegmental phenomena – phonological representations and phonetic structures – segmental organization and coordination
II	'89	Edinburgh – Gerry Docherty – Bob Ladd	88	<i>Gesture, Segment, Prosody</i> – gesture – segment – prosody

Lab Phon	date	location – organizers	#	<i>title</i> – themes
III	'91	UCLA – Pat Keating	100	<i>Phonological Structure and Phonetic Form</i> – intonation – syllables – feature theory – phonetic output
IV	'93	Oxford – Bruce Connell – Amalia Arvaniti	80	<i>Phonology and Phonetic Evidence</i> – features and perception – prosody – articulatory organization
V	'96	Northwestern – Michael Broe – Janet Pierrehumbert	130	<i>Acquisition and the Lexicon</i> – articulation and mental representation – tone and intonation – acquisition and lexical representation
VI	'98	York -John Local -Richard Ogden -Rosalind Temple	90	<i>Phonetic Interpretation</i> – phonological representations and the lexicon – phonetic interpretation and phrasal structure – phonetic interpretation and syllable structure – phonology and natural speech production
VII	'00	Nijmegen – Carlos Gussenhoven – Natasha Warner	115	– phonological processing and encoding – in the laboratory and in the field: relating phonetics and phonology
VIII	'02	Yale – Louis Goldstein – Doug Whalen – Catherine Best	160	<i>Varieties of Phonological Competence</i> – qualitative and variable faces of phonological competence – sources of variation and their role in the acquisition of phonological competence – knowledge of language-specific organization of speech gestures
IX	'04	U of Illinois – Jennifer Cole – José Hualde	180	<i>Change in Phonology</i> – acquisition of sound patterns – indexing of speaker identity in sound patterns – sources of sound patterns in mechanisms of speech perception and production – sources of sound patterns in the interaction of first- and second-language phonologies
X	'06	Paris – Cécile Fougeron – Mariapaolo D'Imperio	240	<i>Variation, Detail and Representation</i> – variation, phonetic detail and phonological modeling – variation at the crossroad between normal and disordered speech – variation and the emergence of phonology – variation and language universals

Laboratory Phonology brought into focus some of the central questions of the time, including the nature of the interface and the language-specific nature of phonetics (contra the view espoused by Chomsky and Halle 1968 *The Sound Pattern of English*), leading to the concept of *phonetic knowledge* (see Kingston and Diehl 1994).

The focus on integrated methodologies meant encouraging phonologists to extend their methodologies beyond the impressionistic and beyond the analysis of what Kenstowicz and Kisseberth (1979) term *corpus-internal evidence*; that is, the transcription of a corpus of utterances. The methodologies include investigating *corpus-external evidence* – a broader range of language behavior whose explanation seems to depend on a speaker’s knowledge of the phonology of his/her language.

It also meant calling on phoneticians to enhance phonetics with more formal, quantitative, experimental methodology. Experimental approaches quickly expanded from linguistic phonetics to include psycholinguistic experimental approaches as well. Laboratory Phonology has enriched our understanding of which facets of phonetics inform phonology both methodologically and conceptually, emphasizing the importance of both production and perception. These methodological shifts were fundamental to breaking down the way that practice in phonology and phonetics respectively led to “the assumed division of labor [...] creates [-ing] a harmful illusion that we can compartmentalize phonological facts from phonetics facts.” (Beckman and Kingston 1990: 5.)

The emphasis on experimental data highlighted the ways that relying on impressionistic data is inadequate. Laboratory Phonology has played a critical role in showing that only with greater attention to fine detail in our empirical studies will we be able to develop adequate models. It has also very much encouraged the idea that we need to strengthen our base of empirical knowledge, through experimental work as well as fieldwork supporting cross-language documentation. *Linguistic phonetics* sets as its goal the documentation of the sounds of the languages of the world, in an effort to answer the questions: What is a possible human speech sound? What is a possible sound system? While it predates Laboratory Phonology by many decades (even centuries on some interpretations), linguistic phonetics is now understood by many to be part of Laboratory Phonology. Noteworthy in this regard are the recent initiatives in language documentation with particular concern for endangered languages.⁴ Descriptive and typological work on sound systems is central to these endeavors.

Laboratory Phonology has led to more sophisticated modeling of speech, which can be seen through the increased participation of computational linguists. It has also fostered and benefited from the development of important research tools shared by the community. Two prime examples are ToBi (Beck-

man and Hirschberg 1994), a prosodic annotation system (described on the OSU department website, <http://www.ling.ohio-state.edu/~tobi/>, as “a framework for developing community-wide conventions for transcribing the intonation and prosodic structure of spoken utterances in a language variety”) and Praat (Boersma and Weenink 2002), a free multi-platform acoustic analysis program (also including resynthesis and a variety of other tools for the analysis and investigation of speech). What is important about these tools beyond their intrinsic usefulness is that they provide a context for shared data collection and analysis.

A central result, seen throughout the LabPhon conferences and highlighted in LabPhon VI, is an enriched awareness of variation, not just in terms of the details of physical realization (implicit in phonetics), but also in terms of variation in all dimensions of language use, leading to the question of the role of variation in the knowledge of sound systems. This awareness has included moves toward a better understanding of sociolinguistic variation, supporting the development of sociophonetics (in contrast to descriptive dialectology). It has also challenged us to pay closer attention to the effects of variation in diachronic change (both themes of LabPhon IX). Attention to phonetics, as well as sociolinguistic and diachronic detail, has revealed the closely integrated nature of language competence and language performance.

