Building on old foundations:
From phonemic theory to C/V-segregation*

Joaquim Brandão de Carvalho

Abstract

This paper aims at showing that the scope of structural phonemics transcends the limits of the 'foundations of phonology', contrary to what is tacitly assumed and appears from some textbooks. It will be argued that the classical concept phoneme, defined as a set of distinctive features, presents both obsolete and still relevant properties. One of these properties, **linearity**, should clearly be abandoned, as follows from acoustic-perceptual evidence as well as from some types of sound change. Thereby, the phoneme in its purest sense can be said to have been superseded by one major trend characterizing post-*SPE* phonological theory: multilinearity. However, a phoneme-based property of distinctive features, their **locality**, is still valid, and is empirically supported by cross-linguistic variation. Now, locality and non-linearity are apparently contradictory. It will be shown that this contradiction cannot be resolved, and that both feature properties cannot be captured, unless consonants and vowels are assumed to be universally segregated within phonological representations. This issue leads to several predictions on C/C and V/V interactions, converges with independent processual evidence like vowel-to-vowel assimilation, and addresses the question of the relationship between phonology and morphology.

1. Introduction

Is the phoneme still a useful concept in phonological theory? If so, does this have implications either for the phoneme or for phonology or for both? Such are the questions treated in this article. The old concept of phoneme has taken several forms since Baudouin de Courtenay's pioneering works; its scope has varied all along the development of structuralist thought in Europe, America and Russia, and even within each of these areas. The advent of generative phonology in the 60's led some of its proponents to criticize the validity of the notion, hence a long period during which the word 'phoneme' (if not the concept itself) seems to have been banned from the phonologist's lexicon, at least in research work. Phonemes and distributional analysis are still treated in the first part of some textbooks, of which Kenstowicz (1994) and Spencer (1996) are good examples. However, the relationship between these 'preliminaries' and further developments discussed in the remaining chapters is, to say the least, unclear, so that the reader cannot escape the impression that the author's actual purpose is to give a historical survey of phonology. Finally, the past decade has seen a focus on constraint-based theories, and, until very recently, issues concerning representations were largely outside the mainstream of research interests in these frameworks.

Beyond the variability of its acceptations throughout the history of structural phonology, the notion phoneme, in the purest conception, presents two properties that should be revisited in the light of one major trend characterizing post-*SPE* phonological theory: multilinearity.[1] One of these phonemic properties, **linearity**, must be abandoned, as will be argued in § 2 on diachronic grounds. Thereby, the classic definition of the phoneme does not survive the

evolution of phonology during the past thirty years. However, as will be seen in § 3.1, a phoneme-based property of distinctive features, which will be called **locality**, has persisted throughout the history of generative phonology, and is empirically supported by cross-linguistic variation. Now, as is shown in § 3.2, locality and non-linearity are apparently contradictory. My point, presented in § 3.3, is that *both* feature feature properties can only be captured if it is assumed that consonants and vowels are universally segregated within phonological representations. As is stressed in § 4, this issue strongly constrains C/C and V/V interactions, converges with independent processual evidence like vowel-to-vowel assimilation, and addresses the question of how phonology and morphology interact.

2. Against the phoneme: non-linearity

2.1 The Linear Thesis

According to its classic definition, the phoneme is a *set of distinctive features* which has the following properties:

(1)   a.   Invariance.[2]

          b.   Linearity (on the syntagmatic axis).

          c.   Discreteness (on the paradigmatic axis).

Only (1b) will be discussed in this section, and (1a,c) will be left aside in this article.[3] As is well-known, linearity was seen as the basic, and perhaps the sole, characteristic of phonemes since it does not follow from the properties of the objects they are made of: features are also invariant[4] and discrete, but they are not linear in the sense that, when a /b/ is pronounced, there is no successivity between, say, [voiced] and [labial]. Hence, if linearity were to be ruled out, then the phoneme might be a useless hypothesis, only features having a theoretical status within the set of phonological units. This was partly the source of Chomsky's (1964: 75-110, esp. 87-88) famous argument against 'taxonomic phonemics', based on the American realization of the minimal pair *writer* : *rider*. Since their lexical bases are /raɪt/ and /raɪd/ respectively, pronunciations like [ɹaɪɾɚ] and [ɹaːɪɾɚ] clearly imply linearity violation.[5]

   Now, do such (frequent) cases really prove the inadequacy of linearity as a *phonemic property*, and, therefore, of the phoneme itself?[6] It should be noted that, for a large part of European and American structuralists, the answer has been negative. Certainly, Baudouin ([1881] 1963) and Hockett (1942), for example, denied, or were tempted to deny, linearity to

the phoneme, and this was, indeed, a matter of discussion during the 40's among American structuralists: thus, Portuguese nasal vowels were analysed by Hall (1943a,b) as 'syllabic phonemes' plus a 'non-linear or suprasegmental phoneme' (nasality), while Trager (1943), in an editorial note to the former's paper, preferred to view them as 'segmental phonemes' though their realization implies linearity violation, as the *writer* : *rider* pair does (cf. Carvalho 1988). I shall not attempt to summarize here the history of linearity in phonological theory; Cao (1985) and Clements (2002) provide good overviews. Let us simply emphasize two points. Firstly, most phonologists seem to have followed Haugen's (1949) opinion, according to which "much would be gained in simplicity if we could say that all phonemes are successive". Secondly, as illustrated in (2), this was allowed by a strict separation between a 'phonological level' and a 'phonetic level':

(2)   a.   Phonological level: /hito/   Japanese *hito* 'man'

         b.   Phonetic level: [çito]   /h/ → [ç] / __ i

Phonemes, as such, only exist at the first, abstract, level, where they obey strict linearity,[7] /h/ *preceding* /i/ in (2a); the violation of this 'ideal' linearity concerns merely the realization of phonemes at the second level, where it is due to 'allophonic rules' like the one in (2b). Henceforth, this will be referred to as the Linear Thesis (LT).

2.2 Multilinear approaches

Since the advent of autosegmental theory (Goldsmith 1976), the allophonic rule in (2b) can be broadly reformulated as in (3):

(3)   a.   h   i   b.   h   i
                | | → | ╱ |
                C   V   C   V

Two points must be stressed. Firstly, the phoneme becomes a complex notion: it is a *relationship* between a skeletal place and some phonetic content. Secondly, while in (2b) /h/ changes into [ç] *before* the phoneme /i/, (3b) tells us that /i/ is realized as something like '[ʲi]' (where [ʲ] stands for the palatal feature of the preceding consonant) whenever it is, say, *combined* with /h/, following a conception that dates back to Baudouin de Courtenay ([1881] 1963: 121 ff.; cf. Cao 1985: 165, n. 26). As a result, (3b)-type representations seem to provide us with a non-linear view of the phoneme.

However, since (3b) tells us that the palatal feature of /i/ *spreads* onto the *preceding* onset, is (3a) necessary? Can we still sustain LT, i.e. the classic idea that the relationship between /h/ and /i/ is *underlyingly* linear? In other words, are there allophonic rules like /i/-propagation in (3b)? Is /i/ lexically associated with both slots? In short, are there phonemes in multinear representations, since linearity is their only specific property (cf. § 2.1)? We will see in § 3 the reasons that still support the necessity of a revised view of the phoneme; here, we will be committed, on the contrary, to provide evidence against its classic definition, i.e. against LT, which is shared by all current theories, as is shown, for example, by the frequent use of dotted association lines in autosegmental phonology.

