The Restrictiveness of Backley's Element Theory

Master's Thesis in Linguistics

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Abstract

Table of Contents

1. Abstract

In this thesis I present articulatory processes to challenge the restrictive grammar of Element Theory. Backley's work presents the many advantages of this new grammar and its implementations in phonological analyses. However; ET's purely acoustic origins reflects signs of substantial restriction when the grammar is utilized to describe purely articulatory processes such as nasal place assimilation. In some cases a possible solution can be presented in the segmental structure where in other cases the theory as represented in Backley (2011) just reasons to be too restrictive.

2. Introduction

To move away from the traditional angle, with which most phonology textbooks approach phonological processes, Phillip Backley (2011) introduces the clear and outlined grammar of element theory that serves as an alternative to traditional distinctive features. In his book on element theory, Backley outlines its theoretical background and introduces the reader to the grammar and applications of the theory within the framework of phonology. Considering his work is introductory, he utilises the more familiar grammar of feature theory to connect the still somewhat unfamiliar concepts of ET to a phonological theory more familiar to the reader. With this connection he also introduces several complications within the traditional feature theory to justify the development of elements as primitives and their accompanying theory[1].

Coming forward from a paper I had written for the linguistics course *Segmental and syllabic structure in the phonology of English* (2018-2019) on voicelessness assimilation in Element Theory this thesis will likewise focus on the possible limitation of Element Theory[2] as outlined by Philip Backley in his work *An Introduction to Element Theory* (2011). Trough the analyses presented in the linguistics paper it became apparent that the ET is able to account for the phonological processes that Backley has chosen to test with this theory. With each of the elements he is able to correctly interpret the processes by just using the six elements, the single segmental tier and the headedness. It came to my attention that when one would go beyond these processes and apply ET to language changes that were not mentioned in Backley this theory would lack. The paper has its focus on voicelessness assimilation in Dutch – a voicing language or L-language – which caused complications for the grammar of Backley's version of Element Theory (hereafter

[1] This thesis is not written to argue about the accuracy of feature theory and distinctive features. The intention of this thesis is therefore not to fix complications of feature theory but, rather, to use its grammar to illustrate the position of elements on the phonological spectrum. The focus will be mainly on the tenets of Element Theory as provided by Backley, and their differences from traditional phonological features.

[2] All mentions of ET in this thesis refer to the theory of elements as defined by Backley (2011) unless stated otherwise.

ET). This instance revealed a possible limitation in the theory. This sparked my interested and convinced me to further analyse the validity of the theory: is it possible that other sections of the theory would show similar limitations when used to analyse phonological processes that Backley has not considered in his book?

This thesis will critically approach the grammar of ET as stated in Backley (2011). The focus will be placed on the capability of the analysis of articulatory processes within the phonology. It will challenge Backley's statement on the fact that elements are defined in acoustic patterns. It will concern itself with the acoustic definition of elements as primes, which comes forward from Backley's statement that articulation has no role in phonology. This proposition lies in contrast with the approach of traditional features currently used in the phonology, which are defined by articulatory descriptions. Not only does ET differ in that it rejects the implementation of articulation in phonology it also limits itself to the use of only six monovalent primes. This limitation makes the theory extremely restrictive, which looking back at FT is something to be desired, but to what extend is this theory too restrictive. The innovation of ET is so radically different from feature theory (FT) that one could wonder if this actually desired. To what extend can elements compensate for the traditional features which are not defined in acoustic patterns or does this cause complications? How capable are these acoustic elements to describe purely articulatory processes? A transition from the traditional features to a more restrictive theory seems appealing but how well does this theory function in the phonology?

Before moving on to examine the limits of the restrictive grammar of ET, the theory's theoretical background will be explained. The following chapter will consider an introduction to the theory which contains an overview of its origin, the elements and the representation of vowels and consonants. Chapter 4 will regard Backley's statement on the effect of a purely acoustic phonology and the rejection of articulation. It will present my own analysis of the acoustic patterns that make up the base of the theory. This overview of elements will address the acoustic nature of the primes and each of their characteristic sound patterns. After these establishments Chapter 5 will concern itself with the analysis of articulatory processes in several languages and will challenge the ability of ET to correctly describe these.

3. THEORETICAL BACKGROUND

3.1 INTRODUCTION

Before challenging the separate core assumptions made in Backley (2011), it is important to understand the theoretical framework of Backley's Element Theory as described in his work. In this chapter the core foundation of ET theory as outlined in Backley will be explained. This chapter will start with an overview of the elements and the grammar in which they are used. This explanation of the theoretical background will include the origin of the six elements | I A U ʔ H L | and considers how they are associated with their characteristic acoustic patterns in the speech signal. Additionally, this chapter will present how this set of elements operates with its given characteristics, and how – with these characteristics – elements can make up for all existing phonological segments in a language. After having illustrated the individual elements, chapter 3.4 will focus on the vowel representation in ET and how both simplex and complex vowels are represented by elements. Chapter 4.34.3.1 will focus on how place elements used for vowels also function as resonance in consonants. Once this is established the focus will shift to the manner elements, the prosodic structure and contrasting pairs. This chapter will also touch on some of the aspects that will lead to the discussion of the core assumptions which have their own section later on. Because of this, further depth on some of the foundational topics within Element Theory will be discussed in the chapters where the core assumption centres around that topic. In his own introduction to the background of his version of element theory, Backley adopts much of the grammar from other linguistic theories to compare his own theory to. Mostly, he compares the grammar of Feature Theory with that of ET, most often to point out the weaknesses of the former. As the shortcomings of feature theory will be a topic in one of the core assumptions, this section solely focuses on the theoretical background of elements and their grammar.

3.2 ORIGIN OF ELEMENT THEORY

Element theory (ET) is primarily a theory that focuses on phonological primes called *elements*. Elements existed before the establishment of ET first as segmental components related to the theoretical work of Dependency Phonology by (Anderson & Jones, 1974). A decade later another theory named Government Phonology (GP) arose which adopted concepts similar to those of DP. DP focused more on exploring alternative implementations of its basic ideas, while GP put emphasis on developing a restrictive theory of primes with segmental structures. Additionally DP adopts the perspective of *SPE* where phonological rules map underlying representations into surface representations, where GP derives alternations from underlying representations and follows universal principles and parameters. These motives show that ET has more resemblance to GP as it likewise establishes a restrictive grammar for a set of primes.

For the use in GP, a proposal for a full set of elements was presented in Kaye, Lowenstamm and Vergnaud (1985). Although only discussing vowel structures, they claimed this set would be appropriate to be used for both vowels and consonants. In Kaye, Lowenstamm and Vergnaud (1990) they adopted a set of eleven elements to be used in GP. In later developments, some of these elements were eliminated in order to maximize empirical coverage (van der Hulst, 2016). In the mid-1990s, Harris and Lindsey (1995) and Harris (1994) are the first to publish work considering an explicit theory concerning the elements. Their work contains the most complete discussion regarding the full set of elements. A revised theory of elements is provided in Backley (2011) wherein the original set is reduced to six elements.

ET is based on autosegmental phonology but assumes that the primes used in the phonological structure are elements instead of the traditional distinctive features. Autosegmental phonology is one of the two major theoretical movements within nonlinear phonology: the development of an alternative to linear phonology. Autosegmental phonology steps away from the concept of feature matrices as presented in *SPE* and depicts segments as vertical listings of features. Prosodic properties such as tone, stress and syllabification were observed to extend over domains larger than a single segment; the matrices of linear phonology were insufficient in displaying this behaviour. In autosegmental phonology these segmental properties are extracted from their matrices and are placed on separate tiers of their own (Goldsmith, 1976). This separation allowed features that display extra-segmental behaviour to function in a somewhat autonomous fashion. Properties on the same tier are arranged in order, while relations between these elements or auto-segments on the different tiers are represented with association lines. These different tiers make the identification of natural classes easier and give way to denoting shared properties between elements.

Even before the existence of ET, both GP and DP aimed to replace or even abandon aspects of the *SPE* framework by creating a phonological grammar that moved away from articulatory primacy (Anderson & Ewen, 1987; van der Hulst, 2016). Instead, the primes used in these non-mainstream theories describe the acoustic images of the speech signal. In contrast to the *SPE* features, these primes do not consider speaker knowledge to be central to the grammar. Instead, the primes are associated directly with the speech signal and describe segments in a way which is shared by both speaker and hearer, moving more towards a general grammar (Backley, 2011). Additionally, Kaye et al. initially proposed for the primes to be arranged on their own tiers below the skeletal tier; however ET has shifted to the stance that elements are the only level of melodic representations and therefore can be mapped directly onto the sound signal (Harris, 1994; Harris & Lindsey, 1995).

Another way elements are able to maximize their empirical coverage is by their inherently positive nature. Unlike the binary features used in *SPE* – where the positive and negative values mark the presence and absence, elements function within a monovalent system which only refers to properties that are present.

The binary distinction used in *SPE* does not correctly portray how phonological processes in language operate. The binary system gives the positive and negative values of properties equal statues. Additionally, this system creates the appearance as if both oppositions are active in the phonology. It furthermore places segments that display the behaviour of the negative opposition within the same natural class. These natural classes group together segments which have similar phonetic properties and therefore display similar phonological behaviour. In binary feature systems, segments containing the [–feature] are placed within the same natural class as the negative opposition is regarded as an active feature. For example, the feature [nasal], oral segments are [– nasal], they do not display any nasality. These oral segments are grouped together in a natural class based on their shared non-nasal characteristic. In the same way [– lateral] segments are grouped together creating a natural class of unrelated segments such as rhotics, obstruents and vowels. These segments do not share any phonetic properties and have no phonological characteristics in common, it therefore does not add to anything to place them in a class. Because elements are monovalent they only contain active elements. Inactive elements are not displayed in their structure and therefore they are correctly placed within natural classes. The monovalency of elements adds to the restrictiveness of the theory as the amount of available primes is limited to the six active elements.

3.3 OVERVIEW OF THE ELEMENTS

The theory that Backley describes in this work uses the six elements |I A U H L ʔ|. The three elements |I A U| are mostly associated with vowels and are used to represent vowels and resonance in vowels. The other elements |H L ʔ| are associated with consonant structure and are paired with vowel elements used to describe consonants. When mentioned as a group, these elements are written together between verticals as shown in the previous sentence, when considered as individual units in descriptions or representations each element is written separately between verticals: |I|, |A|, |U|, |H|, |L|, |ʔ|. The definitions of the elements is addressed in the chapter 4.

According to Backley, these six elements are together fully capable to describe the segments of languages. This limited set of primes is so effective because the elements are not restricted to be used in either consonants or vowels. In addition, these elements are single valued primes and therefore prevent the possibility of overgeneration: the prediction of many possible phonological processes and grammars that are not observed. Moreover, these elements make accurate predictions on how segments are grouped into natural classes. Natural classes contain phonemes/segments that display similar phonological behaviour and phonetic properties. For example, a group of segments that all display nasality and provoke nasal harmony could be placed into a natural class represented by the |N| element.

The elements used in Backley's theory are linked to the acoustic signal. Each of the six elements describes a specific sound pattern in the speech signal. This makes that each element has its own acoustic identity and therefore can be pronounced individually, without any support from other elements. Although elements can be supported by other elements to represent different acoustic patterns this is not necessary for the realization of single marked segments [segments with only one property] (Backley, p. 12). The phonetic representation of each element will be discussed in chapter 4. The monovalency of elements and their ability to be individually realised allows them to exceed segmental structure: resulting in a grammar that can perform on a single level as there is no need for a separate level that conveys phonetic representation. This grammar deviates from the standard multi-level representational arrangement where the underlying abstract phonological units have to undergo structure changing operations in order to function on the phonetic surface level.

3.4 VOWEL REPRESENTATION

In ET the vowels of languages are represented by the three elements | A I U |. These elements are realised as the basic vowels [a], [i] and [u]. Universally the [i e a u o] vowels are the vowels found most in vowel systems cross-linguistically. These vowels are universally unmarked, meaning that they are produced with less effort and can be categorised as belonging to the default linguistic units. These vowels are the simplest and most basic vowels to be found in all languages, therefore they are represented by basic phonological structures. However, ET argues that only three of these basic vowels are actual basic vowels and cannot be broken down into smaller units: the vowels [i u a] which are represented by |I|, |U| and |A|. The basic vowels [o] and [e] cannot be labelled as basic vowels in ET as the theory shows that these vowels can actually be broken down into smaller units and thus have compound structures.

