UCL Working Papers in Linguistics 11 (1999)

Phon-something: a clarification^{*}

PHIL HARRISON

Abstract

This is an attempt to set phonology and its neighbours in and out of the grammar in a consistent theory of mind. A series of definitions of modes of sound perception (and production) is offered with as little commitment as possible to any particular set of phonological tenets. The idea is to make sense of the *modi operandi* of phonology and its interfacing with other levels of representation, giving due regard to considerations of learnability, and (even) of evolution.

1 Introduction

It is worth asking a roomful of veterans of introductory courses in linguistics the question: 'What is the difference between phonetics and phonology?'. A predictable response is that no answer will spring immediately to the fore of anyone's mind, but rather an assortment of original suggestions will be ventured, garnished with admissions of speculation. Apparently basic definitional statements about the nature of 'phon-' representational levels are often assumed without comment, rather than explicitly made, even in the literature that seeks to correlate aspects of more than one of these 'levels'. It is important to emphasise that such definitional statements are in any case only *apparently* basic, because consensus on the status of 'phonology' and the like does not exist. Tacitly or otherwise, phoneticians, phonologists, and linguists in general do not agree on where to place the interfaces either between different cognitive structures, or between the physical and the abstract.

^{*}An earlier version appears as §1.3 of Harrison (1999). Many thanks to John Harris for comments and criticisms.

What follows, then, is an attempt to set phonology in a psycholinguistically coherent context, one that will make sense with relation to acquisition and maybe even evolution. A series of definitions relating to different modes of perception (and production) of sound is offered. The position outlined is acknowledged to be a personal one, but it seems to be important to make a commitment to a jumping-off point, even if it is not one that everybody agrees with. It is in this spirit, and in the hope of generating some correspondence, derisive or otherwise, that these definitions are presented. They are qualified with examples where this seems necessary.

Adjectives rather than nouns are the subjects of the definitions. This is simply to focus attention on the uses of these terms which are presently relevant. Nouns have become closely associated with competing (or supplementary) theories: thus 'Declarative Phonology' *versus* 'Lexical Phonology' *versus* 'Government Phonology' etc. The focus of the discussion here is to characterise as pre-theoretically as possible the different types of cognitive abilities that are identifiable 'this side' of syntax. This may enable an understanding of the meaning (or lack of meaning) in questions such as: 'at what point does perception cease to be '*psychoacoustic*' and become '*phonetic*'?

2 'Acoustic'

Anything 'acoustic' relates to the physical properties of sound, which are entirely modality-neutral and directly quantifiable. For speech, or for music, or for noise, these properties may be durational, frequency-related, intensity-related, or any compound of these three physical parameters measurable off a sound spectrum or temporal representation.

3 'Psychoacoustic'

Anything 'psychoacoustic' relates to the perception of sound by living organisms. This perception may in some cases be directly correlated with acoustic parameters: thus dBHL (hearing level) uses a 'psychoacoustic'¹ baseline which is ultimately derived from the reactions of a group of organisms (people) to physically measured changes in atmospheric pressure. In other cases, no direct acoustic correlation may be possible. The imposition of a categorical boundary in the Voice-Onset-Time continuum, for instance, may ignore any consideration of acoustic salience. While the VOT boundary used by

¹ The term 'psychophysical' is understood here as synonymous with 'psychoacoustic'.

English speakers and chinchilla does occupy a highly 'salient' point in the continuum, where F1 is being attenuated and the excitation of other formants is also changing, the perception of 'voicing' by Spanish native speakers depends only on the presence or absence of a low-frequency voice-bar (Eilers, Gavin & Wilson 1979 for humans, Kuhl & Miller 1975 for the chinchilla). The lack of acoustic salience at the Spanish perceptual boundary does not correlate with a lack of typological distribution. The same boundary is attested to be present in genealogically diverse languages including Japanese, Italian, Dutch and Hungarian.

