

## Chapter 2

# Noise as a Phonological Element: On the Representation of Plosives and Affricates

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**Abstract** This paper is devoted to the problem of the noise component in the phonological representation of consonantal segments, plosives and affricates in particular. In this brief discussion, arguments will be supplied in favour of awarding this property the status of a phonological primitive capable of manifesting itself as an independent segment as well as combining with other such primary elements to form larger, more complex melodic structures.

After the phonetic characteristics of noise have been introduced, we shall explore a number of melody-related phenomena which clearly indicate that noise should be recognised as an independent phonological element. In particular, special attention will be devoted to lenition processes. The data will be taken from two different languages: English and Basque. It will be demonstrated that noise participates in phonological processes independently of other primes. One kind of phenomena we shall focus on will be the so-called edge and anti-edge effects exhibited by affricates. Further, certain cross-boundary events will be elaborated on. The problem of the phonological status of noise will be regarded through the optic of Government Phonology. We shall adhere to the major assumptions of Element Theory which is part of this framework. Applying this model of melodic representation, internal structure of plosives and affricates will be examined.

## 2.1 Theoretical Introduction

The aim of the present paper is to submit evidence testifying to the existence of the phonological primitive of noise as a legitimate member in the structure of released obstruents, plosives and affricates in particular. In this brief discussion, arguments will be supplied in favour of awarding this property the status of a phonological element capable of manifesting itself as an independent segment as well as

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Importantly, our attention will be focused on the internal structure of the aforementioned segment types with a view to depicting the function of the noise prime in their phonological representations. The model of intra-segmental structure adopted in this presentation is non-linear, autosegmental and molecular, in which autonomous elements reside on separate tiers, each being independently synchronized with a skeletal slot and having a unique phonetic interpretation. The major assumptions underlying such a mode of representation are summarized in (1) below:<sup>1</sup>

### 1. *Elements as minimal phonological units*

- Elements are autonomous;
- They are directly co-indexed with skeletal slots;
- Each prime resides on its autosegmental tier;
- Elements are gathered under class nodes which dominate them;
- Each element has a unique phonetic interpretation;
- Elements can combine to form complex melodic structures;
- Their attachment to slots requires an autosegmental licence;
- Only elements associated to skeletal positions can be manifested phonetically;
- Within segmental structures, primes can enjoy different status (head, operator/dependent), the head prime defines the salient property of the segment.

In this molecular approach to segmental structure, segments consist of one or more elements which amalgamate in accordance with the licensing constraints, i.e. co-occurrence conditions, built in the system of a given language.<sup>2</sup> Since, as indicated above, primes can enjoy different status, varying theoretical configurations of elements can be distinguished. These are schematized in (2) below.

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<sup>1</sup>The major characteristics of phonological primes are defined in Harris (1994), Harris and Lindsey (1995) as well as Bloch-Rozmej (2008).

<sup>2</sup>A particular language, for instance, can impose a bar on the combination of given two primes as a result of which they will never be found to co-occur within a single segment. Such a licensing constraint can be identified in English where the elements **I** (frontness, palatality) and **U** (roundness) do not combine within vocalic segments. Consequently, English does not possess front rounded vowels.

2.	(a)	x	(b)	x	(c)	x	(d)	x	(e)	x
				<u>A</u>		A		<u>A</u>		A
								B		B

As depicted in (2a), a prosodic position can dominate no segmental material, thus remaining melodically mute, it can be mono-elemental with this prime being either head or dependent (in (2b) and (2c) respectively), or more elements can build a segment with one of them being its head or with none of the primes in the head status (the structures in (2d) and (2e) respectively). Significantly, the head element (underlined) determines the salient property of the melody. In other words, its contribution to the phonetic shape of the segment is the largest.

This brief characterization of melodic structure proposed by non-linear frameworks, Government Phonology in particular,<sup>3</sup> reveals two important features of elements as phonological entities. Namely, thanks to their autonomous interpretation, elements directly determine the phonetic outcome of a given phonological structure. Secondly, their residence on separate autosegmental tiers allows them to participate in phonological processes independently of the remaining elements belonging to particular segmental representations. Consequently, the recognition of the existence of a given phonological element rests upon two kinds of evidence. Firstly, a phonological prime has to have significant phonetic exponent, which is most obviously supported by the occurrence of melodies defined exclusively by this very element. Secondly, we should be able to detect phonological processes which directly target the posited prime, or alternatively, all the other elements building a segment except the prime in question. Finally, phonological significance of an element derives from its ability to define some important aspect of the system, for example its susceptibility to licensing constraints or other language-specific principles (e.g. being able to occupy the head position of the segment or, alternatively, being a persistent non-head).

