

*Phonetic motifs and the formation of sound structure**

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Abstract

This paper examines the status of language-specific systematic detail in the realisation of phonology and proposes the formalisation of this detail as a set of phonetic *motifs*. It is argued that such motifs form a key component of phonological (linguistic) knowledge and may shape the language-specific emergence of phonological structure, as illustrated by a case study of consonant gemination. It considers how sound *form* may become associated with sound *meaning* in a way which is at once system-internal and open to external factors.

1. Introduction

Phonetic research has become increasingly engaged in: examining linguistic-phonetic variability (hereafter LPV) and the problems such variability raises for the theory of phonological knowledge (e.g. Pierrehumbert, 2001, 2002; Nolan, 1999, Bybee, 2000, 2001; Bybee & Hopper 2001; Keating, 1985; Ladefoged, 1980; Solé, 2003); in scrutinising the parameters which shape this variability (e.g. Foulkes & Docherty, 1999; Docherty & Foulkes, 2000; Docherty, 1999; Local, 2003); and in exploring its implications for how humans understand speech (e.g. Hawkins, 2003). While there is much variability in phonetic performance, what is distinctive about LPV is that it is a) *systematic* and b) *under the control of the speaker*. The term systematicity may imply that differences between linguistic varieties are necessarily discrete and is therefore arguably inappropriate for describing phonetic variation that is frequently gradient in nature (for example, the phonetic ‘fact’ that [ʃ] in English is articulated with more lip-rounding than in French). More accurately, perhaps, it is the overall gross distribution of possible variants which might be thought of as systematic, and variant clustering, as modelled in Exemplar Theory, neatly captures the way in which a two-way distinction may arise from a

* I wish to thank former colleagues at the University of Cambridge and other colleagues at BAAP, LabPhon, MfM and LAGB for their comments and suggestions during the development of the ideas presented here. I also wish to thank the British Academy for funding a Postdoctoral Research Fellowship which allowed me to develop this work.

continuum of possibilities. As for speaker control, this drives a conceptual wedge between so-called “extrinsic allophones” (Ladefoged, 1972), which are linguistic ‘choices’, and the inevitable, or at least default, fall-out of gestural co-ordination that is elegantly modelled in Articulatory Phonology (e.g. Browman & Goldstein, 1989, 1990, 1991, 1992). Solé (1992), for example, shows that vowel nasalisation in American English cannot be explained simply in terms of a natural, non-cognitive process of anticipatory nasal coarticulation, but is a controlled speaker choice. The predictability resulting from systematicity and speaker control creates a linguistic device of potential use to the listener in understanding what has been said (see Local, 2003; Lindblom, 1986, Hawkins, 2003).

This paper provides a brief overview of different types of LPV; proposes its formalisation as phonetic *motifs*; considers the immanent creative potential of motifs to produce *phonic morphemes*; and finally presents a case study of the grammaticalisation of a long-domain motif.

2. A typology of LPV

LPV can be divided into two main types, according to where it can be said to ‘reside’. The locus of variability may be *short* or *long* domain. Short-domain (or what Local (2003) terms “punctual”) variability is typically to be found in the phonetic realisation of a phonemic contrast, and can therefore be said to be paradigmatic. There are many clear-cut and well-known instances of short-domain LPV in the cross-linguistic differences in how phonemes are realised. For example, the realisation of voiced stops in English is strongly characterised by some degree of passive devoicing, while the realisation of voiced stops in French is strongly characterised by active strategies to maintain voicing. Vowel systems are equally susceptible to paradigmatic variability, and in the extreme this may affect the entire vocalic system: for example, vowels in European Portuguese are realised with a velarised resonance not present in Brazilian Portuguese.

A problem here is whether or not we are actually dealing with the realisation of the ‘same’ phoneme cross-linguistically, since the value of any phoneme is, strictly-speaking, only definable in relation to other contrastive sound elements in the same language, and the notion of phonemic identity across two different languages is problematic. Intuitively, what we denote as a / d / in English appears to have much in common with what we denote as a / d / in French, although this common ground is only found when we allow reference to actual acoustic or articulatory properties, a concession which in itself undermines the claim to commonality at an abstract (phonemic) level. Indeed, such observations would appear to undermine any interpretation of phonology as purely abstract. Phonemes are intrinsically associated with (and mappable) to a physical exponent (whether phonetic or signed) and it is precisely this association which makes cross-linguistic

comparison possible. From a purely abstract, structural perspective, English / d / and French / d / cannot be thought of as the same phoneme, because they are only phonemic within the particular phonemic system of each respective language, and yet their phonetic similarity cannot be denied.

The complex nature of the mapping between phonological structure and its phonetic exponents can take different forms. Just as different phonemes (different because pertaining to different phonemic systems) can, phonetically speaking, be near-identical, a single phoneme may, within a single system, map onto a set of exponents which are phonetically very diverse. Such divergent realisation of the same phoneme is particularly striking in the LPV across varieties of the ‘same’ language¹. Nolan (1999), for example, discusses the extensive variation in the treatment of voiceless alveolar stops in different regional varieties of English, particularly when non-stressed and syllable initial. Similarly, Carter’s (2002) investigation of liquids in English reveals a large degree of dialect-specific variation in clear/dark alternations.

Such short-domain LPV is associated with a particular consonant or vowel (or a whole consonant or vowel system, as in the case of vowel velarisation in European Portuguese), and is therefore ‘segmental’ in locus, although its effects may spread over more than the segment in question (e.g. the long-domain spread of resonance properties emanating from liquid alternations in Carter’s 2002 study). Indeed, it is not the attachment to a segment that matters so much as the attachment to some form of paradigmatic contrast, and as Local (2003) and others argue, that contrast, no matter how paradigmatic in nature, may be present at various different parts of the speech signal. The paradigmatic contrast may be phonemic in a traditional sense, grammatical (in a polysystemic sense, cf Local, 2003) or suprasegmental (e.g. systematic variability in the realisation of intonational contrasts, as Garding and Arvaniti (to appear) show for varieties of American English).

The locus of LPV may, alternatively, be ‘inter-segmental’, or long-domain. This is quite distinct from the spread of effects from a short-domain variable, and refers instead to variability associated with the delivery of a *sequence* of consonants, vowels or tones². The phonetic realisation in question is *syntagmatic* in nature. Such variability may be shown through language-specific differences in coarticulation strategies, for example the degree to which a language shows

¹ It might be argued that regional varieties of a language are not the same language. However, taken to this extreme, we would have to take into consideration systematic variability between individual speakers, and this would mean that all languages are idiolects and no shared language exists.