Psychoacoustic perception may or may not be utilised for the ecological advantage gained for an organism by efficient communication: in humans only it may be harnessed in the service of Language. Thus in the remainder of this discussion the term 'psychoacoustic' is used to refer to the perception of sounds which are not linguistically significant. This definition is a negative one, but is of use in a discussion of linguistic perception even though it lumps together a vast and interestingly variegated range of communicative activities.² It puts paralinguistic phenomena on a par with other unstructured, holistic communications between animals, which seems correct, since it is obvious that animals can certainly 'mean' something. Observation of the behaviour of an animal with a highly developed imitative ability *and* the physiological capacity to create speech-like utterances (e.g. a parrot) in a situation where it is patently using these utterances in direct response to that situation can show quite clearly what is possible without any linguistically dedicated capability, and with a purely holistic 'vocabulary'.

It is worth also noting that sound *structures* are not unique to human linguistic communication. Passerine birds clearly impose structural constraints upon their song productions. In the song of the mistle thrush, for example, 'only five themes appear at the beginning, the same theme never both precedes and follows a given theme, most themes are never repeated,' ...and... 'most themes can be followed by no more than one or two other themes' (McNeill 1970: 45). The ecological value of this ability is entirely mysterious. No communicative purpose has been attributed to these productions: the hierarchy of sound structures does not, apparently, reflect an ability to combine

² In particular, of course, the definition ignores the other human cognitive 'separation' of auditory input into unstructured noise and the structures of music. Musical perception involves a trip down a cognitive pathway which arguably ends up at a *different* (though not necessarily less 'central') processing level (see Jackendoff 1987, ch.12). So though a vital distinction would have to be drawn above the level of 'psychoacoustics' between music and noise perception in humans, this distinction is outside the scope of our discussion.

messages. There is equally no suggestion that the thrush's repertoire of songs is infinite, which also sets it apart from the repertoire of human utterances (and of human songs).

The relevance of these facts to our present enquiry inheres in the fact that species comparatively remote from *homo sapiens sapiens* in their phylogenesis display the independent development of comparable psychoacoustic abilities. The songs of the passerine birds are made up of combinations of indivisible constituents with constraints on structure, a creative routine entirely analogous to that used in the productions of grammatical speech. Plenty of intra- and inter-species communication takes place without linguistics, and this can be done with speech sounds if you happen to be a mynah bird.

4 'Phonetic'

At some point we must build a bridge between grammatical objects and structures on the one hand, and the sounds which represent them on the other. It is at this point that opinions begin to be divided. Burton-Roberts & Carr (1996) hold that phonetics and phonology are 'inextricably intertwined', and that both remain outside the province of the genuinely linguistic, with the phonology being best characterised as a 'conventional system of physical representation' (at least for speech), 'literally now ... an interface between the linguistic and the phonetic' (1996: 37). Harris (1996) clearly commits to a position where the fully abstract, linguistic primes of (melody in) phonology each enjoy 'stand-alone phonetic interpretability' (Harris 1996: 551). Life is probably not made easier by definitions like: 'PHONETIC FORM: the output of the phonological component of the grammar, or the phonological component itself' (Crystal 1991: 259). It would be possible to infer from this that 'phonetic' is not commonly regarded as independent of 'phonological', and even that the two may be conflated. '(Phonological) representations have been developed on the basis of the spoken language modality ... (and) are often so close to the phonetics of spoken languages that we cannot rule out the possibility that non-trivial aspects of them are modality-specific' (van der Hulst 1993: 209). This all results in a definition of 'phonetic' that has a mentalistic, or even linguistic, spin to it, and finally confuses the issue by adding an extra, probably quite unnecessary, perceptual level to a linguistic model. Statements like 'a consonant lacking a phonological place of articulation is *phonetically interpreted*³ as a velar' (Rice 1996: 494) are rife, without any apparent need to establish how precisely phonetic interpretation works. One possible

³ Italicisation added.

way out of this confusion that must be worth trying is to adopt the simple position expressed by the following statement: *anything phonetic is not linguistic: anything linguistic is not phonetic:*, and then see what happens.