## 2.2 Noise as a Phonological Prime

Let us now turn to the phonetic effect of noise and discuss evidence implying its phonological status. Government Phonology (henceforth GP) argues in favor of recognizing three manner-defining phonological primitives: occlusion, noise and nasality.<sup>4</sup> To specify the distinctive characteristics of **h**, let us quote Harris (1994: 123): “the elemental pattern of **h** may be defined as noise, which maps onto the speech

<sup>3</sup>The framework first proposed in Kaye et al. (1985, 1990) and considerably refined in e.g. Harris (1994), Gussmann (2002), Cyran (2003), or Scheer (2004).

<sup>4</sup>The element of occlusion defines the effect of stoppiness, or an abrupt decrease in overall amplitude. Nasality will naturally reside in the structure of nasal vowels and consonants (Harris and Lindsey 1995). Further, there are the so-called resonance elements specifying the place of articulation of consonants: **I** (palatality), **U** (labiality) and **A** (coronality). The laryngeal primes **H** and **L**, in turn, are responsible for defining voicelessness and voicing respectively.

signal as aperiodic energy. The articulatory targeting of this effect involves a narrowed stricture which produces turbulent airflow. This element contributes a noise component to the class of obstruent consonants". As further argued in Harris and Lindsey (1995c: 70), "the absence of any supralaryngeal gesture in the independent articulation of [h] is entirely the function of the fact that it lacks its own resonance property. In compounds with other elements, however, the location of the noise-producing gesture will be determined by whatever resonance element may also be present".

Defined in this way, noise will naturally reside in fricatives and affricates, sounds which at least in some phase of their production involve turbulent airflow. Yet, in orthodox feature-based models of segmental representation, this component has not been recognized as phonologically significant in plosives. It has to be observed, however, that in order to comply with the phonetic facts, phonology should be able to account for the aperiodic energy characterizing the release phase of genuine plosives which manifests itself in the form of a noise burst. However, before bringing up evidence supporting the presence of noise in the lexical structure of plosives, let us focus on noise itself. As indicated in the introduction, each phonological prime must have a unique phonetic manifestation. This requirement is satisfied in the case of noise since its independent interpretation is that of the glottal fricative [h]. Also, as already stated, in complex segments represented as elemental compounds, noise defines the aperiodic energy identifiable in the phonetic signal. To illustrate this situation with some examples, the structures of selected English fricatives have been depicted in (3).

3.

[h]	[s]	[θ]	[f]	[v]	[ʃ]
x	x	x	x	x	x
h	<u>h</u>	h	<u>h</u>	<u>h</u>	<u>h</u>
	A	<u>A</u>	U	U	A
	H	H	H		I
					H

(3) discloses one more important dimension of segmental structure that pertains in an obvious way to noise-containing sounds, namely headedness relations. As indicated in (3), head elements are underlined. The head-dependent relation is a GP-specific means of representing elemental salience. In this way, we possess an instrument for representing the difference between strident and non-strident fricatives and affricates. Thus, **h**-headed segments will display greater stridency, or noisiness, than ones in which **h** is just a dependent.

Moving on to the structure of obstruent stops, our aim now is to uphold their representations involving the element of noise, despite its being less significant than occlusion. The latter defines the acoustic effect of an abrupt decrease in overall amplitude, articulatorily effected as constriction. More specifically, we shall address the data illustrating the participation of noise in phonological processing

as an independent prime. In particular, the following processes indicate the presence of **h**:

- Spirantisation,
- Debuccalisation,
- Tapping,
- Glottalling.

### 2.3 Noise as a Process Target and Result: The Structure of Plosives

The acoustics of plosives indicates the necessity of representing them by means of two independent elements: occlusion and noise. Even though the narrowing in the vocal tract typical of plosives is practically equal to zero, their release is accompanied by a short noise burst. However, more compelling evidence in favor of **h** in plosives comes from lenition processes.

