

## The Role of Phonetics within the Study of Language

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**Abstract.** Phonologists have often held that phonetic 'substance' is more or less unrelated to phonological 'form'. This view rests on assumptions about the phonetic domain that are highly questionable on empirical grounds. Evidence is reviewed suggesting that very few phonetic properties of vowels fail to serve the linguistic function of preserving and enhancing distinctiveness. Accordingly, much of what has been considered to be purely phonetic is also phonological in character; that is to say, the domains of phonetics and phonology overlap significantly. Finally, several well-known criticisms of the program of phonetic explanation in phonology are discussed and rejected.

### Introduction

The history of phonology over the past century presents an extraordinarily diverse set of theoretical views. Yet it is fair to say that most linguists during this period have held one belief in common, i.e., that phonetics, the study of speech sounds and how they are produced and perceived, has only an ancillary role in the study of phonological systems. This belief, I argue, rests on an unwarrantedly restrictive construal of the phonetic domain. Properly understood, phonetics takes on a fundamental explanatory role within phonology and becomes a significant part of the study of language.

### A Sketch of Traditional Views of Phonetics

One of the first linguists to drive a wedge between the disciplines now referred to as phonetics and phonology was Baudouin de Courtenay [1], who distinguished the purely physical aspect of language ('anthropophonics') from the psychological aspect ('psychophonetics'). The latter encompasses the system of sound/meaning correspondences that make up a language and focuses on the distinctive role played by certain sound differences [2]. According to Baudouin, only psychophonetics (including what is now called phonology) properly belongs to the study of language.

A quite similar view was held by Ferdinand de Saussure [3], author of the distinction between *parole* (speech) and *langue* (language). After asserting that language is basically psychological, de Saussure describes the relationship between linguistics and phonetics as follows: "The ties between linguistics and phonetics are less difficult to understand than the ties between phonetics and phonology. It is unilateral in the sense that the phonology of sounds but furnishes no exact clarification from the science of sounds. In any event, the two disciplines cannot be separated; the thing that constitutes language is phonology, unrelated to the phonetic sign [3, p. 7]... The vocal sign is not related to language as are the electrical signals transmitting the Morse code to the receiver. Phonation, i.e., the execution of the signal, in no way affects the system itself."

Trubetzkoy [4, p. 11] accepted this Saussurian view of the relationship between phonetics and phonology. He argued that phonetics possesses a large number of articulatory properties. All of these properties are important for the phonetician since it is not correct to say that a sound is produced only if all of these properties are taken into consideration. Yet most of these properties are quite unimportant for the phonologist. The phonologist needs to consider only that aspect of the sound which fulfills a specific function in the language [his italics].

This orientation toward function contrasts with the point of view taken in phonology, to which, as elaborated above, the meaning of the act of speech (i.e., the signifier) must be carefully elicited. This orientation also prevents phonetics and phonology from being grouped together, even though both deal with similar matters. To compare phonology with phonetics, as done by R. Jakobson, phonology is to mathematics what national economy is to mathematics. Phonology belongs to statistics.

For all their other differences, the Prague phonologists, American phonologists, and the phonologists of the other schools of thought have in common a view of phonetics that is fundamentally different from the view of phonetics held by the traditional phonologists.

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A quite similar view was expressed by de Saussure [3], author of the famous distinction between *parole* (particular acts of speaking) and *langue* (the system of language). After asserting that 'everything in language is basically psychological...' [3, p. 6], de Saussure described the relation between linguistics and phonetics:

The ties between linguistics and the physiology of sounds are less difficult to untangle. The relation is unilateral in the sense that the study of languages exacts clarification from the science of the physiology of sounds but furnishes none in return. In any event, the two disciplines cannot be confused. The thing that constitutes language is, as I shall show later, unrelated to the phonic character of the linguistic sign [3, p. 7] ... The vocal organs are as external to language as are the electrical devices used in transmitting the Morse code to the code itself; and phonation, i.e., the execution of sound-images, in no way affects the system itself [3, p. 18].

Trubetzkoy [4, p. 11] accepted and elaborated this Saussurian view:

The speech sounds that must be studied in phonetics possess a large number of acoustic and articulatory properties. All of these are important for the phonetician since it is possible to answer correctly the question of how a specific sound is produced only if all of these properties are taken into consideration. Yet most of these properties are quite unimportant for the phonologist. The latter needs to consider only *that aspect of sound which fulfills a specific function in the system of language* [his italics].