An overview of the fields of study of the branches of the science of 'phonetics' indicates that this attempt on Gordius' handiwork could well be on the right track. These branches are:

- (i) Acoustic phonetics: the study of the physical properties of speech sound. This is therefore a subdiscipline of that branch of physics which studies sound (i.e. acoustics) when that sound is made by the human vocal tract and *used in the service* of language: there is nothing that acoustic phonetics informs us about linguistically significant *speech* that it could not do for any other sound, and in particular for non-linguistic vocalisations. The objects of study are not linguistic.
- (ii) *Articulatory phonetics:* the study of the way the vocal organs articulate *speech* sounds. This is therefore in part straightforwardly a branch of physiology (and anatomy): the specification of places of articulation and all other available phonetic parameters involve physiological (or other physical) mensuration. Once again no specifically linguistic information is delivered by these types of description. However, it may be (wrongly, for reasons to be made clear) argued that articulatory phonetics is also concerned with the transduction of language into the physical plane. We return to this in a moment, because if this were true, the inverse should be true of:
- (iii) *Auditory phonetics:* the study of the various transductions that take place between a sound pressure wave and an electrochemical brain operation. Therefore the field of enquiry is once again squarely set within either a physiology, an anatomy or a physics framework. At the far end of this chain of transductions we end up at a point where it is possible to observe such phenomena as timed nerve-firings and ERP⁴ changes; still physical events, but ones which may *putatively* be found to be associated with different linguistic activities. There is absolutely no empirical suggestion at present that such an association holds, but even if it did, it would be no more use in characterising the linguistic than noting that English native speakers

⁴ Event-Related Potential: a measurement of voltage. See Woods & Elmasian (1986).

employ very similar articulations when pronouncing the beginning of the words 'past' and 'pasta', but that the latter pronunciation does not correspond in voicing with that of an Italian native speaker. In other words, all that is assessable from such information is the quality of the description of a thoroughly extralinguistic event.

In like manner, the fact that sensorimotor processes drive articulatory phonetic reflexes means that we could unpick these transductional processes in the greatest detail without uncovering a trace of anything linguistic. For sure, there is sensorimotor 'knowledge', but the position adopted here is that this 'knowledge' of the position and movement of parts of the organism has not been shown to be language-specific, being as relevant to proprioception as it is to speech.

The three branches of phonetic science, then, do not involve themselves with the linguistic. This does not detract from any contribution a phonetician may make to the statement of systemic language (ir)regularities on the basis of phonetic indications, but such a statement is itself not a statement about a 'phonetic' system, since language-systems are not based on physics or physiology. 'Functional phonetician' is synonymous with 'phonologist'. 'Linguistic phonetics' is an inherently paradoxical phrase. Despite the fact that under this very heading, Ohala (1997) summarises his notion of 'the relation between phonetics and phonology', his definition is completely consistent with the position taken here: 'phonology seeks answers to (mentalistic)⁵ questions employing methods from phonetics' (1997: 693). This does not define or require a type of phonetics that is linguistic.

In humans, psychoacoustic perception maps to language. What, then, could be meant by 'phonetic perception'? Nothing at all, unless in the special sense of the trained conscious attention that a phonetician pays to the sounds of speech. This attention bears the same relation to native-speaker ability as piano-tuning does to musical enculturation.

One last bastion of 'phonetic perception' may be (and has been) posited in dialectal differences, due to the 'You Like Potato'⁶ line of reasoning. In London, the utterance $[ba:\theta]$ refers to the object known in Liverpool as a $[b\varpi\theta]$. Since we know the referents of these utterances to be the same thing, are not [a:] and $[\varpi]$ perceived as 'phonetically' different, but 'phonologically' the same? No, for two reasons. First, there is no

⁵ Parenthesis added.

