

SIMULTANEOUS PHONEMES IN ENGLISH^[*]

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Abstract. The sequence of phonemes in English initial clusters, it has often been remarked, is structurally fixed. Fixed sequences can have configurative but not oppositional value. It is argued within an axiomatic-functionalist framework that the constituent phonemes are functionally simultaneous and occupy a single phonotactic position in a phonotagm. A simultaneous bundle of phonemes is called a 'phonotheme'. The members of a phonotheme determine the nucleus of the phonotagm collectively, in parallel. Phonothemes contrast with ordered (non-simultaneous) permutable sequences in which a non-phonemic schwa vowel interposes, e.g. /sp̩-/, /sp-/, /ps-/ in respectively *sport*, *support*, *perceive* (Southern Standard British English, or 'RP'). The schwa allows diverse determination of the nucleus by the phonemes it separates. Commutation of phonemes within these phonothemes is shown to follow the same pattern as commutation of distinctive features within phonemes, that is to say commutation classes are made up of phonemes that cannot co-occur in a simultaneous bundle.

1. Introduction

In the heyday of Prague functionalism one of its leading figures, Josef Vachek, declared that 'there can, and do, exist simultaneous phonological units but there cannot occur simultaneous phonemes' (Vachek, 1936/1976: 18), an assertion repeated by Haugen (1957/1972: 337), and this seems to have been the position of functionalists ever since. Simultaneity has been an implicit property not of phonemes but of distinctive/relevant features since the concept of distinctive features began to emerge in Prague School writings (see discussion of these terms in Akamatsu, 1988: 81ff). Jakobson, in an encyclopedia article in 1932, defined the phoneme as 'a set of concurrent sound properties' (Jakobson, 1932/1971: 231) and Trubetzkoy used terms such as 'phonologisch relevante Eigenschaften' and 'Vorstellungselemente' which Martinet has interpreted as 'caractéristiques phoniques distinctives qui se réalisent simultanément' (Martinet, 1955: 67, fn.8). Vachek himself defines the phoneme as a bundle of distinctive feature which he describes as simultaneous (Vachek, 1966: 62). The phrase 'simultaneous bundle of distinctive features' occurs in Mulder's definition of the phoneme in his presentations of the theory of axiomatic functionalism (Mulder, 1968: 26; 1989: 214). Mulder's use of the term 'simultaneous' is, however, squarely phonological in the functional sense, whereas Vachek, Haugen and Martinet were using the term in a more phonetic sense to describe events taking place at the same time in the vocal tract with the purpose of realising a given phonological unit such as a phoneme.

[*] Previously unpublished. Peer-reviewed before publication. [Editor's note]

In this paper, which develops and revises previous treatments of the topic in Heselwood (1987; 1992), I use an axiomatic-functionalist framework to argue that there can and do occur simultaneous phonemes in English, that they are what have traditionally been called initial consonant clusters, e.g. *pr-*, *bl-*, *st-*, *skr-* etc. Following Michael Lamb's original coining of the term in the early 1980s, and its definition in Dickins (1998: 142-3; see also 379 Axiom B definition 9a^{0c}), a simultaneous bundle of phonemes is called a *phonotheme*. I then consider whether the phonemes of a phonotheme determine the phonotagm nucleus separately or collectively, relating this question to the distinction drawn by Mulder, and reformulated in Heselwood (2008), between parallel and diverse determination.

The notion of simultaneity is applied to English initial clusters in a recent phonotactic analysis of the role of the schwa vowel in English (Heselwood, 2007), inspired by, though not presented explicitly within, the axiomatic-functionalist framework. In that article, the term 'simultaneous cluster' is used in place of 'phonotheme'.

2. Simultaneity

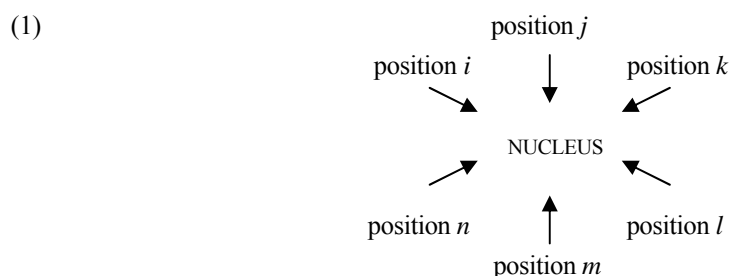
Mulder provides a precise functionally-oriented criterion of simultaneity regarding the occurrence of phonological units: for two or more units to be simultaneous it must be the case that no syntagmatic relations can be established between them (Mulder, 1968: 30-31). Syntagmatic relations are established by refuting a hypothesis of simultaneity (Mulder, 1989: 210), that is to say, in phonology by demonstrating that the sequential order of the units in question is functional. For example, the hypothesis that /l/ and /k/ have a relationship of simultaneity in e.g. *bulk* is refuted because the sequential order /-lk/ can be shown to be functional: changing the order to /-kl/ gives us the phonological form of *buckle*, a different word; the two permuted sequences therefore correlate with two different distinctive functions in English grammar (see Heselwood, 2007, 163-6 for an approach to English phonotactics in which schwa-syllables and syllabic consonants are incorporated into the same distributional frame as a preceding or following full vowel). By contrast, the hypothesis that the distinctive features "labial" and "nasal" have a relationship of simultaneity in e.g. *mist* remains unrefuted unless and until we can find English forms that are differentiated by the order in which these units occur.