There has also been an increased orientation toward psycholinguistics. These issues were brought to the fore at LabPhon V, which explicitly incorporated questions about language acquisition and the lexicon. The collective results of that meeting highlighted the role of stochastic generalization in the organization and knowledge of sound systems and questioned the framing of the relationship between phonology and phonetics as one of mapping between strict modules. This led to much more direct involvement of psychology, leading to Laboratory Phonology being seen more clearly as *cognitive science*. Recent meetings continue to strengthen these themes while drawing in new empirical domains and approaches, e.g. LabPhon VII: phonological processing and encoding; LabPhon VIII: signed language; LabPhon IX: second language acquisition; LabPhon X: disordered speech.

Some simple statistics highlight these developments. Consider first how Laboratory Phonology has grown. Looking at the number of attendees at the LabPhon conferences I–X, Figure 1, we see that there has been very robust growth, from 40 to 240 participants.

LabPhon has grown from being a workshop to a major conference. By maintaining the original organizational structure, with all presentations in plenary sessions and with both papers and invited commentaries, it has effectively maintained a workshop format, albeit with a much larger audience. This format has

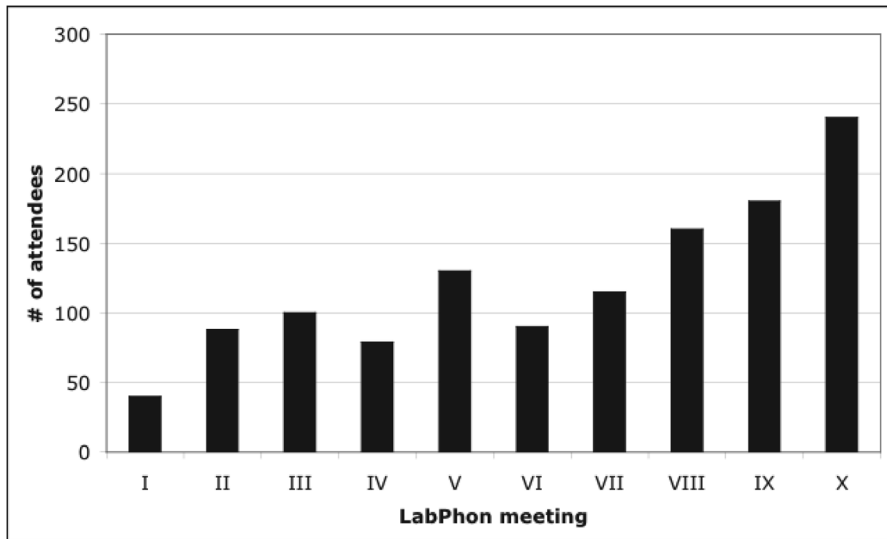


Figure 1. Number (#) of attendees at LabPhon I–X

been highly successful in fostering thoughtful and thought-provoking discussion and exchange. Since LabPhon II, it has become increasingly international. For LabPhon X, there were abstracts submitted from 27 countries. With LabPhon XI having taken place in New Zealand, the increasing geographical diversity of the participants is mirrored by our first meeting in the southern hemisphere (indeed the first outside of Western Europe or the United States).

Next consider the subfields and disciplines represented at LabPhon. In Figure 2, there is a comparison of the specialization of the oral presenters at LabPhon I, II, IX, and X.

This is a very rough (and debatable) characterization of the specialization of the presenters of oral presentations. It does not include poster presenters. In the case of coauthored papers, only the first author is included, unless the collaboration includes multiple subfields or multiple institutions. We can see that at the first two meetings, the presenters were primarily phoneticians and phonologists, while the range of specializations of the presenters at LabPhon IX and X highlights the truly multi-disciplinary nature of Laboratory Phonology. Just the task of identifying the primary specialization of presenters indicated a significant change as it was much harder to identify a primary area of specialization for many of the participants in LabPhon IX and X than for the first two. Not coded here, but noteworthy, is the fact that there were many more joint

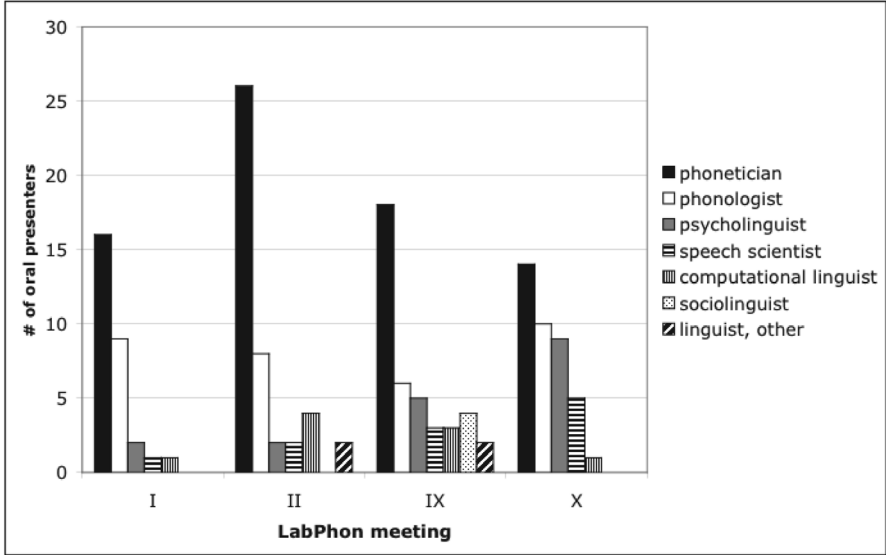


Figure 2. Specializations of oral presenters, LabPhon I, II, IX, X

presentations at LabPhon IX and X, many of which were across disciplines. Thus, Laboratory Phonology has not only become more multidisciplinary, but collaboratively so.