The basic vowels [a i u] are found in nearly all languages, even in languages with very small vowel systems. This signifies that there is some property to them that makes them extremely favourable as vowels. The three corner vowels are said to be maximally dispersed because they have maximally distinct acoustic formants. This also means that vowels with similar formants and pronunciations can be perceived as sounding similar, and therefore are less favoured in languages. A clear arrangement of the position of the three corner vowels and the other two simplex vowels can be created with the aid of a vowel diagram. The diagram displays this triangular overview of the basic vowels as they occupy the extreme points of the vowel space (Figure 3.1**Error! Reference source not found.**). The other two simplex vowels [e] and [o] are located in between the corner vowels.

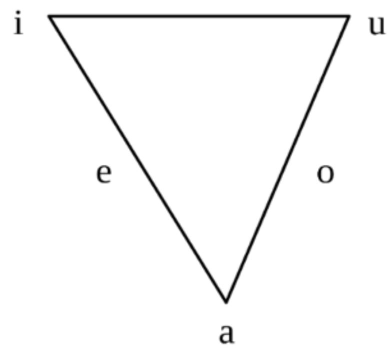


Figure 3.1 A simplified vowel triangle containing the three corner vowels [i u a] and the vowels [e] and [o].

In ET these basic vowels are represented by single element expressions. These expressions cannot be broken down into smaller units and as a result can be labelled as basic expressions. When these basic elements are realised phonetically, they map onto acoustic patterns in the speech signal that produce vowel sounds comparable to the corner vowels [i a u]. When perceiving or producing vowels, speech language users will focus on these three acoustic patterns that represent them. Harris (1994) has labelled these specific patterns with the informal names *dIp* (for the |I| pattern), *rUmp* (for the |U| pattern) and *mAss* (for the |A| pattern), as the vowels mimic these shapes in their patterns. It is important to look at the shape of these acoustic patterns to decide which of these simplex elements make up the more complex compound vowels. The shapes of the vowels can be displayed and analysed through two different methods: a spectral pattern and spectrogram. These spectral shapes will be extracted and analysed in depth in chapter 4.

3.4.1 DEPENDENCY

As mentioned in the previous paragraph, languages which contain a set of contrastive mid vowels, a distinction by the means of a head-dependency relation needs to be implemented in the notation of current acknowledged mid vowels [ɛ] and [ɔ]. To express the contrast between [e] and [ɛ], and [o] and [ɔ] their representation will have to be altered as both are represented by the same combination of elements |A I| and |A U|. This distinction can be made by adding a head-dependency structure to the current established notation. This head-dependency construction is very common in linguistics, not only is it found in phonology, this structure has its roots in syntax and morphology where it is most prominent in the metrical tier. Where two minimal units enter into a relation, this relation will be asymmetrical: where one unit is more dominant than the other. In stress languages two syllables are joined into a foot; where one of the syllables will be stressed and the other remains unstressed. In morphology, a dependent affix may be weak in the sense that it functions as a harmonic target or that it supports a lower lexical contrast than its head. This relation is also found in individual segments where there is an asymmetric relation between its phonetic parts. For the vowel notations in ET this relation proposes that when the two phonetic parts are paired to form a vowel, one of them will be more prominent and will function as the head.

It is not surprising for ET to have implemented this approach in order to distinguish differences in its notation, as its theory has developed form Dependency Phonology (DP) and Government Phonology (GP) which both have implemented this approach in their grammars. In this specific version of ET implemented by Backley, this head-dependency relation is realised a strong-weak relation. For ET specifically, this headedness comes forward from the prominence of the element's acoustic patterns in the phoneme's spectrum. But it is also reflected in the characteristics of the element, weak elements for example will be the target of weakening or assimilation, while strong elements are able to trigger these processes. To express the contrast in mid vowels, headedness can be assigned to the element that is the most prominent in the acoustic pattern of the vowel, for [ɛ] the |A| element would be more prominent than the |I| element, its structure would be represented as |I $\underline{\text{A}}$| where the |A| is underlined to signal its prominence. Not only the place elements but also the manner elements are subject to headedness, here the headedness of the element can also depict an alternative interpretation of manner.

4. REPRESENTATION ELEMENTS AND ACOUSTIC PATTERNS

4.1 INTRODUCTION

Since the introduction of traditional features in the late 1960s, phonological processes have been described with these non-restrictive primes. This denotes that most processes occurring in languages have been proven, described and argued on with the use of these traditional features. Although many works following SPE didn't necessarily focus on the features, they did implement those exact primes in their analyses. Meaning that the perspective as presented in *SPE* was very dominant in the phonology, and the concept that features had an articulatory origin was therefore accepted. ET radically distances itself from the *SPE* approach. With the introduction of elements and their acoustic origins, segments were no longer defined from the speaker's point of view but had shifted its direction to describing the speech signal instead. This more restricted theory aims to use only six primes to describe all available phonological data. Also, the focus in this theory has shifted from the *SPE* standard: as elements are based on the speech signal, they describe the acoustic properties of segments instead. This acoustic origin and restricted availability of primes might be problematic when implemented in the analysis of certain phonological processes of which some have their roots in articulation.

In this chapter, Backley's assumption of the abilities of the acoustic properties of elements will be discussed. Additionally, the restrictiveness of the element inventory will be discussed. Firstly, the acoustic properties of the six primes will be explained to provide the reader with essential knowledge on the basic elements. Secondly, we will briefly indicate on which levels features operate, mostly regarding articulatory and acoustic patterns. Thirdly, Backley's thoughts on articulatory and acoustic patterns will be considered next to the traditional reasoning behind them. The review of both is meant to put the ideas behind them into perspective and give an idea of the implementations and the limitations of both.

4.2 ACOUSTIC PROPERTIES OF |I A U|

As introduced in chapter 3.4 the basic vowels /a i u/ lay the foundation for the three place elements |A I U| in ET. Speech language users will focus on their acoustic patterns when using language. The acoustic patterns of these elements are labelled with the informal names *dIp* (for the |I| pattern), *rUmp* (for the |U| pattern) and *mAss* (for the |A| pattern) (Harris 1994). These shapes can be revealed by analysing their spectrograms in a speech analysis program. Although Backley provides the reader with spectrograms and acoustic patterns of the elements the purpose of this chapter is to provide a more solid phonetic basis for the acoustic properties of |U|, |I| and |A| than is given in the ET literature. The cause for this originates form the limited information available in the literature on the extraction of the spectral patterns from spectrograms. These abstract slices are reasoned to be generated from spectrograms but the exact guidelines are missing from every work in which they are mentioned. This questions the legitimacy of the spectral patterns presented in the literature. This chapter will function as a small phonetic experiment that will analyse the spectrograms of the sounds that represent the elements in ET in order to establish their accuracy.

To successfully extract the spectrogram and the spectral pattern from the speech recording some steps need to be taken to accomplish this. By using recordings and a computer program developed for speech analysis in phonetics it is possible to reveal more information on these elements. The process as to how to extract the spectrogram and spectral envelopes will be described in detail. This process is performed as a reaction to the absence of descriptions on this specific process in Backley's chapter on the vowel elements. He displays the diagrams that are the product of the speech analysis but omits the specific process of how he has extracted this information and hence complicates the possibility to reproduce this fundamental analysis. The spectrogram and spectral envelopes he uses to analyse each of the vowels do not have any (legible) information located at the axis that could reveal the steps taken from spectrogram to slice. When describing the patterns of the resonance element he states in the in-text description that the frequency in the spectral envelope diagram can be read horizontally, and that the peaks themselves "represent bands of intense energy" (Backley 23), but it is unclear in what measurement this energy is expressed. Backley references to have duplicated his patterns from those printed in Harris (1994). When analysing the respective chapter in Harris it is observed that even more abstract spectral frames are used.

These spectral frames are stated to mimic schematic spectral envelopes which in turn can be mapped onto acoustic spectral slices – which are unfortunately absent from the chapter in Harris. In search of a more concise description on the retrieval of these spectral patterns, Harris' referenced collaborated work with Lindsey (1995*)* is considered; herein he also discusses the elemental vowel patterns. In the figure descriptions this work contains, he describes the portrayal of the elemental patterns. However, this work on phonological representation contains the same schematic element patterns as Harris (1994) and therefore does not provide additional information that aids the process for the construction of these specific spectral envelops from spectrograms. As each of the works references a related piece regarding the creation of the spectral envelopes so does Harris & Lindsey (1995) which refers to Harris & Lindsey (1991) published in the Phonologica 1992: Proceedings of the 7th International Phonology Meeting. However, after further research this work neither displays a concrete discussion on how the abstract spectral slices are obtained from the sound data. Since the search for a concrete description as to how to recreate these schematic envelopes has reached a dead end it was necessary to turn to literature related to the speech analysis programme used for this analysis: *Praat*. Though the works that are referenced in Backley did perhaps not have the resources to produce concrete digital analyses of spectrograms and therefore could only display hand-drawn abstract realizations of the spectrogram. However, Backley, who's work clearly contains digitally extracted spectral envelopes, would have been in the position to give a more thorough explanation on how this specific data was extracted. Since he does not offer any description on the process in his chapter concerning the resonance elements, I will describe the process I have used to mimic the results. Using the speech analysis program *Praat* it was possible to analyse the three resonance vowels and extract their spectral envelopes and spectral slices. Following both a detailed *Praat* guide published by Sidney Wood of the Lund University Phonetics Lab and the original *Praat* manual published by the developers Paul Boersma and David Weenink it was possible to figure out the steps to produce similar spectral patterns as in Backley.

The audio files of the vowels for this spectral pattern extraction have been downloaded from the "Vowel" webpage on Wikipedia. This webpage contains an IPA chart that has audio files linked to the vowel phonemes presented in the chart which can be played. The three vowels needed for the initial analysis were downloaded from the webpage and uploaded into the *Praat* Objects list. From this point they were individually analysed, starting with the front unrounded vowel [i]. To start the analysis, the spectrogram of the vowel was viewed. In the spectrogram overview in the Praat environment the overall shape of the segment can be viewed. With the formats turned on in the program, it can be observed that the first formant F1 is located around 250Hz and the second formant F2 at around 2500Hz. The time in the figure is read horizontally and the frequency vertically Figure 4.1.

The spectral envelope that represents the pattern corresponding to the |I| element is created by using the LPC analysis feature in *Praat*. To use a Linear Predictive Coding (LPC) analysis on the spectrum it was necessary to down sample the sound to 11000Hz (from the original 44100Hz), as the formants needed are below 5500Hz. This spectral envelope has been created by analysing the spectrogram's formant listings for F1 and F2 in Praat. From this listing the mean was determined for both the F1 and F2 which establishes the location of the formants needed for the spectral slice. A timestamp containing formants close to F1=250Hz

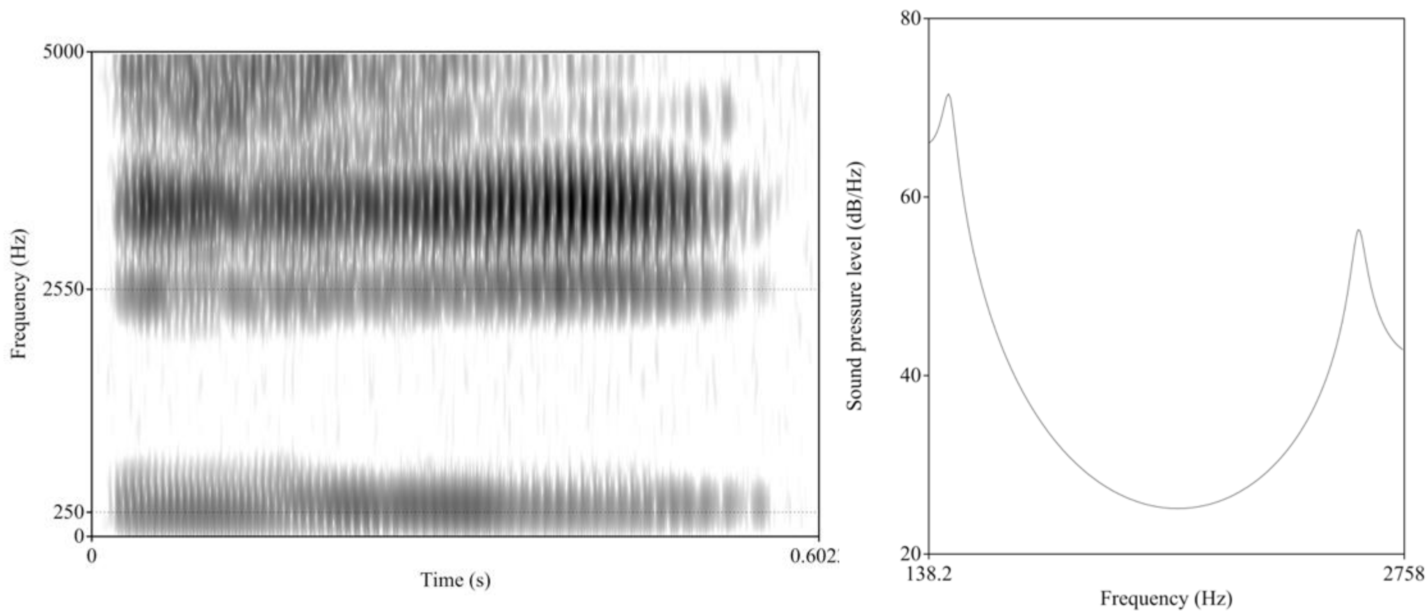


Figure 4.1 |I| (dIp pattern). Left the spectrogram of [i]; right the spectral slice of [i].

and F2=2500Hz was chosen and used to create the LPC. The correct prediction order for this resampled sound was estimated at 24, as the right number of coefficients is advised to be twice the number of formants in the frequency range of the signal plus 2. Since there is roughly a formant every 1000Hz, this signal would need 22+2 coefficients. However, it was found that this setting would retrieve a spectral slice with more detail than needed for the more abstract prediction of the vowel shape. The prediction order was adjusted to 16 and the LPC was created by *Praat* as a new object. From the created LPC a spectral slice was extracted which then could be viewed in *Praat*. For the spectral slice for the |I| element the time stamp of 0.044884 was used as selected to be the closest to the F1 and F2 means from the formant listing. This process produces the figure as shown in Figure 4.1. In this figure the spectral envelope (on the right) is read horizontally, while the spectrogram is read vertically. The other vowel patterns were extracted from their spectrogram in the same way, both with a slice made at a timestamp averaging their respective F1 and F2.