⁶ [n 'aı laık pə't^ha:təu]. From 'Let's Call The Whole Thing Off' by George & Ira Gershwin (1937).

qualitative difference between a 'language', a 'dialect' or an 'accent', but simply different degrees of common ground. Knowing that $[ba:\theta]$ and $[bæ\theta]$ may both be paired with the same concept involves speaking the two relevant 'dialects': in other words, perceiving the phonology of each one. It is easily conceivable that someone who regularly and unconsciously does this may not be able to perform the same trick given an unfamiliar, though acoustically approximately equidistant, pronunciation of the same word (New York City English $[bi \partial \theta]$, for instance), without the benefit of several additional contextual cues. The second reason why this perception is not 'phonetic' lies in the characterisation of the difference between [a:] and [x]. Presumably, mynah birds from London use the first of these pronunciations and Liverpudlian ones the second. They don't need 'phonetics' to do this, just, in the terms used here, 'psychoacoustics'. If we answer this objection by importing human 'lexical meaning' into the characterisation of the contrast between $[\alpha:]$ and $[\alpha:]$ on the grounds that the two sounds can be lexically distinct in both languages (though not between [b] and $[\theta]$), things just get worse. The result is two indivisible 'phonemes': phonemes have been discredited as formal units for thirty years, and in any case were most definitely not 'phonetic'.

The conclusion reached, then, is that 'phonetic' perception may never be deemed linguistic, but must mean explicit introspection on properties of the sounds of speech using encyclopedic knowledge. If this is accepted, it means a rethink for the notion, tacitly accepted in some of the existing literature on infant acquisition, that 'phonetic' perception is some sort of uniquely human precursor to phonological acquisition. Language acquisition is noncontroversially subconscious, getting well under way while consciousness is still being organised. Phonetic perception is conscious attention, and so cannot have any relevance to linguistic development: it refers only to properties of speech subject to mensuration.

5 'Phonological'

The *use* of sound in language is not exclusively driven by physiology. Distributional regularities exist that patently come from elsewhere. All human babies produce bilabial trills: no (or next to no) human language uses bilabial trills. All human languages use [i]: some also use [y]: none uses the second but not the first. Tricorn vowel systems overwhelmingly use [a], [i], and [u]. Young language acquirers may harmonise consonants: steady-state languages generally harmonise vowels. All human languages have stops: most have fricatives, too: none has fricatives only. /r/-sounds displaying

identical cross-linguistic phonological distributions exhibit a wide range of place and manner specifications.⁷ The simplest account of these facts does not suggest that physiology is a primal factor in the acquisition of phonological systems.

Anything 'phonological', therefore, relates to the mentally constituted system that compels and conditions the sounds (including silences) of a language. This definition should so far satisfy those phonologists who hold that phonological components and relations are purely linguistic in nature. Under this assumption, componential and relational properties can be both in the lexicon and at PF: individual objects may be phonetically interpretable, or may need compounding for this to be possible, depending upon the phonological model that is espoused. As it stands, though, the definition above should also satisfy those, like Burton-Roberts & Carr (1996), who see phonology as a non-linguistic interpretative mechanism between the language faculty and sound, since 'mentally constituted' does not equal 'linguistic'. Some further definitional focus is therefore needed to contextualise the present discussion in the light of these competing points of view.

One respect in which phonology could be said to fail to be 'purely abstract' is in its mapping (however this mapping may be characterised) to sound. The 'pure' concept of phonology could have been more easily maintained if there had been any very successful accounts of the phonology of sign.

It has been spectacularly demonstrated by Kegl and her co-workers that if a community of deaf people arises as a result of historical accident, those among the community who have not yet passed the critical period will spontaneously develop Language *within one generation*. However, all the best evidence is syntactic.⁸ Attempts to line up phonology and sign-structure seem more suspect.

During the course of an introductory work on the 'Phonology of ASL', Coulter & Anderson (1993) cite as evidential parallels (1) the organisatation of utterances into segments, (2) the existence of a sonority hierarchy, and (3) the existence of co-

⁷ The diversity of the phonetic manifestations of rhotics is clearly laid out in Ladefoged & Maddieson (1996): after a detailed description of these manifestations, which include approximants, trills, taps and fricatives ranging from dental to uvular in place of articulation, the conclusion is drawn that 'the overall unity of the group seems to rest mostly on the historical connections between ... subgroups, and on the choice of the letter 'r' to represent them all' (Ladefoged & Maddieson (1996: 245).