There have consistently been more phoneticians than phonologists participating, and since LabPhon II there has been an increasingly greater proportion of phoneticians, although this trend was broken at LabPhon X. Also, with the clear exception of LabPhon IX, all of the organizers have been more on the phonetics side.

All of this speaks to Laboratory Phonology’s successful development as a recognized approach to the investigation of human sounds and sound systems. Additional evidence that Laboratory Phonology has established itself includes the fact that some job ads list Laboratory Phonology as a subfield, and many finishing graduate students describe their specialization as being Laboratory Phonology. Noteworthy in this regard is the fact that at the 150th meeting of the Acoustical Society of America, I and many colleagues presented posters in a session entitled Laboratory Phonology (!).

Another way to assess the success and acceptance of Laboratory Phonology is to consider where Laboratory Phonology work appears. Almost definitionally, the most important venue is the LabPhon volumes themselves. Each volume has proved the test of time with seminal work held to very high editorial

standards. There have also been a number of important edited volumes on phonetic/phonology themes (e.g. Ohala and Jaeger 1986 *Experimental Phonology*; Burton-Roberts, Carr, and Docherty 2000 *Phonological Knowledge: Concepts and Empirical Issues*; Hume and Johnson 2001 *The Role of Speech Perception in Phonology*; Hayes, Kirchner, and Steriade 2004 *Phonetically Based Phonology*; and Solé, Beddor, and Ohala 2007 *Experimental Approaches to Phonology*; among others).

What about journals? Indications suggest mixed results on this front. We can consider whether laboratory approaches play an increasingly important role in the journal *Phonology*. First, it is important to remember that *Phonology* (originally *Phonology Yearbook*) defined its purview in a way that certainly encompassed Laboratory Phonology: “The *Phonology Yearbook* is committed to the stimulation, dissemination, and cross-fertilization of ideas in phonology and those disciplines which impinge on it.” (*Phonology Yearbook* 1 1985: vii.)

Indeed one of the first volumes, *Phonology Yearbook* 3, takes as one of its two themes the validation of claims in phonology. Nevertheless, we can see a shift in the acceptance of integrated methodologies if we compare, for example, the first non-thematic volume, *Phonology* 5.1 (1988), with more recent volumes. In *Phonology* 5.1, the papers were all *straight* phonology, including articles on syllable structure, metrical constituency and reduplication, all written by theoretical phonologists. In a recent volume, *Phonology* 22.1 (2005), of the five papers – on topics ranging from identity in Optimality Theory to vowel-length neutralization – three are straight phonology and two take a Laboratory Phonology approach, including experimental phonetic data, as well as evidence from allied subfields (acquisition and language change).

On the other hand, it seems that Laboratory Phonology has had less direct impact on the inclusion of phonology in phonetics journals. Some reflections of Laboratory Phonology are seen in *Journal of Phonetics* and *Journal of the International Phonetic Association*; there seems to be less effect on other phonetics journals. This may be due in part to the position of phonetics as multidisciplinary (not just representing linguistic phonetics) as well as editorial policy, e.g. page limits and strictly structured format. Perhaps ironically, it may also be due to one of the costs of Laboratory Phonology’s success. Impressionistic phonological analyses are now often complemented by experimental work, but that work is not carried out or presented in the ways that are characteristic of phonetics journal publications.⁵

A question I have heard raised from time to time is whether Laboratory Phonology should have its own journal. In the preconference draft of this paper, my conclusion to this question was “I don’t think so”. At LabPhon X, the decision was reached to form a Laboratory Phonology society and launch a

journal. In light of this felicitous decision (which speaks very directly to Laboratory Phonology's coming of age), I reframe my reservations as a cautionary note. It is important that the new journal foster the central point that Laboratory Phonology is about the integration of phonology, phonetics, and increasingly allied fields. We need to ensure that creation of a new journal does not lead to further fragmentation of the field by siphoning off readership and submissions to other linguistic and cognitive science venues.

In many ways, the central goals of better dialog across boundaries, better integration of methodology, and better collaboration, have remained the hallmarks of Laboratory Phonology. The success of Laboratory Phonology is that those issues which at first were defined in the effort to bridge phonology and phonetics are now understood more broadly, as truly interdisciplinary questions, bridging linguistics with psychology, computer science, etc. The central question of understanding the relationship between the cognitive and physical aspects of human speech is now defined as a question of cognitive science.

3. Current questions and challenges

As we have just seen, Laboratory Phonology has had genuine success both in terms of redefining the questions that we ask about the nature of human sound systems and in terms of enriching the methodologies that we use to answer these questions. Yet many challenging questions still present themselves, and much work remains for us to provide fully satisfactory answers to these age-old questions. These questions include the following:

- What is phonological knowledge – as distinct from phonetic or lexical knowledge?
- What are the units of speech – features, segments, syllables, words?
- Are there natural classes, and what are their roles?
- What is markedness?
- What is naturalness, and what is its source?
- To what degree are phonological and phonetic systems language-specific, and to what degree are they common to all human languages?
- In what ways do both production and perception affect phonology?
- How are linguistic knowledge and language use integrated?
- What is the relationship between synchronic sounds systems and diachronic change?
- How does the process of language acquisition result in the knowledge of an adult phonology?

- To what degree are mechanisms of linguistic learning and competence specific to language, and to what degree are they part of more general cognitive mechanisms?