² The degree to which the *spread* of such effects differs cross-linguistically may be considered a form of long-domain LPV. In other words, if [ʃ] is more lip-rounded in Language X than in Language Y, this is an instance of short-domain LPV, and the fact that lip-rounding spreads is an effect of this short-domain LPV. However, if lip-rounding were found to spread further in one language than in the other, this would be an example of long-domain LPV.

coarticulatory resistance, and the timing and direction of coarticulatory influence. Cross-linguistic differences have been found in the realisation of consonant clusters. For example, Gibbon, Hardcastle and Nicolaidis (1993) found several language-specific features in lingual coarticulation of / kl / clusters for 6 European languages, specifically in their tendency to overlap, with Catalan showing the most overlap and no instances of overlap in Swedish. The evidence suggested that these differences were not due to durational factors, i.e. were not, in some sense, mechanical. In the same vein, cross-linguistic investigations of sequences of two consonants across a word boundary reveal that, in contrast to English (Browman & Goldstein, 1990; Byrd, 1996; Zsiga, 1994), Russian (Zsiga, 2000; Kochetov, 2002) separates the two consonant gestures with a time lag. Yanagawa (to appear) explores the acquisition of such differences in second language learning and presents evidence suggesting that ‘no-overlap’ is a default strategy. Different degrees of overlap (including keeping to the default strategy of ‘no overlap’) are therefore to be regarded as linguistic choices. Barry (1992) presents evidence for differences between Russian and English in their production of coronal + velar clusters. In both Russian and English, there is a reduction in gestural magnitude if the coronal is an oral stop; but if the coronal is a nasal stop, gestural reduction occurs in English only. There is no purely phonetic reason for these differences in the delivery of sequences of sounds to exist, and therefore they must be considered as linguistic facts, and thus part of linguistic knowledge.

A particular type of LPV that is clearly long-domain in nature is the set of phonetic properties known as *articulatory setting*. An aspect of phonetic realisation that receives scant attention, articulatory setting is defined by Honikman (1964: 73) as “the over-all arrangement and manoeuvring of the speech organs necessary for the facile accomplishment of natural utterance [which] pervades and, to a certain extent, determines the phonetic character and specific timbre of a language”. It determines such variables as degree of lip mobility, degree of tension in the articulators and pressure made on contact, and tongue-setting characteristics. This language-specific speech *posture* is long-domain in that “it is immanent in all that the organs do”, and though its basis is in articulation, its global character is not restricted to articulation but evident also acoustically. The articulatory setting of French, for example, is characterised in part by a greater degree of lip-rounding *overall*, with respect to e.g. English. This results in changes that can be detected acoustically. Similarly, certain accents of English (e.g. Birmingham) are described as having, generally, a greater degree of pharyngealisation, again imparting a linguistically distinct acoustic signature.

3. The status of LPV: phonetic motifs

Defining the status of linguistic-phonetic knowledge, be it ‘segmental’ or ‘intersegmental’, poses a theoretical challenge. Keating (1990) argues that such

knowledge must form part of the grammar: “[w]hat someone has to know about a language to behave like a native speaker is the grammar of that language: since languages differ in phonetic detail, some account of those differences must be provided by the grammar.” A possible domain for such knowledge to reside is in the phonology, yet, phonetic variation fails to fit comfortably, if at all, into most models of phonology, and remains incompatible with conventional approaches to grammar, an incompatibility that stems in part from the reductionist assumptions and aims underpinning such approaches. The minimalist drive to discover a simple, universal and unifying set of rules, principles or constraints to explain surface variation in all its possible complexity, means that variation is often treated as ‘noise’, simply to be explained away. Furthermore, in order to reach a maximally simple unifying principle that holds together all surface phenomena, explanation inevitably becomes spirally abstract, and this in itself pulls analysis away from the detailed empirical observations that reveal LPV in the first place.

Alternative approaches to phonology, and to grammar more generally (cf Bod, 1998) propose what might be described as a maximalist doctrine of structure, which seeks to incorporate rich systematic detail and posits that abstract structures emerge from the stochastic properties of inherent variability in a highly particularistic manner. Bybee and Hopper (2001) describe linguistic structure (or grammar) as a response to discourse needs, and claim that direct experience with language shapes cognitive representations and categorisation. The framework here for phonology employs the Exemplar Theory of categorisation, which proposes that an acoustic trace of each utterance of a sound or sequence of sounds is stored on a kind of cognitive map, which consequently expresses the actual range of variation in the physical realisation of that category (see also Pierrehumbert, 2001). Word frequency plays a critical role, since higher frequency tokens have a more profound effect on the positioning of the ‘core’ of the emergent category.

On this interpretation, structure is more fluid and shifting than conventional linguistic analysis allows for. Phonological structure may change over the lifetime of an individual, as the phonetic experience to which that individual is exposed also changes. Harrington’s (to appear) study of shift in the Queen’s speech patterns over the last 50 years provides a clear example of this. The emergence of phonological structure is argued to be channelled through cognitive capabilities and capacities. Lindblom, MacNeilage & Studdert-Kennedy (1984) argue for the self-organising emergent nature of phonological structure in both ontogeny and phylogeny, and through empirical modelling show that “in the presence of certain constraints, non-uniform preferences for certain syllables over others arise.” Phonemes, allophone and features are not explicit constructs but are derived from a statistical bias “built into the phylogeny of speech”. The position that linguistic categories are “dynamic, relational, i.e. context-sensitive, and plastic, i.e. labile” is put forth also by Hawkins (2003: 386) in her exploration of the role of systematic fine phonetic detail in speech perception. Here again the focus is on the transformation from experience (in this case, specific memory) to structured linguistic information, as opposed to

this linguistic structure being in some way innate. Categories such as phonemes “are by-products of the route between sensation and meaning” (2003: 399). Not only: Hawkins goes on to claim that such by-products may be by-passed completely, especially in good listening conditions and where familiarity of speakers and discourse make probabilistic assessment especially effective. In other words, meaning may be arrived at directly from exposure to an information-rich acoustic signal, without the need for hierarchical processing.

What underpins these approaches is an attention to the importance of speech *behaviour* in the formation of structure, and a move away from the absolute primacy of innate cognitive structures. The conceptual paradigm here is strongly reminiscent of the sociological theory of *Structuration* (Giddens, 1984), as Bybee and Hopper note (2001), and what this has to say about the transmutation of structure. In Structuration Theory, structure is interpreted as having *duality*, that is to say the structural properties of social systems act as both the medium and the outcome of the process in which structure is generated. Structures, or social norms, condition behaviour, but in turn repeated behaviour either reinforces or slightly deviates these norms and in time reconditions structure. “Society only has form, and that form only has effects on people, in so far as structure is produced and reproduced in what people do” (Giddens & Pierson, 1998: 77).