This orientation toward function is in stark contrast to the point of view taken in phonetics, according to which, as elaborated above, any reference to meaning of the act of speech (i.e., any reference to signifier) must be carefully eliminated. This fact also prevents phonetics and phonology from being grouped together, even though both sciences appear to deal with similar matters. To repeat a fitting comparison by R. Jakobson, phonology is to phonetics what national economy is to market research, or financing to statistics.

For all their other differences with the Prague phonologists, American structural-

ists took a rather similar position on the role of phonetics. For example, Bloomfield [5, p. 128] wrote:

The important thing about language... is not the way it sounds. The speaker's movement, the disturbance in the air, and hearer's eardrum vibration... are of very little moment. The important thing about language is its service in connecting the speaker's stimulus... with the hearer's response... This connection depends... upon a relatively few features of the acoustic form...

Commenting on Bloomfield, Anderson [2, p. 265] noted that:

[r]esearch based on the 'phonemic principle' - the observation that within a given language some phonetic differences serve to distinguish meanings while others do not - has over and over again been held to yield the conclusion that this insight relegates phonetics to a status strictly outside of linguistics. Bloomfield's claim about the linguistic nonsignificance of a phonetic transcription is simply a particular articulation of the expulsion of phonetics from linguistics which was also asserted by Baudouin de Courtenay, Trubetzkoy, Helmslev, and others.

With the rise of generative phonology [6], at least some of phonetics was readmitted into linguistics. As Keating [7] has pointed out, part of what may be called phonetics appears in *The Sound Pattern of English* (SPE) [6] as a set of rules in the phonological component that converts binary feature values into scalar values. However, the rest of phonetics is assigned to an extragrammatical component that corresponds to universal physical and physiological characteristics of speech production. This phonetic component automatically converts the output of the phonological component (the 'phonetic transcription') into articulated utterances. Thus, although Chomsky and Halle [6] repealed one tenet of the earlier phonologists - that only distinctive properties of speech fall within the purview of linguistics - they actually helped

to reinforce the traditional view that (most of) phonetics is outside the domain of language. Among contemporary phonologists, this view remains influential. In fact, Anderson [8, p. 497] has argued that the main value of phonetic investigation is to 'determine what sorts of facts the linguistic system proper is *not* responsible for: to isolate the core of features whose arbitrariness from other points of view makes them a secure basis for assessing the properties of the language faculty itself'.

When phonologists claim that phonetics is outside the domain of language, they evidently do not mean this in the sense that theoretical primitives are (usually) drawn from outside the explicit domain of a theory and yet furnish a basis for explanations of the phenomena subsumed by the theory. Rather, phonetics is seen as outside linguistic theory and *fundamentally irrelevant to that theory*. As implied by the views quoted above, phonetic 'substance' is taken to be related to phonological 'form' much like the way that the material substance of chess pieces (e.g., whether wood or ivory) is related to the game of chess. (The chess metaphor was explicitly used by Saussure [3] in distinguishing 'internal' from 'external' linguistic phenomena.) From such a perspective, phonetics has no explanatory role whatever in the theory of language.

#### The Emergence of Alternative Views Concerning the Relation between Phonetics and Phonology

In chapter 9 of SPE, Chomsky and Halle [6, p. 400] admitted that their theoretical treatment 'suffers from a fundamental theoretical inadequacy... The problem is that

our approach to features, to rules, and to evaluation has been overly formal... In particular, we have not made any use of the fact that the features have intrinsic content. Their proposed remedy was to invoke a set of universal marking conventions that had the effect of simplifying particular grammars to the extent that they contained 'unmarked' (i.e., phonetically motivated) feature values and rules. Although the theory of markedness assigned a role to phonetics that was absent in much of traditional phonology, that role was only implicit. The marking conventions were intended to formalize the notion of 'phonetic naturalness', but they were merely stipulated rather than being derived from independent phonetic principles. In any event, markedness theory has remained a relatively unexplored topic within generative phonology [2].