This spectral slice shows a similar *dIp* pattern that Backley puts forward in his own analysis of the element. The peaks represent the high bands of energy of the formants, while the drop or *dip* in energy corresponds to the unshaded area low energy area in the spectrogram. This dip in the spectral envelope identifies the |I| element.

The |A| element is characterized by a wide band of energy in the lower central part of the spectrum. Its spectral shape has a peak around 1kHz where the F1 and F2 are close together and has bands of low energy on either side. This shape – informally named the *mAss* pattern – can be seen in Figure 4.3, where both the spectrogram and spectral slice show its pattern. The peak in the spectrogram located around 2600Hz is the vowel's F3, which is irrelevant to this spectral analysis of |A|. This shape where the energy bands are in the lower central area of the spectrum indicates a mid vowel, the |A| element can therefore be associated with low and mid vowels.

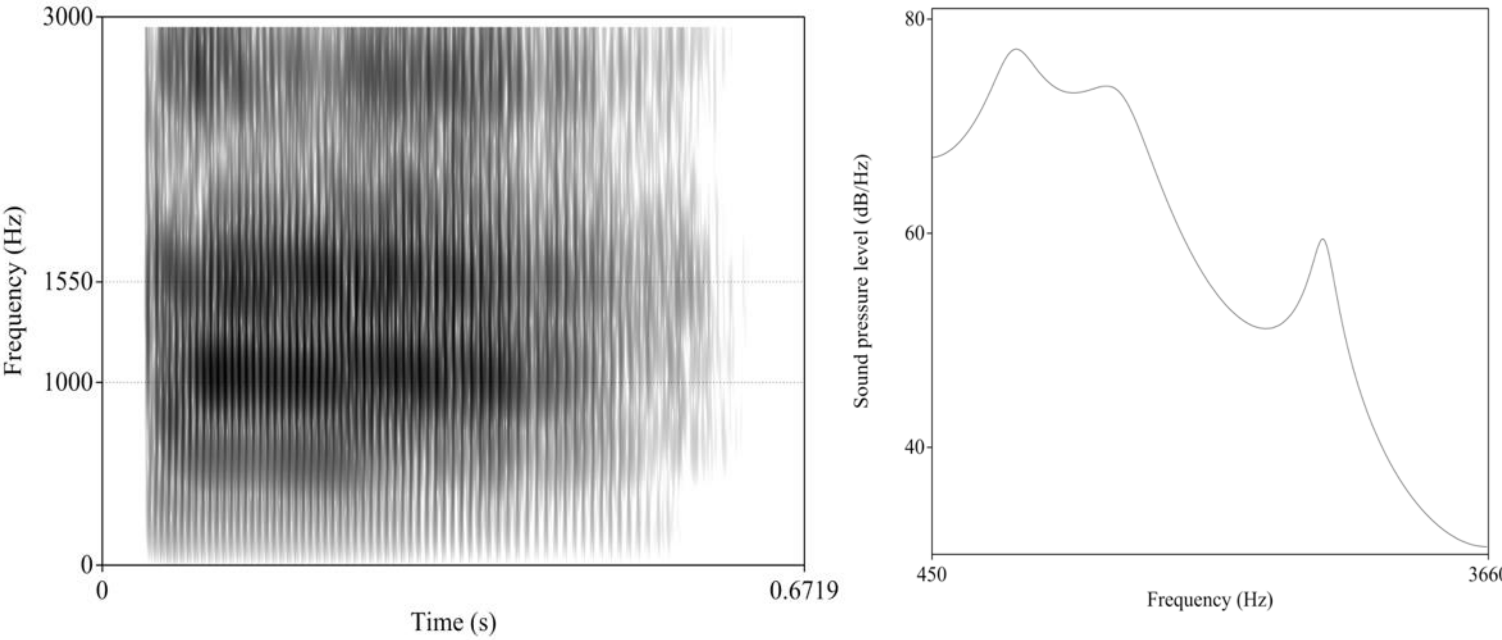


Figure 4.3 |A| (mAss pattern). Left the spectrogram of [a]; right the spectral slice of [a].

Lastly the |U| element is characterized by energy located low in the spectrum after which there is a significant drop in energy as the frequency increases. The low F1 indicates a high vowel, similar as in the *dIp* pattern. The low F2 indicates a vowel located towards the back of the vocal tract, as a high F2's is characteristic for the front vowels, which can also be seen in the dIp pattern in Figure 4.1. Additionally, the closeness of the first two formants indicates that this spectrogram portrays a back vowel. The [u] vowel is

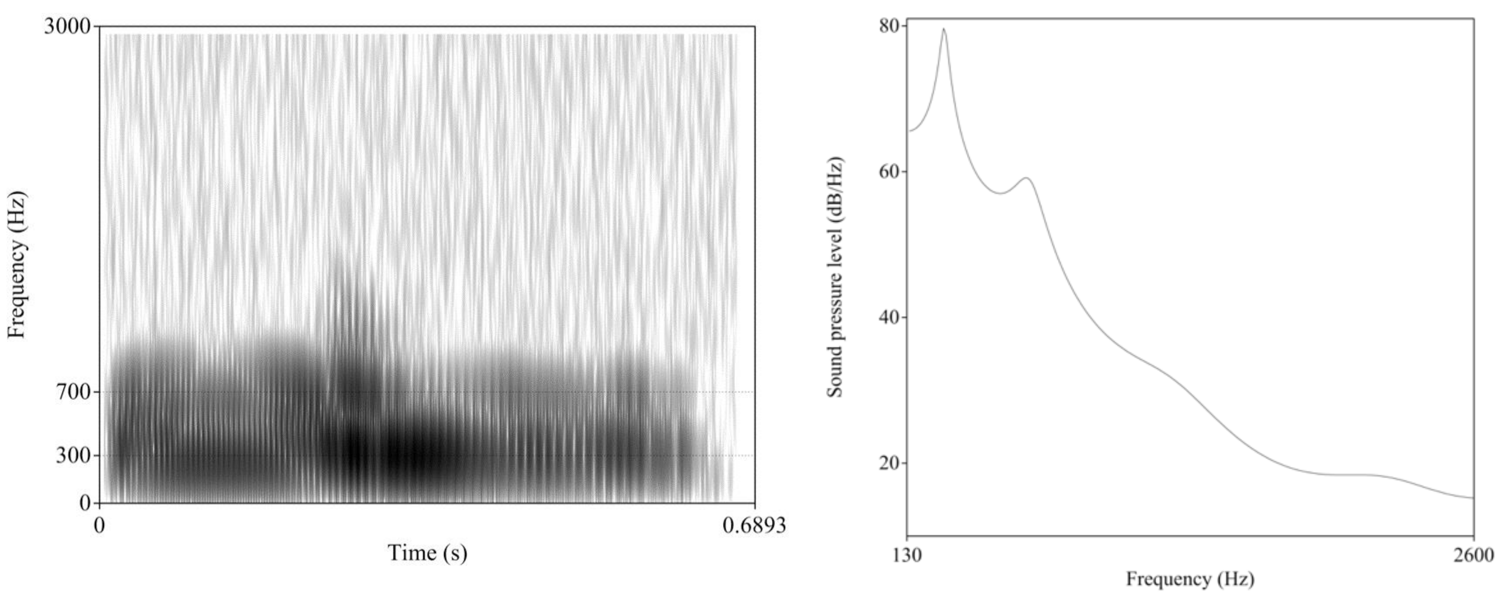


Figure 4.2 |U| (rUmp pattern). Left the spectrogram of [u]; right the spectral slice of [u].

portrayed in Figure 4.2 where the spectral slice shows the clear energy peak between 0-900Hz, these lowered formats can clearly be seen by the spectral energy bands in the lower part of the spectrum in the spectrogram. This pattern, with focus on the drop in energy at higher frequencies, can be produced with lip rounding and is therefore present in back and rounded vowels.

The recreation of these spectral shapes shows that their shapes are not always as clear as those represented in Backley and Harris (1994). Especially the *mAss* pattern deviates from that represented in Backley as it displays the F3 that is not apparent in Backley. The loss of F3 can be related to the cropping of the spectrogram. However *mAss* also displays a different peak in F1 and F2. Where in Backley F1 is lower than F2, the recreated spectrogram in Figure 4.2 shows a higher F1. Furthermore the area under the line in *mAss* is larger in size than that of Backley, this could however be due to the inclusion of F3 within the spectral slice. Both the spectral slices of dIp and rUmp display patterns very close to that of Backley and could be considered a perfect replication. Therefore it can be concluded that the spectral patterns in Backley are extracted from the [i u a] vowels.

4.2.1 COMPLEX VOWELS

As introduced in the previous section, the unmarked vowel system contains five vowels [i e a o u], of which three [i a u] are true basic vowels and the remaining two are actually complex vowels, compounded from elements of basic vowels that they contain in their structure. The two remaining mid vowels are less distinct and are not present in all vowel systems. Each of the simplex vowels has a characteristic acoustic shape that language users are able to identify them by. These identifiers can also be used to recognise the underlying structure of the compound vowels: as they are merely a combination of two simplex vowels. Each of the spectral shapes/patterns are highly distinctive and make the |I U A| elements easy to recognise within these expressions. This can be confirmed by phonetics but also through phonological processes.

The close-mid front unrounded vowel [e] consists of the elements |I| and |A|. The |A| element here pulls down the initial height of the |I| vowel and makes it slightly less close. When looking at the spectral shape of this vowel (Figure 4.5) it can be observed that the central area of the expression displays the *dIp*-pattern which is characteristic for the |I| element (Figure 4.1). The higher part of the expression displays the *mAss* pattern (Figure 4.3), where there is an amount of energy with on both sides drops in energy. Because the spectral pattern of [e] displays both these basic vowel patterns it can be stated that [e] is a combination of both these elements: |I A|.