More recently, within the framework of Critical Realism, Bhaskar (1983) has criticized Structuration Theory for having taken social structure as a given and neglecting the *history* of structures. Bhaskar argues for a theory of *Restructuration* which emphasizes more the process of reproduction and transformation of structure³. This approach allows for a more dynamic, ever-evolving model which lends itself to capturing certain properties of sound systems and how they change. Applying the principles of (Re)Structuration theory to phonology/phonetics, we can say that phonological norms (structure) condition phonetic exponents (behaviour) and that repeated phonetic realisation can reinforce or deviate slightly from these norms (i.e. through either staying within the normal cluster of exemplars or moving to the margins of or outside of this cluster) and, if the latter, in time will recondition that norm (i.e. phonetics reshapes phonology). There are, undoubtedly, fundamental differences between sound systems and societal systems and, undoubtedly, the parallels drawn are limited in scope. However, the concept of a dialectical relationship between shared, abstract norms (idealised language) and actual, physical behaviour (realised language) is arguably valid for both. A precursor to this approach in linguistics can be found in Coseriu (1954; 1962) who discusses the abstraction of “realisational norms” from the pool of speech

³³ The principle of structure being formed from historical processes has a long heritage, with roots in Weber’s (cf 1903-1917 (1949)) theory of social systems and in Durkheim’s (1895) concept of “social facts” as the consolidation of social functions over long periods of time (see also Jones, 1986).

behaviour possible within a given community, and the role of shifts in these norms in the “constant resystematisation of language.”

According to a dynamic model, the dialectical relationship between phonetics and phonology is both synchronic and diachronic in nature, since historical changes are encoded in the present form of a sound system, and also in the way this sound system is realised. This view of sound structure is compatible with Blevin’s (2004) Evolutionary Phonology (henceforth EP) which argues that ‘recurrent synchronic sound patterns have their origins in recurrent phonetically motivated sound change’ (2004: 8). EP also implicitly highlights the *social* basis for the formation and take-up of phonological patterns, claiming that “most of the content of traditional descriptive grammar constitutes learned aspects of human behaviour” (2004: 312). Learned behaviour is transmitted through social interaction, and is not, by definition, intrinsically innate. In this approach, most diachronic ‘pathways of change’ (to use a concept from Bybee, 2001) can be explained ‘historically’ (e.g. through direct genetic inheritance) or phonetically (physical constraints), and cross-linguistic patterns emerge from what Blevins calls “parallel evolution”, and once these have been exhausted, there remains little need, if any, for a universal phonology.

In the search for linguistic explanation, EP takes a critical step forward by attempting to re-set the balance between (presumed) innate, universal structures and varying, particularistic speech behaviour. It provides a suitable framework for the analysis and formalisation of language-specific phonetic detail. LPV forms part of linguistic knowledge and therefore has linguistic status. Furthermore, it is not merely an exponent of linguistic structure, but arguably has its own structure (or systematicity) which may over time impact on phonological structure. Here it is proposed that the ‘facts’ of LPV be formalized as a set of language-specific phonetic *motifs*, which have several key characteristics:

1. Motifs are systematic ‘events’ running through a sound system. Unlike notions of constraints in phonology, motifs describe single, repeated and *measurable* ‘events’. Even though their impact and function can be abstract, motifs exist in the physical domain. For example, the long-domain motif of pharyngealisation as a generalised articulatory setting entails specific articulatory ‘events’ in the vocal tract and specific acoustic ‘events’ in the resulting speech signal⁴.
2. Motifs are structurally significant. They are part of the sound ‘architecture’ of a particular language (or language variety). If a language has a particular co-production strategy, this is a significant and distinguishing property of that language.

⁴ Whether or not these two types of motifs are transparently mappable onto each other is not of importance to the present argument.

3. Motifs are synchronically arbitrary, which means they are not externally predictable. They may (or may not) be indirectly related to certain physical constraints (of the kind explored by e.g. Ohala, e.g. 1983; 1992; 1993) and to forces of functional viability (e.g. Lindblom 1986; 1990), and indeed such factors will delimit the outside edges of variation and influence the frequency of certain motifs across languages. However, these factors cannot dictate precise outcomes: there are always alternative strategies within the bounds of what is physically possible. Similarly, the strategy chosen does not have to be functionally optimum, just functionally viable, and there are many pathways to viability. Hence, there is no solid case for the existence of universals in linguistic phonetic knowledge, only strong *tendencies*.
4. Motifs are historically contingent, reflecting historical structure and processes.

Where cross-language trends exist, these can be accounted for by the notion of linguistic convergence (what Blevins call ‘parallel evolution’) which seeks to explain how a particular trait can emerge independently in different places. Convergence is greatly facilitated by the following factors:

- i) The presence of the same raw materials (in speech, the capacities of the human articulatory and perceptual systems, plus aerodynamic/acoustic properties governed by physical laws), which delimit possible ‘solutions’ to the task in hand (here, communication);
- ii) The presence of the same or similar functional needs; and a given functional serendipity of certain traits or ‘inventions’ (e.g. sounds which are acoustically robust, or articulatorily easy to produce).

The notion of convergence has been applied to evolution in other systems, for example in Evolutionary Biology, where it has been proposed as an explanation for the independent emergence of organs in unrelated organisms, such as the eye; and in Sociology and Anthropology, where it is used to explain the independent emergence of certain social structures and cultural practices or *memes* (ideas, behaviours, or skills transferred by imitation, cf Dawkins, 1976). Kirch & Green (1987) cite as an example the parallel (i.e. unconnected) development of the 2-piece fishhook in various Pacific locations (Hawaii, Easter Island and New Zealand) as a convergent response to an identical functional problem (namely, the absence of pearl shell in these locations).

As shared behaviour idiosyncratic to a given community and evolving within that community, phonetic motifs are a form of socio-cultural knowledge and can be

compared with motifs in other categories of shared behaviour. Recurring themes and practices may express/define a particular cultural tradition, for example:

- i) In music, the non-inevitable, learnt association in the western musical tradition of the minor key with feelings of melancholia;
- ii) In architecture, the psychological impact of certain shapes and styles, e.g. neo-classical pillars and domes denoting power or grandeur;
- iii) In daily social behaviour: cultural differences in familial relations, dining habits and dress code, which demarcate the norms around which individuals' behaviour clusters.

4. The emergence of phonic morphemes

As repeated articulatory, acoustic or perceptual 'events', motifs may result in structures of a higher order, or 'phonic morphemes'. For example, if a particular strategy for gestural co-ordination (a long-domain phonetic motif) leaves a 'gap' between consonants, this will result in vowel epenthesis (a 'phonic morpheme'). In this way, motifs have immanent structure-creating potential. The epenthetic vowel that emerges is an articulatory and acoustic morpheme which has no deeper significance (at this stage) but which is a defining property of that sound system. Articulatory Phonology (Browman & Goldstein, 1989, 1990, 1991, 1992) captures many insights into the mechanical effects of gestural co-ordination, but does not explain why a language has a particular gestural co-ordination in the first place. There may be an inevitability about vowel epenthesis once a particular gestural co-ordination is in place, but the type of gestural co-ordination itself is not inevitable but linguistic, and is formalised here as a language-specific motif resulting in a phonic morpheme.