Actually, is the question of linearity dependent on the (non-)derivational character of phonological theory? In other words, does rejection of the linear phoneme necessarily imply rejection of any type of derivation? Interestingly, during the past twenty-five years, the advent of plurilinearity partially converged with the evolution of linguistic theory, both in syntax and in phonology, towards 'no-rule approaches'. This move was particularly explicit, for example, in the works edited by Goldsmith (1993) as well as in Government phonology (cf. Charette 1991; Harris 1994). Here, rules do not have to be 'motivated', either by autosegmental organization, as in feature geometries (cf. Clements 1985; Sagey 1986; McCarthy 1988; Clements & Hume 1995), or by general constraints, as in Lacharité & Paradis (1993); they should simply be abandoned. Finally, rejection of serialist approaches has led to Optimality theory (OT), which has prevailed in phonological research during these last ten years, and where 'principles and parameters' were replaced with violable constraints.

All current theories, however, are still derivational, insofar as they recognize a distinction between a more abstract level of representation and a more concrete level, and, therefore, principles that derive one from the other. Even 'output-oriented theories' like OT need abstract inputs. I will not discuss here *all* the possible reasons for 2-level approaches in general, either rule-based or not. I will simply observe that the reasons for assuming *allophonic rules* between these levels are largely dependent on whether linearity is viewed as an underlying property of phonological representations, while the reasons for assuming linear phonemes can hardly be seen as dependent on whether there are rules *tout court*. That is the reason why the following chapter will be mainly focused on the relevance of underlying linear phonemes, rather than on the likelihood of derivations. An important issue of this point is that the present discussion concerns virtually all phonological frameworks, and not only those that claim that phonology should not be derivational, while tacitly admitting underlying linear phonemes, and, hence, allophonic rules, as Government phonology, for example, does.

2.3 Diachronic evidence against the linear phoneme

It is a well-known fact that phonemes, defined as linear segments, are not, say, 'natural' units. As was pointed out by Ladefoged (1959: 401), "The ultimate basis for the belief that speech is a sequence of discrete units is the existence of alphabetic writing. This system of analysing speech and reducing it to a convenient visual form has had a considerable influence on western thought about the nature of speech. But it is not the only possible, nor necessarily the most natural, form of segmentation". Ladefoged's assertion could as well be turned round: is the possibility of alphabetic writing not a proof that speech is a sequence of discrete units? However, too many facts seem to falsify this thesis. The role of alphabetic writing in the origin of phonemic theory was also discussed by Lüdtke (1969), who convincingly argues that the invention of the alphabet is due to historical contingencies. More importantly, experimental evidence for the unnaturalness of phonemes, which dates back to Menzerath & Lacerda's (1933) study on coarticulation, gave place to a large array of works when acoustic data invaded the domain of phonetics in the 50's. A number of studies, mainly on the basis of acoustic analysis, proved that the level of coarticulation between sounds is so high that the spoken chain cannot be reduced to a mere string of segments.[8] Parallelly, this was confirmed by speech synthesis (cf. Cooper *et al.* 1952, Peterson *et al.* 1958, Wang & Peterson 1958, Liberman *et al.* 1959, Cooper *et al.* 1963, Tillmann 1967), which showed the perceptual relevance of the so-called 'redundant features' particularly when associated with more 'sonorant' segments (cf. Mattingly 1971, Stevens 1973, Cole & Scott 1974). As a typical example of this point, let us take the case of the French words *cri* [kχi] 'shout' and *gris* [gʁi] 'grey'. If the [ʁ] of *gris* is artificially replaced with the [χ] of *cri*, the resulting word *[gχi] will be perceived as *cri*. Thus, despite the fact that French has a /k/ : /g/ opposition (cf. *qui* 'who' : *gui* 'mistletoe') but not /χ/ : /ʁ/ (both [χi] and [ʁi] being possible realizations of /ri/, *riz* 'rice'), the crucial 'place' of VOT-distinctions on perceptual grounds seems to be attached to the second element of the syllabic onset. Likewise, the perception of the place feature of plosive consonants is known to be almost exclusively based on the type of inclination of vocalic formants, in such a way that [pa], [ta] and [ka] could be said to be 'perceptual diphthongs' (cf. the *locus* theory developed by Delattre *et al.* 1955).

   Now, are such substantive and psycholinguistic facts (among many others) sufficient to rule out LT, that is phonemes seen as underlying linear units? Before the phoneme ceased to be a matter of discussion with the advent of generative phonology, the answer given by authors like Ebeling (1962: 79), Fry (1964), Collinge (1965: 5), and, *contra* Chomsky (1964) and Chomsky & Halle (1965), by Householder (1965, 1966), was negative. Yet, I wish to

show here that *the phonemic theory itself* concurs with psycholinguistic evidence in demonstrating that phonological representations are not pearl necklaces. This follows from sound change.

Let us examine a typical case of what is commonly called 'transphonologization', 'feature transfer' (Martinet 1970: § 6.19) or, following on from Hoenigswald (1960: 93-94), a 'secondary split': the one that is provoked by contextual change. As is well-known, Old Russian had a short /i/-like vowel (henceforth *i*) which palatalized the preceding consonant (exemplified by *t*). As a result, in linear terms, Old Russian showed the following allophonic rules:

(4)   a.   /t/ →   [tʲ] / __ i
         b.   /t/ →   [t] elsewhere

At this stage, we are told that there was only one /t/-phoneme: the phonetic difference between [t] and [tʲ] was not perceived as such by the speaker; it was assigned to the presence of /i/ in the second case and to its absence in the first case. Later on, /i/ was deleted; its palatalizing effect, however, remained; hence, since /i/-deletion implies the loss of the conditioning context, a /tʲ/ : /t/ contrast emerged from the split of the previously unique */t/.

Now, the second stage of this change is absurd in structuralist terms. If the context of an allophone happens to change, then the allophone must also change. Let us imagine a word-game in Spanish consisting in syllable permutation. Given a word like /lago/ 'lake', pronounced as [laɣo], [unlaɣo] 'a lake' will give [uŋgola] and not *[uŋɣola], /g/ being realized as [ɣ] in intervocalic position but as [g] elsewhere. Accordingly, if the palatality of Old Russian [tʲ] is assigned by the speaker to the /i/-phoneme, the loss of the latter should logically lead to *t*-depalatalization; the preservation of the palatalizing effect is, thus, incomprehensible.
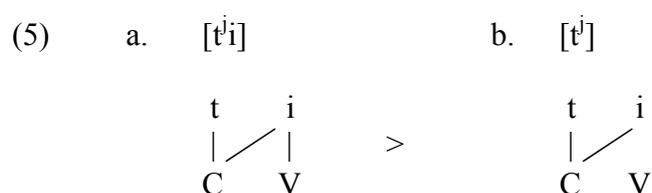
Yet, facts crucially contradict the predictions following from structural phonology, and seem to support the unsustainable claim of the 'secondary split'! It is well-known, indeed, that */ti/ gave Modern Russian /tʲ/, or, at the least, that [i] > Ø *did not imply the deletion of t-palatality*. Why is structural phonology unable to explain a change like [tʲi] > [tʲ]? There are four possible answers; only one is satisfactory.

Firstly, according to structuralist principles, and to most scholars who discussed the problem (Dressler 1972, 1985; Hooper 1976; Hyman 1976; Anttila 1989; Liberman 1991; Haiman 1994; Fertig 1996), if this was possible, it must be because [tʲ] was *already* a phoneme before [i]-deletion. Now, such a claim would be, once again, absurd, since we

should then have had, given the rules in (4), two (phonetically similar) phonemes (/t/ and /tʲ/) in complementary distribution, which is a contradiction in terms. As pointed out by Janda (2003: 409), analyses positing such "marginal", "quasi-" or "secondary" phonemes, as they are called by the authors above, "provide neither any motivation for *why* nor any mechanism for *how* certain [...] allophones which are in complementary distribution could become phonologized".