Partly owing to the difficulties inherent in the 'overly formal' character of the SPE theory, some phonologists during the 1970s developed theoretical approaches that explicitly emphasized phonetic naturalness [9-11]. Moreover, during the same period and later, phonetically oriented investigators achieved considerable success in explaining, for example, certain common types of sound change [12], as well as universal tendencies in the structure of vowel inventories [13, 14] on the basis of phonetic principles. (Ohala's [12] account of sound change relied on the notion of phonetic misperception; Liljencrants and Lindblom [13] and Lindblom [14] explained vowel inventory patterns using a principle of auditory contrast or dispersion together with a principle of minimal articulatory effort, jointly referred to as the *theory of adaptive dispersion*.) This work clearly challenged the traditional belief of phonologists that

phonetics is irrelevant to language.

A different kind of challenge was offered by Keating [7] with respect to a model of a phonetic component of a grammatical, universal, and interpretative of the output of the phonetic system. Keating [7] argued that virtually all phonetic processes answer to the description of this model. Even widely distributed phonetic processes do not occur in all languages, therefore, cannot be viewed as universal. They must rather be viewed as language-specific. Keating [7, p. 128], as well as others, argued that phonetics is properly part of the grammar of languages.

One might be tempted to dismiss this argument that phonetics has a more marginal role in language by Chomsky and Halle believed such a conclusion would be premature. The problem with this argument is that it rests on an impoverished view of the phonetic domain: it is not an automatic 'physical' process, in my view, but a learned skill. Generally, linguistic utterances are a form of skilled behavior, which is learned by the speaker (to communicate with listeners) in an efficient manner. Of course, these communications are often achieved inefficiently or in an apraxic manner, as in the case of young learners of a second language. The efficiency of articulatory motoric domains, articulated by how well one speaks for, and exploits the particular physical parameters of the system.

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One might be tempted to conclude from this argument that phonetics has an even more marginal role in phonology than Chomsky and Halle believed. I think that such a conclusion would be wrong, however. The problem with the SPE model is that it rests on an impoverished conception of the phonetic domain: the very notion of an automatic 'physical speaking machine' is, in my view, fundamentally misleading. Generally, linguistic utterances are a form of skilled behavior, which is to say, the aims of the speaker (to communicate successfully with listeners) are accomplished in a relatively efficient manner. In principle, of course, these communicative aims could be achieved inefficiently or not at all (e.g., by apraxic talkers, young children, or adult learners of a second language). As in other motoric domains, articulatory skill is measured by how well one adapts to, compensates for, and exploits the laws of physics and the particular physical and physiological parameters of the system at hand, in this

case, the respiratory, phonatory, and articulatory apparatus. Note well that these laws and physical/physiological parameters do not uniquely determine the form of utterances. They merely place boundary conditions on the form of utterances and define the energy cost of any particular utterance.

A major goal of phonetic theory is to describe these physical/physiological parameters with sufficient accuracy to permit definition of the set of possible utterances and evaluation of the energy costs of arbitrary members of that set. It is important to recognize that the physical laws and physical/physiological parameters that apply in the case of the speech apparatus serve as *primitives* of phonetic theory (along with properties of the human auditory system), but they in no way exhaust the domain of phonetic theory. (Failure to understand this point is, I suggest, the source of much confusion about the role of phonetics, including the notion of the phonetic component as an automatic 'physical speaking machine'.) Phonetic theory includes, in addition, such propositions as these due to Lindblom [15]:

(a) Other things (including auditory distinctiveness) being equal, language communities tend to favor utterances that exact relatively low energy costs.

(b) Other things (including energy costs) being equal, language communities tend to favor utterances that are relatively distinctive auditorily.

Of course, other things are almost never equal: the talker-oriented demands for minimal effort must always be balanced against the listener-oriented demands for sufficient distinctiveness, and this balance changes as a function of the availability of signal-independent information, the noisiness of the communication setting, and other factors [16]. The point is that although phonetic capabilities may be universal among hu-



we refer to as the *auditory enhancement hypothesis*. The hypothesis is an explanation of the patterns of phonetic covariation of which are widely attested in many languages, that do not appear to be exclusively or even partly from physiological constraints on articulation. It states that the phonetic features of vowels and consonants covary largely because language users tend to select features that enhance auditory effects. (The terms 'phonetic features' in the sense of Jakobson and Halle [6, p. 297], that is, the scales describing independent aspects of the speech signal. However, we do not necessarily propose a set of features.) The enhancement hypothesis is a corollary of the principle of auditory enhancement, which is also closely related to the principle of independent features (Stevens et al. [24] and Stevens [25]). Here, focusing on vowels, I will argue that there have been arguments that have been presented in greater detail [20, 21].