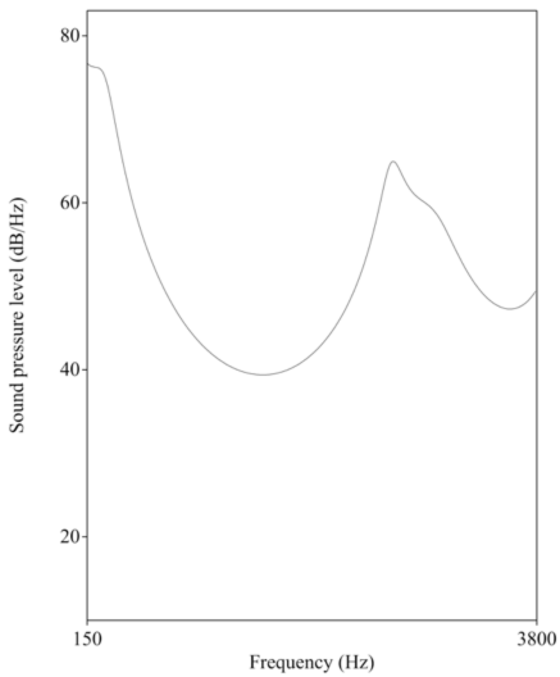


Figure 4.5 Spectral pattern of [e]

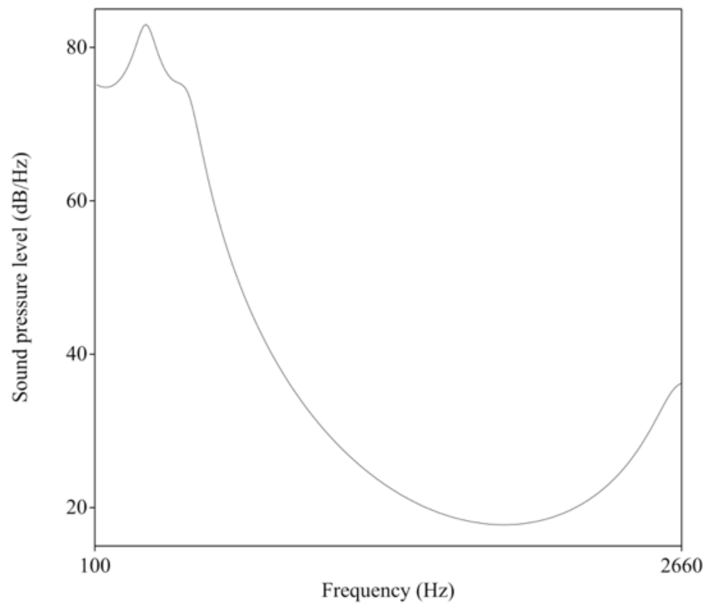
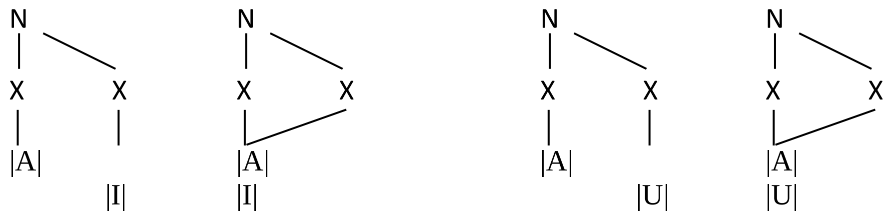


Figure 4.4 Spectral pattern of [o]

The other compound mid vowel is the [o] vowel. This close-mid back rounded vowel displays a combination of the |A| and |U| patterns within its spectral shape (Figure 4.4). According to Backley this pattern should show a combination of a *mAss* patterns and a *rUmp* pattern at the lower part of the spectrum. Where the concentration at the low part of the spectrum is significant for the *rUmp* pattern, the *mAss* pattern is responsible for the drops in energy on both sides of the peak. This means that [o] consists of a combination of both the |A| and |U| elements.

Not only is there evidence found in the speech signal for these compound vowels, the phonology contains processes which put forward the existence of these compounds. English monophthongisation for example demonstrates how two basic elements can form a complex vowel. This is seen in a change in Middle English to 17th century English. In middle English, the diphthongs [aɪ] and [au] were realised separately merged to become the monophthongs [ɛː] and [ɔː] respectively. In this case Backley does not distinguish between the sounds [eː] and [ɛː], this is because they consist of the same two elements. He states that there needs to be different representations for the two if they are contrastive in the language. Words such as [daɪ] 'day' and [paɪ] 'pay' monophthongised to be [dɛː] and [pɛː]. Words such as [lau] 'law' and [kauxt] 'caught' became [lɔː] and [kɔːt]. As can be seen in the prosodic structure of the phonological process does not change drastically. Because the diphthong has changed into a long nucleus it will still take up two positions in the skeletal tier. Moreover, the elements used in the process have also remained the same in both instances. These two examples show that in ET mid vowels are represented by a combination of the basic vowel units |I U A|: where [e] and [o] are represented by the compounds |A I| and |A U| respectively (1).

(1) a. [ai] -> [ɛː] b. [au] -> [ɔː]



4.3 CONSONANT REPRESENTATION

The vowel elements |I U A| are also present in the representation of consonants where they function as place elements. Their resonance properties that were associated with vowel quality can also be associated with the place of articulation in consonants. The use of these three elements in both vowel and consonant structure add to the proper description of language processes such as assimilation, where vowels and consonants influence each other. This concept of consonant-vowel unity makes that all six elements can be used for both the vowels and enhances the ability to explain phonological features as segments share features. In addition, it limits the pool of available primes to describe segment characteristics. Because vowels and consonants share the same set of elements the only way to interpret the difference between the two is through the syllable structure: where vowels appear in the nucleus and consonants in the onset of syllables.

4.3.1 RESONANCE ELEMENTS

The resonance properties of the elements |I U A| are associated with vowel quality, in addition the resonance is also associated with the place of articulation in consonants. The assignment of resonance elements to place of articulation in consonants takes place through the observance of phonological patterning: if certain consonants interact with certain vowels, we can establish that they must have a similar place of articulation. The phonological patterning of segments defines the natural class in which these segments are included.

For the headed |I|-element this natural class is palatals. As previously depicted, |I| is associated with front vowels or front-ness and can for that reason be linked to palatals and coronals. It is further also associated with the glide /j/. This association of /j/ with |I| is recognised because the *dIp*-pattern associated with /i/ is also found in /j/ and this suggests that /j/ contains the |I| element. This assumption is confirmed by phonological evidence such as glide formation in English. Where in expressions such as *skier* and *see out* a glide is inserted to extend the vowel into the following onset: *ski*[j]*er* and *see* [j]*out* (Backley, p. 69). The evidence for the occurrence of headed |I| palatals comes from phonological processes with interaction between palatal consonants and front vowels. This interaction places them in the same natural class. This pattern creates palatalised forms in Slovak where coronal [t d n l] palatalise to [c ɟ ɲ ʎ] when occurring before |I| vowels or /j/ (bara[n] 'ram' ~ bara[ɲ]-iar 'shepherd', hra[d] 'castle' ~ hra[ɟ]-e 'castle' (locative singular)). Other languages also include palatoalveolars [ʃ ʒ tʃ dʒ] in the |I̲| class. Dialects in Brazilian Portuguese (BP) has moved away from European Portuguese (EP) by developing palatoalveolar realisations of the stops [t d] before high front vowels (EP *tipʊ* ~ BP *tʃipʊ* 'type', EP *patju* ~ BP *patʃju* 'yard').

Some languages do not have a contrast between palatal and coronal consonants. In these languages, palatals and coronals form a natural class under |I|; they have similar behaviours and pattern together in the phonology. Korean displays this patterning through the disfavouring of cooccurring |I| segments in *CjV* syllables. In these syllables [j] cannot co-occur with a front vowel, or palatal stops or coronals. The difference in headedness notation for palatals and coronals is indicated according to their acoustic prominence in their spectrograms. Figure 4.6 shows the spectrograms of the alveolars [d] and [z] and the palatoalveaor [ʒ]. The formant pattern in the spectrogram of [ʒ] shows more prominent changes in frequency. This prominence indicates that palatals are headed elements and with that express physical properties stronger than those of non-heads in their phonological characteristics (Backley, 2011).

The resonance of the |U|- element is associated with back vowels but also with labial and velar consonant and with the glide /w/. Like /j/, the spectral pattern of the associated vowel /u/ is similar to that of the consonant /w/: the element expression of the individual element, in this case |U|, can both be interpreted as either the vowel or as the glide. /w/ will originate from the segment next to it containing |U| and will create a vowel-glide formation such as the in English phrase *go away*: go [w]away (2).

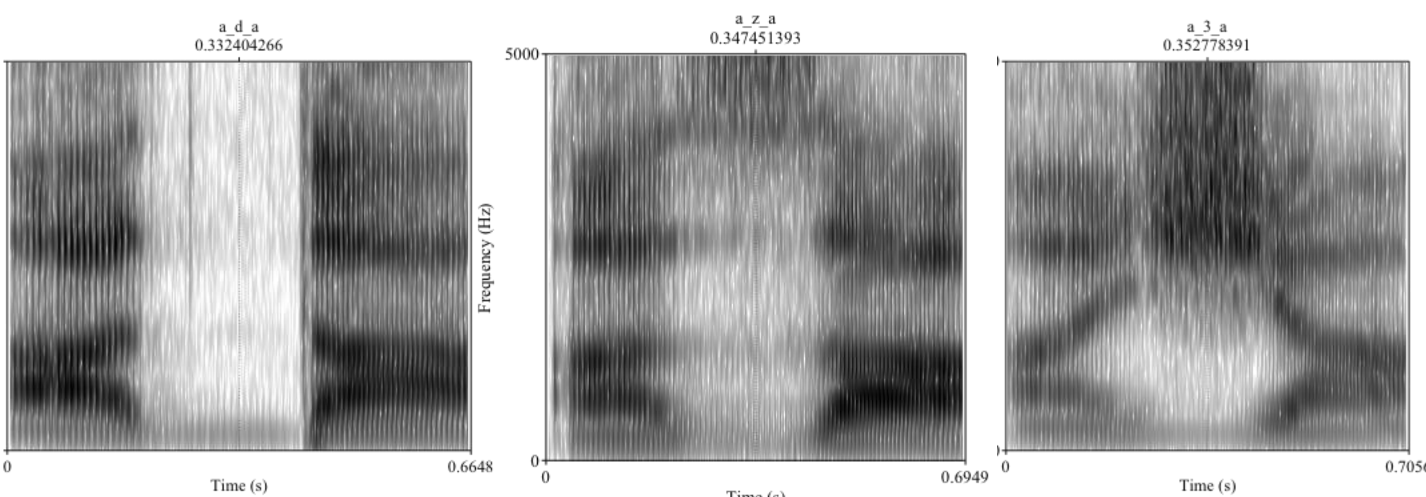
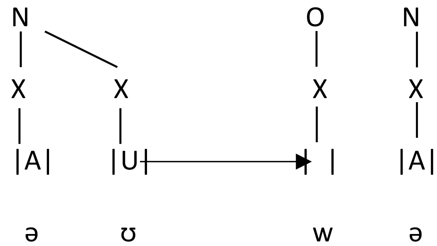


Figure 4.6 Spectrograms with formant patterns for [d, [z] and [ʒ]. Images created in Praat from sound files taken from Wikipedia.

(2) [gəʊ wə weɪ]



Spreading of the |U|-element as the result of an adjacent labial confirms the indication that labials also contain the |U|-element. In Garifuna for example a word-final nucleus must be realised with the default realisation [i] (*inglés* [ĩglesi] ‘English’). When the final segment before the empty nucleus is a labial consonant the default vowel is [u] instead (pásam [pasamu] ‘possum’) (Backley).

The patterning of labials with velars suggests that they contain the same element. This patterning is not only confirmed by ET but has also been addressed by Jakobson, who with the feature [grave]. [grave] differentiates labials and velars, which display high energy in the lower part of the spectrum. This acoustic energy in the lower part of the spectrum patterns together the peripheral categories of labial and velar segments. At the same time, it excludes the segments that are characterised by [acute] and encompass the segments identified as dental or palatal. Examples in the development of English homorganic clusters [mb] and [ng] shows that velars and labials patterning together in English. While in Middle English these clusters were still fully realised, at the end of the 16th century these clusters were reduced to single segments [ŋ] and [m] and resulted in the realisation of climb and sing as [klaɪm] and [siŋ]. This process can be characterised as targeting |U|-segments as other word-final clusters such as palatal [nʤ] (e.g. *strange, fringe*) and coronal clusters [nd] (e.g. *friend, band*) have survived into modern English.

Although velars and labials are acoustically very similar but are distinguished as contrastive features in most grammars. As labials show and increased phonological strength when subject to phonological processes it is assigned the headed |U|-element. Velars on the other hand are often subject to assimilation and is assigned the |U|-element.

Lastly the |A|-element represents coronals, retroflexes and gutterals. Because the latter two are not going to be further discussed in this thesis they are not further discussed. Because the |I|-element embodies the entire class of coronals it is not able to distinguish between contrastive segments within its class. Languages that contain contrastive segments within the coronal category employ both |I| and |A| to represent different kinds of coronals. Dependent on the phonological behaviour of coronal segments they are either defined with |I| or |A| within a language.

4.3.2 COMPLEX CONSONANTS

The resonance elements are able to define a range of classes when interpreted as individual elements. When combined, the element clusters can define segments that contain complex resonance: resonance that cannot be defined by a single place element. With these combinations, natural classes such as labiodentals and palatovelars can be distinguished. The element combination can be determined according to their phonological behaviour. In German for example palatovelars are in complementary distribution with velars. Palatovelars will occur after |I|-vowels while velars will appear after all other vowels (*Dach* [dax] 'roof' ~ Dächer [dɛçɐ] 'roofs').