Pushing things as hard as possible, let us assume that, at some stage of the evolution, the palatal feature 'shifted', in the speaker's mind, from /i/ to /t/ in such a way that [i] was no longer perceived as a phoneme but as an epenthetic vowel automatically triggered by palatalized consonants. However, this is contradicted by facts: in certain varieties of Brazilian Portuguese which undergo coronal palatalization by /i/ and loss of the latter in final unstressed syllables, the resulting [tʲ]-like consonants are nevertheless still perceived as /ti/; interestingly, speakers are unable to pronounce onsets containing *ch*-like affricates in loanwords, and recur to vowel epenthesis (personal observation). If [tʲ] can be interpreted as /ti/, how, then, can [tʲi] be perceived as /tʲ/? The mysterious 'transmutation' of the palatal feature from the vowel to the consonant, which underlies the classic literature on transphonologization, lacks, thus, any empirical basis.[9]

A third, and radical, solution is brought by recent literature, e.g. Booij (2002) and Janda (2003), where it is argued that allophonic properties must be lexically stored in order to survive after loss of the conditioning context. Now, this amounts to rejecting the concept of phoneme itself, that is not only linearity but also invariance, since the underlying representations must contain allophonic as well as distinctive features. Does the solution of such diachronic paradoxes deserve the abandonment of the phoneme? Interestingly, *t*-palatality is viewed in the latter thesis as an allophonic property of /t/, much in the same way as in the LT-based phoneme theory. Now, assuming that /i/ is nothing but some palatal melody, as follows from autosegmental representations (cf. § 2.2), we can explain why structural phonology is unable to account for a change like [tʲi] > [tʲ]. The reason could be glossed as follows: [tʲ] preserved its palatal feature after the loss of the vowel because /i/ *remained despite* [i]-*deletion*:

(5)   a.   [tʲi]   b.   [tʲ]

```
        t      i                    t      i
        | ⟋  |           >          | ⟋
        C      V                    C      V
```

This solution avoids the difficulties met by the other three theses. There are no /t/ and /tʲ/ phonemes in complementary distribution since /i/ is still there. The fact that [tʲ] is still perceived as /ti/ is a natural issue of (5): *i*-delinking does not imply deletion of the second slot, which remains available for contextual *i*-association, as in the case of glide formation before vowel.[10] Finally, the distinction between distinctive and allophonic features, which is at the basis of phonemic theory, is maintained in (5), where the palatal feature (*i*) is distinctive regardless of the number of slots it is associated with. Obviously, this cannot be expressed in linear terms: since classic phonemes lack the distinction between skeletal slots and segmental content (cf. § 2.2), things such as *i*-delinking are impossible to formalise within structural phonology, where both (5a) and (5b) will be assigned the same underlying representation: /ti/.[11] Thus, LT, where phonemes are assumed to be underlyingly linear units, cannot account for a basic mechanism of sound change.

3. In favour of the phoneme: feature locality

3.1 What does a 'set' of features mean?

Assuming, *contra* LT, that linearity is not a phonemic property, is there any justification for the existence of phonemes? Is the phoneme, as was said by Lüdtke (1969: 173), really "an artificial intermediate item between syllable and distinctive feature", a mere cover-term for an arbitrary set of distinctive features?

It could be argued that, despite Chomsky's (1964: 75-110) criticism of 'taxonomic phonemics', many works in generative phonology, from Chomsky & Halle (1968) to Steriade (1987) and Clements (1988), have tacitly admitted that feature sets are not arbitrary, since the distinctiveness of features, and hence their specification, are precisely based on their contrastive combination within a segment-sized unit. Consider the three high vowels of French and Korean: /i y u/ and /i ɯ u/ respectively; they will be given the feature matrices in (6a) on the basis of the redundancy rules in (6b):

(6)   a.

	/i/	/y/	/u/		/i/	/ɯ/	/u/
[back]		−	+			−	+
[round]	−	+				−		+

   b.   [−round] ⇒ [−back]   and   [+back] ⇒ [+round] (French)

          [−back] ⇒ [−round]   and   [+round] ⇒ [+back] (Korean)

As can be seen in (6a), feature relevance is relative to a given contrastive combination within a given system: [–back] is not distinctive *per se* in French vowels; it is so in /y/ (when combined with [+round]) but it is not in /i/ ([–round]), as is [+round] in /y/ (when combined with [–back]) but not in /u/ ([+back]); the same can be said about [+back] and [–round] in Korean. Therefore, the relevance of features follows from the way they combine with one another: French has /y/ but not /ɯ/ while Korean has /ɯ/ but not /y/, or, in other words, French contrastively combines [–back] and [+round] but not [+back] and [–round] while Korean does exactly the opposite, hence the different redundancy rules in (6b) for /i/ and /u/, which are, thus, underlyingly different in both languages. Now, classic phonemes, as opposed to *SPE*-like segments, are nothing but such 'contrastive combinations' of features.

I am not assuming that the feature matrices in (6a) are theoretically justified and descriptively adequate; actually, I think that, for a number of reasons, they are not, and that holistic descriptions where /i/ = {I} and /u/ = {U} *in all languages*, and, hence, /y/ = {I, U} and /ɯ/ = Ø (cf. Carvalho 1997, forthcoming), are preferable to the ones in (6a). In this discussion on French and Korean high vowels, I simply wish to emphasize two facts. Firstly, if generative phonologists had really wished to give up the traditional view of the phoneme, they should have either clearly chosen full specification, or replaced binary features with monovalent elements, as those proposed by Dependency phonology (cf. Anderson & Ewen 1987), Government phonology (cf. Kaye et al. 1985, 1990) or Particle phonology (cf. Schane 1984a,b; Carvalho 1994, 2002b):[12] in both cases, the featural content of the high vowels in (6a) would then have been system-free. Secondly, and more importantly for the present purposes, feature combinations differ from language to language (which remains true even within holistic frameworks, where I and U combine in French but not in Korean). This may seem trivial; however, as will be made clear below, it is one of the empirical bases for supporting the claim that phonemes are still necessary in contemporary phonology.

3.2 Feature locality-based divergencies between languages

Let us now examine cases of feature combination where two or more successive skeletal positions are concerned, such as the example of the French words *cri* and *gris* exposed in § 2.3. As was noted therein, the phonemic combination of features is likely to contradict psycholinguistic evidence. It is certainly true that, say, the main 'perceptual site' of the VOT-contrast corresponds to the second element of the onset. Nevertheless, French has a /k/ : /g/ opposition (*qui* : *gui*), not a /χ/ : /ʁ/ one; thereby, VOT-features can be said to combine contrastively with obstruents in French, not with /r/; they 'belong' in some way to the first

element of a branching onset, not to the second. This is what will be referred to as **locality**, a phonemic property of features which, at first sight, does not necessarily coincide with their phonetic and perceptual localisation, and is easily captured by the 2-level and rule-based LT (cf. § 2.1).[13] Now, languages may differ from one another as to the locality of a given feature. As will be seen, this provides crucial evidence for revisiting the notion phoneme.

In both French and Kabardian, a syllable like [k^{j}i] is possible: cf. Fr. *qui* 'who' and the word for 'twig' in Kabardian (Kuipers 1960: 83). The underlying representations are, however, radically different in both languages. In traditional terms, the former is said to have /ki/, while the latter has /k^{j}ɨ/; in the first case, [k^j] is an allophone of /k/ before the palatal vowel /i/, whereas, in the second case, [i] is an allophone of /ɨ/ after the palatal consonant /k^j/. Hence, there is no word-final [k^j] in French, nor is there word-initial [i] in Kabardian. In autosegmental terms, this will be represented as in (7a,b) (where *I*, *k* and *ɨ* stand for the [palatal], [dorsal] and [high] features respectively):

(7) a. French [k^{j}i]   b. Kabardian [k^{j}i]

As pointed out in § 2.2, it could be said that [I+i] is the realization of /i/ whenever it is combined with /k/ in French, while [k^j+I] is the realization of /k^j/ whenever it is combined with /ɨ/ in Kabardian; accordingly, the distinctive I-feature of the vowel spreads onto the consonant in (7a), whereas the distinctive I-feature of the consonant spreads onto the vowel in (7b). In other words, nothing but the 'history' of each representation in (7) explains the phonological difference between both languages, and the 'origin' of the I-feature, i.e. its locality, is necessarily expressed in linear terms, as is shown in the underlying forms in (8):[14]

(8) a. French /ki/   b. Kabardian /k^{j}ɨ/

Now, this is precisely what follows from the linear framework provided by traditional phonemic theory. Should we, then, in order to capture feature locality, accept linear underlying representations, that is, the LT adopted by most phonologists (cf. § 2.2),[15] but criticized in § 2.3 on the grounds that it fails to account for secondary splits? Let us examine a second example of feature locality-based divergencies between languages.