Motifs, then, are not only structural properties of the sound system in themselves, they can also *create* structure, and hence may play a role in the way sound systems evolve. New structural features may emerge epiphenomenally, similar to the emergence, in architecture, of 'spandrels', unplanned spaces that arises when two arches conjoin, as illustrated in Figure 1. Used generically, the term spandrel denotes the unplanned result of a structural necessity, i.e. something that exists as a consequence of something else. The phenomenon of a feature emerging as a consequence of other features has been applied in other fields: for example, the emergence of a biological trait as a physiological by-product of another trait, in evolutionary biology (Gould and Lewontin, 1979).

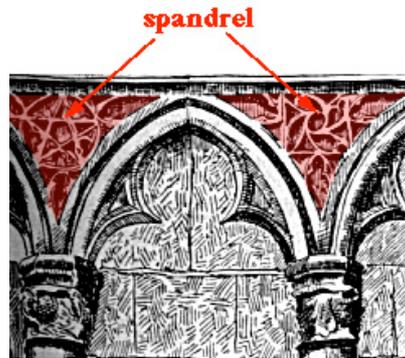


Figure 1: an architectural spandrel

Viewing motifs as structural, rather than merely the exponents of relationships existing at a deeper level, requires a more finely nuanced definition of structure. One interpretation of structure is as a *framework*, in which phonic material ‘sits’. On this interpretation, patterns in sound are indexical markers of something more abstract, more grammatical that lies underneath. Motif complexity would simply reflect underlying structural complexity. This entails a one-way relationship between two levels of encoding (e.g. higher-level linguistic structure and phonetic implementation). An alternative interpretation is to see the different levels as expressing structure in different ways, with an open, two-way and fluid relationship between levels. The systematicity that can be found at different levels is structural in a morphological sense. Conventionally, morphology describes the way phonemes make up larger structures of linguistic meaning. However, used more generally, morphology can refer to any recurring pattern of shapes and to their role in the formation of higher structures, including phonetic patterns (‘motifs’) and their (emergent) transformation into phonological structure. Phonetic motifs and their resulting ‘phonic morphemes’ may, thus, be indexed to other kinds of structure at different levels⁵, just like phonetic indices in Declarative or Firthian framework (see e.g. Firth, 1948). The crucial difference in the model being presented here is the permeability of levels and the independent structural status of the phonetic level.

Spandrels, or emergent phonic morphemes, may emerge and remain without linguistic ‘function’ (although arguably they often - perhaps always - have sociolinguistic function). Where this is the case, they are a form of linguistic ‘junk’, though not quite in the same way as Lass (1990) uses this term. Lass explores ways in which phonemic junk is generated via “systemic collapse” in the morphological system, with retention of repeated phonemic ‘shapes’ but the loss of original function. Here, the junk results from construction, not collapse, though the basic concept is the same: a feature which arises in an unplanned way and which is functionless. Just as Lass’s morphophonemic junk may acquire an unintended

⁵ or, as may be the case with socio-indexical markers, directly onto reference in the ‘real world’.

function, linguistic-phonetic junk may also come to acquire function, in that it may, for example, become the basis of a phonological contrast, or mark a syntactic or prosodic boundary. Lass⁶ calls this process linguistic *exaptation*, adopting a term coined by evolutionary biologists Gould and Vrba (1982) to denote cases where a biological trait which developed *adaptively* for one purpose comes to be used for another purpose (e.g. the hypothesis that wings developed as a mechanism for controlling temperature and later exapted for the purpose of flight: see Dawkins, 1986).

The possibility for structural innovation to emerge from existing structure opens up our understanding of how sound systems evolve. Particular functional opportunities arise from particular structural redundancies: “the path of evolution – both the constraints and the opportunities – must be largely set by the size and nature of [the] pool of potential exaptations” (Gould and Vrba, 1982: 13). Structure may emerge in one or more of the different domains pertaining to speech: articulatory, acoustic or auditory (and their sub-domains). The structure that emerges in this way, and the immanent structural properties within phonetic motifs, are no less linguistic than more abstract structural entities, such as phonological structure, and indeed are not incompatible with such notions if a multi-level approach to sound structure is adopted. Semiotic relations will naturally exist at all these levels and between these levels, and, when combined, these relations describe the semiotics of the sound system. When a structural innovation emerges at a particular level (be that phonetic or phonological), this creates a contradiction or conflict between levels. The dialectic tension arising from such conflict may become a determining factor in bringing about structural change at the other level. It is through structural change that the tension is resolved. Diachronic studies at the phonetics-phonology interface are thus concerned with how repeated patterns of speech behaviour can change form as they migrate through different semiotic levels of the sound system, in a chain of encoding and re-encoding. While a phonetic motif may become re-encoded as a phonological process, the structural basis originated at the phonetic level, and migrated to a different level.

The framework proposed here suggests then that seemingly peripheral (i.e. low-level phonetic) detail (phonetic motifs) may, over time, impact upon more ‘internalised’ and ‘linguistic’ (in the conventional sense) structure, in a process of ‘motif grammaticalisation’. On this interpretation, speech behaviour, which is not precisely containable by minimalist principles or predictable, is a significant determinant in the shaping of phonology ‘proper’. Furthermore, this is not because

⁶ As Lass stresses (1982: 94), the transfer of a concept from evolutionary biology does not entail the belief that languages are biological systems, rather recognition that there are “properties common to historically evolving systems regardless of their substrates”.

phonetic detail is mistakenly analysed by a younger generation acquiring the language as the exponent of a different structure, but because it is of structural import from the outset and because its inherent variability continuously tugs at the apparent monolith of the sound structure as a whole. The overall structure will reach apparent stasis for relatively long periods of a time, but any stasis is intrinsically fragile.

5. Case study: the emergence of geminates

Blevins (2004) identifies a number of diachronic pathways that can result in the creation of phonological geminates, including assimilations of various kinds; vowel deletion; and prosodically conditioned lengthening. It is considered here how at least one of these pathways, prosodically conditioned gemination, may, at least in Italian, have originated in phonetic motifs which subsequently became grammaticalised.