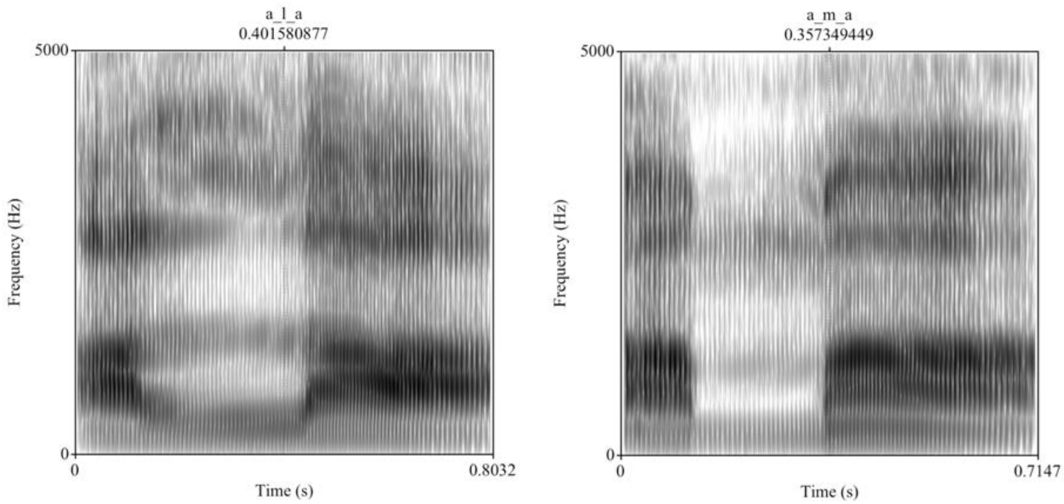


Figure 4.7 Spectrograms of [ala] and [ama] representing oral occlusion of the |ʔ|-element.

4.4 MANNER ELEMENTS

In order to realize consonants, they need, next to the resonance elements just discussed, also a manner element. The elements |ʔ H L| add non-resonance properties of a segment's realization. The non-resonance properties include occlusion, aspiration, voicing, frication and nasality.

The |ʔ|-element is present in segments that experience a drop in acoustic energy in their spectral patterns which will show as an empty vertical slice in the spectrogram, apparent in the spectrogram of [ada] in Figure 4.6. The |ʔ|-element is phonetically interpreted as a glottal stop and marks a drop in oral resonance specified by obstruction in the oral cavity. Like oral stops, nasals such as [n m ŋ] and laterals like [l ɭ ʎ] also have occlusion in the oral cavity and display a similar pattern in their spectrogram in Figure 4.7.
Basque contains phonological evidence for the occurrence of |ʔ| in oral stops, nasals and laterals. Continuous |ʔ| segments are avoided in the language and result in the deletion of the preceding oral stop such as in *bat paratu* [ba paratu] 'put one', *arront lapurre* [arron lapurre] 'a total thief' and *bat naka* [ban aka] 'one by one' (Backley 116). The |ʔ|-element is furthermore found in ejectives, implosives and laryngealised vowels but the discussion of these segments would not add to the thesis.

The |H|-element raises the fundamental frequency in segments and is presented by random noise in the spectrogram. Aperiodic noise can be both continuous and transient: continuous noise is associated with the friction that is perceived in fricatives, while transient noise is recognised by a sudden burst of energy that is produced in stops (Backley, p. 125). The spectrogram in Figure 4.8 of the Dutch word *mist* [ˈmɪst] ‘fog’ shows both transient and continuous noise. Continuous noise can be perceived as a hissing sound that can be heard as frication in fricatives. This can be seen in the spectrogram as an area of high-frequency dense irregular shading that is located towards the top of the spectrogram. The energy in [s] produces

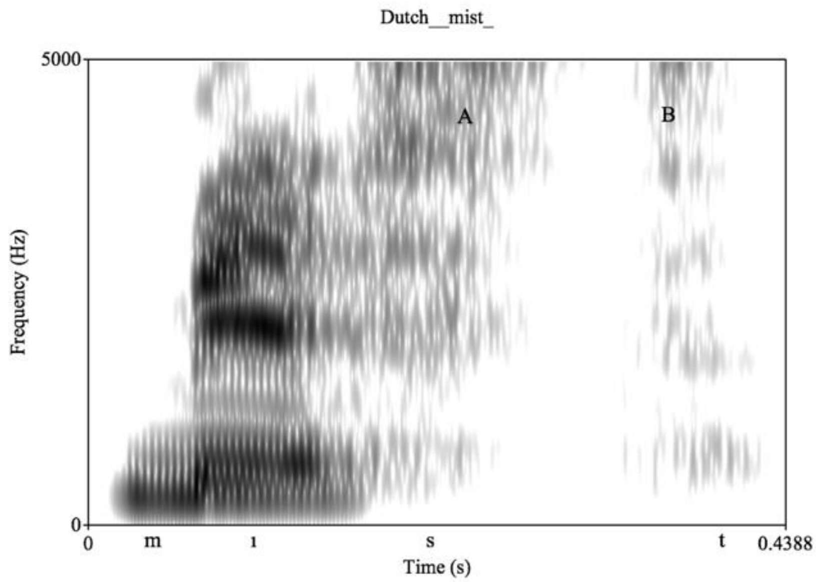


Figure 4.8 Spectrogram of Dutch word [mɪst] ‘fog’

continuous noise and this can be seen in the spectrogram labelled with A. The area in the spectrogram following the ‘gap’ labelled by B is also aperiodic noise. In contrast to the noise in A, the noise in this section is much shorter in duration than that produced by the fricative. This type of aperiodic noise is termed transient noise and is produced by the release section of the oral stop [t]. Although they differ in duration the manner in which they are presented is similar, so both of these types of noise are represented by the |H|-element. Therefore [s] and [t] both contain representations that contain that element: [s] |A H| and [t] |A H ʔ|.

Not only can the noise of the |H|-element be interpreted as frication, furthermore it can be interpreted as aspiration or voicelessness, where the |H|-element would be headed. Languages that contain the aspiration characteristic use it to ‘voicing’ contrast between pairs such as *b–p* which are realised as [b̥] with |H| and [pʰ] with |<u>H</u>| such as in English (Backley, p. 134). Languages that implement |H| as an active element in consonants to convey the voicelessness and aspiration properties can be labelled as H-languages.

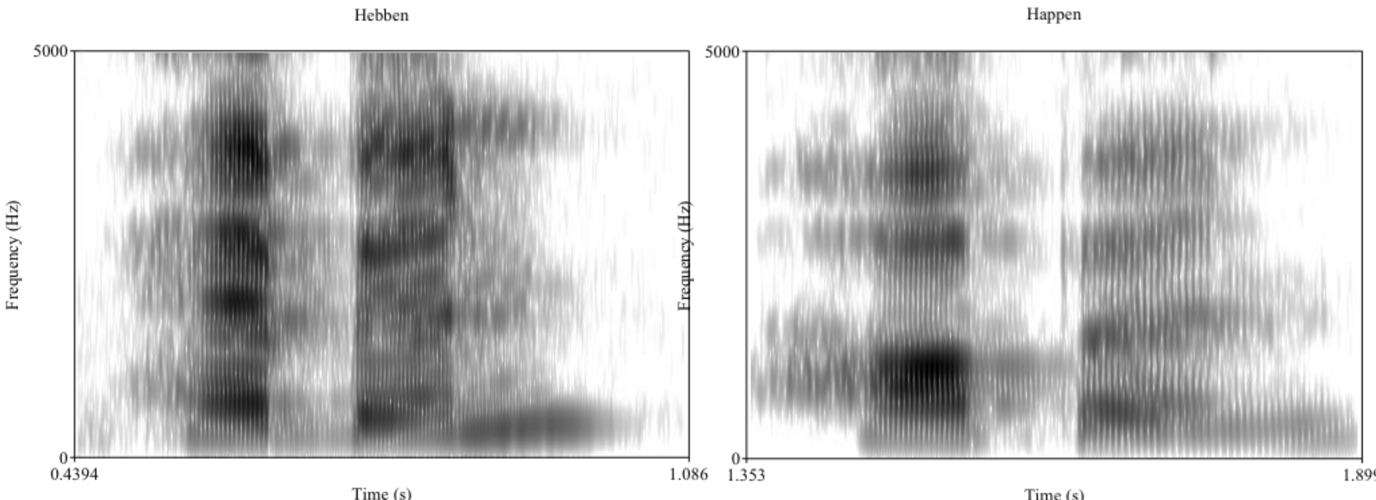


Figure 4.9 Spectrograms of Dutch hebben *and* happen.

The complementary element of |H| is the nasal murmur |L|, which is the element used in L-languages that distinguishes between the *b-p* minimal pair through voicing. The L-element has, in contrast to the H-element, a low frequency energy. This low frequency murmur is produced by lowering the velum; hence it is also associated with nasals. The inclusion of the L-element in fully voiced stops as the active element |L| is what defines the set of L-languages (Backley, p. 151). In Figure 4.9, the voiced /b/, which contains |L|, can be observed to have more prominent energy levels in the lowest formant than segment /p/. These laryngeal contrasts are also linked to the voice onset times of aspirated and true voicing languages. True voicing languages such as French exhibit a voicing lead – here the voicing starts before the release of voiced stops; the short lag or neutral – here voicing starts at the release of the stop and is found in voiceless and unaspirated stops; and the long lag – here the voicing is delayed and starts after the release as in voiceless aspirated stops found in aspirated languages such as English (Backley, p. 135).

Backley argues that although the |H| and |L| elements represent this voicing contrast they are not the equivalent of [±voice]. The [±voice] feature is thought to be universal and when applied to any language with a laryngeal contrast it would divide the obstruents into two sets: one with and one without voice (Backley 134). On the other hand, a *b–p* contrast in one language can be phonologically different from a

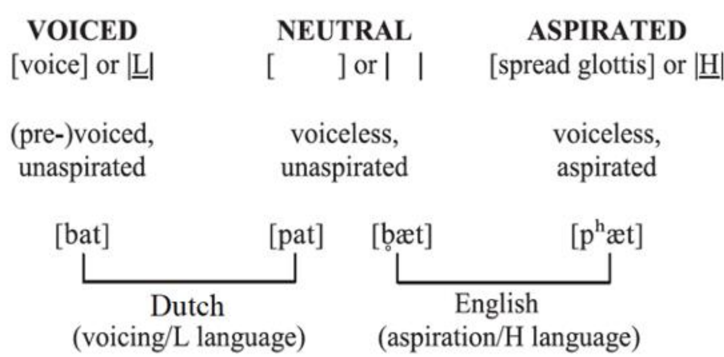


Figure 4.10Edited diagram of L and H languages Dutch and English (Backley 136).

b–p contrast in another; here is where Backley divides languages in being either an L- or an H-language. Where Dutch uses voicing to distinguish between the minimal pairs *p–b, t–d* and *k–g*, English relies on aspiration to separate *b d g* from *p t k*. There is an overlap between laryngeal patterns of the two types of languages; both have stops that fall into the overlapping neutral category where L-languages have voiceless stops and H-languages have unaspirated voiced stops (Figure 4.10). It becomes clear that a binary feature [±voice] would not be able to assign the right features to a Dutch neutral *p* — which would be voiceless or [–voice], and an English neutral *b* which would be 'voiced' or [+ voice]; this is because both have neutral elements that cannot be accounted for in this way (Backley, p. 136). Following the non-traditional view as represented in Figure 4.10, the two features [voice] and [spread glottis] that represent the categories voiced and aspirated, both have equivalent elements in ET: |<u>L</u>| stands for obstruent voicing and |<u>H</u>| stands for aspiration. The neutral stops contain neither |<u>H</u>| or |<u>L</u>| due to the fact that they "are inactive as far as their laryngeal properties are concerned; after all, 'neutral' cannot be deleted, nor can it become active in processes such as assimilation" (Backley, p. 137).

When combining the manner elements, it is possible to create pairings able to represent different phonemes in languages. For example, the combination |ʔ <u>H</u>| represents aspirated stops in aspiration or |H|-languages. With an added resonance element these combinations can represent labial aspirated stops such as /p^h/ |<u>U</u> ʔ <u>H</u>| or aspirated coronals such as /t^h/ |A ʔ <u>H</u>|. With the same manner elements but with different resonance elements it is possible to represent a range of nasal place contrasts: [m] |<u>U</u> ʔ L|, [n̪] |I ʔ L|, [n] |A ʔ L|, [ŋ] |U ʔ L|, [ɳ] |<u>A</u> ʔ L| and [ɲ] |<u>I</u> ʔ L|. This shows that with the restricted index of six elements is able to represent a wide array of realisations.