3.3 Universal C/V-segregation as a non-linear account of feature locality

Consider the case of nasality in Spanish and French. The former has 'nasal consonants' but lacks 'nasal vowels', and thus shows (9a,b)-syllables, while the latter contrastively combines nasality with both consonants and vowels, and thus has (9a-d) *beau* 'beautiful', *mot* 'word', *bon* 'good', *mon* 'my', (9d) resulting from the Obligatory contour principle (OCP):[16]

(9) a. /bo/ b. /mo/ c. /bõ/ d. /mõ/

```
                 N               N               N
                 |               |              / \
      b   o      b   o      b   o      b   o
      |   |      |   |      |   |      |   |
      C   V      C   V      C   V      C   V
```
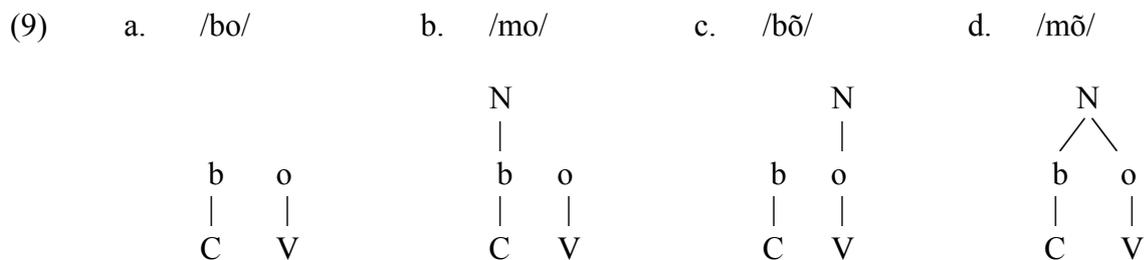
If the only feature locality-based differences between languages were of this type, the phoneme could certainly be viewed as a superfluous unit, as a simple cover-term for a set of distinctive features associated with a given skeletal position.

However, things are slightly more complicated. Taiwanese exhibits, in structuralist terms, the opposite configuration of Spanish: it has only 'nasal vowels'. But it also shows nasal consonants, since voiced obstruents are regularly oral before oral vowels and nasal before nasal vowels (Chang 1985: 19). As a result, it can have both [bo]- and [mõ]-syllables, which are, still in structuralist terms, the realizations of the underlying sequences /bo/ and /bõ/, or, in autosegmental terms, of the representations in (10):

(10) a. /bo/ b. /bõ/ → [mõ]

```
                                      N
                                   /  |
                                 /    |
      b   o                      b    o
      |   |                      |    |
      C   V                      C    V
```
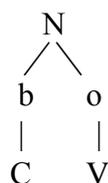
As can be seen once again, only the dotted line in (10b) distinguishes Taiwanese [mõ] from French /mõ/ in (9d), and, thus, accounts for the different locality of N in both languages. The reason why the French syllables [mo] and [bõ] are disallowed in Taiwanese, and cannot thus contrast with (10a,b), is that N *spreads* onto the preceding consonant in Taiwanese, whereas it may be *already there* as in French /m/.
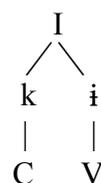
We are, thus, placed on the horns of a dilemma. On the one hand, if we accept LT, phonological theory easily captures feature locality. The syllable [mõ] will be assigned different underlying representations in Taiwanese, where nasality belongs exclusively to the vowel, and in French, where nasality is lexically associated with the vowel *and* the consonant; similarly, French and Kabardian will be given the different underlying representations in (8a,b). Thereby, structural phonology would simply be dressed with autosegmental clothes, and the phoneme could be defined as a set of distinctive features underlyingly associated with a given skeletal position. However, as was seen in § 2.3, LT is contradicted not only by psycholinguistic evidence but also by theory-internal diachronic arguments.

On the other hand, if we reject LT, we will be able to account for psycholinguistic evidence as well as for the diachronic paradox discussed above. Accordingly, much in the line of the Saussurean game of chess, representations will be viewed as ahistorical objects, where any difference between languages must be built in. However, if neither I-spreading nor N-spreading are assumed in (7a,b) and (10b), we will fail to capture feature locality, and, thereby, the phonological differences among these languages. Indeed, just as both [t^{j}i] and [t^j] are underlyingly /ti/ in unilinear frameworks (cf. § 2.3), so do multilinear models lead, in this case, to the unique representations in (11) for French and Taiwanese [mõ], and for French and Kabardian [k^{j}i]:

(11)   a.   [mõ]   b.   [k^{j}i]

                        N   I
                       /ⵏ\   /ⵏ\
                    b   o   k   ɨ
                    | | | |
                    C   V   C   V

Given (11a,b), nothing but *ad hoc*, i.e. non-built-in, stipulations could explain why Taiwanese, unlike French, disallows [bõ] and [mo] as contrastive combinations, and why no French word ends by [k^j], while no Kabardian word begins by [i].

How, then, can feature locality and non-linearity be conciliated? If we take seriously the idea that underlies the former, according to which N or I 'belong' either to the consonant or to the vowel, then the representation in (11a) is likely to suggest a very simple and straightforward answer to this question. The fact that French allows the four possibilities in (9) clearly shows that N may be contrastively associated both to the consonant and to the vowel. Hence, in French /mõ/, *two* N-features can be said to conflate by virtue of the OCP. Thus, French /mõ/ and Taiwanese [mõ] differ by the number of N-features involved (two in the former *versus* only one in the latter), which should be phonologically represented. Now, this necessarily implies OCP violation, unless the two N-features of French /mõ/ are assumed to be localized on different tiers, that is *unless consonants and vowels are universally segregated*; indeed, assuming that only French has C/V-segregation, in order to avoid OCP violation in [mõ], would be, of course, circular, and the problem with the palatal feature would be left unsolved. As a result, the syllables [mõ] and [kʲi] will be assigned the following representations in the different languages:[17]

(12) a.   French [mõ]   b.   Taiwanese [mõ]

      c.   French [kʲi]   d.   Kabardian [kʲi]

In sum, C/V-segregation provides the only way of mapping phonemic differences into phonological representations while avoiding LT, that is of capturing both feature locality and

non-linearity.[18] The phoneme can then be broadly defined as a subset of features located in either of these tiers, and sharing at least one skeletal slot.

4. Three issues of the present thesis

The representations proposed in (12) need further discussion on at least three points. Firstly, a serious problem for C/V-segregation as a solution for mapping feature locality is that it applies only to linearity violation involving C/V (and V/C) interactions, and fails to generalize to V/V or C/C interactions. Thus, unlike [kʲi] and [mõ], the French earlier example [kχi] (cf. § 2.3), involving a C/C linearity violation, cannot be assigned more than one representation, where the source of the voiceless feature (if any) spreading on the consonant tier remains ambiguous between the first and the second element of the onset. Clearly, if we wish to account for feature locality in *all* cases, C/V-segregation is not a sufficient solution, and may thus be unnecessary.

