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 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 unilat.eral in the sense that the study of languages extracts 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 phonetic 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 itself.

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 a signer) 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 structuralists 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:

[Research based on the 'phonoemic 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 relates 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 evaluation has been overly formal... In particular, we have not made any use of the fact that the features have intrinsic context'. 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 'marked' (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; Liljencrantz 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 came from Keating [7] with respect to a model of a phonetic or grammatical, universal, or interpretation of the cut-off logical component of the [7] argued that virtually every answer to the description of this model. Even widely processes do not occur therefore, cannot be vie They must rather be vie Keating [7, p. 128], as from the physical speak properly part of the grammar.

One might be tempted to argue that phonetics should appear to have more marginal role in Chomsky and Halle bel such a conclusion would be incorrect. The problem with that is that it rests on an impov of the phonetic domain: an automatic 'physical' is, in my view, fundam Generally, linguistic utts of skilled behavior, which the speaker (to comm with listeners) are accordi
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A different kind of challenge was raised by Keating [7] with respect to the SPE model of a phonetic component as extra-grammatical, universal, and automatic in its interpretation of the output of the phonological component of the grammar. Keating [7] argued that virtually no phonetic processes answer to the description implied by this model. Even widely attested phonetic processes do not occur universally and, therefore, cannot be viewed as automatic. They must rather be viewed, according to Keating [7, p. 128], as ‘once-removed... from the physical speaking machine’, and properly part of the grammar of particular languages.

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 aphasic talkers, young children, or adult listeners 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-
The Auditory Enhancement Hypothesis

As noted above, the theory of adaptive dispersion of Lindblom [14] and Lindblom and Engstrand [16] has had considerable success in predicting universal tendencies in the structure of vowel inventories. For example, it explains the fact that the most common vowels among the world’s languages are the so-called ‘point’ vowels, /i/, /a/, and /u/, and that the next most common are the mid front vowels, /e/ and /ɛ/, and the mid back vowels, /o/ and /ɒ/ [17]. The effect of selecting relatively peripheral vowels is obviously to enlarge the acoustic/auditory space occupied by the vowel system, which makes for greater distinctiveness among the vowel categories. It is useful to inquire how this strategy of vowel dispersion is phonetically implemented, particularly under unfavorable listening conditions. One fairly simple approach is to use tongue-body and jaw positions that represent articulatory extrema (e.g., a high front or a high back vowel), because articulatory distinctiveness tends to be correlated with acoustic distinctiveness. Although this is one important way that dispersion is achieved, the full story appears to be a good deal more complex – and interesting.

In recent years, my colleagues and I [18–23] have been exploring the phonetic implementation of the dispersion strategy for both vowels and consonants. Our findings to date are consistent with a general claim that we refer to as the auditory enhancement hypothesis. The hypothesis is an attempt to explain patterns of phonetic covariation, many of which are widely tested among languages, that do not appear to derive exclusively or even partly from physical or physiological constraints on speech production. It states that the phonetic features of vowels and consonants vary as they do largely because language communities tend to select features that have mutually enhancing auditory effects. (We use the terms ‘phonetic features’ in the sense of Chomsky and Halle [6, p. 297], that is, ‘physical scales describing independently controllable aspects of the speech event’; however, we do not necessarily adopt their proposed set of features.) The auditory enhancement hypothesis is a corollary of Lindblom’s principle of auditory dispersion and is also closely related to the theory of redundant features independently developed by Stevens et al. [24] and Stevens and Keyser [25]. Here, focusing on vowels, I summarize arguments that have been presented elsewhere in greater detail [20, 21, 23].

In the UCLA Phonological Segment Inventory Database [17], which includes segment inventories of 317 representative languages, 93.5% of back vowels are rounded whereas 94% of front vowels are unrounded. This covariation of feature values is clearly not attributable to anatomical coupling; rather, as noted by Stevens et al. [24] and others, it appears to be an instance of auditory enhancement. Tongue retraction and lip rounding both yield a lower second-formant (F₂) frequency, which is a main distinguishing property of back vowels such as /u/. Moreover, a typical form of lip rounding combines both lip protrusion and lip constriction [26] and may contribute to F₂ lowering acoustic correlate of frication. The body is a high F₂ fricative counteracted by lip rounding.