The particular focus in this paper is on initial clusters in English such as /pr, bl, skr (or /sKr/ in an archiphonemic analysis), sm/ etc., which do not occur in any other permutations. Rather than view the lack of permutations as an accidental gap in the phonotactics of English, it should be seen as a structural fact preventing refutation of a hypothesis of simultaneity.

3. The phonotagm

It appears to have been generally assumed by functionalists that phonemes are like links in a chain extending through the syntagmatic dimension of phonological structure with, on the whole, little thought given to whether the functional status of the relationships between successive links might or might not always be the same in the description of a given language. More attention has been given over the years to paradigmatic relations in phonology than to syntagmatic ones although Mulder has done much to restore the balance with his notion of the

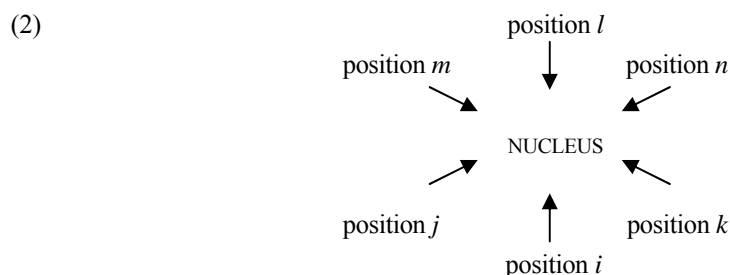
phonotagm, also called by him ‘distributional unit’ – defined as ‘a self-contained bundle of positions’ (Mulder, 1989: 444 Axiom B definition 9a), a domain in which syntagmatic relations of a limited number of different theoretically-defined kinds can be set up between the positions that comprise it and, by virtue of their assignment to those positions, between phonemes. Dickins (1998: 63) explains that Mulder establishes ‘ordering relations’ not between the phonemes in a phonotagm, nor even between the positions of the phonotagm, but between a phoneme and a position. For Mulder, it is an ordered relation because the phoneme stands in the position but the position does not stand in the phoneme (Mulder, 1968: 118). The positions comprising a phonotagm consequently have no ordering relations vis-à-vis one another and are therefore unordered, or simultaneous (Mulder, 1969: 118). In phonotactics, it is the relationship between a peripheral position and the nucleus which is important, not the relationship between one peripheral position and other peripheral positions. The simultaneity of phonotagm positions means we can represent peripheral positions as being arranged around a nucleus, with each position having a different relationship to the nucleus and a different label to identify it, but being equally close to it, as in (1):



Arrow represents relationship of determination: $a \rightarrow b$ means a determines b .

Relations of simultaneity and non-simultaneity between phonological elements can thus be distinguished by whether they are ordered with, respectively, the same position or different positions. How the positions are arranged in a representation such as (1) is unimportant as long as each position is unambiguously identifiable; the representation in (2) below is therefore functionally equivalent to (1).

However, Mulder names positions according to their sequence in realization, those containing phonemes realized before the nucleus being called ‘explosive’, those containing phonemes realized after the nucleus ‘implosive’ (Mulder, 1987: 36; 1989: 229; 1994: 50). There is then a certain tension, even contradiction, between regarding phonotagm positions as simultaneous on the one hand, and formalizing realizational sequencing into a linearly-represented model where one makes a division between pre- and post-nuclear positions. Mulder (1987: 36) in fact talks about some positions being



further from the nucleus than others, and refers to phonotagms as a ‘chain of positions’ and as ‘ordered successions of phonemes’ (Mulder, 1987: 35-6). It is difficult to reconcile this with simultaneity and it is beyond the scope of this paper to attempt to do so, but it should be remembered that description in functionalist linguistics is based on observation and if observation tells us that possibilities for occurrence are structurally different before and after the nucleus, then our description should take account of it. Indeed, how can we assign phonemes to positions without observing where they occur in realization?

That combinatorial possibilities are different in pre-nuclear and post-nuclear positions in English is uncontroversial (see e.g. Fudge, 1969; Cruttenden, 2001: 240-43; Heselwood, 2007: 166). They are thus distinct domains for indirect tactic relations, that is, tactic relations between non-nuclear constituents. If this were not the case, the general statement that /l/ clusters with /t/ and /d/ after a nucleus but not before it, e.g. *pelt*, *petal*, *field*, *fiddle*, but not */tl-/, */dl-/ or */lt-/, */ld-/, would hardly count as worth a mention whereas, in the absence of refuting examples, it is an important constraint on the combination of these phonemes in English and shows that the kind of indirect tactic relations they may contract with each other depends on phonotactic context. Similarly the permutability of /s/ and /p/ (or of one with the archiphoneme of the other) after a nucleus but not before it is a significant fact about our description of English, e.g. *lisp-lips* but only *spill*, not **ps-*; it is, furthermore, an important language-specific phonotactic fact about English which is not shared by, for example, analogous phenomena in Greek – e.g. *spiti* ‘house’ and *psomi* ‘bread’.