One of them is the process of *vocalization*, which results in the weakening of the segment. In Element Theory,<sup>5</sup> such an effect is represented as decomplexification of a melody carried out through the loss of elements which become delinked from their skeletal slot. From the phonological perspective, the advantage of such effects derives from their ability to indicate independent elements defining the place and manner of articulation of sounds. Thus, the process of debuccalisation targets the place-defining prime and discloses the existence of manner primes. With respect to obstruents, two processes seem to be of utmost importance: spirantisation and loss of audible release. Since each process targets one element at a time (Clements 1985), weakening can be characterized as the suppression of some aspect of the elementary content of a segment. In other words, lenition involves progressive decrease in the melodic complexity of a segment. It seems reasonable to expect that the weakest segments, which are pre-deletion targets, are the least complex, i.e. monoelemental. In this way, lenition testifies to the existence of individual primes.

With that in mind, let us examine the stages of one of the opening processes, quoted in Harris (1994):

4. *Opening trajectory* (Harris 1994: 120)

Spirantization	>	Aspiration	>	Deletion	
Plosive	>	Fricative	>	<b>h</b>	> Ø

Defined in terms of progressive decomplexification, the process of lenition reveals the existence of the noise prime which shows up as the least complex segment between the two extremes of a released obstruent and zero. In this type of lenition process, the

<sup>5</sup>Element Theory is part of the Government Phonology framework. It pertains to the nature and phonological behaviour of elements within melodic structures.

element targeted is that of occlusion, whereas the one that remains is noise. Such a development can be found in Ireland and Merseyside area of England. A couple of illustrative examples come from Harris (1994: 121):

- |    |      |       |        |        |
|----|------|-------|--------|--------|
| 5. | get  | [gɛs] | letter | [lɛsə] |
|    | at   | [æh]  | not    | [nɒh]  |
|    | that | [dæh] | but    | [bʊh]  |

As the [h]-final forms indicate, spirantisation has given way to debuccalization to [h] in function words. Thus, the element of noise turns up as the most primitive unit of the lenited segments (see (9) below).

Further, we can identify a process which directly targets the noise prime, often leaving the remaining elements intact. The development that is meant here is that of tapping, or flapping. The process is firmly established in most of North America, Australia, Ireland and parts of England. Examples depicting this phenomenon are listed in (6):

- |    |        |          |         |           |
|----|--------|----------|---------|-----------|
| 6. | pity   | [pɪɾɪ]   | pretty  | [prɪɾɪ]   |
|    | fit us | fɪ[r] us | get off | ge[r] off |
|    | city   | [sɪɾɪ]   | set up  | se[r] up  |

As can be seen, the intervocalic context yields a coronal tap, a segment consisting of the occlusion prime and one specifying the place of articulation. It loses, however, the element of noise (see (9) below). A more radical form of weakening resulting in the loss of both noise and resonance primes takes place in the case of glottalling:

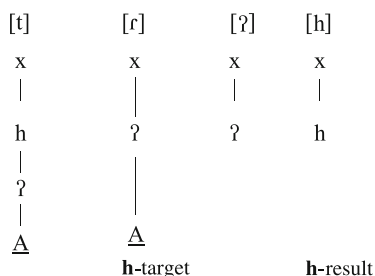
- |    |                    |       |                 |
|----|--------------------|-------|-----------------|
| 7. | <i>Glottalling</i> | >>    | <i>Deletion</i> |
|    | Plosive            | > ? > | Ø               |

In this lenition type, prevalent in Scotland and England, the loss of the coronal gesture is accompanied by the delinking of noise, the residual reflex being realized with glottal stricture, as in

- |    |      |         |       |         |
|----|------|---------|-------|---------|
| 8. | pit  | [pɪʔ]   | bit   | [bɪʔ]   |
|    | pity | [[pɪʔɪ] | peter | [pi:ʔə] |

The three weakening developments occurring in the varieties of English can be structurally depicted as follows:

9.



It can be clearly noticed that the processes of lenition operating in English disclose the existence of an independent element of noise which can be both the target of the process and the sole resident of the segment after the delinking of the remaining primes has been effected.

In what follows, we shall look into the structure of affricates, whose behaviour implies the presence of both manner-defining primes in their structure: that of occlusion and that of noise.

