A VIEW OF THE FUTURE OF PHONETICS

Björn Lindblom
Department of Linguistics, Stockholm University,
S-10691 Stockholm Sweden

ABSTRACT

To produce new knowledge and promote applications serving practical needs fundamental research is necessary. However, as hard times strike and research funding is cut, sponsors in government and other sectors tend to demand useful results *without* expensive "digressions" into basic science. Should the future of phonetics be entrusted to applied areas? Will phoneticians succeed in convincing sponsors of the intrinsic merits and practical necessity of their own research? The future of phonetics is in whose hands? Phoneticians still have a choice.

INTRODUCTION

Phonetician - a jack of all trades, a master of none? Or a person holding the key to a more profound understanding not only of speech, but of human language as a whole. Phonetics - a science in its own right? Intellectually, yes. There are plenty of good questions around from which to build a future phonetics. But will there be anybody to ask them in the future? For, no matter how forcefully articulated, the long-term priorities of fundamental research continually face the threat of being overruled by short-term definitions of social "needs" and of being replaced by the short-sighted agenda of "immediate usefulness". However, since answers to the core questions of phonetics have timeless and cross-cultural intrinsic value and provide the knowledge resources without which future practical applications will not be possible, prospects are good that, armed with good questions, good methods and a critical awareness of the role of external "market forces", phoneticians of the next century will be ready to meet the challenges and will find themselves contributing to one of the most central and dynamic of scientific enterprises: *Understanding human language*.

"WHAT IS A PHONETICIAN?"

At the opening of the XIIth ICPhS at Tallinn, that question was raised by Ladefoged [1] who noted that "communication engineering, physical acoustics, psychology, anatomy, physiology, linguistics, applied linguistics, computer science and poetry" are part of our lives as phoneticians.

> " ... we are phoneticians, we, the people who come to phonetics congresses, and know something about some of these diverse disciplines. None of us can know enough about all of them, *which is why being a complete phonetician is an impossible task.* But every four years we can get together and pool our knowledge. This is phonetics." (Ladefoged 1988; italics ours).

Ladefoged is right in saying that a complete mastery of all the disciplines that overlap with phonetics is an impossible task for any single individual. But is such broad knowledge really a relevant goal? Is it not the case that our interest in adjacent fields is limited to those aspects that help us answer the questions we ask? Phoneticians seek facts and insights about how speech is produced, perceived and acquired. And about how the world's sound patterns are related to the on-line phenomena of speaking, listening and learning. It seems clear that those and other questions are highly interdisciplinary presupposing bits of

knowledge coming from anthropology, biology, cognitive science, computer science and engineering, linguistics, literature and music theory, mathematics, neuroscience, philosophy, physics, sociology and several other fields. The student of sign language is in an analogous sitation.

Is a phonetician a jack of all those trades, but a master of none of them? Or a person with an agenda defined by the questions (s)he asks? Somone who makes *selective* use of information from a variety of sources? Who uses only what helps explain certain facts and makes certain measurements possible?

According to the second possibility, a phonetician is a person seeking an understanding of the issues most relevant to developing phonetic theory and who aims at acquiring *enough knowledge* about other fields to be able to extract relevant information from them and put it to productive use. "Being a complete phonetician" would still be a remote goal and a forbidding task for the individual, but not one that we could not easily cope with, given good questions, good methods and lots of colleagues to argue and interact with.

If we opt for the latter definition, what are the questions? That, of course, is one of the issues to be debated at the ICPhS 95. I would like to offer here a short sketch of my own line of reasoning and the priorities that it gives rise to.

WHY PHONETICS BELONGS IN A BIOLOGICAL FRAMEWORK

To structuralists like Saussure, the form of language was a set of social conventions shared by the members of a speech community. During the second half of the 20th century, a significant event was the appearance of Chomsky's *Syntactic Structures* which made explaning why children acquire their mother tongues the ultimate goal of linguistics. Chomsky's writings have undoubtedly been major factors in turning the focus of linguistic theory from the descriptive to the explanatory, from the group to the individual and, thus, from the social to the biological.