The LA Phonological Segment Inventory [17], which includes segments of 317 representative languages, shows that most of the back vowels are rounded, most of the front vowels are unrounded. This covariation of feature values is attributable to anatomical factors, as noted by Stevens et al. [24]. However, it appears to be an instance of auditory enhancement. Tongue retraction and lip rounding both yield a lower second (F<sub>2</sub>) frequency, which is a distinguishing property of back vowels. Moreover, a typical form of articulation combines both lip protrusion

and lip constriction [26], which independently contribute to F<sub>2</sub> lowering. A principal acoustic correlate of fronting the tongue body is a high F<sub>2</sub> frequency, which would be counteracted by lip rounding. Thus, the combinations of a back tongue position and rounding and of a front tongue position and nonrounding produce vowels that are acoustically and auditorily distinctive. In the case of high front vowels, the lips tend to be not merely unrounded but actively spread. This configuration not only shortens the front cavity, it also flares the vocal-tract opening, both of which contribute to a higher F<sub>2</sub> frequency [27].

A more general acoustic framework for evaluating these and other gestural covariations is provided by Chiba and Kajiyama [28] and Fant [29]. Given a tube-like configuration such as the vocal tract, there are several independent ways to alter a resonant (or formant) frequency: it can be lowered either by (a) lengthening the tube, (b) constricting the tube in any region where an antinode exists in the standing volume-velocity waveform corresponding to the resonance, or (c) dilating the tube in any region where a node exists in the same standing wave. (The inverse of each of these operations results in a raising of the resonant frequency).

Consider how these theoretical options are exploited to yield, for example, a lower F<sub>2</sub> frequency in the production of /u/. Vocal-tract lengthening may be achieved either by protruding the lips (as noted, a typical correlate of back vowels) or by lowering the larynx [30]. When lip protrusion is physically prevented, talkers nevertheless produce acoustically appropriate tokens of /u/ by spontaneously lowering the larynx [31]. Even when producing citation utter-

ances under unrestricted speaking conditions, talkers have been shown to lower the glottis during /u/ tokens [32; also unpublished data of Delattre cited by ref. 32], although there appear to be some individual differences in the extent to which glottal lowering is specific to back vowels [33].

In addition to vocal-tract lengthening, talkers achieve a low F<sub>2</sub> frequency during /u/ by constricting the vocal tract at or near the regions of the two volume-velocity antinodes for the second resonance, namely, at the lips and the upper oral pharynx [29, fig. 2-5, p. 112]. Also, the vocal tract is dilated in the palatal region and in the lower pharyngeal region, at locations near the volume-velocity nodes of the second resonance. The enlargement in the palatal region is, of course, a consequence of tongue-body retraction, but the dilation of the lower pharynx, caused by tongue-root advancement, appears to be largely independent of other gestural features of /u/ [34]. Tongue-root advancement is characteristic not only of high back vowels but also of other high vowels such as /i/. Although this gesture appears to have a modest lowering effect on F<sub>2</sub> frequency for /u/, its principal effect is to lower F<sub>1</sub> frequency [34] and therefore to enhance the F<sub>1</sub> lowering effect of tongue-body position in the case of high vowels generally.

There is evidence that talkers achieve auditory enhancement by other means as well. As just indicated, the distinction between high and low vowels is signaled largely by differences in F<sub>1</sub> frequency. These differences appear to be enhanced in the production of oral vowels by covariation between tongue (and jaw) height and velar elevation controlling the degree of opening between the oral and nasal cavities. High vowels are



, 46). Fischer-Jørgensen [47] has reported that German short lax *e* considerably lower tongue virtually the same  $F_0$ , as their counterparts, a finding that raises questions about the anatomical coupling. An alternative possibility is that *e* is called 'intrinsic vowel pitch' in the case of deliberate auditory enhancement. There is quite good evidence that we judge vowel height not simply by the  $F_1$  frequency, but rather by the distance between  $F_1$  and  $F_0$ . Smaller  $F_1 - F_0$  differences yield higher vowels. Perhaps talkers control  $F_0$ , reducing the  $F_1 - F_0$  for high vowels and increasing it for low vowels. If this account is correct, then high vowels should be produced with greater activation of the cricothyroid muscle, the muscle engaged in the active control. I first noticed this since my colleagues and I first reported this prediction, confirming evidence reported for speakers from three language communities: Danish [52], and English [53].