To take an example provided by Mulder, the phonological form of *scramble* requires, according to his analysis, a phonotagm with at least seven positions set out linearly as in Table 1 (Mulder, 1989: 231-2; /K/ and /N/ are archiphonemes).

Table 1: Mulder’s phonotactic analysis of *scramble*.

pre-explosive	1st explosive	2nd explosive	nuclear	1st implosive	2nd implosive	3rd implosive
s	K	r	a	N	b	l

Assigning the three pre-nuclear phonemes to separate positions means that one has to be able to refute a hypothesis of simultaneity by demonstrating that the sequential order /sKr-/ is functional and that to assign all the phonemes to the same peripheral position would not be justified, but no examples of phonological forms have been adduced that show this to be the case in English. Mulder counters this point by saying that, in relation to the /sTr-/ in e.g. *strength*, ‘Admittedly there is no permutability in explosive position, but this is irrelevant, as one has to consider the whole of the phonotagm, not some part, in assessing ordering relations’ (Mulder, 1989: 296), a stipulation which is, it must be said, consistent with the simultaneity of positions in a phonotagm. Yet a few pages later he advances the case for assigning the \overline{tj} in e.g. *chair* to a single position – that is, he regards it as what he terms a ‘semi-cluster’, saying that ‘within that position it acts in the absence of permutability (there is no /jT/ in explosive position) as a simultaneous bundle’ (Mulder, 1989: 299-300). If one has to consider the whole of the phonotagm then examples such as *witch-wished* ought to be sufficient to refute a hypothe-

sis of simultaneity in the case of *chair*.¹ To be fair, Mulder appeals to the further criterion of expandability, pointing out that ‘in the case of prenuclear /tʃ-/ , there can be no phoneme preceding it, nor following it explosively. As there are two phonemes which occupy a place equivalent to three positions, we can under those circumstances not assign any of the two phonemes to a specific position. All there is left is to regard /tʃ/ as a whole as standing in a position equivalent to those three positions, i.e. an archiposition’ (Mulder, 1989: 299). However, this criterion, as well as the criterion of permutability, would mean that e.g. /θr-/ (as in *three, throw*) is equally a semi-cluster, and it is far from clear why he does not represent /sm-/ (as in *small*) as a semi-cluster (Mulder, 1989: 231): it is neither permutable nor expandable (see fn. 2 below).

Mulder’s analysis of *twelfth* further conflicts with the criterion of attested occurrence elsewhere in the phonotagm. The phoneme /t/ is assigned to an archiposition (Mulder, 1989: 231) on the grounds that /sTu-/ (i.e. [stw-]) is not found in English. True, but the permutation /-usT/ is found in implosive positions in e.g. *oust, soused*. While /sTu-/ is treated by Mulder as a structural impossibility in English, the non-occurrence of explosive /tSr-/ , /kSr-/ etc. he seems to see as accidental.

3.1. *Configurative function*

A hypothesis of simultaneity is not refuted for /sKr-/ , /sTr-/ , /tu-/ or, in fact, for any initial cluster in English. The distribution of classes of phonemes across the three pre-nuclear positions Mulder sets up (see Table 2 below for examples) is entirely predictable. Pre-explosive position can only take /s/ , and any pre-nuclear occurrence of /s/ will be in this position – we could even call it the /s/-position. Oral sonorants (semi-vowels and liquids) occurring within the phonotagm and before the nucleus will always be in the 2nd explosive position, and this position can only contain oral sonorant phonemes – we could call it the oral sonorant position (there is the marginal exception of /li-/ in e.g. *lure* which many English speakers report as feeling ‘odd’). Equally predictable are the occupants of the 1st explosive position: these are the obstruents other than /s/.² Where we have such absolute bidirectional predictability there can be no semiotic value and the sequential order of the phonemes in these clusters is therefore not a semiotic feature. Given a phoneme from any of these categories – /s/ , obstruent, oral sonorant – its sequential position in an explosive combination of phonemes is structurally predetermined. Semiotic redundancy does not of course mean communicative irrelevance, as Jakobson was concerned to point out (Jakobson & Waugh, 1987: 39-41).

From a listener’s point of view the onset of the phonological form of a word must play an important rôle in word-recognition (Cutler, 1989) and a high degree of redundancy would certainly make the task easier insofar as it restricts the set of possible realizational forms that the listener could have heard. Instead of being a semiotic feature, the sequential order of the pho-

¹ It may be, however, that Mulder would analyze the final /t/ in *wished* as an instance of what he calls a ‘morpheme’ (Mulder, 1989: 228-33; see also Mulder, 1987: 37) or, later, an ‘accidental phonological appendix’ (Mulder, 1994: 51) in which case it would lie outside the basic distributional unit. I have argued against this analysis elsewhere (Heselwood, 1997: 98-9).