A more general account of these other sources is provided by Chomsky [28] and Fant [29]. Given a high back feature, several independent ways of characterizing the tube in an articulatory system exist in the form of high frequencies corresponding to high-frequency waveforms, or (c) dilating the region where the node exists in a high vowel (i.e., the inverse operation). The inverse operations result in a raising of the vowel frequency.

Consider how these tendencies are exploited to yield, for example, F₂ frequency in the production of the high back vowel /u/ by spontaneously low. Even when producing
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ently contribute to F1 lowering. A prin-
cipal acoustic correlate of fronting the tongue
body is a high F2 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 short-
ens the front cavity, it also flares the vocal-
tract opening, both of which contribute to a
higher F2 frequency [27].

A more general acoustic framework for
evaluating these and other gestural covari-
ations is provided by Chiba and Kajiyama
[28] and Fant [29]. Given a tube-like config-
uration such as the vocal tract, there are
several independent ways to alter a reso-
ant (or formant) frequency: it can be low-
ered either by (a) lengthening the tube, (b)
constricting the tube in any region where an
antinode exists in the standing volume-ve-
bility waveform corresponding to the res-
ance, or (c) dilating the tube in any re-
ion where a node exists in the same stand-
ing-wave. (The inverse of each of these op-
erations results in a raising of the resonant
frequency.)

Consider how these theoretical options
are exploited to yield, for example, a lower
F1 frequency in the production of /u/. Vo-
calect tract lengthening may be achieved
either by protruding the lips (as noted, a
typical correlate of back vowels) or by low-
ring 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 condi-
tions, talkers have been shown to lower the
glotis during /u/ tokens [32; also unpub-
lished 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 F1 frequency during
/u/ by constricting the vocal tract at or near
the regions of the two volume-velocity an-
todes for the second resonance, namely, at
the lips and the upper oral pharynx [29,
fig. 2-5, p. 112]. Also, the vocal tract is di-
lated in the palatal region and in the lower
pharyngeal region, at locations near the vol-
ume-velocity nodes of the second reso-
nance. The enlargement in the palatal re-
ion is, of course, a consequence of tongue-
body retraction, but the dilation of the
lower pharynx, caused by tongue-root ad-
vancement, appears to be largely indepen-
dent 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 low-
ersing effect on F2 frequency for /u/, its
principal effect is to lower F1 frequency [34]
and therefore to enhance the F1 lowering ef-
ect of tongue-body position in the case of
high vowels generally.

There is evidence that talkers achieve au-
ditory enhancement by other means as well.
As just indicated, the distinction between
high and low vowels is signaled largely by
differences in F1 frequency. These differ-
ences appear to be enhanced in the produc-
tion 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
produced with a relatively tight closure of the velopharyngeal port, whereas low vowels are produced with a modest degree of velar lowering. This coarticulation has long been recognized by phoneticians [35], and was once assumed to be a purely passive effect of anatomical coupling between the tongue and velum [36]. However, this mechanical account appears to be ruled out by electromyographic evidence of active velar raising during the production of high vowels [37]. An enhancement account of the coarticulation receives support from the acoustic theory of vowel nasalization [38-41]. Increasing the area of the velopharyngeal port monotonically raises the frequency of the first oral formant. Therefore, in the case of high vowels, velar lowering would tend to counteract the acoustic effects of the high tongue (and jaw) position, making these vowels less distinctive. On the other hand, a small to moderate amount of velar lowering in the case of low vowels would tend to reinforce the high frequency of F₁, enhancing distinctiveness. Notice that this account applies only to oral vowels: with larger velopharyngeal openings, a nasal formant becomes prominent in the low-frequency region of the voice spectrum, and this (together with a nasal zero) apparently reduces the auditory separation between high and low vowels [42, 43].