We have made considerable progress on many of these questions in recent years; yet none of these has been fully answered. To reach a deeper understanding of these and other fundamental questions, the next major challenge is to develop better-integrated models to account for the richer empirical body of knowledge we have been acquiring. In what follows, I neither focus on specific theories of phonology or phonetics nor attempt to evaluate specific models in considering the questions just posed. Rather I would like to discuss how we frame both models and assumptions and how this framing affects our investigations. The discussion is thus more sociological and philosophical in nature. In §4, I consider how we structure our discussion about models and theories. Then in §5, I turn to a set of assumptions underlying generative linguistics to think about how they influence our research.

4. The framing of models

It is important to understand how theoretical framing and even the rhetoric of our linguistic investigations affect our conclusions. I would like to briefly consider how our discourse about models influences our interpretations (§4.1) and then turn to the question of models as descriptions vs. explanations (§4.2).

4.1. Polarization of models

Much of the recent discourse about theories or models of linguistics has been polarized. Arguments are too often framed in either/or terms. Either this model – in wholesale terms – is *right* or that model is *right*. This sort of rhetoric is not necessarily the best way to advance our understanding of the nature of human language. I would like to suggest that our discourse and prevailing attitudes have led to an amplification of differences that goes beyond intellectual usefulness. In highlighting the differences, we also lose sight of how much of a shared agenda we have in our investigation of the nature of human language. In the domain of sound patterns, this division has at least implicitly played out in the assumption that somehow phonology is *formal* and phonetics is *functional*. (For example, Hale and Reiss 2000, in thinking about where *naturalness* resides, define phonology as purely formal and relegate all *substance* to the phonetics.)

Here I would like to draw a distinction between method and rhetoric. The scientific method widely adopted in linguistics necessarily and appropriately defines explicit hypotheses with clearly stated assumptions to be tested. On the

other hand, the rhetoric used sometimes overstates the case being made about particular claims and models. The general strategy of testing the most constrained or most easily falsifiable theory is integral to sound scientific methodology. Simple models can thus be tested and developed and elaborated as needed to provide an empirically adequate account of observed phenomena. The problem is that often the assumptions made relative to the nature of the linguistic systems are too simplistic to account for the documented complexity of the phenomena before us. We are at a juncture where richer, more complex models need to be developed and tested. The questions being tested also need to be state-able and testable in theory-neutral ways.

An important contribution of Laboratory Phonology has been to move away from this either/or way of thinking – by supporting more integrated methodologies. Yet somehow even within Laboratory Phonology, when we are attempting to model our results, we also often fall prey to this either/or rhetoric, where models based on different kinds of data are framed in opposition to each other. Our next challenge is to carry over our integrated methods to our theorizing.

Consider the current debate about the nature of lexical representations – whether they consist of sparse abstract representations along the lines generally assumed within generative phonology – or whether they consist of much finer-grained details, as usually assumed within both connectionist and exemplar views of lexical representation. The framing of this debate suggests that either one end point or the other is correct. Yet much empirical work supports the conclusion reached by Pierrehumbert (2003); Beckman (2003); Beckman, Munson, and Edwards (2007); Cutler et al. (this volume); and Ramus et al. (this volume); and others, that both fine-grained and coarse-grained information are part of lexical representations. At the coarse-grained end are abstractions that I believe look a lot like what we traditionally assumed to be a phonemic or *underlying* representation. This body of work leads us to the conclusion that we need to avoid reductionist thinking. Pierrehumbert (2001: 196) argues against reductionist models, stating that “Thus the cutting edge of research concerns non-reductionist models. In non-reductionist models a representational framework is developed for each level of abstraction.” Pierrehumbert (2003: 178) describes the relationship between more abstract and more fine-grained information as follows: “In viable theories of phonetics/phonology, there is a ladder of abstraction, each level having its own representational apparatus. Thus, the theory as a whole must delineate both the available representation at each level and the principles relating one level to another.”

As phonologists, we need to take seriously the evidence of the effects of fine-grained details on phonology. Yet on the other side, this does not mean that there is not true abstraction. It is important to realize that just because abstract knowledge

may be built out of fine-grained details (one of the ideas within the notion that language is *emergent*), it does not mean that the abstractions do not exist.

4.2. Models as descriptions vs. explanations

Another important question is what we understand the goal of theorizing to be. Do linguistic models strive to provide *descriptions* or *explanations*? I believe that these are often confused. This arises in part from the difference between the strict definitions of adequacy of grammars defined in Chomsky's early work – and more casual usage. It also stems from linguistics as a field privileging *theory* over *description*.

It is worth reminding ourselves of the specific technical definitions given by Chomsky. Chomsky (1965: 26–27) contrasts descriptive and explanatory adequacy:

To summarize briefly, there are two respects in which one can speak of 'justifying a generative grammar.' On one level (that of descriptive adequacy), the grammar is justified to the extent that it correctly describes its object, namely the linguistic intuition – the tacit competence – of the native speaker. [...] On a much deeper and hence much more rarely attainable level (that of explanatory adequacy), a grammar is justified to the extent that it is a *principled* descriptively adequate system, in that the linguistic theory with which it is associated selects this grammar over others, given primary linguistic data with which all are compatible.

Our rhetoric often suggests that we think we are talking about explanatory adequacy, while in many cases, we are really talking about descriptive adequacy. Achieving descriptive adequacy is in no sense a trivial result, since descriptive adequacy has predictive power. I believe that we are making good headway on more descriptively adequate models, especially as we continue to add to our empirical base of knowledge through cross-linguistic work and integrated methodologies. Explanatory adequacy can only be achieved when we have multiple truly descriptively adequate grammars to compare. Both more top-down and bottom-up approaches are useful and can work in tandem as we develop more empirically adequate models.