² The nasals /m/ and /n/ can cluster with /s/ and with /i/ , but never at the same time, e.g. *smooth, snooze, muse, news*, but not */smi-/ (except for the one lexical item *smew*) or */sni-/ . In a Mulderian analysis, nasals after /s/ occupy the archiposition deriving from the suspension of contrast between 1st and 2nd explosive.

nemes in these clusters is, then, what Jakobson calls a *configurative* feature (Jakobson & Waugh, 1987: 41-3).

Table 2: Examples of English prenuclear phonemes distributed over the three positions set up by Mulder (1989: 231).

PRE-EXPLOSIVE (/s/-slot)	1ST EXPLOSIVE (obstruent slot)	2ND EXPLOSIVE (oral sonorant slot)	EXAMPLE
s	P	l	split
s	P	i	spume
s	T	r	string
s	K	u	square
s		l	slit
s			sit
s		u	swear
	p	l	ply
	p		pie
s	P		spy
	b	l	blue
	b		buy
	t	u	twin
	t		tin
	d	r	drew
	d		do
	k	i	queue
	g	l	glue
	f	l	flew
	v	i	view
	θ	r	through
		r	rot
		l	lot
		u	what
		i	yacht

3.2. Potential for functional ordering³

Being unable to refute a hypothesis of simultaneity for any prenuclear clusters in English means we must provisionally regard the phonemes of the cluster as a simultaneous bundle occupying just one position in the phonotagm, i.e. the three positions of Table 2 can be collapsed into a single prenuclear position. There is a clear analogy here between the distinctive feature constituents of a phoneme and the constituent phonemes of a phonotheme, and the

³ For the distinction between functional ordering and realizational sequencing, see Mulder & Hervey, 1975.

analogy is entirely a valid one in that in both cases a hypothesis of simultaneity has not been refuted. The difference, however, is that in the case of the distinctive features of a phoneme the hypothesis has not been refuted in *any* phonological context whereas in the case of the phonemes of a phonotheme considered separately there will be at least one context where a hypothesis of simultaneity has been refuted. So, for example, the feature “labial” has a relation of simultaneity (symmetrical relation) with at least one other distinctive feature in *all* its contexts of occurrence, e.g. in the contexts “nasal” (/m/), “voiced, occlusive” (/b/), “unvoiced, fricative” (/f/) etc. and is therefore unorderable under all conditions of occurrence. But if we take any member of any of the clusters in Table 2 we can show it has a non-simultaneous (asymmetrical) relation with at least one other non-nuclear phoneme in at least one phonotactic context. Taking /s/ to illustrate this, it must be the case that its relation with /t/ (an indirect tactive relation via the nucleus) is different in e.g. *kits* and *kissed* because either /s/ or /t/ or both must be in a different phonotactic position. Table 3 shows three of the possible ways of accounting for this syntagmatic difference.

In version A of Table 3 /t/ is in a different position in the two forms; in B /s/ is in a different position; and in C they are both in different positions. Whichever version we adopt, and there are of course other possible ones, the relation between /s/ and /t/ cannot be said to be the same in *kits* and *kissed*. That is to say, at least one of them can determine the nucleus from more than one position. It is therefore demonstrably *not* the case that /s/ is unorderable under all conditions of occurrence. We can summarise by saying that distinctive features are phonological units which do not have the potential for functional ordering and therefore always occur in simultaneous bundles (although we have to allow bundles that comprise a single feature), while phonemes are phonological units that do have this potential, but which, contrary to Vachek’s declaration, may also occur in simultaneous bundles; in the latter case, functional ordering with respect to other members of the bundle is suspended. It is to be noted that this is not the same as the suspension of contrast between positions which gives rise to an archiposition. A simultaneous bundle of phonemes occupies a single primitive position in the phonotagm, not a position contextually derived from two or more primitive positions.

Table 3: Three ways of accounting for the syntagmatic difference between *kits* (/kits/) and *kissed* (/kist/). The indexing of positions here is arbitrary and intended only to accommodate these examples.

	explosive	nucleus	1st implosive	2nd implosive	3rd implosive
A. kits	k	i	t	s	
kissed	k	i		s	t
B. kits	k	i		t	s
kissed	k	i	s	t	
C. kits	k	i	t	s	
kissed	k	i	s	t	

3.3. *Clusters as single units*

There is nothing essentially new about attempting to describe certain clusters as distributionally unitary. Firth, the founder of the British ‘Prosodic Analysis’ school of linguistics, suggested that initial *spr-*, *str-*, etc. might best be seen as single elements (Firth, 1936: 543) but he did not examine the implications of this. One of Firth’s followers took up the suggestion pointing out that in English ‘the constituents of the initial consonant cluster of a word are severely limited in their mutual relations’ (Hill, 1966: 211) and we may interpret his statement that e.g. *spl-* be regarded as a ‘shape’ rather than a ‘sequence’ as an appreciation of the absence of functional ordering. However, his description of this ‘shape’ as a ‘sigmatized lateralized unvoiced bilabial plosive’ denies phonotactic autonomy to the three constituents and leads to the conclusion that they are phonologically quite different from the singletons /s/, /p/ and /l/. This is of course to be expected in a polysystemic approach such as the Firthian school’s, but Hill’s description of *spl-* does seem arbitrary: why not ‘labially occluded lateralized apical fricative’, or ‘hissed labially occluded lateral’, for example?