4.5 <u>Reflection</u>

When objectively looking at some of the complex spectral patterns it is difficult to interpret which elements it contains. Such as the form of Figure 4.4 form has more of the combination of |I| and |U| than that of |AU|. This is because the |U|-pattern as shown in Figure 4.3 is not nearly as steep as that in Figure 4.4. This puts forward that the spectral slice of [o] is difficult to interpret as the combination of |A| and |U|. When a theory such as ET is established solely on acoustic grounds one would assume that it would have solid acoustic evidence to make up for the basic element of the theory. When establishing the correct settings in *Praat* to generate the LPC I found that the adjustment of the number of coefficients would drastically alternate the shape of the spectral slice. Meaning that the outcome of the shape would not nearly represent that of Backley if the coefficient was set to 30 instead of 24. This difference in outcome also suggests that Backley could have made the spectral slices in such a way that it would clearly represent the desired shapes in order to account for those found in Harris. As mentioned in the introduction to this paragraph, it was impossible to establish a methodology for the extraction of spectral slices as none of the works that considered these shapes included any kind of instructions on how these were produced. The lack thereof made me doubt the legitimacy of the patterns and convinced me to analyse the spectrograms for myself.

This does not count for just the vowel resonance but also for the manner resonance, especially that of the occlusion element |ʔ|. Backley argues that the occlusion element of /m/ and /l/ is visible in the spectrum because they contain the |ʔ|-element, which it is. There is a clear drop visible in the spectrogram where these segments are located. He then provides us with phonological evidence for the presence of |ʔ| in /l/ an /m/ as he gives examples from Basque (presented on p. 21 in this thesis, p. 116 of Backley) which strengthens the evidence for the existence of the |ʔ|-element in /l/ and /m/. Subsequently he provides examples from Frisian where apparently /l/ does not contain |ʔ|. And follows this up by introducing a study by Mielke (2005) which claims that coronal nasals and laterals were found to behave as |ʔ|-segments in about half of the surveyed languages. This means that although the spectrogram of /l/ and /n/ (figure 4.9) show that there is oral occlusion present in the segment this cannot be assumed as true as their phonological behaviour proves otherwise. Then what contributes the analyses of the segments acoustic signal to the establishment of the structure of a segment. One would expect that a theory based purely on acoustics would find some stability in its analysis of acoustic patterns.

4.6 ARTICULATORY AND ACOUSTIC PATTERNS

Backley's thoughts on the properties of primes are very restrictive: articulation plays no role in phonology. This perception is the strong opposite of many of the linguists working with SPE features in their analyses. The idea of the existence of units smaller than phonemes is put forward in Backley's first chapter on articulation and perception. In order to describe the behaviour of phonemes, there must exist smaller building blocks which, when combined, create these segments. The uncovering of these units could also justify as to why certain sounds behave similarly to each other — as to why they interact. Hence, for segmental phonology it is essential to uncover this set of basic units in order to correctly describe the behaviour of sounds in languages.

4.6.1 BACKLEY'S VIEW ON ARTICULATORY AND ACOUSTIC PATTERNS

From his description of primes becomes apparent that Backley disfavours a certain set of primes and prefers another specific set for the use in phonological analyses. Emanating from the general disagreement within phonology regarding the correct identity of these units, Backley clarifies to likewise have doubts on the capability articulatory features. The primes predominantly used in modern day's phonology are labelled as *features* and are based on articulatory properties: therefore, they have their origins in phonetics. Because of this origin, these features do not align with the original goal of a generative grammar — the goal opts for a model that focusses on the linguistic knowledge of the ideal speaker-hearer.

4.6.2 BACKLEY'S STATEMENTS REGARDING ARTICULATORY PATTERNS

Backley states that capturing the knowledge of an ideal speaker-hearer is not a priority for feature theories, since features are based on speech production and therefore focus on speaker knowledge. He states that the thought behind articulatory features stems from the assumption that speakers are also hearers. Therefore, they have the ability to understand utterances by matching the perceived sounds with the articulatory movements needed to produce them (Backley). Several theories describe in more detail how this thought is realized. Direct realist theory for example, focuses on direct awareness of the world. It claims that it is possible for the hearer to perceive the movements of the actual vocal tract, or gestures, directly. In addition, another theory, the Motor Theory of Speech Perception, hypothesises that the hearer would perceive speech as an acoustic event, after which they could translate it into the correct articulatory movements to reproduce those sounds as a speaker. At first glance these theories seem to be accurate, as we are able imitate another speaker's speech. However, Backley presents two arguments that contradict the assumptions of these theories. First, perceiving movements of the speech organs is not possible for the hearer as they are not visible during speech production (Backley). Second, although the translation of acoustic events sounds very probable, infants are capable of perceiving speech earlier than they are capable of producing it themselves. Moreover, those who are unable to speak because of physical restrictions are supposedly still able to develop a normal grammar; they are thus able to perceive and process speech. This means that the inability to produce speech does not restrict someone from perceiving speech. On the other hand, those unable to perceive speech through auditory-acoustic input are rarely able to develop native-like spoken language. Backley states that these arguments could suggest that speech perception is more fundamental to grammar than speech production. Hence, the use of articulatory features is most likely not an ideal source to base phonological primes on.

4.6.3 BACKLEY'S STATEMENTS REGARDING ACOUSTIC PATTERNS

On the other hand, the primes that Backley promotes in his work do capture the linguistic knowledge shared by both parties. These primes are referred to as *elements*. The way these primes are represented within ET favours neither speaker nor hearer, as they are associated directly with the speech signal. The actual speech signal is the only component of the communication process that is shared by both parties (Backley). It lies between the two parties and each extract what they need to process or produce speech. The physicality of the speech signal allows for it to be measured and described in absolute terms, such frequency and amplitude. However, these exact measurements are not relevant to the speaker and hearer. Instead only the acoustic shape is relevant to them for distinguishing the different acoustic patterns containing useful linguistic information. According to ET, hearers pay attention specifically to these acoustic patterns that are significant for language when listening to speech. Furthermore, the theory's grammar proposes that there is "a direct mapping between these acoustic patterns and phonological categories in the grammar" (Backley, p. 5). This mapping makes it so that elements have a double representation: they represent specific acoustic patterns of the physical speech signal and abstract phonological information of the mental grammar. This process can be perceived in (Figure 4.11). From the perceived speech signal (physical) hearers extract those acoustic patterns (physical) that contain useful linguistic information (abstract). The linguistic information in the acoustic patterns is then matched to the corresponding elements of the grammar where it can be linked to phonological structures and morphemes.

The speech signal, used by hearers for extracting linguistic information, is also used by speakers. Since speakers produce instead of perceive speech, the process is the reverse to that of hearers. The goal of speakers is to produce a comprehensible utterance which in its way can again function as input for hearers. The communication process of the speaker starts with the abstract mental objects of the phonological grammar instead of perceiving the speech signal. First, the mental grammar of the speaker retrieves the components of the utterance from the mental lexicon. This is followed by the association of elements in the utterance's phonological structure with the acoustic patterns containing the correct linguistic information. The corresponding acoustic patterns function as vocal targets for the speaker to reproduce. The elements in the process function as the abstract speech targets, where the acoustic patterns are the physical targets. Lastly the speaker uses different vocal organs to produce the acoustic patterns the shape of speech signal.

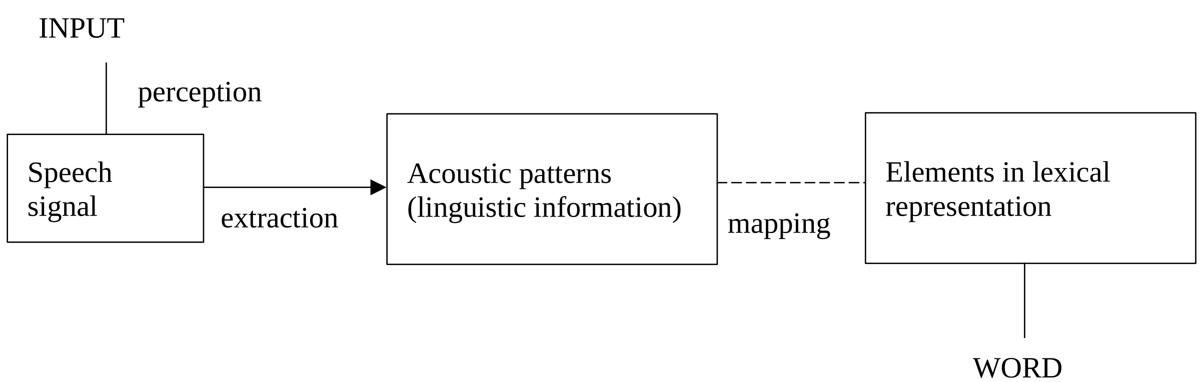


Figure 4.11 The communication process (hearers) (Backley, pp. 5).

Because in ET, elements are related to both the mental and the physical aspect of speech it allows the speech signal to be the mode of phonological analysis. The linguistic information extracted from the speech signal is in ET represented by elements. These elements are directly associated with the speech signal in the form of acoustic patterns. Because of this direct association, the elements as represented in ET work towards the goal of generative grammar.

4.7 TRADITIONAL THOUGHTS BEHIND ARTICULATORY AND ACOUSTIC PATTERNS

Backley has defined a strong justification why he favours the use of acoustic elements over that of the traditional primes. As for now, the primes, that are being used in standard phonology are labelled as *features*. When combined, these features represent phonological segments — while individually, they have the ability to represent phonological classes (Backley, 2011, p. 1). Although used to describe phonological segments and processes this current dominant set of features stems entirely from phonetics. Moreover, the current set of features has remained unchanged since their original presentation in the *Sound Pattern of English* (Chomsky & Halle, 1968). Contrary to this set, in an earlier submission considering feature theory not all features were based on articulatory properties. The set of features proposed in *Fundamentals of Language* (Jakobson and Halle, 1952) contains nine pairs of contrasting features. Opposing features such as [compact]/[diffuse] and [tense]/[lax] are defined both in acoustic terms (e.g. frequency and amplitude) and articulatory terms (e.g. shape of the resonance chamber and tongue position). Although both works disagree on a number of issues, they do agree that each feature is defined in terms of some phonetic property.

There must be a reason why features, and especially those with articulatory origin were, and still are, heavily used in the analysis of phonological processes. Although generally phonologists have followed the tradition of using the articulatory features of *SPE* there exist more recent works which consider auditory and acoustic feature definitions for analysis (Flemming, 1995; Steriade 2000). To not only regard the view of Backley, who's reasoning is clearly favoured towards that of acoustic elements, it is also important to focus on the reasoning behind the use of articulatory features. This section will describe the thoughts of other linguists on the functioning of distinctive features and the role they assume in phonological analyses. This will mostly concern the thoughts forwarded in influential works which had great impact on the framework of distinctive features and served as frameworks for many works after. Not only will this section focus on the articulatory properties of distinctive features but will also consider the acoustic aspect some linguistics have given them.

4.7.1 TRADITIONAL THOUGHT BEHIND ACOUSTIC FEATURES

Jakobson brings forward in *Preliminaries to Speech Analysis* that an acoustic approach is essential for the analysis of phonemic patterns; a similar idea to that of Backley. His ideas regarding the feature theory is often referred to as the Jakobsonian system. This work contains a universal set of 20 features which are paired in contrasts such as oral vs. nasal. The hypothesis of this work states that while each feature could be assigned a distinctive acoustic correlate, not all features could be assigned a unique articulatory correlate. This acoustic approach is, according to Jakobson not only highly desirable but also essential to properly interpret phonemic patterns. This is due to the fact that Jakobson's view of language as a perceptual system.

This idea of language as a perceptual system comes forwards from their description of the consecutive stages of speech decoding – where the perceptual level is given an increased level of pertinence:

> "In decoding the message received (A), the listener operates with the perceptual
> data (B) which are obtained from the ear responses (C) to the acoustical stimuli (D) produced by the articulatory organs of the speaker (E)." (12)

The relevance of the perceptual level is raised because they reason that "the closer to the destination of the message (i.e. its reception by the receiver), the more accurately we can gauge the information conveyed by its sound shape" (p. 12). They determine the levels of hierarchy as perceptual, aural acoustical and articulatory where the latter carries no direct information to the receiver and therefore is of least importance. While Jakobson's approach is based on the acoustic system it is still biased; they do not focus on the speech wave not to the knowledge of the speaker but towards the knowledge of the listener instead. However, even with this approach the acoustic analysis does allow the authors to find symmetries in phonemes that were not found with the use of the articulatory approach used in other works on features.

With the analysis of the acoustic side of speech production it has to be kept in mind that Jakobson's idea of introducing phonetic data into phonemics was still very controversial at that time and most linguists had been very hesitant to implement phonetic data for their phonemic classification (Garvin et al., 1953). The implementation of acoustic data was highly desirable only if it was possible "but as yet, despite a number of efforts in that direction, it seem[ed] not realistically feasible" (Hockett, pp. 259). JFH's acoustic interpretation of phonemic contrasts only uses privative oppositions also eliminates some of the troubles found in the equipollent interpretation between different points of articulation.