To quote Lass's (1984: 33) comments on the structuralist axiom of 'separation of levels', this problem "raises the important point that what counts is not how 'right' a theoretical claim is, but how testable it is, and what we can learn from trying to push it as hard as possible. Strong claims, even if untenable, can be heuristics: methodological guidelines or strategies for analysis". Specifically, if C/V-segregation does account only for feature locality violation involving C/V (and V/C) interactions, it will be assumed that, contrary to what was implicitly admitted in § 2.3 regarding /kri/ : /gri/, *only in C/V (and V/C) interactions feature locality is a relevant segmental property*, and thereby unpredictable cross-linguistically. Thus, while [kʲi] and [mõ] were seen to have different underlying representations from language to language, C/C interactions as the one in [kχi] are uniformly prosodically-driven: voice(lessness) is not associated with a particular segment as such but with the head of the complex onset, and this must be true universally, no language showing underlying contrasts such as */Kχi/ : */Kʁi/ (where K = obstruent archiphoneme) instead of /kri/ : /gri/. Hence, some strong predictions are being made on C/C interactions in general. For example, are there cases where voicing assimilation goes from right to left in one language and from left to right in another language? Clearly, the answer should be 'no'. More accurately, as is argued for in Carvalho (2002a,c), except in the case of complex onsets, voicing universally goes from right to left; otherwise (as illustrated by a comparatively much smaller sample of cases), it should not result from propagation, but from 'templatic' constraints (which may affect laryngeal properties as well as length).

Likewise, V/V interactions, such as the Brazilian Portuguese assimilation /e, o...i, u/ → [i, u...i, u] (e.g. in *menino, bonito, seguro, coruja*) and presumably all post-lexical harmonic phenomena, are foot-conditioned. In those cases, the source of feature propagation is encoded by the prosodic (syllabic and metrical) hierarchy of the language, where it often coincides with the governing element; Dependency phonology (cf., e.g., Anderson & Ewen 1987: §§ 3, 7.6) provides good illustrations of this.[19] It is unlikely, however, that C/V interactions behave the same way as C/C and V/V interactions, the relationship between the major constituents of the syllable pointing to symmetry, as is shown in Carvalho (2002a: § 2, 2002c), where consonantal aspiration and voice are seen as resulting from symmetric 'CV contours'. Certainly, LT and derivation could handle the V/V and C/C, as well as the C/V and V/C, interactions without problems; however, few predictions would be made by such theories, and their explanatory power would, thus, be incomparably lower.
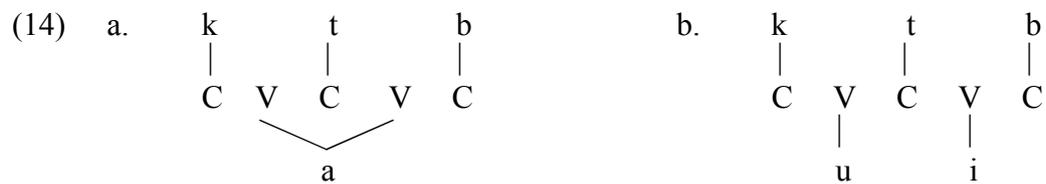
The second point I wish to stress is that, as is well-known, the phonological basis for assigning a distinct tier to a given unit has generally been defined, in plurilinear models, on functional grounds, such as the relative freedom of propagation shown by tones and harmonic features. Here, I am proposing that autosegmental segregation may be due to *structural* reasons, specifically to what I have called feature locality. Thereby, the old, though revised, concept phoneme is implemented within autosegmental representations, and the scope of structural phonemics clearly transcends the limits of the 'foundations of phonology'; indeed, it has important consequences for the shape of current phonological representations, and concurs with well-known processual evidence like vowel-to-vowel assimilation in pointing to the necessity of universal C/V-segregation.

Finally, concerning more particularly the relationship between consonants and vowels, it is assumed here that they are universally located in different tiers.[20] Now, C/V-segregation has mainly been proposed in the case of the non-concatenative morphology of Semitic languages, as in the well-known perfective forms of the Arabic verb meaning 'to write' (3rd p.):

(13)   Active   Passive

   a.   katab   kutib   unmarked mood

   b.   kattab   kuttib   'causative'

   c.   kaatab   kuutib   'participative'

As can be seen, there are three morphemes in these forms: the root, the voice and the mood, which are borne by consonants (/ktb/), vowels (/a/ : /ui/) and syllabic templates (CVCVC :

CVCCVC : CVVCVC) respectively. This morphological type led to the currently assumed representations of (13a) given in (14) (cf. McCarthy 1979, 1981):

(14) a.   k   t   b   b.   k   t   b
              | | | | | |
          C   V   C   V   C   C   V   C   V   C
                   _____/ | |
                      a   u   i

Now, the actual segregation in (14) does not concern consonants and vowels as such; the segregated objects here are the lexical root and the grammatical morphemes. It may seem strange that consonants and vowels are only segregated in the literature when they bear different morphological units;[21] tones, for example, have always been assigned a specific tier, regardless of whether they play a lexical or a grammatical role. The conclusion that may be drawn from the 'phonemic' representations proposed in (12) is that the shape of phonological representations does not follow from morphological organization. If Arabic shows C/V-segregation, this is not due to morphological reasons. On the contrary, particular morphologies just exploit such and such universal characteristics of the phonological structure of words. It is because consonants and vowels are universally segregated that they may bear distinct morphemes, should occasion arise.

Joaquim Brandão de Carvalho
Université Paris 8 / UMR 7023
jbrandao@ext.jussieu.fr

Notes

* I wish to thank two *FL* referees for their very constructive comments.

1 Only notions such as 'linearity' or 'skeletal position', shared by most authors who worked either within the different schools of structural phonology or, later on, within (post-)generative autosegmental frameworks, will be treated in this article. Hence, theories will be referred to in broad terms ('structural phonology', 'plurilinear models', etc.), and no specific references will be cited for such notions. Only particular cases of divergency vis-à-vis the mainstream will be explicitly mentioned: cf., e.g., § 2.1 for non-linear claims within structural phonology, § 2.3 and note 15 for 'non-orthodox' theses on the lexical storage of features in recent phonological research.

2 Which means that the features a phoneme is made of must be shared by its allophones.

3 As well as biuniqueness, since this property concerns only those American structuralists who supported the well-known premiss: "once a phoneme, always a phoneme". As is pointed out by Anderson (2000: 16-17), it is not the case that Halle's (1959: 22f.) biuniqueness-based argument against the 'structuralist phoneme' shows classic phonemic analyses in general to lead to loss of generalization, since his Russian example could be simply accounted for by a theory that employs archiphonemes, as Trubetzkoy's ([1939] 1969: §§ III.2.C, V) does.

4 Insofar as a feature can be seen as an abstract label for a set of phonetically-based cues: consider, for example, a feature like 'fortis' which involves both laryngeal and supralaryngeal aspects.

5 I will leave aside the fact that the problem with the *writer* : *rider* example also involves invariance: what may be common to both voice and length? Indeed, this can be seen as resulting from the system of primitives chosen (see, for example, Carvalho (2002a,c), where voice and length are shown to be 'allophones' of the same invariant), not from the concept phoneme itself.

6 I am leaving out for the moment the possibility that removing linearity from the list of its defining properties would still not make the phoneme a useless notion, since it is then still conceivable as a *set* of distinctive features (cf. § 3.1), which, as was pointed out by a reviewer of this article, makes sense in gestalt terms anyway (cf. Sapir 1933).