Fundamental frequency (F₀) is another parameter that covaries with vowel height, higher vowels tending to have higher values of F₀ [44]. Most phoneticians have assumed that this coarticulation is an automatic consequence of anatomical coupling between the tongue and the larynx via the hyoid bone, although there is little agreement about the specific mechanism by which the vocal folds are stretched as a result of this coupling [33, 45, 46]. Fischer-Jørgensen [47] has recently reported that German short high vowels have considerably lower tongue height, but virtually the same F₀, as their tense counterparts, a finding that raises some doubts about the anatomical coupling hypothesis. An alternative possibility is that what has been called “intrinsic vowel pitch” is actually a case of deliberate auditory enhancement. There is quite good evidence that listeners judge vowel height not simply on the basis of F₁ frequency, but rather by the auditory distance between F₁ and F₂ [48-50]. Smaller F₁–F₂ differences yield perception of higher vowels. Perhaps talkers actively control F₂, reducing the F₁–F₂ difference for high vowels and increasing it for low vowels, to enhance auditory distinctiveness. If this account is correct, then high vowels should be produced with greater activation of the cricothyroid muscles, the principal muscle engaged in the active control of F₂. Since my colleagues and I first made this prediction, confirming evidence has been reported for speakers from three different language communities: Danish [51], Finnish [52], and English [53].

There are many other instances of phonetic coarticulation in the production of vowels that are naturally explained in terms of auditory enhancement. For example, Ohashi [54] showed that the three vocal-tract constrictions (labial, palatal, and pharyngeal) that characterize the production of the American English vowel /æ/ correspond closely to the three antinodes in the standing volume-velocity waveform of the third resonance. Thus, each of these constrictions contributes to the lowering of the F₁ frequency that is the main distinguishing property of /æ/. Also, Stevens et al. [24] pointed out that the raising of the tongue blade characteristic of high fron- 
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Some Implications of A 
Enhancement

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The Role of Phonetics
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formant frequencies. What is true for vowels 
appears to be no less true for conso-
nants. Much of the recent experimental 
work carried out in our laboratory has indi-
cated that consonantal distinctions (e.g., 
the medial voicing contrast) are signaled by 
ensembles of cues that are mutually 
9enhancing auditorily [18, 19]. It appears 
that a good many phonetic universals (or, 
more precisely, general phonetic tenden-
ties) that were assumed to result from phys-
ical or physiological constraints on speech 
production may actually derive from a gen-
eral 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 re-
dundancy), talkers generally elect to trade-
away some perceptual distinctiveness for 
greater ease of production. But the poten-
tial for high levels of distinctiveness must 
be built into the signaling system, to be ex-
plotted when communication conditions 
are less than favorable.

Some Implications of Auditory 
Enhancement

Lindblom's dispersion principle and the 
hyphosis of auditory enhancement clearly 
belong to the domain of phonetics. Both at-
tempt 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, phono-
nological 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 charac-
ter. 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 proper-
ties form a coherent system within the 
larger system of language.

(b) Psychological representation: Phonol-
ogy 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 rele-
vant, 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 col-
clection 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 distinct-
iveness. However, to the extent that 
the theory of adaptive dispersion and the audi-
tory enhancement hypothesis account for 
the structure of common vowel inventories
and for widely attested patterns of phonetic covariation, then the traditional view of the phonetic domain must be considered overly restrictive.

First, the phonetic properties of vowels are systematic (according to the theory of adaptive dispersion) inasmuch as they reflect optimizing tendencies that operate globally over the vowel space. Within this framework, the requirement of sufficient contrast is defined relative to entire vowel inventories and not simply with respect to individual vowels.

Second, the auditory enhancement hypothesis is a claim that many patterns of phonetic covariation, including some usually attributed to physical and physiological constraints on speech production, actually reflect a strategy of preserving intelligibility. If the hypothesis is correct, then these patterns must somehow be represented in the minds of talkers as part of their implicit linguistic knowledge. [For an expanded treatment of the notion of 'phonetic knowledge', see ref. 55.]