In the sense commonly used, evaluation of explanatory adequacy (the *psychological reality* of our models) will only be possible as we come to better understand how the brain works. We may be able to judge models as more or less plausible, but we need to be careful about more literal claims of psychological reality. It is not enough to show that there are possible computational implementations of our grammars to show that they are psychologically real. Consider, in this regard, connectionism. It is a useful approach to the description

of how language works, but it does not in and of itself offer an explanation. Dell (2000) states the following:

Connectionism, in its broadest conception, is not a theory of learning, cognition, or perception. It is a language for expressing such theories. (p. 348.)

The problem is that connectionism is not, by itself, the answer to a theory of the lexicon. A connectionist model only has a chance to do the right thing if its representational assumptions (how its input and output units correspond to reality) and its architectural assumptions (which layers are present, which connect to which) are correct. (p. 347.)

Greater care in our claims and rhetoric about what our models can accomplish will foster more collaborative discourse across paradigms.

5. Assumptions and their implications

It is useful to think about how the foundational assumptions of early generative theory have shaped our theories and our approaches to linguistic investigation. These include an interwoven set of assumptions, set out by Chomsky (1965) in *Aspects of the Theory of Syntax* and in other seminal work:

- the definition of the *ideal speaker/hearer* within a *homogeneous speech community*
- the *separation of competence and performance*
- the importance of *modularity* and the *avoidance of redundancy*
- the direct role of the task of *language acquisition* as the source of *language universals*.

These assumptions were originally largely defined in terms of syntax, but also strongly influenced phonology – either directly or indirectly. Many of us implicitly follow these assumptions. (In this broad sense, I understand Optimality Theory to be a theory of generative phonology.) Others have implicitly or explicitly rejected them.

To understand what motivated these assumptions and why they have been useful, we need to think about them in the intellectual context of the time. The framing of early generative linguistics as an approach to the study of language was in part as a rejection of American Structuralist approaches to the study of language, particularly with regard to the influences of behaviorist approaches to psychology. It seems that part of the motivation for assuming a specific endowment for language, as well as assumptions about universals and their linkage to language acquisition, arose from substantive and methodological gaps be-

tween linguistics and cognitive psychology in the late 50s and early 60s. In some sense, the Chomsky-Piaget debate (Piattelli-Palmarini 1980) was a reflection of how little was known about early cognitive development at that time. Certain assumptions about universal endowment of linguistic abilities served to get the enterprise off the ground. What were working assumptions have become foundational beliefs of the theory. Crucially, these assumptions need to be reevaluated in light of what we have learned not only in linguistics but also in the psychology and neurobiology of language over the past 40 or so years.

In §5.1–§5.3, I consider these assumptions in a bit more detail.

5.1. Ideal speaker/hearer in a homogenous speech community and the separation of competence and performance

Central to early generative theory is the idea that there exists *an ideal speaker-hearer in a homogenous speech community* and that *competence and performance are separate*. As stated by Chomsky (1965: 3–4):

Linguistic theory is concerned primarily with an ideal speaker-listener, in a completely homogeneous speech-community, who knows its language perfectly and is unaffected by such grammatically irrelevant conditions as memory limitations, distractions, shifts of attention and interest, and errors (random or characteristic) in applying his knowledge of the language in actual performance. [...] The problem for the linguist, as well as for the child learning the language, is to determine from the data of performance the underlying system of rules that has been mastered by the speaker-hearer and that he puts to use in actual performance.

Fundamental to generative linguistics has been a sharp division between competence and performance. We study competence through performance (but only because that is the sole lens that we have on competence). This view emphasizes that our ability to use linguistic systems is founded on a system of (implicit) knowledge. It directly captures an intuition that *knowing* a language entails linguistic competence. It emphasizes the view that there is a fundamental difference between human language and other animals' systems of communication and also between language and other sorts of human communication and human cognitive activities. It has served as a useful division for analyzing and modeling the enormously complex data that we are faced with as linguists.

While useful in many ways, the literal separation of competence from performance has profound consequences for the success of linguistic investigations. It places much of the rich variation and complexity of language outside of the purview of the linguist. This issue has been central to many theoretical debates within linguistics since the 1960s. Scholars working within Laboratory Phonology have contributed in important ways to rethinking both the notion of an ideal

speaker-hearer within a homogeneous speech community and a separation of competence vs. performance. This can be seen quite clearly in discussion about the nature of variation. As discussed above, a central theme within Laboratory Phonology has been that language is intrinsically variable and contextually interpreted; contrast is inextricable from this variation; and competence exists *through* performance. Language knowledge and language use need to be understood in relationship to each other. They are two sides of the same coin.

5.2. Modularity and avoidance of redundancy

The grammar is understood to be *modular*. In *Aspects of the Theory of Syntax*, there is discussion of three components: “This system of rules can be analyzed into the three major components of a generative grammar: the syntactic, phonological, and semantic components.” (Chomsky 1965: 16.)

We have inherited assumptions about the need for strict modularity and the high cost of redundancy. Consider, for example, the view espoused by Hale and Reiss (2000: 162): “The modular approach to linguistics, and to science in general, requires that we both model the interactions between related domains, and also sharply delineate one domain from another. Occam’s Razor demands that, in doing so, we avoid redundancy and the postulation of unnecessary factors.” In a broad sense, there is strong evidence of modularity of the mind coming from linguistics, psychology, and neurobiology. Just to cite one example, Bornstein and colleagues (Bornstein 2006), in work investigating multiple intelligences in children, show that many children demonstrate either a strength or weakness in a particular type of intelligence, and this deviation from the mean does not correlate with other strengths or weaknesses. They conclude that this provides strong evidence for modularity of the mind.