Payne (2005) reveals a high degree of systematic variability in the phonetic interpretation of geminate consonants in the Pisan variety of Italian. In particular, it is found that geminate and non-geminate duration and the contrast between these depend on an interaction of consonant type, position in the word and prosodic factors. Specifically, for phonetic sequences that fall within the intonationally prominent part of the phrase, there is a very strong tendency for consonants, both geminate and non-geminate, to be longer in duration when post-stress. For example, the post-stress word-medial geminate [tː] in *fattolo* (*it having been done*) is longer than the pre-stress geminate in *fattore* (*factor*), and the post-stress word-medial non-geminate [f] in *rafano* (*horseradish*) is longer than the pre-stress consonant in *safari* (*safari*). It would seem, therefore, that a long-domain motif of post-stress lengthening is present in this variety, and is specific to stresses which are intonationally prominent. Away from intonational prominence, consonants are longer when *pre-stress*, but this is arguably more ‘natural’, since the pre-stress consonants in question in Italian are always in the onset of the stressed syllable, and therefore would be expected to be longer as an effect of general lengthening of stressed syllables⁷.

Prosodic lengthening at the phonetic level appears to correlate well with historically grammaticalised (phonologised) forms of gemination in the same variety and in Standard Italian (which is very closely related, historically, to Pisan Italian). This similarity between live phonetic patterns and structurally anchored phonological patterns suggests that gemination originated in a linguistically-distinct

⁷ According to conventional principles of syllabification, post-stress consonants are only part of the stressed syllable when they are geminate. Post-stress lengthening is therefore, arguably, less phonetically inevitable than pre-stress lengthening, and therefore a stronger candidate for being a linguistic phonetic motif.

phonetic motif which is still active. From a diachronic perspective, position in relation to stress may have played a decisive role in the development of gemination (from Latin to Italian) in more than one way. Most striking is the development, in central and southern Italo-Romance dialects and the varieties of regional Italian spoken in the same area, of a post-lexical process of word-initial consonant gemination known as *raddoppiamento sintattico* (henceforth RS). RS is triggered in two ways, either by certain lexical items preceding the consonant in question:

e.g. *a Parigi* ‘to Paris’ [a p:ar'idʒi]

where the preposition *a* triggers gemination of the word-initial [p] of the following word, or by a stressed final vowel in the preceding word:

e.g. *menù nuovo* ‘new menu’ [men'u n:w'ɔvo]

where a stressed final [u] triggers gemination of the word-initial [n] of the following word. While lexically triggered RS can be found all over central and southern Italian and Italo-Romance dialects, the prosodically conditioned version of RS is geographically limited to central dialects and varieties of Italian, of which Pisan Italian is one. In this variety, then, as Payne (2005: 178) points out, “the phonetic tendency for post-stress lengthening [...] mirrors the phonological process of postlexical gemination.”

Post-stress lengthening is also apparent word-internally in the development of certain words in the passage from Latin to Italian⁸:

BRUTUS	>	<i>brutto</i>
ATOMUM	>	<i>attimo</i>
LEGITIMUM	>	<i>legittimo</i>
FEMINAM	>	<i>femmina</i>

The similarity between phonetic and phonological processes, and between lexical and post-lexical processes, suggests a general underlying systematicity – or long-domain motif (namely, phonetic post-stress consonant lengthening), that also became grammaticalised to produce lexical geminates and a live postlexical process of phonological gemination (RS).

For post-stress consonant lengthening to be a long-domain phonetic motif, it must be non-inevitable, which means either it is not the natural, unplanned consequence of the phonetic implementation of stress or, if it is the default, unplanned consequence, it must be possible to suppress this consequence. Either way, the presence of this motif must represent some sort of linguistic choice, be that the

⁸ This was possibly linked, Vincent (1988) claims, to other factors such as word structure (i.e. position of the stressed syllable in relation to the end of the word).

choice to do something non-inevitable, or the choice not to suppress a default strategy. The association of phonological stress with some form of lengthening is widely attested and, as Blevins (2004: 173) points out, “may take the form of tonic vowel lengthening, post-tonic consonant gemination, syllable-initial consonant lengthening, or any combination of these.” Blevins goes on to suggest that “the simplest explanation of lengthening under stress is that length is a direct phonetic manifestation of stress”. Although Blevins does not directly consider how and why this association between longer duration and stress may have arisen and taken root (i.e. become conventionalised, or *grammaticalised*) in so many, unrelated languages, e.g. Rotuman (Churchward 1940), Hebrew (Laufer 1999) and Italian (Bertinetto 1980), it is arguably an example of parallel evolution. Keeping within Blevins’ theory of Evolutionary Phonology, there are various possible pathways that could explain how such an association could have ‘asserted itself’ in any particular language. We might suppose that among multiple phonetic signals for a particular phonological structure (in this case, a stressed syllable), one particular type of signal (in this case, increased phonetic duration) came to be the best exemplar in the linguistic input for a speech community. This could have come about either through a) its own increased frequency in the linguistic *output* and subsequent selection by the listener based on probabilistic principles, or possibly through b) a more pro-active selection in the mind of the ‘listener’, irrespective of whether its incidence had increased or not.

According to a), the number of times a stressed syllable was produced with some form of lengthening would have increased in proportion to other variants of the same syllable, and this could be as a result of inherent random variability in production, as Blevins argues. The listener then performs an act of CHOICE, in that she selects this signal as the best exemplar for the phonological structure in question. This is shown schematically in Table 1, where phonetic variants are represented by a set of arbitrary symbols, the most common variant being ‘*’.

Table 1

SPEAKER produces:	& * ! * & \$ @ * ! ! * & \$ *
Most common variant =	*
LISTENER selects:	*
Selection is via:	LISTENER CHOICE

However, selection could, alternatively, entail a form of CHOICE on the part of the *speaker*, a possibility that Blevins does not explore, at least not explicitly. Arguably, in order to be able to manipulate phonetic variation for sociolinguistic purposes (amongst others), speakers must, logically, be able to exert some degree of control over the phonetic variation in their own speech production. Speakers may acknowledge social groups by switching sociolinguistic codes, or their own default code may change as their social circumstances change. This is not to claim that speakers operate control on their productions with structurally teleological aims in mind, rather that in addition to there being inherent, random variation around a norm, it may reasonably be presumed that speakers have some control over how they map certain aspects of this variation to sociolinguistic contexts with which an association has been formed. Once they are aware of an association, they are at liberty to exert some degree of selection and produce this particular variant more often. On this interpretation, the increased occurrence of the particular phonetic signal (longer duration) would be a result of pro-active SPEAKER CHOICE, as shown schematically in Table 2. Since in actual communication the boundary between listener and speaker is somewhat artificial, in that a speaker will also be a listener and vice versa, it may be more accurate to view the process of CHOICE as pertaining to a given speech group as a whole⁹, and one which describes the conventionalised association of phonetic form and phonological ‘meaning’.