A similar analysis is offered by Fujimura & Lovins (1978) who present these clusters as simultaneous bundles of features rather than sequences of individual segments. In a later paper Fujimura (1988) describes the cluster *sp-* as an unordered set of the features {stop, spirant, labial}, implying again that a clustered /s/ is a different entity from an unclustered /s/. Furthermore, as with Mulder’s semi-cluster, these analyses necessitate bundling incompatible features together into one set, and therefore compromising paradigmatic oppositions.

There have also been suggestions that some clusters are neither single units nor sequences of units. Akhmanova (1971: 44), for example, theorises that ‘In the “phoneme – cluster” hierarchy [tʃ] and [dʒ] stand midway between *p, t, k, b, d, g*, etc. and *pr, tr, kr, br, dr, gr*, etc.’ Anderson & Ewen (1987: 265) describe clusters such as *st-* as complex segments along with affricates and propose setting up ‘a gradient between segment and sequence on which complex segments occupy an intermediate position’. Similar thinking is behind Devine’s (1971) plea for recognition of the syntagmatic ambiguity of these clusters.

A fundamental incoherence attends these proposals, however, insofar as they challenge us to conceive of an element that at one and the same time does and does not contrast with itself (or neither does nor does not) on the syntagmatic axis. Either there is one distributional prime, or more than one: there can be no halfway house here.

The notion of the *phontheme*, presented below, acknowledges the non-refutation of hypotheses of simultaneity regarding English initial clusters and at the same time avoids the problems identified in these previous attempts to account for their limited combinatorial possibilities. That is to say, the integrity of paradigmatic oppositions and syntagmatic contrasts is preserved when these clusters are modelled by the phontheme.

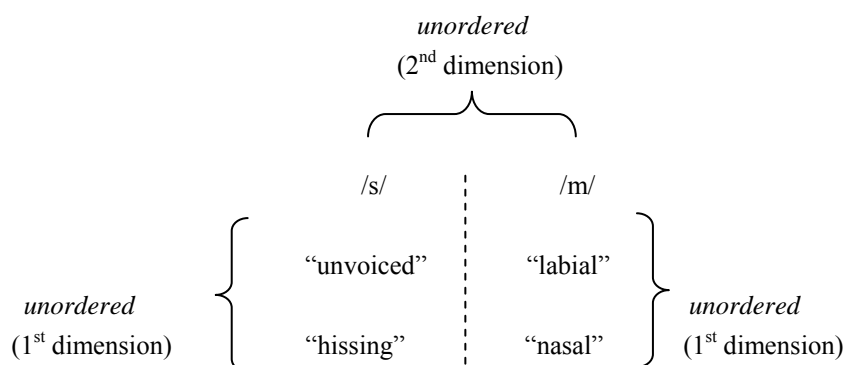
3.4. *The phontheme*

As has been demonstrated, a hypothesis of simultaneity can be refuted for phonemes in post-nuclear positions but not for those occurring in the pre-nuclear part of the phonotagm in what have traditionally been called initial clusters in English. The members of these clusters can therefore be assigned to a single phonotactic position (Heselwood, 2007: 166-7), meaning that we have a simultaneous bundle of phonemes, or, put another way, a simultaneous bundle of

simultaneous bundles (Heselwood, 1987: 80-81). It is useful to think of it as simultaneity in two dimensions, the first being the simultaneity that obtains between the constituent distinctive features of a phoneme, the second being the simultaneity between the constituent phonemes of the cluster. Following a suggestion made originally by Michael Lamb (personal communication), the term *phonotheme* will be used for a simultaneous bundle of two or more phonemes (Dickins, 1998: 142-3; 379); following Mulder's convention for representing semi-clusters, phonothemes will be transcribed with a ligature. In terms of set theory, a phonotheme is an unordered set of unordered sets as diagrammed in (3) for the phonotheme $\sqrt{sm-}$; although unordered, the sets are nevertheless discrete and thus avoid the unwelcome consequence of having incompatible features in the same set.

The unorderedness of the distinctive feature constituents of a phoneme means that it is of no matter whether we state the content of /m/ as the unordered set {"labial, nasal"} or as {"nasal, labial"} – they are equivalent expressions. By the same token it is of no matter whether we state the content of the phonotheme $\sqrt{sm-}$ as the unordered set {/s/, /m/} or {/m/, /s/}. By convention, however, distinctive features are stated in the order 'glottal feature, place-of-articulation feature, manner-of-articulation feature', e.g. /b/ as

(3) Simultaneity in two dimensions in an initial cluster. The unordered sets {"hissing", "unvoiced"} and {"labial", "nasal"} form one dimension, and the unordered set {/s/, /m/} forms the other. Note that the two sets of distinctive features remain discrete sets.