In many other instances of phonetic variation in the production of vowels is naturally explained in terms of anatomical enhancement. For example, Ohala [54] notes that the three vocal-tract constrictions (labial, palatal, and pharyngeal) that characterize the production of the English vowel /æ/ correspond to three antinodes in the standing-waveform of the third harmonic. Thus, each of these constrictions contributes to the lowering of the  $F_3$  frequency, the main distinguishing property. Also, Stevens et al. [24] pointed out that raising of the tongue blade

characteristic of high front vowels contributes to the distinctive elevation of higher formant frequencies. What is true for vowels appears to be no less true for consonants. Much of the recent experimental work carried out in our laboratory has indicated that consonantal distinctions (e.g., the medial voicing contrast) are signaled by ensembles of cues that are mutually enhancing auditorily [18, 19]. It appears that a good many phonetic universals (or, more precisely, general phonetic tendencies) that were assumed to result from physical or physiological constraints on speech production may actually derive from a general strategy of language communities to preserve intelligibility. Of course, this strategy imposes an articulatory cost. And it is clear that under favorable conditions of communication (e.g., low noisiness, high redundancy), talkers generally elect to trade away some perceptual distinctiveness for greater ease of production. But the potential for high levels of distinctiveness must be built into the signaling system, to be exploited when communication conditions are less than favorable.

#### Some Implications of Auditory Enhancement

Lindblom's dispersion principle and the hypothesis of auditory enhancement clearly belong to the domain of phonetics. Both attempt to explain phonetic facts (the phonetic structure of segment inventories and patterns of phonetic covariation in speech production) by appealing to the perceptual requirements of listeners. The explanatory content of both claims rests ultimately on a theory of how speech sounds are repre-

sented auditorily and a theory of auditory distance. What is perhaps less clear is that the phonetic facts that these claims purport to explain are also, for the most part, phonological facts. Trubetzkoy [4, p. 92], one of the founders of modern phonology, took the structure of vowel inventories to be among the important facts to be explained by his theory of 'distinctive phonic properties'. Moreover, within the framework of generative grammar, covariation of phonetic features has typically been described by means of *phonological* redundancy rules.

Let us explore further the above proposition – that the facts under discussion are *both* phonetic and phonological in character. From the linguists' views sampled in the initial portion of this paper, it is possible to identify at least three traditional hallmarks of the phonological domain:

(a) *Systematicness*: Phonological properties form a coherent system within the larger system of language.

(b) *Psychological representation*: Phonology is part of the implicit knowledge of the language user along with knowledge of morphology, syntax, and semantics.

(c) *Distinctiveness*: Phonological aspects of the speech event are linguistically relevant, that is to say, distinctive.

In contrast, the phonetic domain is seen from this traditional perspective as relatively unsystematic (i.e., more or less a collection of particular facts), as pertaining exclusively to physics and physiology (i.e., not part of the linguistic knowledge of the language user), and as neutral with respect to issues of linguistic relevance and distinctiveness. However, to the extent that the theory of adaptive dispersion and the auditory enhancement hypothesis account for the structure of common vowel inventories



crete categories, or what Jakobson called 'mere otherness'. I believe an objection misses the point. At the phonetic level of description, phonological activity may perhaps be all or nothing. However, most phonologists (including all of those cited in the early part of this paper) have maintained that the phonetic properties (independent of the) phonetic properties. Phonological activity is considered at the level of description (as it eventually is), it is very difficult to avoid a certain interpretation of the concept [see, e.g., ...].

facts that belong unmistakably to the phonetic domain, and that include some of the most detailed aspects of speech production and perception, appear to display the principal hallmarks of the phonological domain as traditionally understood. This suggests that there is a serious gap between many linguists (and, for that matter, many phoneticians) have viewed phonology and phonetics. Rather than being two relatively independent disciplines that share a common boundary, they overlap considerably, both at the descriptive level and at the level of explanation. A similar conclusion has recently been defended by Ohala [57], who suggests the notion of a boundary or 'interface' between phonology and phonetics is replaced by that of an integration of the two disciplines.