Table 2

SPEAKER associates:	* as preferred marker for a given phonological structure (for sociolinguistic reasons)
SPEAKER produces:	more exemplars of * than of others
Selection is via:	SPEAKER CHOICE
LISTENER hears:	more * than other variants
LISTENER associates:	* as prototypical marker of given phonological structure
Selection is via:	LISTENER CHOICE

⁹ The term ‘speech group’ is used to denote that group of people for whom a given ‘phonetic form – phonological ‘meaning’ association’ is operative, i.e. not just known, but in use, e.g. speakers of British English who use High Rising Terminals in statements. Speakers may, naturally, belong to many speech groups, and their affiliation to speech groups is presumed to be in constant flux.

With the association of longer duration with stress, there is a possible further complication. Even if from a purely synchronic process the association can be entirely arbitrary (i.e. linguistic) the association between stress and duration arguably originated in a natural association, and the motivation for the link subsequently obscured. The grammaticalisation of natural associations has been proposed for several other linguistic associations. It has been argued, for example, that the linguistic use of high pitch (rising intonational contours) with uncertainty and question-asking, originates in a natural, *biological* association of high pitch with small humans and therefore, historically, with increased social vulnerability (see Ohala, 1983), and that this biological code (see Gussenhoven, 2004) is retained in an iconic relationship.

Arguably, the association between abstract prominence (lexical stress) and acoustic-perceptual prominence (longer duration) is a form of iconic relationship: a stressed syllable has prosodic importance relative to other syllables, and a longer duration can only facilitate the perception of that syllable in speech, since it allows for a greater window of opportunity for perception¹⁰. An iconic relationship has a strong advantage in that it is transparent, and does not trigger contradictory signals. This in itself may be a strong motivating factor in the preferred selection of an iconic variant as ‘best exemplar’ (both in the mind of the speaker and of the listener), and in its own resistance to change. Table 3 shows this type of selection schematically. An alternative explanation, (Table 4), is that the incidence of the phonetic signal does not change, but the listener selects it through a more proactive process of selection, based on the same rational principle of iconicity. Listener CHOICE may also combine with an increase in variants (whether randomly or through speaker CHOICE), as in Table 5.

Table 3

SPEAKER judges:	* as ‘natural’ marker for a given phonological structure
SPEAKER produces:	more * than other variants
Selection is via:	SPEAKER CHOICE
LISTENER hears:	more exemplars of *
LISTENER associates:	* with the given phonological structure

¹⁰ Loudness and pitch change are other devices for enhancing prominence. While loudness is not known to be linguistically coded, pitch change is widely grammaticalised, both in intonational contours, and in lexical tone.

Selection is via:	LISTENER CHOICE
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Table 4

SPEAKER produces:	& * ! * & \$ @ * ! ! * & \$ *
RANDOM VARIATION	(‘*’ is <u>not</u> the most common variant)
LISTENER judges:	* as more ‘natural’ phonetic marker of given phonological marker
Selection is via:	LISTENER CHOICE

Table 5

SPEAKER produces:	& * @ & * * \$! * \$ @ !
RANDOM VARIATION	(‘*’ is <u>most</u> common variant)
	<i>or</i>
SPEAKER judges	* as ‘natural’ phonetic marker for given phonological structure
SPEAKER produces:	more ‘*’
Selection is via:	SPEAKER CHOICE
LISTENER hears:	more ‘*’
LISTENER judges:	‘*’ to be the prototypical marker of a given phonological structure, and this is confirmed by a judgement that * is also the more ‘natural’ phonetic marker
Selection is via:	LISTENER CHOICE

As Blevins makes clear (2004), although the phonetic origins of a given phonetic resource may be thought of as *natural*, in the sense that articulatory, acoustic and perceptual facts about a phonetic resource are physically determined, and not learnt behaviour¹¹, its take-up and use in a given language is *not* natural, but governed by an intricate psychological game of evaluation and choice at the level of individual speakers and how they interact as a wider speech community. In this sense, the association of longer duration with stress is a combination of natural determinism and a language-specific (i.e. culturally contextualised) evolution of form and ‘meaning’. Indeed, different languages adopt the association in different ways, with some languages using vowel lengthening, and other languages using consonant lengthening. Even among languages which lengthen consonants, there is cross-linguistic variation with regard to *which* consonant lengthens, and position in relation to the stress and within the word may play a role. While in Pisan Italian, it has been shown (Payne, 2005) that an intonationally prominent stress triggers lengthening in following consonants, whether these are non-geminate or already geminate, in Cypriot Greek (Payne & Eftychiou, 2006), a stressed syllable triggers lengthening of *preceding* non-geminates (for all positions of the word) and geminates (when these are word-initial). In other words, while different languages, or language varieties, are subject to the same (universal) physical and functional limits and opportunities, the way these languages ‘cope’ with these limits and ‘harness’ these opportunities is particularistic, and thus the influence that phonetic patterns can have on phonological structure is particularistic.

A further factor which could enhance the probability of a phonetic variant being selected above others (either by the speaker, or by the listener, or by both) may be whether or not this phonetic resource already exists in the language, i.e. the influence of structural analogy. It would seem more likely that the development of prosodically conditioned geminates in Italian would have been facilitated rather than hindered by the pre-existence of lexical geminates inherited from Latin¹². One might also entertain the possibility of different phonetic motifs converging, within a single language, to produce a single phonological phenomenon (in this case, a geminate). In Italo-Romance, geminates result, both historically and synchronically, not just from prosodically conditioned lengthening, but also from processes of assimilation (which may, like prosodic lengthening, be prominence-related). Susceptibility to assimilation of sequences of consonants may ultimately depend on a particular linguistic-phonetic motif, which may in turn be more phonetically ‘live’ in certain varieties (for example Sardinian, where there is even a

¹¹ Or innate, for that matter.

¹² Connected to this, it is also interesting to speculate on the extent to which the existence of a phonetic motif of prosodic lengthening may have contributed to the preservation of lexical geminates in Italian, while phonological length distinction in consonants was lost in all other Romance languages.

live process of assimilatory RS – see Ladd and Scobbie, 2003) than in others. Payne (2005) also shows that robustness of the geminate contrast (which varies with consonant type) appears to correlate with functional load, which suggests that any factor which enhances selection of a particular exemplar will have a determining effect on the shaping of phonological structure. It is possible that structural *harmony*, i.e. the same or similar features reoccurring in different ways and in different places in the sound system, facilitates the process of exemplar evaluation and selection. These suggestions, though intuitively very appealing, remain speculative and in need of further investigation.