"voiced, labial, occlusive", so by convention we can state the phonemes of a phonotheme in their order of realization. But the fact that {/m/, /s/} is equivalent to {/s/, /m/} in this context leads to a problem in the traditional functionalist postulation of an archiphoneme in e.g. *spill*, *still*, *skill* (Trubetzkoy, 1969: 79-80; Davidsen-Neilsen, 1978: 183; Akamatsu, 1988: 189; Mulder, 1989: 238). These initial clusters are phonothemes, so the /s/ and the occlusive are in a relation of simultaneity and it becomes unclear how to argue that one of them provides the context of neutralization for the other: if {/P/, /s/} is equivalent to {/s/, /P/}, how then can /s/ be the context for the neutralization of the /p/:/b/ opposition any more than the occlusive can be said to be the context for neutralization of the /s/:/z/ opposition? The choice of which is the context for which is arbitrary. There are four logically possible phonothemes of the form {(/s/ or /z/), (/p/ or /b/)} but the principle of simplicity in linguistic description means we need assume that only one actually occurs and we cannot determine which one it is in a non-arbitrary manner. If we wish to avoid arbitrariness we have no option but to say that both these oppositions have been suspended and that the *sp-* phonotheme should be represented as {/S/, /P/}.

The context for neutralizations of this kind is the co-occurrence of certain distinctive features in the same phonotactic position; in this example, co-occurrence of “hissing” and “occlusive”. In other words, where “hissing” and “occlusive” occur together in a relation of simultaneity the “voiced”：“unvoiced” opposition is suspended in the position in question. In fact it seems that wherever “hissing” occurs in two-dimensional simultaneity in English there is suspension of the “voiced”：“unvoiced” opposition. This has a phonemic analogue in English where there is no “voiced”：“unvoiced” opposition among phonemes containing the feature “nasal”, for example.

3.4.1. *Determination*

We need to consider at this point the relations between a phonotheme and the nucleus of a phonotagm. A phonotheme in a peripheral position will necessarily involve subordinate direct tactic relations with the nucleus (Mulder, 1989: 445, Axiom B definition 11a). The important question is whether each member of the phonotheme has its own subordinate tactic relation with the nucleus, or whether there is just the one relation such that the phonotheme as a whole determines the nucleus. The difference can be represented as in (4) using the phonotheme /pr/ as an example.

- (4) a) Separate determination of the nucleus by the members of a phonotheme.
b) Collective determination of the nucleus by the members of a phonotheme.



Determination of the nucleus of a phonotagm, or any construction, can only happen from a non-nuclear (peripheral) position within the same construction. It would be incoherent to claim otherwise if we accept that a phonotagm is ‘self-contained’ (Mulder, 1989: 444 Axiom B definition 9a; Dickins, 1998: 377-8 Axiom B definition 9a). Occupancy of a peripheral position is a necessary and sufficient condition for a phoneme to determine a nucleus, it is what makes such determination possible. When a single phoneme occupies a peripheral position, e.g. /p/ in *pen*, it is the totality of what is in the position that determines the nuclear /e/. That is to say, the constituent distinctive features of /p/ – “unvoiced, labial, occlusive” – determine it collectively, not separately. We can think of a peripheral position as a single channel connecting to the nucleus through which the contents of that position relate to the nucleus, i.e. establish a direct tactic relation with it. The same conclusion must perforce be reached in the case of the constituent phonemes of a phonotheme: a phonotheme is ‘a single determining entity’ (Heselwood, 1992: 132) as represented in (4b). Wherever there is more than one element in a peripheral position – two or more distinctive features, or two or more simultaneous phonemes – each element of course contributes to the determination of the nucleus – if it did not, it would not be ‘separately relevant to the purport of the whole of which it is a part’ (Mulder, 1989: 436 Axiom A definition 1a; see also Dickins, 1998: 356-7): it would not have distinctive function and so would not in fact *be* a distinctive feature or phoneme. Taking my reformulation of Mulder’s distinction between parallel and diverse determination (Mulder, 1989: 174-5) presented in Heselwood (2008), we can say that, because there is no attested permutation of the members of a pho-

notheme, and no possibility of permutation of distinctive features, there is parallel determination. Where there is permutation, there is diverse determination. This point is returned to later in section 4.

A phonotheme is a member of a position class, or paradigm, and meets the definition of a paradigmeme (Mulder, 1989: 445 Axiom B definition 10a; Dickins, 1998: 382 Axiom B definition 10a). As a single determining entity, it forms, in relation with its peripheral position, a single syntagmeme⁴ (see the definitions of syntagmeme in Mulder, 1980: 48 Axiom B definition 10; 1989: 445 Axiom B definition 10; and in Dickins, 1998: 381-2 Axiom B definition 10) as represented in (5).

