BIOLOGICAL AND SOCIAL GROUNDING OF PHONOLOGY: VARIATION AS A RESEARCH TOOL

James M. Scobbie

Queen Margaret University, Edinburgh
jscobbie@qmu.ac.uk

ABSTRACT

Phonological-phonetic sound systems are abstractions away from substance, so while they are grounded in biological capacity, they also reflect phonetically un-natural relationships arising from a variety of linguistic factors. Sociolinguistic variation is one of these non-biological factors.

Pilot articulatory results are presented from derhoticised Scottish English. It can have onset/coda allophony far more radical than the systems that are normally examined in articulatory research. Ultrasound analysis shows acoustic rhoticity in codas may have a post-alveolar constriction so delayed that acoustic rhoticity is covert. Perceptual recoverability of social identity has to be considered in addition to plain phonetic factors.

Keywords: ultrasound, Scottish English, rhoticity, sociophonetics, articulation

1. INTRODUCTION

Physiological and perceptual perspectives are crucial for understanding how we generate and interpret acoustic signals capable of encoding language. Linguistic sound systems are shaped by these human capacities, in tandem with our cognitive system. All are biologically grounded.

There is, however, a great flexibility inherent in linguistic systems. After all, natural languages can be conveyed visually through manual, upper body and facial signing rather than via speech. If the abstract spatio-temporal organization and categorization of signs and sign-components is "phonological", this is a good argument that there are generalized principles at this level that are abstract and not bound to the medium of transmission. But we can reach this conclusion just by considering oral-aural system. Here, the challenge to biological grounding comes from a better understanding of the extent of abstractness in phonological categories and relationships, simple non-biologically conditioned generalisations, and the systematic tension between the effects of opposed grounded tendencies.

The basic remit of phonology is to establish and analyse systems of contrast and contrast-like phenomena. True contrast is when a difference in sound conveys a categorical and arbitrary difference in meaning. "A" difference in sound might be on one parameter or be multidimensional; may be relatively consistent or variable; may be easy to produce or perceive, or hard. Phonology includes relationships and categories which do not rely on quantitative phonetic similarities. As a discipline, it is motivated by dissociation between actual phonetic substance and more abstract systems [1].

Some phonologists argue strongly against encoding functional explanations into the phonological formalism [5]. Phonetic explanation is, however, widely taken to be desirable, whether it is "in" the phonology or not. It is uncontroversial that core phonological concerns are abstract. Consider, for example: the phonemic identity of phonetically different allophones from different places in structure (e.g. British English /t/ being [t^h] in *top* and [ɹ], [ɾ], or [ʔ] in *get away*); whether a sound is one phonological unit or two (e.g. /k^w/ vs. /kw/); whether identical sounds in different languages are phonologised differently (e.g. [$p^=$] being /p/ or /b/).

How a contrast is conveyed needs consideration of phonetic substance. But *systems* of contrast are more problematic, and understanding them may demand consideration of phonetic substance more in some cases (e.g. the shape and unmarkedness of five vowel systems) than others (e.g. paradigms and systems that have arisen or maintained through lexicalization or other higher-level processes).

An understanding of the general functional pressures which establish phonetically natural abstractions and lead to unmarked systems will inform all kinds of phonological research. Nevertheless, the challenge for phonological understanding will *always* be those parts of the system which are not phonetically natural [1]. It seems that the individual natural functional pressures on language (if they are what is responsible) are rich and contradictory enough to be able to push different bits of the system in different directions, so that the abstract whole is not explained by its concrete parts. The learner has to construct the system as a whole.

2. INDIVIDUAL DIFFERENCES

The biological grounding of phonology refers in part to factors common to all humans, telling us about language in general. It is also useful to look at individual speakers of the same language, because their similarities and differences provide a range of data for the study of phonetics and phonology in general. Such variation may be transparently related to biological differences, in terms of sex, height, laryngeal physiology, and differences in craniofacial structure. We can also ask how speakers converge on acceptable shared speech targets from different physiological starting points.

There is, in addition, a set of *non*-biological factors crucially relevant to understanding phonological systems, language change, and acquisition. *Social* structures, which are the *sine qua non* of sociolinguistic studies of phonological and phonetic variation and change, are a crucial element in the study of biological grounding of phonology. This is because although it is individual speakers and perceivers who each create their own phonology — it is solely for the purpose of joint communication with groups and communities. To understand how individual biological differences impact on phonology, we need to factor in individual sociolinguistic differences which affect phonology too.

First, it is absolutely crucial to recognise that speakers of the same language do *not* necessarily need to "converge on acceptable shared speech targets" by attempting to sound identical – they do not even need to share a phonology in broad terms: accent variation can be fairly extensive [3], [16].