However, does evidence of modularity of the mind entail the specific assumptions often made in generative linguistics about the nature of modularity? Is there necessarily strict modularity? Does modularity entail sharp delineation? Could there be modularity that is not rigid? The lack of strict modularity is implicit in approaches that understand the relationships between linguistic domains through interfaces. If we do not subscribe to strict modularity between, for example, phonology and phonetics and between phonology and the lexicon, then it becomes an empirical question if drawing a distinction is useful. Does a division of labor contribute to both descriptive and explanatory adequacy?

When we assess linguistic models, one of our criteria is often avoidance of redundancy. To be sure, Occam’s Razor compels us in this direction, but I also think that there has been an underlying assumption about the high cost of redundancy that might be overemphasized. Occam’s Razor is a methodolog-

ical premise, not a theoretical goal. Strong empirical evidence highlights the complexity of language.

One source of the perceived cost of redundancy, I think, is due to early Information Theory and its impact on linguistic theory. At the outset of the information age, storage was very costly, and through implicit parallels between the way computers and the mind work, it was assumed that there was little room for redundancy. We see this influence, for example, in the stated goals of Jakobson, Fant, and Halle's (1963: 9) feature theory.

Information Theory uses a sequence of binary selections as the most reasonable basis for the analysis of the various communication processes. [...] It is an operational device imposed by the investigator upon the subject matter for pragmatic reasons. In the special case of speech, however, such a set of binary selections is inherent in the communication process itself as a constraint imposed by the code on the participants in the speech event. [...] This follows from the fact that the sole information carried by the distinctive feature is its distinctiveness.

It was argued that features were binary and that we should have as few as possible. The Jakobson, Fant, and Halle feature set consisted of approximately 15 features with some features doing double or even triple duty. The same features defined consonants and vowels and most features had multiple roles, e.g. [grave] and [acute] serving as primary features in both vowels and consonants. Chomsky and Halle (1968) expanded the feature set to avoid certain inadequacies, but the goals of binarity, a minimal feature set understood to be universal, and avoidance of redundancy in lexical representation, were all carried over.

In the meantime, we have learned a lot more about the complexity and richness of the brain. This means that the role of redundancy in language needs to be reconsidered in its own right. The empirical base of knowledge to which Laboratory Phonology has amply contributed provides at least part of the answer. As discussed above, there *is* redundancy in sound structure.

5.3. Language universals and their implications for acquisition

Chomsky (1965: 27) defines the goal of universal grammar and the task of the child acquiring language as follows:

A theory of linguistic structure that aims for explanatory adequacy incorporates an account of linguistic universals, and it attributes tacit knowledge of these universals to the child. [...] Language learning would be impossible unless this were the case. [...] What are the initial assumptions concerning the nature of language that the child brings to language learning, and how detailed and specific is the innate schema (the general definition of 'grammar') that gradually becomes more explicit and differentiated as the child learns the language?

I believe many would agree about the importance of the final part of this statement. However the equation of the task of the linguist and the task of the child acquiring language has major consequences for the definition of *language universals* and their relationship to *language acquisition*. This inextricable linkage is neither logically nor empirically warranted. (See Pierrehumbert, Beckman, and Ladd 2000; Vihman and Velleman 2000; Gerken 2005 for discussion.)

There are two central points that merit emphasis. First, how we learn is *not* the same as what we know. In this vein, Vihman and Velleman (2000: 307–309) point out that neither a model of “phonology all the way down” which models early acquisition in terms of adult categories and rules or constraints, nor a “phonetics all the way up” approach which assumes that phonology emerges gradually out of the phonetics, offers an adequate account of the acquisition of a phonological system. As a consequence, both language acquisition and linguistic universals need to be investigated and understood in their own right. Only then can we understand how they are interrelated.

Consider in this regard the widely discussed issue of feature theory as universal. The term *universal* is used in many different ways. To think about the ways in which the set of possible speech sounds is universal and to think about the ways that there is or could be a *universal feature theory*, we need to understand in each particular case what is meant by the term *universal*. In the broadest sense, as linguists, we strive to develop a *universal theory*, in that we aim to delineate the properties of possible human language. Many of us are directly or indirectly engaged in addressing the questions: What is a possible human speech sound? And what are the representations of the set of possible speech sounds and the categories defined by them? These goals of course pre-date generative linguistics, as seen, for example, in the long-standing interest in and accepted need for an international phonetic alphabet. This defines one of the central themes of linguistic phonetics and in its general characterization, I believe, is quite uncontroversial.

No matter what our theoretical assumptions, we still need to address the following questions:

- What *are* we endowed with that enables us to build up a system of phonological contrasts so successfully and so quickly?
- Why is it that the possible categories of contrasts across languages are quite limited and the systems show such surprising similarities across languages?
- How do we explain evidence suggesting both language-independent and language-specific dimensions of language acquisition?

I think we would all agree that a partial answer comes from constraints imposed by the psycho-acoustics of the human ear and the nature of the human vocal

track. But as stated by Fromkin (1977: 370), these are *necessary* but not *sufficient* constraints.

Generative theory accounts for the definition of possible speech sounds, as well as an explanation of *natural classes* and *markedness*, by positing a small vocabulary of elements or parameters that we are endowed with, defined to be a universal set of so-called distinctive features. *The Sound Pattern of English* has been foundational in this regard: “The total set of features is identical with the set of phonetic properties that can in principle be controlled in speech; they represent the phonetic capabilities of man, and we would assume, are therefore the same for all languages.” (Chomsky and Halle 1968: 294–295.) These phonetically defined properties are understood together to define the inventories and patterns in phonology. Much attention has been paid to delineating the proper set, in terms of observed natural classes and in terms of phonetic correlates.