(5) The members of a phonotheme represented as a single syntagmeme.

$$\left. \begin{array}{l} p \\ r \end{array} \right\} \mathbf{R} e^i \quad \text{or} \quad (\overline{pr}, e^i)$$

e^i denotes a particular explosive position in a phonotagm

\mathbf{R} denotes the relation between a phoneme and the position it occupies

Bracketed expression shows the phonotheme and its position as an ordered pair (Mulder, 1980: 48 Axiom B definition 10).

Combining the representations in figures 4 and 5, we can represent the determination of a nucleus by a syntagmeme comprising a phonotheme and a position as in (6).

(6) Determination of the nucleus by a syntagmeme comprising a phonotheme and a position.

$$(\overline{pr}, e^i) \longrightarrow \text{nucleus}$$

So far in this section it has been argued that the phonemes of a phonotheme determine the nucleus of the phonotagm in the same way, i.e. in parallel. It remains, however, to say that because phonemes are by definition (minimum) syntagmatic entities, and all syntagmatic entities in a construction have tactic relations with each other even in the absence of syntagmatic relations (Mulder, 1989: 442 Axiom B definition 7c2; Dickins, 1998: 371 Axiom B definition 7c1), it is theorematic that there are phonotactic relations within a phonotheme and that therefore there can be phonotactic relations within a single phonotagm position.

Nearly a century ago, Baudouin de Courtenay (1910/1972: 272) likened the component parts of a phoneme to the notes in a musical chord but it is more appropriate to apply the musical chord simile to a phonotheme. The distinctive feature components of a phoneme are then more like the partials of a single note. That phonothemes are realized sequentially is analogous to a pianist playing a chord as an arpeggio because he/she cannot reach all the keys at once. Explanation for the realizational sequence is probably to be sought in sonority relations

⁴ This departs from the view in Heselwood (1992: 132) where each phoneme in a phonotheme is said to be a paradigmeme in its own right, and thus to form, with its position, a syntagmeme.

and the strong tendency for sonorant sounds to be closer to a vowel and obstruent sounds to be further from it, a point returned to below.

3.4.2. *Commutation*

There remains the question of the commutation classes within a phonotheme. If the phonemes of a phonotheme are, as this paper is arguing, a simultaneous bundle then we cannot ascertain the commutation classes by positional criteria. For example, we cannot (provisionally) establish the class that /r/ belongs to in e.g. /k \overline{r} / by noting other phonemes that can follow /k/ in this context precisely because we are saying that /r/ does NOT follow /k/ in any functional sense - it is from a functional point of view simultaneous with it. We can, however, approach it a different way, the same way in fact that we approach the commutation of distinctive features in phonemes.

The distinctive features of a phoneme are by definition simultaneous yet we have no trouble identifying the commutants of a given feature. Only those features that cannot co-occur commute with each other. So for example English /b/ comprises the features “voiced, labial, occlusive”. “Unvoiced” commutes with “voiced” but they cannot co-occur; “voiced” and “labial” co-occur but cannot commute and there are very clear phonetically-grounded reasons why these and other restrictions on co-occurrence and commutation are found. Applying the same criteria to the phonemes of a phonotheme, we can state that the commutants of /r/ in /k \overline{r} / are those phonemes that cannot co-occur with it in phonothemes. As there are no attested examples of /r/ occurring with /l, i, u/, or of any of these occurring with any of the others, we can set these up as commutants.⁵ In realizations of phonothemes these elements always come last, an observation best accounted for by what Greenberg (1970: 131) has called ‘the law of the voiced syllable center’ and what others have called ‘the sonority principle’ (Laver, 1994: 503-5) or the ‘sonority sequencing generalization’ (Hall, 2006: 6), not by language-specific phonotactic distribution patterns.

Similarly, occlusives do not co-occur in English initial clusters, neither do nasals. Although there is not sufficient space here to examine all the co-occurrence restrictions involved, and thereby to exhaustively identify members of phonothematic commutation classes, it is worth pointing out that /s/ (or its archiphoneme /S/) can occur with almost every phoneme (or, where relevant, its archiphoneme) that clusters initially in English. Of course /s/ does not cluster with /ʃ/, but arguably the latter does not cluster with anything initially in English: phonetic [ʃɹ] in e.g. *shriek*, *shrew*, *shrank*, etc. is best described as the realization of /s \overline{r} / with anticipatory coarticulation, cf. the realization of /t, d/ in *tree*, *dream* etc.

4. Ordered sequences

Simultaneity cannot be refuted for what have traditionally been called initial clusters in English, and therefore only one phonotactic position need be set up for them. But simultaneity can be refuted for consonants separated in realization by schwa, and these sequences do require

⁵ The /li-/ in *lure* has already been noted as a rare exception. Its marginal status, and the fact that it is felt by many native speakers to be unusual, can be attributed to the co-occurrence of /l/ and /i/ in a phonotheme violating a general restriction. For the history and accent distribution of clusters with /i/ see Wells, 1983: 206-8, 247-8, 330-31.

another phonotactic position. If we compare, for example, *support* and *terrain* with *sport* and *train* respectively, we find the pretonic consonants are reversible around the schwa in the former pair – e.g. *perceive*⁶, *retain*. The phonotactic structure can be accounted for by setting up two explosive positions. If we also consider *light* and *alight*, we can account for them in a similar fashion, i.e. by assigning /l/ to the first explosive position in *light* and to the second in *alight*, analogous to the different phonotactics of /l/ in *plight* and *polite* (see Heselwood, 2007: 169). Table 4 contains examples to compare ordered clusters with simultaneous clusters (phonothemes). The occurrence of pretonic schwa in English word-forms is in fact entirely predictable by reference to whether the second explosive position is occupied or not (Heselwood, 2007: 171).