7 Otherwise, they are not phonemes. Therefore, most structuralist schools allow to some extent the kind of distinction made by Firth (see Langendoen 1968; Palmer 1970) between 'prosodemes' and 'phonemes' *stricto sensu.*

8 Cf., for example, Schatz (1954), Delattre *et al.* (1955), Fischer-Jørgensen (1956), Liberman *et al.* (1956), Malécot (1956), Stevens & House (1956), Liberman (1957), O'Connor *et al.* (1957), Harris *et al.* (1958), Hoffman (1958), Fischer-Jørgensen (1958), Truby (1958, 1959: 91 ff.), Fant (1960), Delattre (1962), Delattre *et al.* (1962), Delattre (1964), Reddy (1966, 1967), Liberman *et al.* (1967), Studdert-Kennedy (1976), Pickett (1980).

9 As was pointed out by two reviewers of this paper, diachronic evidence might be seen as problematic when adduced for a certain point about the synchronic working of the phonological component. It may be argued that diachronic changes are quite different from synchronic processes: while the latter can be viewed as operations which take one symbolic representation and transform it into another one, there is no such thing as a copying mechanism which transfers representations from the brains of one generation to the next; thus, different patterns might emerge through some sort of reanalysis. This is not impossible. However, sound change is not taken here as a historical phenomenon, but simply as the trace of what was once a synchronic phonological process first involving 'free' variation, and, later on, loss of the conservative variant. Now, as is shown by palatalization processes, this second stage does *not* lead to an automatic reanalysis of the remaining variant.

10 As a result, transphonologization is not an all-or-nothing process: it is only when *t* and *i* are necessarily linked to the same C-position, and only to this position, since the V-slot has been lost, that a new '/tʲ/-phoneme' can be said to emerge.

11 More generally, notions such as 'floating unit' cannot be expressed for this reason in linear terms, nor, thus, can *liaison*-type facts be elegantly captured within structural phonology (cf. Encrevé 1988).

12 Note that Radical underspecification theory (cf. Archangeli 1984, 1988), though allowing only one value *per* feature in a given system, still recurs to markedness and redundancy rules like the ones in (6b).

13 The term 'locality' may seem somewhat misleading, given its usual sense in phonological literature, which refers to something related to 'adjacency'. I simply did not find a better word. By locality, I mean a property that could be roughly glossed as: "phonological objects have some place of origin from which they operate".

14 Though no feature geometry is used in (7, 8), these representations can also be seen as shorthands for hierarchical structures à la Clements & Hume (1995): I is, thus, primitively dominated by the V-place node in French, but by the C-place node in Kabardian.

15 Indeed, (7)-type representations, where feature locality is captured by LT, are commonly assumed by most phonologists, including those who claim that phonology should not be derivational. In a short chapter curiously entitled "The death of the phoneme", Kaye (1989: 149-154), comparing the Desano [m], which is due to nasal harmony, with the homorganic nasal of English *im*balance, writes: "In the Desano case, it is the nasal element that spreads onto the various consonants and vowels. In English, it is the *b* that spreads onto the nasal […]" (1989: 152). Clearly, this amounts to admitting that a given feature (here nasality and labiality) has, say, a 'primitive site', which may vary from language to language, as opposed to 'secondary' or 'derived sites'. Now, linear phonemes are nothing but such 'primitive sites'. Are they really dead or simply repressed? Actually, only two theoretical trends, to my knowledge, fail to capture feature locality, because they reject LT, and would apparently require the French and Kabardian examples to be assigned the same representations in both input and the output: one is dependency phonology (cf., e.g., Anderson & Ewen 1987); the other is the version of optimality theory presented by Kager (1999: § 2), where this is due to the combined effect of the ROT and Lexicon Optimization, which when taken together require underlying representations to contain allophonic as well as distinctive features ; cf. also Booij (2002) and Janda (2003) mentioned in § 2.3.

16 The OCP will be viewed here as a strong universal constraint affecting any [αF] [αF] tautomorphemic sequence (cf. Yip 1988), when there is no dependent features attached to [αF] (cf. Mester 1988).

17 Why is it, then, that in (12b) the N of the V-tier can interact with the *b* of the C-tier, in such a way that only (phonemically) voiced onsets are nasalised in Taiwanese? Indeed, it could be objected that, if consonants and vowels really belonged to distinct spheres, the *b* should be invisible for the N. This requires a detailed response that cannot be developed here. Let us simply say that laryngeal properties are not to be seen as segmental features, but as the result of onset/nucleus interactions (cf. Carvalho 2002a,c); hence, the condition for N-spreading in Taiwanese, i.e. voice, is not located on the C-tier but at the interface of both tiers, that is within the skeleton. Otherwise, propagation would not be constrained, as is the case for I in (12c,d), since all consonants are palatalised by /i/ in French, and all vowels are palatalised by palatal dorsals in Kabardian.

18 Furthermore, similar facts can be found within the same language. For example, what is the difference between French *(br)iller* 'to bright', [bʁije], and its 3rd p. *il* [bʁij], on the one hand, and *(pr)ier* 'to pray', [pχije], and its 3rd p. *il* [pχi], on the other hand? If consonants and vowels remain on the same tier, the only way of differentiating both stems consists in assuming either I-propagation, i.e. an allophonic rule like /i/ → [ij] / Cr_V, in *prier*, while *briller* has an underlying bipositional I-feature, or, if *prier* is assigned the latter representation, a I+I sequence in *briller*, i.e. OCP violation. Now, C/V-segregation allows us to preserve OCP while avoiding derivation, I being on the sole V-tier in *prier*, where it is associated with two slots, but in the V- *and* in the C-tiers in *briller*.

19 Let us stress that this is supposed to be true only for post-lexical phenomena like Khalkha Mongolian vowel harmony (cf. Rialland & Djamouri 1984; Goldsmith 1985). On the contrary, Turkish vowel harmony, for example, which applies from left to right whereas stress is word-final, is a lexical process in the modern language. Actually, the fact that harmony and feet do not line up is a clear symptom of the morphological (i.e. conventional) character of the former, which can be shown on independent grounds anyway.

20 As is also claimed, in a sense, by some speech production theories, which argue that consonants and vowels belong to separate channels in the speech 'plan', but must interact through implementation in the same vocal tract (cf. Fujimura 1992).

21 The only exception I know of is Archangeli's (1984) account of Yawelmani.

Bibliography

Anderson, John M. & Colin J. Ewen. 1987. Principles of dependency phonology. Cambridge: Cambridge University Press.

Anderson, Stephen R. 2000. "Reflections on "On the phonetic rules of Russian"." Folia linguistica 34, 11-27.

Anttila, Raimo. 1989. Historical and comparative linguistics. Amsterdam, Philadelphia: Benjamins.

Archangeli, Diana. 1984. Underspecification in Yawelmani phonology and morphology. Doctoral dissertation, MIT.

Archangeli, Diana. 1988. "Aspects of underspecification theory." Phonology 5, 183-207.

Baudouin de Courtenay, Ian A. 1963. Izbrannyje trudy po obshchemu jazykoznaniju. Moscow: Akademija Nauk SSSR.

Booij, Geert. 2002. "The balance between storage and computation in phonology." In: Sieb Nooteboom, Fred Weerman & Frank Wijnen (eds.), Storage and Computation in the Language Faculty. Dordrecht: Kluwer, 115-138.

Cao Xuan Hao. 1985. Phonologie et linéarité. Réflexions critiques sur les postulats de la phonologie contemporaine. Paris: SELAF.

Carvalho, Joaquim Brandão de. 1988. "Nasalité et structure syllabique en portugais et en galicien: approche non linéaire et panchronique d'un problème phonologique." Verba. Anuario galego de filoloxia 15, 237-263.

Carvalho, Joaquim Brandão de. 1994. "What are vowels made of? The 'no-rule' approach and particle phonology." Studia linguistica 48, 1-27.

Carvalho, Joaquim Brandão de. 1997. "Primitives et naturalité." Langages 125, 16-36.

Carvalho, Joaquim Brandão de. 2002a. De la syllabation en termes de contours CV. Mémoire d'Habilitation, Ecole des Hautes Etudes en Sciences Sociales.