Third, as the above review indicates, there appear to be very few phonetic properties of vowels that are devoid of linguistic relevance. Although it is customary for linguists to distinguish sharply between phonetic features that play a distinctive role in a phonological opposition and those that are 'allophonic', 'redundant', or 'predictable', the auditory enhancement hypothesis suggests that many or most features in the latter category in fact play an important linguistic role in enhancing distinctiveness. Some might argue that the term 'distinctiveness' is being used here in the sense of an auditory gradient or scale, which should not be confused with the normal linguistic usage of the term, implying only a partitioning into discrete categories, or what Jakobson has termed 'mere otherness'. I believe that such an objection misses the point. As a purely logical level of description, phonological distinctiveness may perhaps be all or none. However, most phonologists (including virtually all of those cited in the early portion of this paper) have maintained that the distinctive properties of utterances are (some subset of the) phonetic properties. When distinctiveness is considered at the phonetic level of description (as it eventually must be), it is very difficult to avoid a graded interpretation of the concept [see, e.g., ref. 56].

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

Phonetic Explanation in Phonology

In response to the rise of phonetically oriented approaches to phonology during the 1970s, a number of linguists expressed some doubts and criticisms. The program of phonetic exegesis briefly described two of these. Dinnen [58] argued that attempts to provide a phonological rule in question is only one of several ways to satisfy the positivist constraint. For example, Haase [59] suggested that the rule of prosodic phrasing in English (e.g., sonorant-#) follows from a constraint that: Once voicing the nucleus of any syllable no longer remains in the phrase.

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The Role of Phonetics

In recent categories, or what Jakobson called 'mereness', I believe an objection misses the point. At the level of description, phononactiveness may perhaps be all or nothing, but at the level of description (as it evolves), it is very difficult to avoid interpretation of the concept [see...].

Examples that belong unmistakably to a domain, and that include some detailed aspects of speech process, perception, appear to display principal hallmarks of the phenomenon as traditionally understood: there is a sense of a boundary or in-between phonology and phonetics, a sense that phonetics and phonology have viewed phonetics and phonetics. Rather than being independent disciplines that require a common boundary, they are considered, both at the level of a discipline and at the level of explanation, same conclusion has recently been reached by Ohala [57], who suggests notion of a boundary or in-between phonology and phonetics placed by that of an integration of two disciplines.

Explaination in Phonology

Use to the rise of phonetically-proofs to phonology during number of linguists expressed some doubts and criticisms concerning the program of phonetic explanation. Here I briefly consider two of these criticisms.

Dinnensen [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 positivist phonetic constraint. For example, Harms [59] had suggested that the rule of progressive devoicing in English ([sonorant] → [-voice]/[-voice] → #) follows from a universal phonetic constraint: Once voicing ceases following the nucleus of any syllable, voicing can no longer resume in that same syllable. Dinnensen [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-one 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 Dinnensen [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 requirements [cited by Dinnensen] 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 explanations make 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 interminable 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 Chiselin [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 Harn'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 utterance. Presumably, this theory would, among other things, yield a probabilistic explanation for the wide distribution of rules such as progressive devoicing and regress voice assimilation.

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 actually 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] 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 extralinguistic foundation? When in this way, the burden of proof is placed on every aspect of language has an some other domain, given our current state of affairs, is actually finding secure explanation for any aspects of Language.

I would demur to Anderson in two respects. First, I suggest that linguists hold more numerous (and fugitive) than those that hold the view. The opinions sampled in this paper at Second, it seems to attribute the first camp somewhat to linguists in the secularly Chomsky) rather than the usual explanations that are usually e-assigned to the burden on how strongly the views of speech camps are stated.

As noted earlier, And this, for the linguist, the kind of linguistic constraints will essential to language [4]. It goes well beyond Chomsky above, that some component of language is essential in terms of extrinsic factors. It asserts that language in such factors.

I think that Anderson rejected on several great example of what Popper [sensationalism], the doctrine of monists and Aristotelians
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The Role of Phonetics

31

494 - 495) begins; two general views:

1. Ill-known critique of the princi-ple explanation is that of An-

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

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References

The Role of Phonetics


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Phonetics and P
A Sociopsychology

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Abstract. Our aim is to understand how phonological rules enable us to comprehend the world and how the variation in phonological rules is no longer a part of language behavior but is a part of language behavior:

Phonological
Sociopragmatic Bases

Phonetics and phonology are basic components of action theories and are fundamentally phonetic one [1980], which consider speech special cases of intentions. Extending this perspective and the structural organization, Linell [1982] define forms as plans for phonotactic recently. Brown and 1989] have developed a utulatory gestures as phonet