Table 4: Simultaneous and ordered explosive clusters.

	1st explosive	2nd explosive
sport	\widehat{sp}	
support	s	p
perceive	p	s
train	\widehat{tr}	
attrition		\widehat{tr}
terrain	t	r
retain	r	t
plight	\widehat{pl}	
apply		\widehat{pl}
polite	p	l
lapel	l	p
light	l	
alight		l

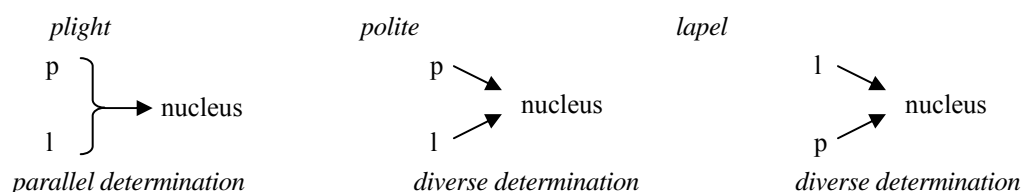
The phonological difference between *support* and *sport*, between *terrain* and *train*, and also *polite* and *plight*, can be represented as a difference in the kind of indirect tactic relation obtaining between the first two consonants. In the first of each pair this relation is asymmetrical (non-simultaneous), in the second it is symmetrical (simultaneous). That is to say, *sport* and *train* each begin with a phonotheme, / \widehat{SP} -/ and / \widehat{tr} -/, while *support* and *terrain* begin with the ordered clusters /sp-/ and /tr-/. Forms such as *the port*, *the rain*, *the light* also contain a bound syllable with schwa⁷ and thus are structurally parallel to *support*, *terrain*, *polite* phonologically speaking.

Returning to the question of parallel and diverse determination raised in section 3.4.1 above, the distinction can be applied to, respectively, simultaneous and ordered clusters as represented in (7):

⁶ I am assuming non-rhotic varieties of English, such as RP, or Southern Standard British English.

⁷ There is a strong case for regarding unstressed *the* etc. as clitics although this has not traditionally been the view of grammarians (see e.g. Huddleston (1976: 45-7)), and the case is even stronger if the schwa is not the realization of a phoneme.

(7) Parallel and diverse determination by simultaneous and ordered clusters.



In *polite* and *lapel*, the /p/ and /l/ determine the nucleus diversely because they meet the two required conditions for diverse determination – 1) they permute, and 2) the different permutations correlate with different distinctive functions (Heselwood, 2008). By contrast, in *plight* they determine the nucleus in parallel because the conditions for diverse determination are not met.

To accommodate the analyses of *support*, *terrain*, *polite* etc. the English phonotagm needs to be set up with at least two explosive positions, and there have to be adequate criteria for assigning phonemes and phonothemes to them. Exploration of these criteria and their implications for the syntagmatic phonological description of English is beyond the scope of this paper, but the issues are addressed to some extent in Heselwood (2007), where sequences that arise from Latin prefixes such as *ab-*, *ob-*, *sub-*, *ad-*, *acc-*, *succ-* etc. are considered, as are examples that seem to refute the hypothesis of simultaneity of e.g. *sk* in *askance* in light of the *ks* in *accede*, for which a third explosive position is postulated.

5. Conclusion

A hypothesis of simultaneity has not been refuted for any of the consonant clusters traditionally described as initial clusters in English and therefore they are all examples of phonothemes; that is, the constituent phonemes can be described as all occupying the same position in syntagmatic phonological structure. It follows that only one explosive phonotagm position is required to accommodate them; within that position there are tactic relations but not syntagmatic relations. The phonemes in a phonotheme cannot be shown to determine the nucleus of the phonotagm in different ways any more than can the constituent features of a phoneme and therefore there is parallel determination. Commutation classes in phonothemes are set up to contain those phonemes that do not co-occur in a phonotheme. A relationship of simultaneity in a phonotheme means that, in deciding whether or not an opposition is suspended within a phonotheme, we cannot separately identify a position of neutralization and a context of neutralization.

A second explosive position is required to account for the difference between pairs such as *sport-support*, *train-terrain*, *plight-polite* and also *light-alight*, and a third seems to be called for to handle a small number of forms with Latin prefixes. The question of how to deal in an axiomatic-functionalist framework with catenations of schwa syllables in e.g. *and the support*, *to the train*, *for a light* (where the gradable items occur in their weak forms) from a phonotactic point of view has yet to be properly considered.

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