Scobbie and Stuart-Smith have called for greater use of social stratification in traditional phonetic research rather than the usual focus on homogenous groups of subjects because of the extra dimension of structured information which introducing subject stratification brings [9], [10]. By incorporating sociolinguistic stratification into studies of individual variation we can avoid confounding individual physiological differences with learned social differences. Another advantage is that because social differences are learned, they are like cross-linguistic differences, but provide a more constrained context for experimentation: *minimally*-different linguistic structures are involved [10]. Exploiting subtle sociophonetic patterns reduces experimental noise because it incorporates factors controlling some of the variation. For example, subjects can be selected who represent sociolects that are *known* to sound different somehow, to add to factors like sex and age that have both biological and social aspects.

3. SOCIAL AND ARTICULATORY DIFFERENCES IN SCOTTISH ENGLISH /r/

3.1. Scottish English /r/ and derhoticisation

Scottish English is normally viewed as a clearly rhotic dialect of English. Actually, there is a great deal of variation in /r/, particularly in coda /r/ [13]. Specifically there is variable derhoticisation, which Stuart-Smith's close auditory and acoustic analysis of Glasgow speakers [13], [14] shows to be far more complex and gradient than RP or Standard German (classic mature non-rhotic systems) or US English (a classic rhotic system).

Crucially, variation is linked to social factors, i.e. different relationships between a relatively consistent post-alveolar approximant onset and a widely varying coda /r/ carry social meaning. Thus, if we wish to understand general patterns of coda weakening, including biological grounding, social variation like this offers a valuable testing ground. Some speakers have a subtle onset-coda differential, some a far wider one. There appears to be change in progress, initiated by working class speakers, from a rhotic to a non-rhotic system, so that coda /r/ in the coda is turning phonologically and phonetically into a vocoid [14].

3.2. Articulatory analysis

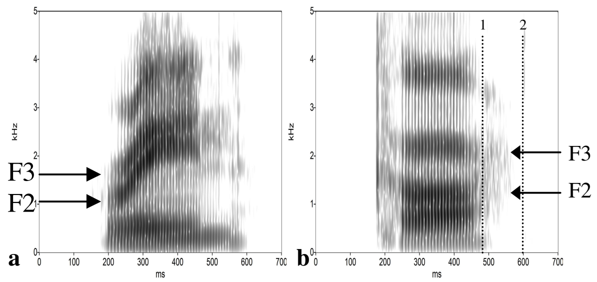
The rhotic phonemes of many languages are characterized by articulatory complexity, an unpredictable relationship with acoustic output, interspeaker flexibility, and allophonic variation. A wide articulatory variation can occur in an acoustically homogenous target such as American English /r/. Even when it is an approximant [ɹ] it displays wide individual articulatory variation [2], [7], [15].

Speech production research relies on uncommon, difficult, expensive and intrusive techniques which are not typically used on naïve vernacular speakers. Articulatory analysis using EPG has been used for sociolinguistic ends [6], but a technique more suitable for the study of vernacular /r/ and its attendant vowels is Ultrasound Tongue Imaging (UTI) [11], [7]. We are now using UTI to investigate Scottish /r/, testing also the extent to which the use of the technique impinges on vernacular speaker behaviour. Pilot investigation of derhotic and fully rhotic speakers in the laboratory is under way: some preliminary findings are reported here.

3.3. Pilot results and discussion

Covert rhotic-like lingual articulations were observed in two derhoticised Scottish speakers. This was reported previously for one Dutch speaker and one of the Scottish speakers [11], shown in Fig. 1.

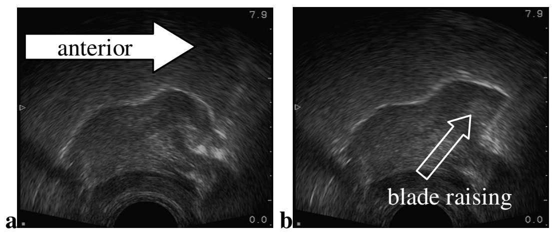
Figure 1: Onset rhoticity in (a) *rain* vs. coda derhoticisaton in (b) *car*, from a Scottish speaker "P0".



P0's /r/ is a rhotic approximant in onsets (Fig. 1a), a tap medially, and adds a pharyngeal quality in codas (Fig. 1b). This prepausal token of /kar/ is near-monophthongal [kɑ̥ˠ], and has widely-spaced F2 & F3 with a hint of F3 lowering and F2 raising in the devoiced phase. *Ear* would typically be [iʌ].