### Explanation in Phonology

In response to the rise of phonetically oriented approaches to phonology during the past few decades, a number of linguists expressed

some doubts and criticisms concerning the program of phonetic explanation. Here I briefly consider two of these criticisms.

Dinnsen [58] argued that various attempts to provide a phonetic explanation of some phonological rule fail because the rule in question is only one of several possible ways to satisfy the posited phonetic constraint. For example, Harms [59] had suggested that the rule of progressive devoicing in English ( $[-\text{sonorant}] \rightarrow [-\text{voice}]/[-\text{voice}]$ ) follows from a universal phonetic constraint that: Once voicing ceases following the nucleus of any syllable, voicing can no longer resume in that same syllable. Dinnsen [58] points out correctly that progressive devoicing is not the only way to satisfy the phonetic constraint (e.g., a rule of regressive voice assimilation found in Standard Catalan also works). This one-to-many mapping between posited phonetic constraints and phonological means of satisfying the constraints indicates that phonetic explanations of this type do not have the *deductive-nomological* form which Dinnsen [59, p. 172] takes to be 'most pertinent to the issues in this paper'.

The expression 'deductive-nomological', which is due to Hempel [60, 61], refers to forms of scientific explanation in which a particular fact (the *explanandum*) is logically deducible from certain statements of general law together with statements of particular conditions that apply (both sets of statements making up the *explanans*). Examples of deductive-nomological explanation are familiar in various domains within physics and chemistry but are much less common in fields such as biology and geology, not to mention the cognitive and social sciences. Even within physics, the deductive-nomological form of explanation often

fails to apply. Fortunately, scientists and philosophers of science have long recognized that other forms of explanation may satisfy the paramount scientific requirement [cited by Dinnsen] of explanatory relevance and testability. In certain cases where the explanandum cannot be logically derived from the explanans, Hempel and others refer to *probabilistic* or *statistical* forms of explanation. With respect to these explanatory forms, the most one can assert is that the explanans makes probable (to some specified degree) the explanandum. Although, generally speaking, deductive-nomological forms of explanation are to be preferred, in most cases scientists must at least provisionally settle for probabilistic forms, because the full intricate skein of laws and relevant conditions is not completely known.

That probabilistic forms of explanation may, in fact, satisfy the requirements of relevance and testability is well illustrated by Charles Darwin's [62] theoretical account of the formation of coral reefs [discussed in ref. 63], now universally accepted by biologists and geologists as being fundamentally correct. The account depends crucially on the assumption (independently confirmed by Darwin's geological study of the South American coastline) that land formations undergo intermittent periods of uplift and subsidence in relation to sea level. Darwin hypothesized that the three observed categories of coral reef—fringing reefs, barrier reefs, and atolls—represent progressive stages corresponding, respectively, to (a) the emergence of a volcanic island which becomes surrounded by coral, (b) the subsidence of the outer perimeter of the island, leaving a lagoon between the reef and the land, and (c) the complete subsidence of the

island, leaving only the exposed reef. As Ghiselin [63] points out, this explanation satisfies the requirements of relevance and testability, despite its lack of deductive-nomological form. Although the existence of a particular type of reef at a particular location cannot be logically derived from general laws and known conditions, the theory is overwhelmingly confirmed by a variety of facts. For example, the geographical distribution of the three categories of reef (with reefs tending to cluster according to geological age) fully corroborates the theory. As in all forms of probabilistic explanation (including Darwin's theory of natural selection), testability resides in predictions or postdictions about distributional and statistical tendencies, not in the derivation of statements about particular facts.