Other work of Jakobson and Halle *Fundamentals of Language* (1956) brings forward very similar ideas. The listeners perception is described as essential in the definition of features in both auditory as well as articulatory descriptions. Sounds are analysed by the listener with a binary decision in both physical aspect and motor level. They operate along the idea of the inner approach. This approach states that phonemes consist of bundled sound features which the listener has been learned to extract from the speech waves (pp. 8). This approach thus merely locates the features and their bundles within the speech sounds, be it on their motor, acoustical or auditory level they argue to be the most appropriate premise for phonemic operations (Fundamentals, pp. 8). They display this idea of the inner approach in the way the listener decodes a message: The listener receives a message in a language he knows. He correlates the message with the code accessible to him; this code contains all distinctive features, their combinations and rules to joining phonemes into sequences.

4.7.2 TRADITIONAL THOUGHT BEHIND ARTICULATORY FEATURES

The other traditional concept of feature theory is that with the use of features based on articulatory properties. Instead of describing the distribution of acoustic energy, these distinctive features describe the position of the vocal organs which consist of the glottis, pharynx, nose, tongue and lips. Articulatory features are based on the knowledge of the speaker as they consider the place, position and manner of the sound produced. Because these articulatory features focus on the knowledge of the speaker, they do not maintain the goal of a generative grammar. Since it is not in accordance with generative grammar, it seems illogical that subsequent work has retained these articulatory features.

The most influential post-Jakobsonian work that defines features solely in articulatory terms is that of Chomsky & Halle *The Sound Pattern of English* (*SPE*) (1968). After the publication of this work phonologists have generally used the *SPE* theoretical system to analyse phonological processes from an articulatory viewpoint. The list of universal phonetic features they describe in their work represent the phonetic capabilities of humans. Their large feature system is almost entirely based on speech production categories. It consists of 30 features which can considered to be quite excessive, especially when compared to the 12 features that Jakobson, Fant and Halle introduced in *Preliminaries*. The size of the set of features was a pay-off between efficiency and reality: to correctly identify the relations within the vowel and consonant systems (Fant, 1969). SPE functions on linear theory. It considers properties such as tone, stress and length to be represented by binary features. With the introduction of non-linear phonology these properties are captured in representations involving prosodic structures.

According to *SPE* these features are part of the universal grammar and therefore all languages utilize a similar set of speech properties to construct their phonological systems. The features function as phonetic parameters as they provide a representation of an utterance which can be interpreted as instructions to the articulatory system. where each feature contains a description of its articulatory realisation. Chomsky and Halle also express that there were serious shortcomings on the general knowledge of speech events. The exclusion of acoustic groupings is stated to not have been in scope with their work, however it also puts more importance on the articulatory aspect of the speech process. They present the phonological components as an underlying form which with readjustment rules transform into the phonetic form which is uttered by the speaker.

Although both acoustic and articulatory feature theories seem to uphold within the explanation given in their original works, it becomes clear that there are indeed some flaws that haunt the foundations. Both theories have undergone developments and have led to the establishment of other phonological theories. Additionally, it has become clear that the comments Backley makes on the aspects of feature theory are quite rash. It is certainly true that some proposition in these theories need revision, however many of these theories were stimulating and have laid foundations on which other linguists have built to develop different theories. Not only these traditional feature approaches are problematic to the phonology, ET also has some debatable aspects that some can think of as major inadequacies of a theory. The flaws that Backley addresses in his introduction are well known weaknesses of the original works of feature theory. Many linguistics have addressed these problems and developed the theories into something more correct.

4.7.3 RELATION BETWEEN PRIMES

Backley makes an excellent point, it is definitely more desirable to work with primes that are located in a neutral space shared by both listener and speaker than with those biased towards either party. The phonological processes described with these acoustic elements would therefore represent the speech signal. The elements seem very rational to work with when presenting individual segments, however they can be considered as an obscure way to describe phonological processes. This is because they would omit any articulatory influence from phonological analyses. One could wonder whether this is desirable. In addition, Backley pushes back from articulatory features so drastically that it could considered to be quite remarkable. It has to be kept in mind that the phonology has been developed on the assumption that distinctive features are an authentic part of its vocabulary. In contrast to the standard theory of FT, ET has a much more limited array of available primes. This restrictiveness is desired in order to minimize the chances of overgeneration: the prediction of too many phonological processes that simply are not realistic. However, in comparison to the number of available features in SPE and those proposed by Jakobson the number of available elements seems very small – and could maybe even be too limited that it makes ET too restrictive. It would be interesting to indicate to what degree do elements and feature overlap, to see where ET has solved some of the overgeneration problems with the introduction of elements.

Jakobson also stressed the importance of an acoustic approach and its essentiality to correctly interpret phonemic patterns. At the same time Jakobson had no access to the concept of acoustic elements to implement in his analyses; instead he provided the acoustic specifications of features. With these acoustic specifications, binary features would, like elements, describe the patterns in the speech signal instead of the position of the vocal tract. For example, the Jakobsonian feature *grave* is specified as "a concentration of energy in the lower frequencies of the spectrum" (JH 31). This classifies back vowels as *grave* while front vowels are classified as *acute*, as they display energy in higher frequencies. *Grave* corresponds to the *SPE* features [–coronal] found in labial and velar consonants, and the feature *back* for vowels. The Jakobsonian feature [grave] corresponds to the |U|-element in ET. |U| has its acoustic energy located in the lower frequencies and is likewise realised as labial (when headed) and back (non-headed). This element has a one on one correspondence to its Jakobsonian counterpart, which in its case relates to two SPE features.

Another Jakobsonian feature *compact* is specified by the concentration of energy of a dominant formant in the central region. This can best be observed in vowels, where in compact vowels the F1 lies closer to the upper formants. Open vowels such as /a/ and /o/ display this compactness in their acoustic patterns (Figure 4.3 and Figure 4.4 respectively) and therefore can be categorised as compact vowels. This feature is translated into SPE as *anterior* for consonants, and as *open-close*, or *high-low*, for vowels. Like the Jakobsonian feature grave, the feature *compact* can be translated to elements. However, this feature appears to be more difficult to translate into elements than the previous feature *grave*. One way to find this feature complementary element is to look at the phonemes that are *compact* and translate these phonemes into elements to perceive if they contain complementary elements. First the list of compact phonemes J&H give consists of the English consonants /k g ʃ/ and /ŋ/ (28). These segments can be transcribed into elements as seen in Table 4.1. These consonants are contrasted against their *diffuse* counterparts.

Compact		*Diffuse*			
/k/	|U ʔ $\underline{\text{H}}$|	/t/	|A ʔ H|	/d/	|A ʔ |
/g/	|U ʔ H|	/p/	|$\underline{\text{U}}$ ʔ H|	/b/	|$\underline{\text{U}}$ ʔ |
/ŋ/	|U ʔ L|	/s/	|A $\underline{\text{H}}$|	/f/	|$\underline{\text{U}}$ A H|
/ʃ/	|$\underline{\text{I}}$ ʔ |	/n/	|A ʔ L|	/m/	|$\underline{\text{U}}$ ʔ L|

Table 4.1. Segments containing the feature compact *opposed to those containing* diffuse*; translated into elements.*

Table 4.1 shows that compact distinguishes ‘back’ consonants from ‘front’ consonants. The line between compact (back) and diffuse (front) lies between the palato-alveolar and the alveolar. In ET there are two elements needed describe the single acoustic feature [compact]. The two elements representing acoustic patterns that depict compactness are |$\underline{\text{I}}$| (headed), which describes palatal consonants and |U| (unheaded) which describes velar consonants. The vowels represented by the feature compact are /e a o/, which are represented in ET by |$\underline{\text{I}}$ A|, |A| and |U A| respectively. This shows that the elements used to represent *compact* in consonants are different that those that represent the feature in vowels.

Another method to translate the acoustic feature into elements is to solely look at the acoustic pattern represented by the feature and matching it to the element that describes the same acoustic pattern. When looking solely at the description of the acoustic pattern and comparing this to the elements that correspond to the same acoustic pattern there are some other answers. Since both J&H and Backley have based their primes on acoustic patterns one would expect both theories to have a single representation for that specific pattern. If we would look at the acoustic pattern as described for the feature compact one could perhaps realise a single element to the acoustic pattern that represents the acoustic feature. The acoustic pattern for compact is described in Jakobson & Halle as “relative predominance of one centrally located formant region (or formant)” (27). This description does not provide concrete enough information to pinpoint it to a specific element. Neither do their spectrograms (48) provide a clear formant for the consonants to relate them to a specific acoustic pattern that matches those of any element. One would expect J&H referred to an acoustic pattern similar to that of |A| as its spectral shape is characterised by the mass of energy in de lower central parts of the spectrum. It could also be represented by the U-element which similarly to |A| has an energy mass, although it is located more in the lower regions of the spectrum and not so much the centre. However, the A-element is not represented in the consonants that are positive for the compact feature. On the other hand, the U-element is properly presented in the velar consonants.

It appears that articulatory features can be translated into elements. Therefore, it should be possible for elements to describe purely articulatory phonological processes as the features needed for its proper description can simply be translated into elements. Although some will not translate into the other 'language' one on one there is an overlap.

This difference in the assignment of primes to phonemes is also reflected in the different natural classes established within the different theories. The natural classes in acoustic based phonology are sorted differently than the natural classes in articulatory phonology. In the Jakobsonian system labial and velar consonants form a natural class as they share the same acoustic pattern labelled as *grave*, however they do not form a natural class when defined with articulatory features; as some phonemes are defined as *coronal* and others as *back*. In ET these phonemes are placed in the natural class of |U|. It seems that an acoustic specification allows for the characterisation of certain natural classes. These segments would not be categorised into these natural classes if they would have been defined in purely articulatory terms. With these acoustic specifications as mentioned in Jakobson it becomes clear that the articulatory features are able to be defined in acoustic correlates, as every articulatory movement in speech production has an acoustic effect. The effect of this translation from articulatory to acoustic will be that the long list of features as presented in *SPE* will no longer be appropriate, as it is possible to define articulatory features with similar acoustic patterns and therefore place them under the same acoustic correlate. Labials and velars are in ET placed in the same natural class of U as they both shows similar acoustic patterns (rUmp) in their spectral slices.

5. ET RESTRICTIVENESS IN ASSIMILATION

5.1 STOP-FRICATIVE ASYMMETRY

The restrictiveness of ET can also be observed through the analysis of phonological processes. One phonological process that will be analysed with ET are assimilation processes. This common articulatory process take place across different languages and is observed in many different forms. One of the most recognised forms of assimilation is that of nasal place assimilation. In this process the nasal phoneme assimilates to the place features of another consonant within its proximity. In the most common instances of this type of assimilation an underlyingly coronal nasal assimilates to an immediately following obstruent creating a homorganic nasal-obstruent cluster. These processes have been widely accounted for with different forms of FT (e.g. Padgett 1994). Padgett (1994) uses FT – specifically feature geometry – to describe the different behaviours of nasals in assimilation processes. One would expect the assimilation to fricatives to be as natural al that to stops, however language after language shows that this is far from true and that nasals typically only assimilate to stops. Nasal place assimilation is often found to reject the combination of nasals and fricatives. The combination of the features [+nasal] and [+continuant] are disfavoured in many languages. This can be explained phonetically: nasality is produced with a closed mouth and airflow through the nose, while in a segment with [+continuant], such as fricatives, the airflow escapes through the mouth; these two are difficult, if not nearly impossible to combine. Therefore, languages opt for other sound changes in order to avoid the combination of [+nasal] and [+continuant] such as the deletion of the nasal or the assignment of default place. In ET we see that assimilation is related to the |ʔ|-element. When segments agree in the possession of |ʔ| place resonance is able to spread to their neighbouring segment. When one of the segments lacks |ʔ| the assimilation is not able to take place. In these cases the nasal remains in its position in front of the |ʔ|-less element – a disfavoured position. In order to solve the heterogenic cluster the language will implement sound changes to resolve this clash. Firstly we will observe the history of fricatives to see to their origins and possible element structures. Thereafter , the chapter will see to different kinds sound changes and of reactions to the avoidance of nasal-fricative assimilation, in which ET will be put to the test to account for these articulatory processes.

5.1.1 HISTORY OF FRICATIVES

Fricatives often originate from voiceless stops. This means that the structure of fricatives of Germanic languages inherited these changes from Proto-Germanic should have the same structure. Historically these fricatives were voiceless stops that were subjected to a sound change due to a chain shift. Because this chain shift targeted the sounds developing form Proto-Indo-European to Proto-Germanic, fricatives of languages not part of these proto-languages could behave differently. A behaviour different than that of Germanic fricatives can be related to an element structure that differs from that of Germanic fricatives, as they would have gone other changes of their own. Furthermore, the historical linguistics of English also shows a disfavour for the combination of [+nasal] and [+continuant].