Seeing language as a fundamentally biological phenomenon is particularly compelling in the light of language typology and language acquisition. Language is unique to our species. There is no known human culture without language. On the surface, the world's languages vary greatly in terms of their grammar and phonetics, but behind all the geographical, historical and seemingly diverse facts, a great many structural similarities have been identified. Looking at acquisition we note that children learn to speak (or to use sign) spontaneously without conscious effort or explicit instruction. They do so in a period of time which is remarkably short in view of the complexity of what they acquire and considering the incomplete and often degraded input that reaches their ears (the "poverty of input" argument). Children who grow up in linguistically deprived environments give especially vivid examples of the alleged "information-poor" input and the "spontaneity" of the process. For instance, children surrounded by speakers of "pidgin", lack normal adult models. Nevertheless they develop "creole" languages that are more complex and more similar to normal adult languages. Also, there are reports on deaf children whose hearing parents do not master sign language well. On their own these children apparently acquire a sign grammar that is more elaborate than that of the input and closer to the normal adult model.

Facts such as these inevitably lead to the conclusion that human language could not possibly be something that a few of our ancestors thought of, and which then caught on and spread across the globe. Language is not a "cultural invention". It must be seen rather as a biologically based behavior unique to man.

IF BIOLOGY, WHAT KIND OF BIOLOGY?

To many syntacticians and psychologists, language form is complex and arbitrary, and, although all languages appear to be cut from the same cloth, their formal idiosyncracies, so the argument goes, defy functional explanation.

Leading phonologists [2] concur with this "view from syntax". Briefly stated, their claim about sound patterns is that, when everything associated with language use (production, perception, learning, memory, social factors etc) has been accounted for, there will remain a large core of phenomena, "...'Language per se'...", the innate language faculty, "which is not reducible to features of other kinds.... It is exactly this area ... that ought to occupy the central concern of linguists if they wish to arrive at an adequate conception of the essential and special nature of human Language" (Anderson 1981:495).

While fully accepting that learning language is a biological process, many behavioral scientists have not embraced the notion that language form is beyond functional explanation. Among them are phoneticians like ourselves. Our perspective on sound structure brings out the obvious - but by no means trivial - facts that all phonetic forms must be pronounceable, and that phonetic forms that differ in meaning must meet the condition of perceptual distinctiveness. Less obvious, but nevertheless true, is the fact that as these conditions, pronounceablitity and distinctiveness, interact during the development of a lexical system, they are capable of giving rise to structures of considerable complexity in completely unsupervised, self-organized ways.

The 'formalist' and the 'functionalist' views contrasted here both attribute a strong biological component to language learning. Both views share the assumption that language acquisition results from an interaction between two components: innate "predispositions" on the one hand, and experience of the ambient language, on the other. What exactly is the nature of these two components? This is where the two approaches differ in two major ways: They disagree on how the linguistic facts should be interpreted (the *arbitrary* vs *natural* issue), and on the nature of the innate "predispositions" (the *modular* vs *non-modular* issue, that is "specific to language", or "not specific to language").

To the formalist, languages are underlyingly similar but built in arbitrary and basically unnatural ways. The reason children learn language, despite its formal idiosyncracies, is that they are equipped with a 'language organ', a specialized "module" in their brains. In Chomskyan terminology: Universal Grammar, a prespecification of possible grammars from which children select their native languages by 'parameter setting'.

To the functionalist, on the other hand, language form, especially phonology, is natural, and hence normal children learn it effortlessly. As shown by a huge literature on speech development and child phonology, children develop sound structure as a result of an interaction between the linguistic input and "innate behavioral predispositions".

What is the difference, then, between the two approaches? Are Universal Grammar and "innate behavioral predispositions" two different names for the same thing? The answer is provided by how the two approaches take their stance on the naturalness and the modularity issues.