6. Conclusion

This paper has sought to argue that change in sound structure may be driven and shaped by properties immanent in low-level systematic phonetic patterns, (motifs), from which phonic morphemes emerge. Though shaped to some degree by the physics or function of speech, phonetic motifs are, critically, detached from such ‘natural’ deterministic factors and are linguistic and non-universal in nature. It has been argued that the structural innovation that emerges from motifs is the product of the peculiar redundancies of a particular language and the peculiar opportunist strategies that unfurl within that language. A brief examination of phonetic and phonological processes of consonant lengthening in the Pisan variety of Italian illustrates how low-level phonetic motifs may become structurally anchored in a language, possibly facilitated by pre-existing patterns and a general structural bias which leads to priming. While adhering to the fundamental tenets of Evolutionary Phonology (see Blevins, 2004), which attends to the phonetic causes of and diachronic pathways to structure, this approach presented here may also provide a missing link between the self-organisation of phonetic form, and its eventual association with and attachment to structural ‘meaning’.

It has not been within the scope of this paper to discuss the (sociolinguistic) spread of phonetic motifs, the resulting emergent phonic morphemes, and meaningful sound structures throughout a given speech community. Instead, the purpose has been to consider the transformation of phonetic material into abstract structures - a continual process of morphogenesis in the sound system - from a purely analytical perspective. In this, it aspires to provide a new perspective on the supposed Phonetics-Phonology interface. The approach is decidedly *post-structural*, in that while Structuralism creates a closed system of oppositions on a single level of abstraction (Phonology), Post-Structuralism can be thought of as providing a stratified and dynamic system of relations, which re-incorporates the materiality of sound substance. The nuts and bolts of this sound materiality are the universal ‘facts’ of speech production and perception, but these are filtered and harnessed in different ways cross-linguistically. With a dynamic and open relationship between different levels of a sound system, an exchange can occur

between low-level systematicity (phonetic structure) that arises and higher-level phonological structure. This permeability between the tangible phonetic world and the most abstract, grammaticalised structures means that the structures that emerge, historically, and the linguistic functions to which they become attached, are inherently contextualised. Investigations of this permeability may open a renewed engagement with spoken language, and an exploration of the semiotic potential that lies in its inherent variability.

References

- Barry, Martin C. (1992). Palatalisation, assimilation and gestural weakening in connected speech. *Speech communication* **11**. 393-400.
- Bertinetto, P.M. (1980) The perception of stress by Italian speakers. *Journal of Phonetics* **8**: 385-395.
- Bhaskar, Roy (1983). Beef, Structure and Place: Notes from a Critical Naturalist Perspective. *Journal for the Theory of Social Behavior*, **13**. 81-95.
- Blevins, Juliette (2004). *Evolutionary Phonology*. Cambridge: Cambridge University Press.
- Bod, R. (1998). *Beyond Grammar: An Experience-Based Theory of Language*. (Csli Lecture Notes, no 88) Chicago: University of Chicago Press.
- Browman, Catherine P. and Louis Goldstein (1989) Articulatory gestures as phonological units, *Phonology* **6**. 201-252.
- Browman, Catherine P. and Louis Goldstein (1990). Tiers in Articulatory Phonology, with some implications for casual speech. In *Papers in Laboratory Phonology I. Between the Grammar and Physics of Speech*, John Kingston and Mary E. Beckman (eds.), Cambridge: Cambridge University Press. 341-376.
- Browman, Catherine P. and Louis Goldstein (1991). Gestural structures: distinctiveness, phonological processes and historical change. In *Modularity and the Motor Theory of Speech Perception*, I. G. Mattingley and M. Studdert-Kennedy (eds.). Hillsdale NJ: Lawrence Erlbaum. 313-338.
- Browman, Catherine P. and Louis Goldstein (1992) Articulatory Phonology: an overview. *Phonetica* **49**: 155-80.
- Bybee, Joan (2000). Lexicalisation of sound change and alternating environments. In *Papers in Laboratory Phonology V*, M. Broe and J. Pierrehumbert (eds.). Cambridge: Cambridge University Press. 250-269.
- Bybee, Joan (2001) *Phonology and language use*. Cambridge: Cambridge University Press
- Bybee, Joan and Paul Hopper (2001) Introduction to frequency and the emergence of linguistic structure. In *Frequency Effects and the Emergence of Linguistic Structure*, Joan Bybee and Paul Hopper (eds.). Amsterdam: John Benjamins. 1-24.
- Byrd, Dani (1996) Influences on Articulatory Timing in Consonant Sequences. *Journal of Phonetics* **24**: 209-244.
- Carter, Paul G. (2002). Structured variation in British English liquids: The role of resonance. Ph.D. diss., Department of Linguistics, University of York.
- Churchward, C. Maxwell. (1940). *Rotuman grammar and dictionary*. Sydney: Methodist Church of Australasia, Department of Overseas Missions.
- Coseriu, Eugenio (1958). *Sincronía, diacronía e historia; el problema del cambio lingüístico*. Montevideo: Impresora Cordon.