Ultrasound Tongue Imaging reveals a more complex situation, with tongue shapes very similar to those observed in P0's canonical *rhotic* acoustic output [2], [15]. Fig. 2a shows the position of the tongue approximately at point 1 in Fig. 1b, followed (Fig. 2b) by a tongue-blade raising gesture, roughly towards the post-alveolar region, at point 2. In this typical token, P0 employs a rhotic-like articulation in coda /r/, *despite the lack of canonical formant-based acoustic evidence for rhoticity.*

Figure 2: Frame 1 (a) from the end of phonation of P0's *car*, and frame 2 (b) three ultrasound frames later (120ms), showing maximal tongue blade raising.



Patterns of such onset/coda prosodic allophony without any apparent mismatch between acoustic output and articulation [2], [4], [7], [15] suggest strong cross-linguistic tendencies (with language-specific variation) in syllable-based liquid allophony [4]. In order to aid lexical retrieval, perceptual recoverability is an important factor to be balanced against ease of articulation (e.g. [12]). In the case of /r/, a weaker coda is expected; but how weak? The search for a phonetic/biological basis for allophonic differences is essential to phonological research. But the pattern in Fig. 1 is, I think, more canonically "phonological" than some of the more subtle differences of [2], [4], [7], [15] precisely because it is more phonetically extreme and more clearly at a cusp of phonological change.

The mere existence of such behaviour is interesting. Uncovering its social context will be truly revealing, because while the role of the listener in language change is essential [8], it is not sufficient. Speakers have to create articulatory behaviour on the basis of the input they hear; what they hear may be occasionally unclear, but it is patently variable. Speakers like P0 seem to achieve an acoustic target which is appropriate for the intended social group by aiming at the perceptual *un*recoverability of their rhotic-like articulation. The rhotic articulation generates little acoustic rhoticity by extreme delay of the tongue-tip constriction. We have also observed strong gestural reduction rather than this sort of strong delay in non-prepausal contexts [11]. While delay and reduction are typical articulatory processes for the coda, and may well be biologically grounded, it is clear that the *extent* of coda weakening is both variable and potentially very wide: the actual phonological pattern is learned and varies from person to person. It is therefore unclear what it means to say that such phonological patterns are biologically grounded.

Each person actively participates in socially-variable systems as a listener and as a speaker. The role of the speaker as an *active agent* — who has to recreate the sociolinguistic variables around them in order to convey social meaning appropriately — is a central aspect of language variation and change which has received little attention, not least due to the lack of any articulatory data. Instead, the complex and unpredictable relationship that exists between speech sounds and vocal tract configurations is generally addressed by laboratory-based phonetics experiments, but these typically aim for homogeneous subject pools.

4. CONCLUSIONS

The biological foundations of phonology are important for explaining the ultimate causes of phonological structure, including the limits of pronounceability and perceptibility as well as likely systems — markedness, in other words. Contrast is fundamental to phonology, and it is valuable to study the phonetics of contrast. Much research in phonetics presupposes that words in a given language can be divided unambiguously into smaller phonological units, the phonetic properties of which can then be investigated. In fact, establishing the inventory of these units and structures is one of the challenges for phonological analysis.

In Scottish English, we may say that an abstract unit "/r/" exists in various positions, in phonetically-grounded variants. But there is strong evidence that younger working class speakers are altering the phonetic articulation and the acoustic nature of the relevant words relative to the older generation [14]. How can we tell if *bear* is /ber/ or /beə/, *car* is /kar/ or /kɑ/? To choose is to change the higher level phonological system.

If phonology were biologically grounded, then the rhotic system *and* the non-rhotic system *and* the gradual change from the former to the latter are all grounded. But the preservation of a contrast while one of its poles moves through phonetic space is not exclusively determined by motor control, physiology, perception or a functional pressure to preserve that contrast. Social factors introduce very different functional pressures.

Phonetic patterns encoding lexical contrast and ones encoding social meaning are both abstracted away from idiolectal characteristics. General physiological and cognitive tendencies are indeed the background for phonology. In the case above, they can begin to explain why it is coda /r/ which is weakening (relative to the onset), and why it does so through reduction and delay of the post-alveolar constriction. Both seem to be general tendencies [2], [4]. But the *same* grounded principles within the *same* language and speech community are being instantiated very differently by different groups who have knowledge of each others' systems, and target their own accordingly [3], [14]. A sociophonetic perspective provides data that cuts across the patterns detectable in a homogeneous sample, which is why variation is a useful research tool, for core issues in phonetics and phonology. Both disciplines have much to gain when phonetic research can get out of the laboratory and sociolinguistic research can get into it.

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