Carvalho, Joaquim Brandão de. 2002b. "Formally-grounded phonology. From constraint-based theories to theory-based constraints." Studia linguistica 56, 227-263.

Carvalho, Joaquim Brandão de. 2002c. "What are phonological syllables made of? The voice/length symmetry." In: Jacques Durand & Bernard Laks (eds.), Phonetics, phonology, and cognition. Oxford: Oxford University Press, 51-79.

Carvalho, Joaquim Brandão de. forth.. "Représentations versus contraintes. Explications formelles et substantielles en phonologie." In Actes des 3èmes Journées d'études linguistiques (Nantes, 2002). Rennes: Presses Universitaires de Rennes.

Chang, Yuen-Chin. 1985. Contribution à la recherche tonale sur un des dialectes min-nan parlé à Taïwan. Doctoral dissertation, Université de Paris 3.

Charette, Monik. 1991. Conditions on phonological government. Cambridge: Cambridge University Press.

Chomsky, Noam. 1964. Current issues in linguistic theory. The Hague: Mouton.

Chomsky, Noam & Morris Halle. 1965. "Some controversial questions in phonological theory." Journal of linguistics 1, 97-138.

Chomsky, Noam & Morris Halle. 1968. The sound pattern of English. New York: Harper & Row.

Clements, George N. 1985. "The geometry of phonological features." Phonology yearbook 2, 225-252.

Clements, George N. 1988. "Toward a substantive theory of feature specification." Proceedings of the 18th annual meeting of the North-Eastern Linguistic Society. Amherst, MA: Graduate linguistic student association, 79-93.

Clements, George N. 2002. "Some antecedents of nonlinear phonology." Folia linguistica 34, 29-55.

Clements, George N. & Elizabeth V. Hume. 1995. "The internal organisation of speech sounds." In: John Goldsmith (ed.), The handbook of phonological theory. Cambridge, MA: Blackwell, 245-306.

Cole, Ronald A. & B. Scott. 1974. "Towards a theory of speech perception." Psychological review 81, 348-374.

Collinge, Neville E. 1965. "Some linguistic paradoxes." Journal of linguistics 1, 1-12.

Cooper, Franklin S., Pierre C. Delattre, Alvin M. Liberman, J. M. Borst & L. J. Gerstman. 1952. "Some experiments on the perception of synthetic speech sounds." Journal of the Acoustical Society of America 24, 597-606.

Cooper, Fanklin S., Alvin M. Liberman, Leigh Lisker & Jane H. Gaitenby. 1963. Speech synthesis by rules. Proceedings of the Speech Communication Seminar. Stockholm: Royal Institute of Technology, F2.

Delattre, Pierre C. 1962. "Le jeu des transitions de formants et la perception des consonnes." Proceedings of the IVth International Congress of Phonetic Sciences. The Hague: Mouton, 407-417.

Delattre, Pierre C. 1964. "Change as a correlate of the vowel-consonant distinction." Studia linguistica 18, 12-25.

Delattre, Pierre C., Alvin M. Liberman & Franklin S. Cooper. 1955. "Acoustic loci and transitional cues for consonants." Journal of the Acoustic Society of America 17, 769-773.

Delattre, Pierre C., Alvin M. Liberman & Franklin S. Cooper. 1962. "Formant transitions and loci as acoustic correlates of place of articulation in American fricatives." Studia linguistica 16, 104-121.

Dressler, Wolfgang U. 1972. Allegroregeln rechtfertigen Lentoregeln. Innsbruck: Institut für vergleichende Sprachwissenschaft, Universität Innsbruck.

Dressler, Wolfgang U. 1985. Morphonology : The dynamics of derivation. Ann Arbor: Karoma.

Ebeling, C. L. 1962. Linguistic units. The Hague: Mouton.

Encrevé, Pierre. 1988. La liaison avec et sans enchaînement. Phonologie tridimensionnelle et usages du français. Paris: Seuil.

Fant, Gunnar M. 1960. Acoustic theory of speech production. The Hague: Mouton.

Fertig, David. 1996. "Phonology, orthography, and the umlaut puzzle." In: Rosina Lippi-Green & Joseph Salmons (eds.), Germanic linguistics: Syntactic and diachronic. Amsterdam: Benjamins, 169-184.

Fischer-Jørgensen, Eli. 1956. "The commutation test and its application to phonemic analysis." In: Morris Halle et alii (eds.), For Roman Jakobson: Essays on the occasion of his sixtieth birthday, 11 October 1956. The Hague: Mouton, 140-151.

Fischer-Jørgensen, Eli. 1958. "What can the new techniques of acoustic phonetics contribute to linguistics." Proceedings of the VIIIth International Congress of Linguists. Oslo: Oslo University Press, 433-478.

Fry, Dennis B. 1964. "Experimental evidence for the phoneme." In: David Abercrombie (ed.), In Honour of Daniel Jones: Papers contributed on the occasion of the eightieth birthday, 12th September 1961. London: Longmans, 59-72.

Fujimura, Osama. 1992. "Phonology and phonetics: A syllable-based model of articulatory organization." Journal of the Acoustical Society of Japan 13.E, 39-48.

Goldsmith, John. 1976. Autosegmental phonology. Doctoral dissertation, MIT.

Goldsmith, John. 1985. "Vowel features and umlaut in Khalkha Mongolian, Yaka, Finnish and Hungarian". Phonology yearbook 2, 253-275.

Goldsmith, John (ed.). 1993. The last phonological rule. Reflections on constraints and derivations. Chicago: University of Chicago Press.

Haiman, John. 1994. "Ritualization and the development of language." In: William Pagliuca (ed.), Perspectives on grammaticalization. Amsterdam: Benjamins, 3-28.

Hall Jr., Robert A. 1943a. "The unit phonemes of Brazilian Portuguese." Studies in linguistics 1, 1-6.

Hall Jr., Robert A. 1943b. "Occurrence and orthographic representation of phonemes in Brazilian Portuguese." Studies in linguistics 2, 6-13.

Halle, Morris. 1959. The sound pattern of Russian. The Hague: Mouton.

Harris, John. 1994. English sound structure. Cambridge, MA: Blackwell.

Harris, K. S., H. S. Hoffman, Alvin M. Liberman, Pierre C. Delattre & Franklin S. Cooper. 1958. "Effect of third-formant transitions on the perception of the voiced stop consonants." Journal of the Acoustic Society of America 30, 122-126.

Haugen, Einar. 1949. "Phoneme or prosodeme?" Language 25, 278-282.

Hockett, Charles F. 1942. "A system of descriptive phonology." Language 18, 3-21.

Hoenigswald, Henry M. 1960. Language change and linguistic reconstruction. Chicago: The University of Chicago Press.

Hoffman, H. S. 1958. "Study of some cues in the perception of the voiced stop consonants." Journal of the Acoustic Society of America 30, 1035-1041.

Hooper, Joan Bybee. 1976. "Word frequency in lexical diffusion and the source of morphophonological change." In: William M. Christie (ed.), Current progress in historical linguistics. Amsterdam: North-Holland, 96-105.

Householder Jr., Fred W. 1965. "On some recent claims in phonological theory." Journal of linguistics 1, 13-34.

Householder Jr., Fred W. 1966. "Phonological theory: A brief comment." Journal of linguistics 2, 99-100.

Hyman, Larry M. 1976. "Phonologization." In: Alphonse Juilland, Andrew M. Devine & Laurence D. Stephens (eds.), Linguistic studies offered to Joseph Greenberg. Vol. 2. Saratoga, CA: Anma Libri, 407-418.

Janda, Richard D. 2003. ""Phonologization" as the start of dephoneticization — Or, on sound change and its aftermath : of extension, generalization, lexicalization, and morphologization." In: Brian D. Joseph & Richard D. Janda (eds.), The Handbook of Historical Linguistics. Malden, MA, Oxford: Blackwell, 401-422.