- Coseriu, Eugenio (1962) *Teoría del lenguaje y lingüística general : cinco estudios*. Madrid: Editorial Gredos.
- Dawkins, Richard (1976) *The Selfish Gene* Oxford: Oxford University Press
- Dawkins, Richard (1986) *The Blind Watchmaker* New York: W. W. Norton.
- Docherty, Gerard J. (1999) Speaker, Community, Identity: Empirical and Theoretical Perspectives on Sociophonetic Variation. In *Proceedings of the 15th ICPHS, Barcelona*, 11-16.
- Docherty, Gerard J. and Paul Foulkes (2000). Speaker, speech & knowledge of sounds. In *Phonological Knowledge: Conceptual & empirical issues*, Noel Burton-Roberts, Paul Carr & Gerard J. Docherty (eds.). Oxford: Oxford University Press. 105-129.
- Durkheim, Emile [1895] (1064.) *The Rules of Sociological Method* ed. By George E. G. Catline, trans. By Sarah a. Solovay & John H. Mueller. New York: The Free Press of Gleco.
- Firth, J. R. (1948). Sounds and Prosodies. In *Transactions of the Philological Society*. 127-152.
- Foulkes, Paul & and Gerard J. Docherty (1999). *Urban Voices*. London: Arnold.
- Garding, Gina and Amalia Arvaniti (to appear). Dialectal variation in the rising accents of American English. In *Papers in Laboratory Phonology IX: Change in Phonology*, J. Cole & J. Hualde (eds.).
- Gibbon, Fiona, William Hardcastle and Katerina Nicolaidis (1993). Temporal and Spatial Aspects of Lingual Coarticulation in / kl / sequences: A Cross-linguistic Investigation. *Language and Speech*, **36**: 261-277.
- Giddens, Anthony (1984). *The Constitution of Society: Outline of the Theory of Structuration*. Cambridge: Polity Press.
- Giddens, Anthony & Christopher Pierson (1998). *Conversations with Anthony Giddens: making sense of modernity*. Cambridge: Polity Press.
- Gould, Stephen J. and Elizabeth Vrba (1982) Exaptation – a missing term in the science of form. *Paleobiology* **8**: 4-15.
- Gussenhoven, Carlos (2004). *The Phonology of Tone and Intonation*. Cambridge: Cambridge University Press.
- Harrington, Jonathan (to appear). Evidence for a relationship between synchronic variability and diachronic change in the Queen's annual Christmas broadcasts. In *Papers in Laboratory Phonology IX: Change in Phonology*, J. Cole & J. Hualde (eds.).
- Hawkins, Sarah (2003). Roles and representations of systematic fine phonetic detail in speech understanding. *Journal of Phonetics*, **31**: 373-405.
- Honikman, Beatrice (1964). Articulatory settings. In *In Honour of Daniel Jones*, D. Abercrombie, D. B. Fry, P. A. D. MacCarthy, N. C. Scott and J. L. M. Trim (eds.). London: Longmans Green. 73-84.
- Jones, Robert A. (1986) *Emile Durkheim: An Introduction to Four Major Works* Beverly Hills, CA: Sage Publications, Inc.
- Keating, Patricia A. (1985) Universal phonetics and the organisation of grammars. In *Phonetic Linguistics: essays in honor of Peter Ladefoged*, V. A. Fromkin (ed.). Orlando: Academic Press. 115-132.
- Keating, Patricia A. (1990) Phonetic representations in a generative grammar. *Journal of Phonetics* **18**: 321-335.
- Kirch, P. V. & R. C. Green (1987). History, Phylogeny, and Evolution in Polynesia. *Current Anthropology*, **28**: 431-456.
- Kochetov, Alexei (2002) Production, Perception and Emergent Phonotactic Patterns: A Case of Contrastive Palatalisation. London and New York: Routledge.
- Ladefoged, Peter (1972). Phonetic prerequisites for a distinctive feature theory. In *Papers in Linguistics and Phonetics to the Memory of Pierre Delattre*, A. Valdman (ed.). The Hague: Mouton.
- Ladefoged, Peter (1980). What are linguistic sounds made of? *Language* **56**: 485-502.

- Ladd, D. Robert and James M. Scobbie (2003). External sandhi as gestural overlap? Counter-evidence from Sardinian. In *Papers in Laboratory Phonology VI, Phonetic Interpretation*, John Local, Richard Ogden and Rosalind Temple (eds.), Cambridge: Cambridge University Press.
- Lass, Roger (1990) How to do things with junk: exaptation in language evolution. *Journal of Linguistics*, **26**: 79-102.
- Laufer, Asher (1999). Hebrew. In *Handbook of the International Phonetic Association: a guide to the use of the International Phonetic Alphabet*. Cambridge: Cambridge University Press. 96-99.
- Lindblom, Björn (1986) On the origin and purpose of discreteness and invariance in sound patterns, In *Invariance and Variability in Speech Processes*, J. S. Perkell & D. H. Klatt (eds.). Hillsdale, NJ: Lawrence Erlbaum Associates. 493-510.
- Lindblom, B., MacNeilage, P.F., and Studdert-Kennedy, M. (1984). Self-organizing processes and the explanation of phonological universals. In Butterworth, Comrie, Dahl (Eds.), *Explanations for Language Universals*. Berlin: Mouton. 181-203.
- Lindblom, Björn (1990). Explaining phonetic variation: a sketch of the H&H theory. In *Speech Production and Speech Modelling*, William J. Hardcastle & A. Marchal (eds.). Amsterdam: Kluwer. 403-439.
- Local, John (2003). Variable domains and variable relevance: interpreting phonetic exponents. *Journal of Phonetics*, **31**: 321-339.
- Nolan, Francis J. (1992). The descriptive role of segments: evidence from assimilation. In *Papers in Laboratory Phonology II. Gesture, Segment, Prosody*, G. J. Docherty and D. R. Ladd (eds.). Cambridge: Cambridge University Press. 261-280.
- Nolan, Francis (1999). The Devil is in the Detail, In *Proceedings of the 14th ICPhS, 1999, San Francisco*, **1**: 1-8.
- Ohala, John J. (1983). The origin of sound patterns in vocal tract constraints. In *The production of speech* P. F. MacNeilage (ed). New York: Springer-Verlag. 189-216.
- Ohala, John J. (1992). What's cognitive, what's not, in sound change. In *Diachrony within Synchrony*, M. Morrissey and G. Hellermann (eds.). Frankfurt: Peter Verlag. 309-355.
- Ohala, John J. (1993) The phonetics of sound change. In *Historical Linguistics: Problems and Perspectives*, C. Jones (ed.). Longman: London. 237-278.
- Payne, Elinor M. (2005) Phonetic variation in Italian consonant gemination. *Journal of International Phonetic Association* **35**. 153-181.
- Payne, Elinor M. & Eftychia Eftychiou (2006) Prosodic Shaping of Consonant Gemination in Cypriot Greek. *Phonetica*, **63**: 175-198
- Pierrehumbert, Janet B. (2001). Exemplar dynamics: Word frequency, lenition and contrast. In *Frequency and the Emergence of Linguistic Structure*, J. Bybee & P. Hopper (eds.). Amsterdam: Benjamins. 137-157.
- Pierrehumbert, Janet B. (2002) Word-specific phonetics. In *Laboratory Phonology 7*, C. Gussenhoven and N. Warner (eds.). Berlin: Mouton. 101-139.
- Solé, M.-J. (1992). Phonetic and phonological processes: the case of nasalisation. *Language and Speech*, **35**: 29-43.
- Solé, M.-J. (2003) Is variation encoded in phonology? In *Proceedings of the 15th ICPhS, Barcelona*, 289-292.
- Vincent, Nigel. (1988) Non-linear phonology in diachronic perspective: stress and word-structure in Latin and Italian. In *Certamen Phonologicum – Papers from the 1987 Cortona Phonology Meeting*,. Turin: Rosenberg and Sellier. 421-431.
- Weber, Max [1903-1917] (1949). *The Methodology of the Social Sciences*. Edward Shils and Henry Finch (eds.). New York: Free Press.
- Yanagawa, Mariko (to appear). Consonant Timing in L2 English: The Emergence of a Default Pattern. In *Papers in Laboratory Phonology: Change in Phonology*, J. Cole & J. Hualde (eds).

- Zsiga, Elizabeth (1994). Acoustic Evidence for Gestural Overlap in Consonant Sequences. *Journal of Phonetics* **22**: 121-140.
- Zsiga, Elizabeth (2000) Phonetic Alignment Constraints: Consonant Overlap and Palatalisation in English and Russian. *Journal of Phonetics* **28**: 69-102.