⁸ For a comprehensive list of references to works by Kegl and her colleagues, see publications by the American Sign Language Linguistic Resource Project, Boston University, at http://web.bu.edu/ASLLRP/publications.html. All concern syntactic structure.

occurrence constraints (1993: 12). 'Segments', however, are not necessarily phonological units, but linearly aligned objects which could as easily be representational of other categorical systems (such as syntax) unless they are further specifed. The best example of a sonority effect that is offered is the behaviour of a sign which looks a bit like a classic 'sonorant' in that it comes after the initial sign of an utterance and before the 'syllabic peak'. However, it then proceeds to be prohibited in just the place where it is predicted to exist in a rhymal closure (op. cit.: 9). Finally, the three examples of co-occurrence constraints that are presented are the signs for 'HEAD', where the signer indicates two points on the head, 'FLOWER', where each nostril is indicated, and 'EYES' where the signer points at each eye in turn (op. cit.: 12). These signs are just too full of iconic content to be considered arbitrary, in the way that the sound-address of a lexical item is arbitrary. They are therefore not easily comparable to phonological objects. Iconicity has certainly a role to play in the genesis of lexical items,⁹ but given that there is no such thing as a primitive language, there can be no prediction that the 'phonology' of sign languages should be more iconic than that of spoken language.

Again, in a dissertation which aims at 'laying the groundwork for a model of visual phonology', Uyechi (1996: 17) finds that 'at a low level of representation the constructs of a spoken language phonology are different from the constructs of a visual phonology'. The hope is held out that 'the organisation of these atomic units into more complex units' ...may... 'follow general principles of organisation that are the laws of a theory of universal phonology' (op. cit.: 17). If this is phonology, then it lacks primes altogether, since there is no common ground between the units of 'spoken' and 'visual' phonology. 'Phonology' is left with only 'general principles', and thus becomes a system not easily recognisable to phonologists of spoken languages.

Other attempts to conflate phonological constituents with those of sign language seem to end up emphasising differences, rather than similarities. Considering the centrality of the onset constituent to *all* versions of syllable structure theory (even theory without constituents), it would be expected to find some analogous constituent in sign. It is somewhat surprising, then, to find that in a detailed discussion of the units of sign, the claim is made that 'syllables in sign structure lack ONSETS at the phonological level' (van der Hulst 1993: 211). This analysis is interpreted (in the same volume) as 'there are no

⁹ Katamba (1998), for instance, identifies a conflict between sound symbolism and a constraint against voiceless labials in Luganda and uses this to illuminate the origin of certain alternations (in an Optimality Theoretic framework).

phonological onsets, ... but only phonetic onsets, which are the transitional movements that precede signs' (Corina & Sandler 1993: 200). Using the definition of 'phonetic' proposed in §4, it becomes impossible to assess such a statement.

Van der Hulst also notes that 'monomorphemic signs are typically monosyllabic' (op. cit.: 235). Again, such isomorphism is far from commonplace in spoken-language phonology.

Given that visual and aural perception depend on quite different (spatial and temporal) cues, it is an eminently reasonable exercise to see if it is possible to characterise the organisation of sign as 'phonological'. But, from the examples cited so far, the attempt seems to have failed. Stronger evidence of a phonology without psychoacoustics may at some stage be presented. For the moment, however, some ground must be conceded to the 'non-linguistic' school of thought on the nature of the 'phonological', if 'linguistic' means 'irreducible to language-external principles'. Phonology, unlike syntax, must map to the perception (and production) of sound, so users of sign language are never, as far as has hitherto been established, going to need phonology. Let us propose, then, that phonology is 'substrate-specific', founded in sound both phylogenetically and ontogenetically. Can it still be purely abstract? Dennett (1995:149-186) gives an up-todate summary (for non-specialists) of the state of current knowledge about the origin of life on the planet, and in particular he draws on references which show how simple risktaking algorithms may have led to the appearance of pre-life forms (like viruses) in a crystalline environment, and eventually to (comparatively) highly organised biological life-forms, 'Vastly' well 'Designed' (in Dennett's terms) to resist entropy. Importantly, for life or for semi-life (organisms like viruses which may not live independently), biological algorithms are all that there is. During their mechanical progress through evolutionary pathways, these algorithms may produce systems which exhibit design features possessing abstract properties. 'Flowers are biological systems, but their petals are ... often organized into patterns elegantly generateable from a nonredundant base' (Brody 1997: 8). Obedience to nonreducible abstract constraints is not inconsistent with biological origins. If syntax is linguistic, in that it is 'perfect', or 'nonredundant' or 'abstract' in its conformity to principles which are not language-external, and since Language did not evolve by Magick, then a linguistic system can and must be instantiated by a bunch of dumb biological algorithms. An infinitely closer link in the evolutionary chain can be invoked by proposing that the mentally-constituted system of phonology has evolved using the perception of sound, and is acquired by each human by mapping sound perception onto this evolved system. Understood like this, anything 'phonological' relates to a genuinely abstract, and dedicated, system of pattern