Returning to Harms's [59] phonetic constraint concerning the resumption of voicing within a syllable, we can see that this clearly amounts to an instance of probabilistic explanation in that it disallows certain types of phonological rules, but it does not uniquely determine a phonological outcome. As an explanation of distributional tendencies across languages, the constraint is both relevant and testable. However, the constraint is nevertheless open to a different kind of criticism: it is only slightly more general than the phonological facts it purports to explain. A far more desirable phonetic explanation in this case would be one that is based on *independently verified* assumptions about the physiological difficulty of resuming voicing within the relevant phonetic contexts. It has been a characteristic weakness of many putative phonetic explanations (as well as of the various marking conventions within generative phonology) that they are merely stipulated

to be true in view of the prevalence of certain types of phonological rules. Such explanations obviously run the risk of circularity. To repeat an earlier point: an important aim of phonetic theory is to provide independent means of estimating the relative energy costs of different utterances. Presumably, this theory would, among other things, yield a probabilistic explanation for the wide distribution of rules such as progressive devoicing and regressive voice assimilation.<sup>1</sup>

Another well-known critique of the program of phonetic explanation is that of Anderson [8], whose ideas about the role of phonetics have already been mentioned briefly. Anderson [8, pp. 494–495] begins by contrasting two general views:

Many linguists – and by no means only those of this century – have pursued the possibility that virtually all aspects of Language... are accessible from one or more general perspectives (as special cases of the functioning of the upper respiratory tract, pragmatic strategies for successful social interaction, a generalized learning strategy, etc.).

Other linguists have taken a rather different view. Within the tradition that sees Language as a unique human capacity (or 'mental organ' in the terms of Chomsky (1980 [65] and elsewhere)), it is possible to suggest that there are at least some components of this capacity that are particular to Language itself, and which therefore cannot necessarily be studied or explained directly as special cases of other systems.

He goes on to write [8, p. 495]:

... it is perhaps better to contrast the two views above not as an empirical issue, but rather as a choice between research strategies: Should we or should we not limit the terms and constructs of linguistic theory to elements that can be given an ex-

<sup>1</sup> When these comments on probabilistic explanation were first written, I was unaware that Ohala [64] had already made a similar argument in a paper on phonological explanation.

tralinguistic foundation? When in this way, the burden of proof is shifted, it seems thoroughly mysterious that every aspect of language has an explanation in some other domain, given our difficulty in actually finding secure explanations for any aspects of Language.

I would demur to Anderson's criticism in two respects. First, it suggests that linguists hold views that are more numerous (and more influential) than those held by other camps. Second, it seems to attribute the first camp somewhat unfairly to linguists in the secondarily Chomskian rather than to claims, than are usually expected, in the assignment of the burden of proof on how strongly the views of the camps are stated.

As noted earlier, Anderson's view is that, for the linguist, the irreducibly extralinguistic aspects of phonetics (and other extralinguistic aspects such as perceptual psychology) are not part of language. Claims that those aspects of speech control that are arbitrary with respect to linguistic constraints will be 'essential to language' [4, p. 10] goes well beyond Chomsky's view above, that some components of the capacity for language are not explainable in terms of extralinguistic factors. It asserts that language is not related to such factors.

I think that Anderson's view is rejected on several grounds. For example, what Popper [6] has called 'methodological solipsism', the doctrine of logical positivists and Aristotelians

view of the prevalence of certain phonological rules. Such exercises run the risk of circling at an earlier point: an important theory is to provide a means of estimating the relations of different utterances; this theory would, among other things, yield a probabilistic explanation of the distribution of rules such as devoicing and regressive assimilation.<sup>1</sup>

A well-known critique of the probabilistic explanation is that of Anderson's ideas about the role of phonetics have already been mentioned. Anderson [8, pp. 494-495] begins with two general views:

View 1 - and by no means only those who have pursued the possibility that views of Language... are accessible from extralinguistic perspectives (as special cases of the upper respiratory tract, pragmatic for successful social interaction, a learning strategy, etc.).

View 2 - those who have taken a rather different tradition that sees Language as a capacity (or 'mental organ' in the Chomskian (1980 [65] and elsewhere)), it is clear that there are at least some capacities that are particular to Language which therefore cannot necessarily be explained directly as special cases of

Anderson to write [8, p. 495]:

It is perhaps better to contrast the two views on an empirical issue, but rather as a matter of research strategies: Should we permit the terms and constructs of linguistics to be elements that can be given an extralinguistic foundation?

In my comments on probabilistic explanation written, I was unaware that Ohala had made a similar argument in a paper on probabilistic explanation.

extralinguistic foundation? When the question is put in this way, the burden of proof appears to shift. Indeed, it seems thoroughly mystical to maintain that every aspect of language has an explanatory basis in some other domain, given our rather limited success in actually finding secure explanations of this sort for any aspects of Language.