There is far from a consensus on how much of the definition of the sound system comes from the physical world vs. how much is intrinsic to the nature of the linguistic system. There is disagreement about whether the physical factors directly define the nature of the phonological system or whether their effects are indirect, mediated by the grammar. For example, it has been argued that certain principles, such as *symmetry* (Hayes 1999, Gordon 2006), *simplicity* (Gordon 2006) and *economy* (Clements 2003) are intrinsic (but not necessarily unique) to the phonological system. These questions remain as central issues within phonetics, phonology, and Laboratory Phonology, and ongoing work continues to address and elucidate this interesting and complex set of questions.

Understanding how well the proposed feature sets and categories defined by them capture adult phonological systems, as well as thinking seriously about how such categories are acquired, will ultimately allow us to understand the ways in which language-specific, species-specific, and more general physiological and psycho-acoustic properties together define the nature of phonological systems and the task of their acquisition. The point is that unless we move away from a *literal interpretation* of feature theory as universal: “The significant linguistic universals are those that must be assumed to be available to the child learning a language as an a priori, innate endowment” (Chomsky and Halle 1968: 4); we will not make progress on understanding the nature of the linguistic endowment, since the literal interpretation predetermines the answers.

We see that there are ways in which these foundational assumptions are not literally true and require reconsideration. If we can unpack and rethink these assumptions, we will be able to move away from a polarized discourse and come to understand the ways in which these assumptions are useful and the ways in which they are not. Laboratory Phonology has played an important role in rethinking these assumptions. Yet there is more work to be done in this regard.

With careful articulation of our assumptions, we may well find more agreement and less disagreement within linguistics and with closely allied fields.⁶ Some of these points may seem obvious, and yet at least the rhetoric that one hears at conferences and reads in journals suggests that these ideas need to be addressed and rethought. These are all foundational issues that I believe we have to discuss explicitly, carefully, and empirically.

I would like to suggest here some middle ground. I argue that in large measure these assumptions are *approximately* correct but not in the literal sense in which they are often interpreted. I now turn to the ways in which generative models are approximately right.

6. Generative grammar as an excellent approximation

I have argued that there are a number of ways in which generative theory may not be *literally* correct. On the other hand, while there are critiques of generative models that need to be taken seriously, it is important to understand the genuine successes of such models and why they do as good a job as they do of modeling phonological systems. Generative models have proven to be excellent *approximations* of adult grammars. This is a non-trivial result when we consider the complexity of linguistic systems across the languages of the world.

Consider, for example, the efforts to define and delineate possible speech sounds. Maddieson and Precoda (1990) (a revised and updated version of Maddieson's 1984 *Patterns of Sounds*) identifies roughly 900 segments (potentially contrastive elements) occurring in a representative sample of 451 languages. These are quite well characterized in categories definable by distinctive feature theory (or, for that matter, the categories implicit in the IPA chart). This is a striking result when one considers the complexity of these systems and the wide range of variation across the languages of the world. From this simple characterization, we have learned a lot about the typology of the sounds of the languages of the world.

Pierrehumbert, Beckman, and Ladd (2000: 285) among others rightly point out a serious problem, which is that these categories are only definable in a roughly equivalent way. The categories are language-specific in the sense that "there are no languages in which the implementation of analogous phonemes is exactly the same." The categories show more variation across languages and are fuzzier than predicted by *The Sound Pattern of English* distinctive feature set (or the framework implied by the IPA chart). These formalizations do not capture these differences. The intuition is that categories are built up out of experience (although I do not believe we yet understand the mechanism that

links experience to representation). In some technical sense then, distinctive feature theory is *wrong*. But does this mean that we should throw it out? No. First of all, both the IPA chart and feature theory are excellent tools for language description and fieldwork, which is essential for the all-important documentation of the thousands of still poorly described languages of the world. They also have a certain predictive power and have proven very useful in the characterization of phonological and phonetic typological patterns. Moreover, as we come to understand why formal systems are only approximately right, it becomes an interesting question why they do as well as they do. As we come to better understand *how* categories are acquired, we will come to better understand why categories are somewhat fuzzy.

If we frame our discussion in terms of *right* and *wrong*, then we miss the opportunity to understand what is *almost right* about these models. We need to critique these models in a more sophisticated way. We need to understand their limitations while also understanding the insight they offer. It may be that feature theory is right at a particular level of granularity or it might be, as suggested by Pierrehumbert, Beckman, and Ladd (2000), that feature categories capture the end state, but not how the system is formed. The crux of the problem is that generative models are good models of adult grammar, but they are less successful as models of language acquisition, language change, and sociolinguistic variation. In some sense, adult grammars must be built out of these elements and so ultimately an accurate model must show how this happens.

It is also worth thinking about why in fact a model that captures an approximation of adult grammar might be on the right track. Within phonology, we often focus on the sounds as part of a system, and within phonetics, we are interested in the physical properties, but ultimately we need to remember that the sounds of language are central elements in a system of communication. For communication to be successful, all we need is for individual grammars to approximate the individual grammars of those we are communicating with. Standard generative assumptions postulate an ideal speaker-hearer competence. Yet for the system of communication to work, we just need to share systems that are approximately the same, close enough to avoid too many misunderstandings. (I believe that miscommunication happens much more than we usually acknowledge. We just do not pay that much attention, and usually our miscommunications do not matter that much. But they happen all the time. This suggests that the grammars of individuals are only approximately shared by members of a speech community.)

7. Conclusions

In conclusion, we have seen that Laboratory Phonology has grown tremendously since acquiring a name and becoming codified as an approach. At the 10th LabPhon, we were still asking the same basic question – about the relationship between the cognitive and physical aspects of sounds systems. However, we are now trying to understand this in a richer multidisciplinary way, considering not only the relationship between phonology and phonetics. Laboratory Phonology has become an interdisciplinary approach to investigating the nature of human language in the domain of speech.