## 2.4 Affricates: Noise and Occlusion Together and Apart

Affricates are often considered as consonants having bi-segmental structure. Such a conception stems from the articulatory evidence which reveals the presence of two consecutive phases: constriction and narrowing producing friction. The approaches to affricates vary. On the whole, we can distinguish the following theoretical possibilities of representing affricates:

10. (a) One segment attached to a single skeletal slot
- (b) Two segments attached to two adjacent slots
- (c) Two segments linked to one slot (contour structure)
  - i. Whole segments are attached to the slot
  - ii. Elements from different tiers are linked to a single slot
    - With an ordered sequence of stop + fricative parts
    - With an unordered sequence of stop + fricative parts

The first option was proposed in Rubach (1994), where affricates were treated as strident stops. Yet, the evidence on the so-called edge effects concerning different behavior of affricates with respect to the segments on their right and to their left-hand neighbors implies a bi-partite analysis. The data on stress placement in English, on the other hand, exclude the analysis of affricates as a sequence of two independent positions attached to a stop and to a fricative. More specifically, in English verbs, stress falls on the last heavy syllable and should the last one be light, on the penult. Consider the words in (11):<sup>6</sup>

- |                 |              |          |
|-----------------|--------------|----------|
| 11. (a) Torment | (b) Maintain | (c) Edit |
| Collapse        | Arouse       | Cancel   |

If affricates consisted of two positions, syllables containing them should behave just like ones containing long vowels or a final VCC sequence. This, however, does not take place, as depicted below:

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<sup>6</sup>Letters indicating the stressed vowels are in bold type.

## 12. Manage, damage, encourage

Hence, we infer that the affricate-containing word-final syllable is light. This, in turn, suggests that affricates are linked to a single skeletal position. Such a representation is known as a contour structure. It has to be acknowledged at this stage that even among phonologists who opt for the contour analysis, there are ones who argue in favor of the Ordered Component Analysis, with a strictly determined sequence of a stop plus fricative parts (e.g. Hoard 1967; Campbell 1974; Hockett 1975; Ewen 1982; Clements and Keyser 1983; Sagey 1986; Steriade 1994; van de Weijer 1996). The Unordered Component Hypothesis represented by Lombardi (1990) and Hualde (1988a, b, 1991), assumes that the order of affricate components is irrelevant. These two opposing viewpoints are possible and justifiable since affricates exhibit on the one hand edge effects, and on the other hand, anti-edge effects. Put differently, they sometimes behave with respect to the left-hand segments as stops and to the right-hand ones as fricatives, but on other occasions this order does not matter. Consider the past tense allomorphy or plural forms in English:

- |                  |                 |                |
|------------------|-----------------|----------------|
| 13. wanted [tɪd] | but messed [st] | watched [tʃt]  |
| cats [ts]        | buses [sɪz]     | watches [tʃɪz] |

Clearly in the above examples, with respect to the right-hand segments, affricates behave like fricatives. However, Lombardi (1991) brings up data from Basque which undermine the Ordered Component Analysis. In Basque, stops are voiced after a nasal or lateral segment, as in

- |             |                   |                      |
|-------------|-------------------|----------------------|
| 14. afal-tu | [afald <u>u</u> ] | ‘have dinner, perf.’ |
| ken-tu      | [kend <u>u</u> ]  | ‘take away, perf.’   |

Yet, affricates resist the voicing operation:

- |               |            |                        |
|---------------|------------|------------------------|
| 15. afal-tsen | [afaltsen] | ‘have dinner, imperf.’ |
| ken-tsen      | [kentsen]  | ‘take away, imperf.’   |

The facts addressed so far bring to light the following properties of affricate segments:

16. *Affricates*

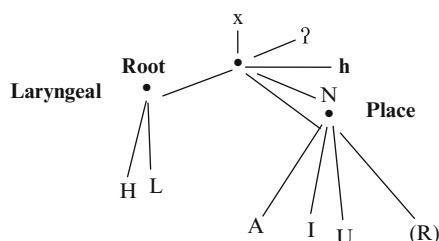
- Are prosodically simplex.
- Are melodically complex.
- Exhibit inconsistent behavior with respect to the processes targeting them from the right and from the left, which depends not on the sequential ordering of their parts but the presence of a given feature or the character of the process.