I would demur to Anderson's characterization in two respects. First, it appears to suggest that linguists holding the first view are more numerous (and perhaps more influential) than those holding the second view. The opinions sampled in the early portion of this paper suggest otherwise. Second, it seems to attribute to linguists in the first camp somewhat stronger claims, and to linguists in the second camp (particularly Chomsky) rather more modest claims, than are usually expressed. Clearly, assignment of the burden of proof depends on how strongly the views of the respective camps are stated.

As noted earlier, Anderson [8] believes that, for the linguist, the importance of phonetics (and other extralinguistic disciplines such as perceptual psychology) is to define those aspects of speech communication that are not part of language. Only those properties that are arbitrary with respect to extralinguistic constraints will reveal 'principles essential to language' [4, p. 496]. This claim goes well beyond Chomsky's claim, cited above, that some components of the human capacity for language are not directly explainable in terms of extralinguistic factors. It asserts that language in its 'essence' is unrelated to such factors.

I think that Anderson's claim should be rejected on several grounds. First, it is an example of what Popper [66] has termed 'essentialism', the doctrine held by both Platonists and Aristotelians that the aim of

scientific inquiry is to provide definitions of objects in terms of their essential properties. An alternative to essentialism is the Galilean view that the principal aims of science are to discover and explain empirical relations among objects, events, properties, and quantities.

Second, Anderson's claim appears to be fundamentally at odds with much of what we know about biological and cultural evolution. The notion that a complex cognitive-behavioral system such as language could somehow evolve independently of existing physical, physiological, psychological, and cultural constraints is simply implausible. Adaptation through natural and cultural selection (the source of most organic and cultural complexity) always occurs with respect to a wide range of external and internal constraints. This is true regardless of whether the system in question is highly specialized in its function or is instead an intersection of more general abilities. Human language is primarily spoken, and, accordingly, the speech apparatus and the auditory system must have constrained its evolution.

An issue arises, however, concerning the extent to which the effect of phonetic and other constraints are discernible in the phonological structure of languages. Anderson [8] reviews a number of cases in which what may have begun as a phonetically motivated rule becomes, through various historical changes, phonetically unnatural, or 'crazy'. (Presumably, these are just the kinds of rules that Anderson assumes reflect the essential character of language.) The question is whether the existence of such rules poses a serious obstacle to the program of phonetic explanation. Without attempting to answer this question in any

comprehensive way, I offer a few general remarks. Phonologies, like most natural objects, are influenced by a variety of factors (e.g., phonetic, psychological, and historical-cultural). The influence of any one factor may at times be obscured by the influence of other factors, which is why proposed explanations of recurrent phonological patterns must typically be probabilistic rather than deductive-nomological. I have argued that, even within the domain of phonetics, unique outcomes are not implied by the known constraints. What must be demanded of phonetic explanations is that they are (a) motivated independently of the phonetic or phonological facts being explained and (b) testable on the basis of cross-linguistic distributional and statistical tendencies. There are a growing number of phonetic claims (e.g., the theory of adaptive dispersion and the auditory enhancement hypothesis) that already satisfy these standards and that may serve as part of a more comprehensive explanatory framework for phonology. The research strategy that I advocate does not presuppose that all phonological facts must be phonetically explainable. However, it does seek to apply phonetic explanations where possible and to avoid ascribing phonological facts to a 'mental organ' whose hypothetical properties are motivated entirely on the basis of the facts in question.

### Conclusion

Traditionally, phonetics has been assigned a marginal role in the overall study of language. The arguments offered here suggest that there is, in fact, a good deal of overlap between the disciplines of phonet-

ics and phonology, and that the program of phonetic explanation should be vigorously pursued.

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## Phonetics and Phonology A Sociopsychological Approach

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**Abstract.** Our aim is to extend the sociopsychological approach and to comprehend phonological variation in part of language behavior variations: phonological and phonetic changes. In this hand, steps of analysis in

### Phonetic, Phonological, and Sociopragmatic Bases

Phonetics and phonology are connected in action theories. The dominant phonetic one [1980], who consider speech as a special case of intentional action. Extending this perspective to phonology and structural organization, Linell [1982] defines phonological forms as plans for phonetic action. Recently, Browman and Goldstein [1989] have developed a theory of articulatory gestures as phonological units. They traced them back to you