To fully accomplish the work ahead of us, we need to extend our integrated methodologies to truly integrated models, and we need to be willing to be critical of our working assumptions. There are elements of insight in the various approaches and frameworks that are widely used to understand the nature of sound systems. But a polarized, either/or discourse about the right kind of model is not going to solve the problem. The right kind of model is not going to be simple. Because the very nature of language is so complex, an adequate model will be complex, and we are most likely to properly characterize it through synthetic approaches. The model needs to enable us to accurately model adult grammar, not as epiphenomena, but as a system of knowledge, while also modeling acquisition, language use, and language change. And it needs to give us insight into the ways in which the adult grammar grows out of these. The model needs to be psychologically plausible and give insight into both the ways that the linguistic system builds on general cognitive abilities and also the ways in which it is special.

In closing, I briefly return to a sociological perspective on Laboratory Phonology. First, I have argued that Laboratory Phonology exemplifies truly interdisciplinary work and as such is an excellent model of cognitive science. Yet it is my strong impression that speech remains underappreciated in many cognitive science circles. It is also important to consider how successfully Laboratory Phonology has bridged the gap between more theoretical and more empirical approaches to the study of sounds and speech. Have we sufficiently engaged theoretical phonology, or is the line just drawn at a different place?

At the outset, Laboratory Phonology was seen as a redefinition, a more comprehensive way of doing phonology, and many central figures in theoretical phonology participated. While some of these scholars have remained involved, there are also many theoretical phonologists who do not participate in Laboratory Phonology, and the proportion of phonologists has decreased relative to other fields. Thus in a way, Laboratory Phonology has become a broader multi-dimensional approach to studying linguistic sound systems, but it has not fully encompassed theoretical phonology.

I would like to share a speculation on why this is the case. The early LabPhons framed our understanding of the phonology-phonetics interface very much within the modular framework that grew out of *The Sound Pattern of English*, embedded in a number of operational assumptions, including a sharp division between phonology and phonetics: “how should the task of explaining speech patterns be divided between the models of grammatical function that are encoded in phonological representations and the model of physical or sensory function that are encoded in phonetic representations?” (Beckman and Kingston 1990: 1.) The thinking of many practitioners of Laboratory Phonology has evolved from these earlier views in a number of directions as discussed above and as seen throughout the recent LabPhon conferences. Yet, precisely because Laboratory Phonology is not a theory as such, the collective influence of our results outside of Laboratory Phonology – on theoretical phonology and cognitive science – has not been as great as it should be, because these results are seen as *empirical* and not *theoretical*. To succeed, we need to reach out to theoretical phonology and to the broader cognitive science community to educate them about how our approach informs not only empirical matters but theoretical ones as well. Formation of a Laboratory Phonology society is an excellent step in this direction and will support us in collectively facing the intellectual and sociological challenges that face us.

I believe that we will accomplish our goals by continuing to collaborate in the full sense of the word, through substantive collaborations with scholars in allied fields and by encouraging our students to cross-train in ways that we did not (e.g. postdoctoral experience in related fields). Recent trends in this direction are very encouraging. I look forward to hearing about our collective progress at the LabPhon meetings to come.

Notes

1. My thanks to the many scholars who provided input to this paper, including organizers of previous LabPhons who shared both organizational information about earlier meetings and their own impressions of the contributions and challenges of Laboratory Phonology. Special thanks to Pam Beddor, Ioana Chitoran, Nick Clements, Cécile Fougeron, John Goldsmith, Louis Goldstein, Steve Hilgartner, Marie Huffman, Pat Keating, Bob Ladd, Lisa Lavoie, Marek Przewdziecki, Anastasia Riehl, Michael Wagner, Doug Whalen, Lisa Zsiga, and members of the Ph2 group at Cornell, who discussed with me the ideas presented here and/or commented on earlier versions of this paper. Needless to say, I alone am responsible for the views expressed here.

2. I dedicate this paper to Peter Ladefoged. While an active and enthusiastic participant, Peter wasn't really a founder of Laboratory Phonology. His contribution, I believe, was more foundational. He was one of the central figures who opened the intellectual space for Laboratory Phonology to happen and encouraged his students and colleagues to approach sound systems in new and innovative ways. Especially for those of us who were Peter's students, he gave us so much and influenced us in such profound ways that his contributions are timeless. To me, one of Peter's greatest contributions was his openness – to new ideas, to new ways of thinking, and his profound belief that he always stood to learn new things from everything he did and everyone he interacted with. May we all aspire to foster the spirit of openness and intellectual curiosity embodied by Peter.
3. This is sometimes abbreviated as LabPhon. I will use the term LabPhon to refer to the conference.
4. These include, for example, the Endangered Language Fund at Yale, The Hans Rausing Endangered Languages Project at SOAS, and typological work at the Max Planck Institute for Evolutionary Anthropology, Leipzig.
5. This raises a potential concern. In incorporating experimental work in phonological studies, it is important that we heed one of the themes of LabPhon II: "if phonology is to be successfully tested in the laboratory, scientific rigor is essential." (Docherty and Ladd 1992: 2.)
6. Many members of the Laboratory Phonology community have reached similar conclusions about the need to rethink fundamental assumptions and indeed my own thinking has been strongly influenced by this work. In this regard, Pierrehumbert, Beckman, and Ladd (2000)'s position paper about Laboratory Phonology is particularly important, serving as a catalyst to refocusing our understanding of the nature of the undertaking.

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