While the formalist says no to naturalness and yes to modularity, the functionalist's responses are the opposite. The functionalist assumes that, on the path to the adult phonological system, the child gets significant help from what she finds pronounceable (neuro-motoric constraints on the production of speech), what appears salient and distinctive in the speech

stimulus (auditory and perceptual constraints). Clearly, the mechanisms of hearing and the respiratory, phonatory and articulatory apparatus, are products of man's "innate endowment". But, importantly for functionalist methodology, those mechanisms are not "modular" (specific to language), since they subserve a number of other functions as well (listening to non-speech, breathing, processing food etc). (The analogous argument applies to the production and perception of sign). It is precisely at this point that the "view from syntax" diverges drastically from the "view from phonetics".

Accordingly, the functionalist hypothesis says that, by making natural movements and sounds that are adapted to production constraints, the child "fortuitously" stumbles over aspects of the adult phonology from which further, more differentiated development can then occur.

An illustration: At about six months of age children begin to produce "canonical babbling": [bababa], [dadada] etc. A simplified, but instructive account of this behavior might be given as follows. (It might be termed the *easy-way-sounds-OK* approach, or, in Swedish, *görs-lätt-hörs-rätt modellen*). The child who hears others communicate tries to participate by making articulatory gestures that are as motorically "natural" (=biomechanically low-cost) and as acoustically "salient" as possible.

Result: A vocalization with articulators in near-neutral positions combined with a mandibular open-close oscillatory movement. By doing this, the child ends up with an utterance that is not yet language, but which resembles it very strongly: [bababa], [dadada] etc. The syllable-like aspects of canonical babbling are "emergents", that is novel features arising as fortuitous consequences of a search strategy set up to scan the space of motoric possibilities from low to greater production "complexity" [3].

The point is that, in this case, children appear to get significant help, not from prespecified, "specific-to-language" information in Universal Grammar, but from general behavioral processes such as "adaptation" and "emergence". According to this interpretation the striking thing about canonical babbling is not that it shows the child coming closer to language, but rather language (phonology) being of a form that is close to the child. From the child's point of view is, in a sense, located "just around the corner".

Restating and generalizing: Is *language as a whole* learnable because it is eminently natural and reachable via processes of "adaptation" and "emergence"? Or is adult linguistic competence so hopelessly remote from where the child starts that it needs help from "specific-to-language" specializations in our genetic endowment (cf Universal Grammar)? Broadening the perspective further: To what extent should the contents of the phonetic systems that are found in the world's languages, and that are acquired by the world's children, be seen as "formal, largely prespecified, idiosyncracies". Alternatively, to what extent should they be seen as natural, behaviorally derived "adaptive emergents"?

The case for Universal Grammar rests largely on arguments from syntax. More familiar with speech processes and sound structures, phoneticians view things differently: Presumably, most of us believe that it is no accident that, in the world's languages, we find close matches between the facts of sound structure on the one hand and the phenomena of on-line speech on the other. A parsimonious (and an, in principle, uncontroversial) interpretation of such observations would be that phonological units and processes are adapted to their use in speaking, listening and learning. Implication: *Why should syntax be different*?

WHY PHONETICS HAS A PRIVILEGED ROLE

Phonetics is in a particularly good position for applying the program of contemporary biology to language. If it does, prospects are favorable for arriving at a more complete and profound explanatory theory not only of speech, but eventually of human language as a whole. Phonetics could lead the way in such an undertaking, because phoneticians have more direct access to the stuff that explanations are made of, namely facts and principles whose empirical motivation is independent of the data to be explained. Phonetics can invoke knowledge which is relevant to speech but which was acquired independently of it, often in adjacent fields, such as information on the general mechanisms of hearing and motor control, a circumstance that gives phonetics a situation that is unique compared with that of other domains of linguistic inquiry (cf syntax), and perhaps also that of many areas of biology. From that perspective being a jack of all trades turns out to be an asset, not a handicap.