Kager, René. 1999. Optimality theory. Cambridge: Cambridge University Press.

Kaye, Jonathan D. 1989. Phonology: a cognitive view. Hillsdale, NJ: L. Erlbaum.

Kaye, Jonathan D., Jean Lowenstamm & Jean-Roger Vergnaud. 1985. "The internal structure of phonological elements: a theory of charm and government." Phonology yearbook 2, 305-328.

Kaye, Jonathan D., Jean Lowenstamm & Jean-Roger Vergnaud. 1990. "Constituent structure and government in phonology." Phonology 7, 193-231.

Kenstowicz, Michael. 1994. Phonology in generative grammar. Oxford, Cambridge, MA: Blackwell.

Kuipers, Aert H. 1960. Phoneme and morpheme in Kabardian (Eastern Adyghe). The Hague: Mouton.

Lacharité, Darlene & Carole Paradis. 1993. "The emergence of constraints in generative phonology and a comparison of three current constraint-based models." Canadian journal of linguistics 38, 127-153.

Ladefoged, Peter. 1959. "The perception of speech." [Proceedings of the Symposium of] Mechanisation of Thought Processes. London: National Physical Laboratory, 399-409.

Langendoen, D. Terence. 1968. The London School of linguistics: a study of the linguistic theories of B. Malinowski and J. R. Firth. Cambridge, MA: MIT Press.

Lass, Roger. 1984. Phonology. An Introduction to basic concepts. Cambridge: Cambridge University Press.

Liberman, Alvin M. 1957. "Some results of research on speech perception." Journal of the Acoustical Society of America 29, 117-123.

Liberman, Alvin M., Pierre C. Delattre, L. J. Gerstman & Franklin S. Cooper. 1956. "Tempo of frequency change as a cue for distinguishing classes of speech sounds." Journal of experimental psychology 52, 127-137.

Liberman, Alvin M., Frances Ingemann, Leigh Lisker, Pierre C. Delattre & Franklin S. Cooper. 1959. "Minimal rules for synthesizing speech." Journal of the Acoustical Society of America 31, 1490-1499.

Liberman, Alvin M., Franlin S. Cooper, Donald P. Shankweiler & Michael Studdert-Kennedy. 1967. "Perception of the speech code." Psychological review 74, 431-461.

Liberman, Anatoly. 1991. "Phonologization in Germanic: umlauts and vowel shifts." In: Elmer H. Antonsen and Hans Henrich Hock (eds.), Stæfcræft: Studies in Germanic linguistics. Amsterdam: Benjamins, 125-137.

Lüdtke, Helmut. 1969. "Die Alphabetschrift und das Problem der Lautsegmentierung." Phonetica 20, 147-176.

Malécot, André. 1956. "Acoustic cues for nasal consonants." Language 32, 274-284.

Martinet, André. 1970. Economie des changements phonétiques. Traité de phonologie diachronique. 3rd ed. Berne: Francke.

Mattingly, Ignatius G. 1971. "Synthesis by rule as a tool for phonological research." Language and speech 14, 47-56.

McCarthy, John J. 1979. Formal properties of Semitic phonology and morphology. Doctoral dissertation, MIT.

McCarthy, John J. 1981. "A prosodic theory of nonconcatenative morphology." Linguistic inquiry 12, 373-418.

McCarthy, John J. 1988. "Feature geometry and dependency: a review." Phonetica 43, 84-108.

Menzerath, Paul & Armando de Lacerda. 1933. Koartikulation, Steuerung und Lautabgrenzung: eine experimentelle Untersuchung. Berlin, Bonn: Dümmler.

Mester, Armin. 1988. "Dependent tier ordering and the OCP." In: Harry G. van der Hulst & Norval Smith (eds.), Features, segmental structure and harmony processes. Vol. 2. Dordrecht: Foris, 127-144.

O'Connor, Joseph D., L. J. Gerstman, Alvin M. Liberman, Pierre C. Delattre & Franklin S. Cooper. 1957. "Acoustic cues for the perception of initial /w, j, r, l/ in English." Word 13, 24-43.

Palmer, Frank R. (ed.). 1970. Prosodic analysis. London: Oxford University Press.

Peterson, Gordon E., William S.-Y. Wang & Eva Sivertsen. 1958. "Segmentation techniques in speech synthesis." Journal of the Acoustical Society of America 30, 739-742.

Pickett, James M. 1980. The sounds of speech communication: A primer of acoustic phonetics and speech perception. Baltimore, MD: University Park Press.

Reddy, Dabbala Raj. 1966. "Segmentation of speech sounds." Journal of the Acoustical Society of America 40, 307-312.

Reddy, Dabbala Raj. 1967. "Phoneme grouping for speech recognition." Journal of the Acoustical Society of America 41, 1295-1300.

Rialland, Annie & Redouane Djamouri. 1984. "Harmonie vocalique, consonantique et structure de dépendance dans le mot en mongol khalkha". Bulletin de la Société de Linguistique de Paris 79, 333-383.

Sagey, Elizabeth. 1986. The representation of features and relations in nonlinear phonology. Doctoral dissertation, MIT.

Sapir, Edward. 1933. "La réalité psychologique des phonèmes". Journal de psychologie normale et pathologique 30, 247-265.

Schane, Sanford A. 1984a. "Two English vowel movements: a particle analysis." In: Mark Aronoff & Richard T. Oehrle (eds), Language sound structure: Studies in phonology presented to Morris Halle by his teacher and students. Cambridge, MA: MIT Press, 32-51.

Schane, Sanford A. 1984b. "The fundamentals of particle phonology." Phonology yearbook 1, 129-155.

Schatz, C. D. 1954. "The role of context in the perception of stops." IRE [Institute of Radio Engineers] Professional Group on Information Theory Transactions 7, 44-50.

Spencer, Andrew. 1996. Phonology. Theory and description. Oxford, Cambridge, MA: Blackwell.

Steriade, Donca. 1987. "Redundant values." In: Anna Bosch, Barbara Need & Eric Schiller (eds.), Papers from the parasession on autosegmental and metrical phonology. Chicago: Chicago Linguistics Society, 339-362.

Stevens, Kenneth N. 1973. "The potential role of property detectors in the perception of consonants." Research Laboratory of Electronics, M.I.T., Quarterly progress report 110, 155-168.

Stevens, Kenneth N. & Arthur S. House. 1956. "Studies of formant transitions using a vocal tract analog." Journal of the Acoustical Society of America 28, 578-585.

Studdert-Kennedy, Michael. 1976. "Speech perception." In: Norman J. Lass (ed.), Contemporary issues in experimental phonetics. New York, London: Academic Press, 243-293.

Tillmann, Hans Günther. 1967. "Akustische Phonetik und linguistische Akustik. Automatische Spracherkennung (ASE) und die Möglichkeit einer automatischen Deskription gesprochener Texte." Phonetica 16, 143-155.

Trager, George L. 1943. Editorial notes in Hall Jr. (1943a), 6, and Hall Jr. (1943b), 12-13.

Trubetzkoy, Nikolaj S. 1969 [1939]. Principles of phonology. Berkeley, Los Angeles: University of California Press.

Truby, Henry M. 1958. "A note on visible and indivisible speech." Proceedings of the VIIIth International Congress of Linguists. Oslo: Oslo University Press, 393-400.

Truby, Henry M. 1959. Acoustico-cineradiographic analysis considerations with especial reference to certain consonantal complexes. Stockholm: Acta radiologica. (Acta radiologica; supplementum 182).

Wang, William S.-Y. & Gordon E. Peterson. 1958. "Segment inventory for speech synthesis." Journal of the Acoustical Society of America 30, 743-746.

Yip, Moira. 1988. "The Obligatory Contour Principle and phonological rules: A loss of identity." Linguistic inquiry 19, 65-100.