recognition which depends on the speech signal for its physical and psychophysical (psychoacoustic) correlates. Maybe the fact that the evenly-spaced formants associated with a neutral tube configuration regularly cue *phonologically* neutral vowels is a vestigial ghost of the evolutionary process, rather than a mere coincidence.

Having defined phonology in this way, the picture should be completed with an illustration of its alignment with morphosyntax. There is plenty of evidence for the lack of isomorphism between morphosyntactic and phonological domains which need not be recapitulated here (see for instance Harris 1994: 42-84, Spencer 1991: 42-43). The fact that an exposition of Lexical Phonology can deliver up a quote such as '...it is ... firmly established that morphological and phonological (cyclic) structure need not be isomorphic' (Kaisse & Hargus 1993) shows that this is in no way controversial. This lack of isomorphism, however, does not prohibit language phenomena which depend on coterminous domains, merely makes them optional. Neeleman & Weerman (1997: 129ff.) use Selkirk's (1986) proposal that phonological phrases are closed at the right edge of XP, where XP is any syntactic phrase, in an account of the setting of a word order parameter during acquisition. They contend that VO languages (e.g. English) differ from OV languages (e.g. Dutch) in that the case checking domain of the first type is Selkirk's phonological (ϕ) phrase, and of the second type a syntactic phrase (mcommand domain). This is relevant here as circumstantial evidence for the (relatively) close connection between phonology and sound for the following reason. Among the raft of effects produced by the setting of this parameter, the ϕ phrase-setting results in a more constrained linear order in the VO languages than that exhibited by the OV languages: intervening adverbials are permitted only in the latter. The phonological option for the parameter results in a comparatively greater surface adjacency effect being observable.

This type of adjacency effect does not undermine the entirely mentally constituted nature of 'phonological' as it is proposed here. Nor, of course, do these proposals say anything at all about the 'syntactic' *per se*. But the word that *is* becoming etiolated in definitional power is 'linguistic', unless it be used as a generic term covering the various computational systems utilised in the communication of Language. There may be parallels to be drawn between one or another phonological or syntactic model ('Government' is, or was, one), which reflect the operation of language-dedicated principles. But PF must continue to interface directly with the physical, so phonological primes maintain an ancient taproot into sound. This effectively removes any way of assessing the 'phonological' as '*wholly* linguistic', in the way that syntax may be assessed, using 'linguistic' in its strong sense of 'non-reducible to language-external

principles'. Finally, the whole exercise becomes meaningless if 'syntactic' is conflated with 'linguistic' in its weaker, generic sense.

Whither modularity, if all this is so? Do we have to live with the fact that we have potentially let the strategies of 'general cognition' into the language faculty by the back door? The understanding of a 'mental module' in this discussion is that it is delimited and defined not by the (generalisable) strategies available to it, but by the designed and specialised summation of those strategies in the service of a particular cognitive process. Anything 'phonological' refers itself to an abstract pattern recognition system that interfaces with psychoacoustics and with morphosyntax.