THE INFLUENCE OF "MARKET FORCES" ON RESEARCH PRIORITIES

In his opening plenary address of this congress, Kohler asks: Is phonetics a language science in its own right? Indeed it is, he concludes, by virtue of the paradigm of phonetic phonology and phonetic explanation [4]. The present remarks are compatible with his views. In fact, they go further in suggesting that phonetics may even hold the key to tomorrow's linguistics.

Both Kohler's discussion and our own have a strong programmatic touch. They are as it were *in-principle scenarios* for phonetics. How viable would those (and other possible) scenarios be when confronted with the real world?

We, the people who get together at phonetics congresses, ask the questions that define our field! That may indeed be so, but what determines the questions we ask? Purely intellectual, intra-disciplinary reasons? In principle, *yes*, but, in practice, *only to some extent*. We are all shaped by the niches where we find it possible to survive academically and otherwise. Hence, even the most idealistic thinkers among us must continually adapt to a broad range of academic, economic, sociological and political factors. Internationally for many phoneticians, survival today means work oriented towards practical needs. On teachers of phonetics, there is increasing pressure to adapt curricula to the current needs of the students who are more likely to become active in applied areas than in fundamental research - that is, of course, if they get jobs at all.

So while we are free *in principle* to ask whatever questions we want and to give phonetics the directions that we ourselves favor, we are reminded that, *in practice*, it is ultimately society at all levels that significantly influences how we ask our questions. The contents of our subject matter is shaped by local and global "market forces" whether we like it or not. If there is no demand for fundamental knowledge, it is unlikely to emerge, or, if it does emerge despite all odds, it will do so much more slowly.

What is wrong with that? Why not entrust the future of phonetics to applied areas and let our fundamental understanding of speech processes develop as a spin-off from various applications, reaching us, as it were like crumbs from the rich man's table?

Our answer must be no. The following three objections should be borne in mind.

First, working in applied areas we are under absolutely no obligation to promote basic science, to solve problems so that we learn more about human speech. There is no such constraint as "basic knowledge and theoretically solid science first, then practical applications". The only objective in applications is that of solving limited and well-defined practical problems in a manner satisfying all performance criteria.

Consider an example from speech technology. Finding out how speech is produced, structured acoustically and perceived is relevant both to the phonetician and the speech technologist. However, phoneticians study human behavior, whereas speech technologists construct machines. Are these tasks basically the same? Yes and no.

Suppose we were to study birds and airplanes rather than humans and speaking machines. Obviously jumbo jets do not flap their wings. Consequently, birds and planes are built according to entirely different performance criteria. There is a parallel here with human and machine speech production. If human ears cannot tell the difference between synthetic and natural speech, but the resulting signals are made in totally different ways, should we refuse to have a certain telephone service installed that sounds all right, but happens to use speech produced by totally ad hoc and non-biological rules? Clearly that would be like waiting to fly until jumbo jets begin to flap their wings. If the telephone service is good enough from the customer's point of view, commercial forces will most certainly impose it on us whether it represents a good model of human speech or not.

Despite the possibility of potentially fruitful interactions with technology and other areas, the overall conclusion is clear: In applied phonetics, we never dig deeper than necessary to solve practical problems. In applied projects the long-term task of explaining speech represents an irrelevant detour. Shortcuts are acceptable and welcome.

Our second objection derives from those conclusions: Using applied phonetics to increase fundamental knowledge offers neither the most direct or fastest route nor any guarantees.

The third and most important objection concerns a fact that is often overlooked in current discussions of research and development. Most technical applications of today were made possible by fundamental research begun a very long time ago.

In that context, our previous metaphorical use of birds and airplanes is somewhat misleading. It gives the justification for the fact that, in applied work, the first priority is solving practical problems, not contributing to basic science.

However, before we accept that conclusion we must stop to consider *how practical problems get solved at all*. The knowledge that goes into a solution must never be taken for granted nor trivialized.

The much more significant implication of the bird-airplane metaphor is therefore this: Although planes are heavier than birds and fly faster, engineers could not have built them successfully without a thorough understanding of *aerodynamics*.