To clarify the last point, it has to be added that for the outcome of the process it seems to matter how much of the internal structure of the affricate is visible to the process. This point will be illustrated presently.



GP argues in favour of the geometric organization of elements in the subsegmental plane. This hierarchical arrangement is depicted in (17).

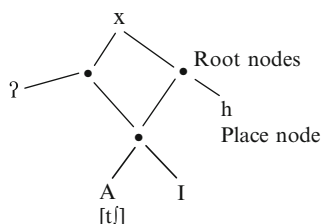
17. *Geometric configuration of elements: Elements grouped under class nodes*



Individual elements are organized under class nodes: the Root, Place/Resonance and Laryngeal. A phonological process can involve either a single prime or target the whole class node, thus affecting all the elements gathered under it.<sup>7</sup>

GP has its own answer to the affricate dilemma which is based on the recognition of class nodes. In detail, Harris (1994) proposes a *contour structure* with an internal geometry of elements which are arrayed under class nodes. This structure is depicted in (18)

18.



The representation rests upon the assumption that elements can co-exist under a single skeletal position without actually undergoing fusion, unlike in plosives for instance.<sup>8</sup> The structure assumes that within a single melody, two independent manner elements, occlusion and noise, are dominated by two different Root nodes, which prevents fusion.<sup>9</sup> Both Roots are linked to a single Resonance or Place node, which expresses the homorganicity of the affricate parts. This structure accounts for the fact that with respect to the processes depending on syllable weight, affricates behave as prosodically simplex segments. Importantly, the two Roots reside on a single autosegmental tier, which secures a sequence of the

<sup>7</sup>For more information on element geometry, see Harris (1994) and Bloch-Rozmej (2008).

<sup>8</sup>In plosives noise and occlusion are fused under a single slot.

<sup>9</sup>The idea of two Root nodes goes back to Clements (1987). McCarthy (1988) proposed that manner elements should be dominated directly by the Root.

stopness and noise phases. Harris's structure of an affricate is very useful in the account of affrication processes attested in English. In English, apart from the two lexical affricates, the coronal [t] and [d] can undergo affrication to [ts] and [dz], especially in the intervocalic position, as in [pitsi], [tsen] [dzip]. This effect is characteristic of the London vernacular speech (Wells 1990). In some cases, this process leads to spirantisation, whereby [t]>[ts]>[s]. In terms of GP, the affrication of plosives can be analysed in terms of the Root node split. Namely, a single Root undergoes cloning, whereby each of the new Root nodes comes to dominate its own manner element, both Roots being still synchronized with a single Place node. Interestingly, and luckily for our contour analysis, affrication takes place before a vowel. It must be stressed that between a plosive, which is a constricted sound, and the vowel, which is characterized by considerable opening in the vocal tract, the articulatory distance is huge. Hence, affrication can be seen as a mechanism reducing this distance by the progressive opening of the full constriction of the stop part of the affricate, through the narrowing of the noise phase of its latter part before eventually a vowel succeeds.

*constriction > narrowing > opening*

## 2.5 Conclusion

In conclusion, we hope to have demonstrated that the element of noise is a legitimate member in the structure of all released obstruents, including fricatives and plosives. However, the phonetic contribution of the prime to the manifestation of these segment types is different. More specifically, in the structure of plosives, noise has to fuse with occlusion. In fricatives, **h** is the sole manner-defining element. Further, it has been shown that noise possesses a unique phonetic manifestation and can be a single resident of a consonantal segment. In isolation, **h** is interpreted as a glottal fricative.

Furthermore, noise can be directly targeted by phonological processes and it remains in the structure of a consonant after spirantisation/aspiration processes have lenited this segment. Both manner-defining primes – occlusion and noise – are needed in the structure of affricates as they enable us to express both their bi-segmental phonetic nature and the puzzling behaviour of affricates with respect to phonological processes. We have demonstrated that a special contour structure should be employed in the phonological representation of affricates. In such configurations, noise and occlusion have to be independently dominated by separate Root nodes which are both linked to a single Place/Resonance node. This geometric arrangement of primes enables us to provide an account of the phonological phenomena involving affricates much more efficiently than has been done in the traditional, non-autosegmental frameworks.

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