The last part of the definition of 'phonological' needs to state that phonology is not *itself* a single system. The independence of prosody and melody is at the very least an unavoidable recurring *leitmotif* of phonological theories: it is a central tenet of those theories that hold with representations (Kaye, Lowenstamm & Vergnaud 1985, Harris 1994 and Harris & Lindsey 1995, among others), and even Optimality Theory's constraints can be seen to target either one or the other of these interdependent systems (Prince & Smolensky 1993). Hence phonology should properly be regarded as bimodular, rather than as a single module.

References

Brody M. (1997). Mirror Theory ms., UCL London

- Browman C.P. & Goldstein L. (1989) Articulatory gestures as phonological units. Phonology 6, 201-251
- Burton-Roberts N.& Carr P.(1996). On Speech and Natural Language. *Newcastle & Durham Working Papers in Linguistics* 4, 13-40
- Corina A. & Sandler W. (1993). On the nature of phonological structure in sign language. *Phonology* 10, 165-208
- Coulter G.R. & Anderson S.R. (1993). Introduction. In *Phonetics and Phonology Vol.3 Current Issues in ASL* (G.R. Coulter, editor) London: Academic Press
- Crystal D. (1991). A Dictionary of Linguistics and Phonetics (3rd. edition). Oxford: Blackwell
- Dennett D.C. (1995). Darwin's Dangerous Idea London: Penguin
- Eilers R.E., Gavin W., & Wilson W.R., (1979). Linguistic experience and phonemic perception in infancy: a cross-linguistic study. *Child Development* 50, 14-18

Harris J. (1994). English Sound Structure Oxford: Blackwell

- Harris J. (1996). Phonological output is redundancy-free and fully interpretable. UCL Working Papers in Linguistics 8, 551-574
- Harris J. & Lindsey G. (1995). The elements of phonological representation. In *Frontiers in Phonology: Atoms, Structures, Derivations* (J.Durand & F.Katamba, editors) Harlow, Essex: Longman

- Harrison P.A. (1999). *The acquisition of phonology in the first year of life* PhD thesis, University of London
- Hulst H.G. van der (1993). Units in the analysis of signs. Phonology 10, 209-241
- Jackendoff R. (1987). Consciousness and the Computational Mind Cambridge, MA: MIT
- Katamba F. (1998). Cophonologies: The Case of Luganda. Paper presented at the *Sixth Phonology Meeting*, University of Manchester, May 1998.
- Kaisse E. M. & S. Hargus (1993). Introduction. In *Phonetics and Phonology vol. 4* (S. Hargus & E. Kaisse, editors) San Diego: Academic Press
- Kaye J., Lowenstamm J., & Vergnaud J-R., (1985). The internal structure of phonological elements: a theory of charm and government. *Phonology Yearbook* 2, 305-328
- Kuhl P.K. & Miller J.D. (1975). Speech perception by the chinchilla: Voiced-voiceless distinction in alveolar plosive consonants. *Science* 190, 69-72
- Ladefoged P. & Maddieson I. (1996). The Sounds of the World's Languages Oxford: Blackwell
- McNeill D. (1970). The Acquisition of Language New York: Harper & Row
- Neeleman A. & Weerman F. (1997). L1 and L2 Word Order Acquisition. *Language Acquisition*, 6.2, 125-170
- Ohala J.J. (1997). The relation between phonetics and phonology. In *The Handbook of Phonetic Sciences* (Hardcastle & Laver, editors) Oxford: Blackwell
- Prince A. & Smolensky P. (1993). Optimality theory: constraint interaction in generative grammar. *Technical Report #2 of the Rutgers Centre for Cognitive Science* Rutgers University
- Rice K. (1996). Default variability: the coronal-velar relationship. *Natural Language and Linguistic Theory* 14, 493-543
- Selkirk E.O. (1986). On Derived Domains in Sentence Phonology. *Phonology Yearbook* 3, 271-405 Spencer A. (1991). *Morphological Theory* Oxford: Blackwell
- Uyechi L. (1996). The Geometry of Visual Phonology CSLI: Stanford, CA.
- Woods D.L. & Elmasian R. (1986). The habituation of event-related potentials to speech sounds and tones. *Electroencephalography and Clinical Neurophysiology* 65, 447-459