We do not need to be experts on the history of physics to realize that aerodynamics was not invented overnight. Normally, the knowledge that is being put to various practical use today took centuries to accumulate. In our own time, Gunnar Fant and others developed a theory of speech and showed how to apply it to make synthetic speech. Without wanting to detract from the considerable achievements of these pioneers, we should recognize that their efforts were anchored in a thorough understanding of acoustics, a branch of physics with a long history and with a body of knowledge to which Sir Isaac Newton (1642-1727), Jean Baptiste Joseph Fourier (1760-1830), Lord Rayleigh and many others made significant contributions [5].

The formation of knowledge embodied in scientific theories can be compared to the formation of fossil fuels. They need time to develop. We know that burning fossil fuels leads to a *depletion of resources* and poses a serious growing threat to life on this earth. Many people are therefore hard at work to promote the use of renewable energy

sources and advocate a society based on the philosophy of *recycling*.

Analogously, research funding policies that favor applied over basic research represent a kind of "depletion of resources" which must be balanced by the long-term support of general and fundamental science. On paper, that would seem to be an obvious responsibility of both state and private organizations. However, as we all know, in practice, maintaining the balance between "depletion" and "renewal" in scientific research is not achieved automatically. It presupposes a strong and active participation by the researchers themselves.

CONCLUDING REMARKS

The future strength of phonetics rests on the recognition of two main facts:

First, understanding human spoken language is understanding an important part of ourselves and of our place in nature and society. Pursuing such an undertaking successfully within the framework of general science will result in a rational account of language and speech and will show how man is to some extent unique, but basically a product of the same processes of continuous biological evolution that made all other organisms. The impact of such an account will eventually be enormous as education and communications technology spread it across the globe and to all the cultures of the world. The fact that phonetics has a privileged position in that undertaking makes phonetic research a priority of high timeless and cross-cultural intrinsic value.

Second, technological, educational, clinical and other applications cannot do without a fundamental understanding of human spoken language. Some of our colleagues would no doubt disagree. Numerous proceedings from speech technology conferences convey a strong sense of optimism about the power of computational and statistical methods that should provide shortcuts to the much slower, step-by step and experimentally based search for insights about the way humans process spoken language. The tacit hope seems to be that, before long, we will see systems that achieve speaker independent recognition of connected speech and that do so successfully although they make minimal use of phonetic, linguistic and other behavioral knowledge.

What is probability of success of such efforts? Given the complexity of spoken language, we can safely assume that such systems may score impressively on limited tasks, but are extremely unlikely to ever come near complete success in emulating human performance *unless they are based on comprehensive models of human behavior*. Assuming otherwise would seem to severely underestimate the immensity and complexity of human language. It resembles betting against other events of infinitesimally low probability, e.g. life having arisen several times in several places in the universe.

Favored by sponsors, gambling on shortcuts will no doubt continue to attract people and cost a lot of money, although it appears singularly untempting to the informed phonetician. Supporting, and doing, fundamental research seems like a much safer strategy in making phonetics useful.

REFERENCES

[1] Ladefoged P (1988): "A view of phonetics", *UCLA Working Papers in Phonetics 70*, also plenary address, International Congress of Phonetic Sciences XII, Tallinn.

[2] Anderson S R (1981): "Why phonology isn't natural", *Linguistic Inquiry* 12:493-539.

[3] Willerman R (1994): *The phonetics of pronouns: Articulatory bases of markedness*, doctoral dissertation, University of Texas at Austin.

[4] Kohler K J (1995): "Phonetics - A language science in its own right?", plenary address, International Congress of Phonetic Sciences XIII, Stockholm.

[5] Hunt F V (1992): *Origins in acoustics: The science of sound from antiquity to the age of Newton*, New York:Acoustical Society of America through the American Institute of Physics.

ACKNOWLEDGEMENTS

The author would like to thank Sue Brownlee, Catharina Kylander and Rolf Lindgren for suggesting valuable revisions of a draft of this paper.