The English fricatives stem from those found in Proto-Germanic which originated in a sound change where voiceless stops became voiceless fricatives. This sound change was part of a set of sound changes that have been labelled as Grimm’s Law. Grimm’s Law covers three interrelated changes in a series of stops from Proto-Indo-European to Proto-Germanic. This series of changes is able to sketch an image of the element structure of the fricatives found in English (3).

<table>
<tr><td>(3) a.</td><td colspan="2">*/p/ > /f/</td><td colspan="2">*/t/ > /θ/</td><td colspan="2">*/k/ > /h/ (/x/)</td></tr>
<tr><td></td><td>|<u>U</u>|</td><td>|<u>U</u>|</td><td>|I|</td><td>|I|</td><td>|U|</td><td>|U|</td></tr>
<tr><td></td><td>|ʔ|</td><td>| |</td><td>|ʔ|</td><td>| |</td><td>|ʔ|</td><td>| |</td></tr>
<tr><td></td><td>|H|</td><td>|H|</td><td>|H|</td><td>|H|</td><td>|H|</td><td>|H|</td></tr>
<tr><td>b.</td><td colspan="2">*/b/ > /p/</td><td colspan="2">*/d/ > /t/</td><td colspan="2">*/g/ > /k/</td></tr>
<tr><td></td><td>|<u>U</u>|</td><td>|<u>U</u>|</td><td>|I|</td><td>|I|</td><td>|U|</td><td>|U|</td></tr>
<tr><td></td><td>|ʔ|</td><td>| |</td><td>|ʔ|</td><td>| |</td><td>|ʔ|</td><td>| |</td></tr>
<tr><td></td><td>|H|</td><td>|H|</td><td>|H|</td><td>|H|</td><td>|H|</td><td>|H|</td></tr>
<tr><td></td><td>|<u>L</u>|</td><td></td><td>|<u>L</u>|</td><td></td><td>|<u>L</u>|</td><td></td></tr>
<tr><td>c.</td><td colspan="2">*/bh/ > /b/</td><td colspan="2">*/dh/ > /d/</td><td colspan="2">*/gh/ > /g/</td></tr>
<tr><td></td><td>|<u>U</u>|</td><td>|<u>U</u>|</td><td>|I|</td><td>|I|</td><td>|U|</td><td>|U|</td></tr>
<tr><td></td><td>|ʔ|</td><td>| |</td><td>|ʔ|</td><td>| |</td><td>|ʔ|</td><td>| |</td></tr>
<tr><td></td><td>|<u>H</u>|</td><td>|H|</td><td>|<u>H</u>|</td><td>|H|</td><td>|<u>H</u>|</td><td>|H|</td></tr>
<tr><td></td><td>|<u>L</u>|</td><td>|<u>L</u>|</td><td>|<u>L</u>|</td><td>|<u>L</u>|</td><td>|<u>L</u>|</td><td>|<u>L</u>|</td></tr>
</table>

English words that contain fricatives distinguish themselves from cognate words from other Indo-European languages that do not stem from the Germanic branch. When these cognates are compared to each other the languages from the other branches do not show the results of the sound change as observed in Grimm's Law (4). From (4) the structure of fricatives can be established.

(4)		*Spanish*	*French*	*English*
	*/p/ > /f/	pie	pied	foot
		padre	père	father
	*/t/ > /θ/	tres	trois	three
		tu	tu	thou
	*/k/ > /h/	(can)	chien (<kani-)	hound (< hund)
		corazón	cœur	heart

Examples taken from Campbell (2013; 43)

Fricatives that stem from the branch of Romance languages show that their fricatives could possibly have another origin, as they stem directly from the voiced aspirated stop */bh/ and */dh/ (Campbell). The element structure for Classical Latin /f/ can be found in (5). These structures show the weakening of both the Proto-Indo-European /bh/ and /dh/ to Latin fricative /f/ through which the previously voiced segments lose their voicing elements. This shows that if we follow this interpretation, both instances of /f/ would still contain the |ʔ|-element. Although this structure is possible, it is unlikely for /f/ to contain |ʔ| in both instances. There could have been a later weakening that would have gotten rid of |ʔ|, or the sound change was able to delete both the voicing segment and the occlusion. To establish the correct structure of /f/ for Romance languages it is necessary to look at phonological processes considering these segments. Through these processes we can observe their behaviour and establish an accurate element structure.

(5)	*/bh/ > /f/		*/dh/ > /f/	
	|U|	|U|	|I|	|I|
	|ʔ|	|ʔ|	|ʔ|	|ʔ|
	|H|	|H|	|H|	|H|
	|L|		|L|	

According to Cser (2016) Classical Latin does not contain nasal consonants before fricatives in surface representations. This means that Classical Latin experiences nasal deletion when the nasal is followed by fricative /s/ or /f/ (Latin does not contain voiced fricatives /z/ and /v/ phonemically). The majority of nasal vowel and [f] occurrences are found in prefixed forms such as *in-* or *con-* plus an /f/-initial stem such as (*conferre* [kõːfɛre] 'collect', *infamis* [ĩːfaːmɪs] 'disreputable'). It is also found in simplex forms although not as often (*inferus* [ĩːferus] 'lower'). On the other hand, nasals occur more often before [s] such as in *ensis* [ẽːsɪs] 'sword', *anser* [ãːsɛr] 'goose' and *monstrum* [mõːst̪r̪õ] 'omen'. Because Classical Latin does display assimilation between nasals and stops ([mb] *imbibere* 'drink in', [ŋk] *inquirere* 'inquire' vs. *inest* 'is in') but shows the avoidance of nasals followed by fricatives, it can be assumed that the elemental structure of fricatives must differ from that of stops in respect to its manner elements. If not, nasals would have just as easily assimilated to fricatives as they do to stops. Because stops do contain the |ʔ|-element it can be deduced that Latin fricatives similar to the Proto-Germanic fricatives no longer contained this element. So, although Classical Latin has descended from a different branch of Proto-Indo-European than Proto-Germanic, the structure of fricatives is similar as we can reason that like Proto-Germanic it no longer contains the |ʔ|-element.

Another observation that can be made in the development of these historical languages is the avoidance of nasal fricative clusters in the development of Old English from Proto-Germanic (6). This nasal fricative combination observed in morpheme final position is unwanted and its avoidance has resulted in the deletion of the nasal. To make up for the loss of the nasal the vowel is simultaneously lengthened (6). In certain German cognates it can be observed that the /n/ before the fricative has been retained such as in *fünf* 'five', *Mund* 'mouth and *Gans* 'goose'. This shows that not all Germanic languages have an aversion to the nasal-fricative clusters. The nasal-fricative clusters in Dutch display a different behaviour that those in OE and German. Where German and OE have chosen for either deletion or acceptation Dutch contains an irregular indication of deletion and lengthening process. In some instances the nasal-fricative clusters are allowed such as in *gans* 'goose' and *mond* 'mouth, while in others they have been deleted and the vowel lengthened such as in *vijf* 'five'.

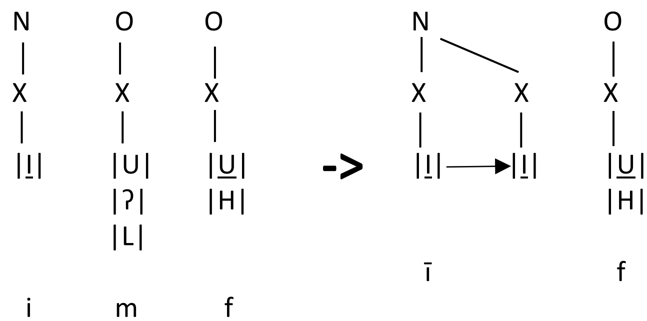
(6) a.

Proto-Germanic	Old English	
*fimf	fīf	'five'
*gans-	gōs	'goose'
*grinst	grist	'grist'
*hanh-	hōh	'heel'
*linθj(az)-	līθe	'mild'
*munθ	mūθ	'mouth'
*tanθ-	tōθ	'tooth'

Examples taken from Campbell (2013)

b.

a. *fīf*



5.1.2 FRISIAN NASAL ASSIMILATION

We also see this nasal-fricative avoidance in Frisian, a language very close related to Old English. Frisian likewise exhibits the avoidance of nasal-fricative clusters but demonstrates a different outcome to the situation than Old English nasal-fricative clusters, where the nasal is deleted. In the Frisian prefix *in*-, [n] assimilates in place of articulation with the following stop as can be seen in (7). Here both the /n/ and the following stop contain the |ʔ|-element which allows the assimilation to take place and for the nasal to take on the place of the following stop (8). When the nasal /n/ is followed by a fricative or the lateral /l/ the nasal it is not able to receive the place of articulation from the fricative or lateral consonant as both the lateral /l/ and the fricatives do not contain |ʔ|. In this environment the |I ʔ| of the /n/ are deleted and its nasal quality |L| moves to the vowel that precedes it and gives this its nasality. This process can be observed in (8) where the greyed out area represents the deleted elements.

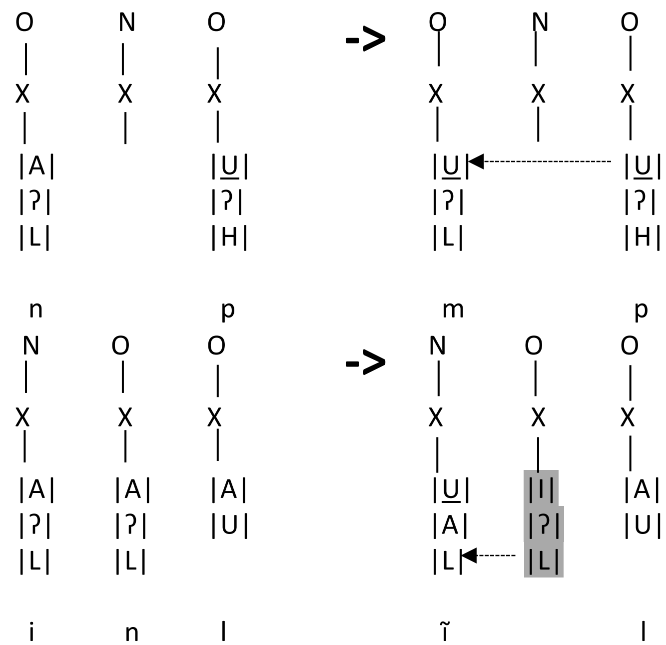
(7) a.	in-pakə	[impakə]	'to wrap up'
	in-gɪən	[iŋgɪən]	'to enter'
b.	in-fɑlə	[ĩfalə]	'to fall in'
	in-veɲə	[ĩvɛɲə]	'to live with one's parents'
	in-lɪzə	[ĩlɪzə]	'to preserve'

Examples taken from Backley (2011)

(8)

a. in-pakə [mp]

b. in-lɪzə [ĩl]ɪzə



5.1.3 Polish Nasal Assimilation

Polish presents a similar asymmetrical behaviour to nasal-fricative assimilation just like Old English and Frisian. Polish is one of the languages that displays different behaviours within nasal assimilation. In Polish assimilation to fricatives is blocked, in these cases the nasal gets assigned its default place. Polish nasals display different behaviours when it comes to nasal place assimilation: where the one is the expected nasal assimilation and the other is nasal gliding. The place assimilation occurs before stops and affricates, and the gliding occurs elsewhere – before fricatives and word-finally. Polish contains the nasal segments /n/ and /m/, but also two nasal vowels /ą/ (realized as [õ]) and /ę/. These vowels are not full nasals like French nasalized vowels but are realized as a sequence of an oral vowel and a nasal segment. (9) contains some examples taken from Padgett (1994, p. 480) that show the assimilation of the nasal vowel in Polish. As we previously saw for the English examples, assimilation can only take place when both the nasal and the following consonant are specified for the |ʔ|-element or [–cont]. Because the Polish nasal vowel is a vowel it will not carry |ʔ| in its structure, as the |ʔ| is a manner element in consonants and therefore is not available for vowels.

(9)	ząb	[zomp]	‘tooth’
	zęby	[zembɨ]	‘teeth’
	ręce	[rence]	‘hands
	tęcza	[tentʃa]	‘rainbow’
	bądź	[bońć]	‘be (imperative)’
	węgiel	[veŋg’el	‘coal’

For FT, Padgett explains that the nasal consonant portion of the nasal vowels is underlyingly placeless and surfaces as the nasal consonant when it has assimilated. In this case FT has the ability to properly represent the nasal consonant portion of the vowel, while ET is too limited to properly represent this structure. ET operates on a single level and therefore does not differentiate a separate deep structure containing underlying place indications that go through structure changing operation before surfacing (Backley, p. 13). The assimilation processes for *ząb* and *ręce* as they most likely would be represented in ET can be found in (10), where the phonetic realisation has been displayed and the nasal is already realised. This is how Backley realises the phonological processes with ET. With this representation there is no account on where certain segments originate from and would incorrectly display the process, making it look like insertion rather than assimilation. This limited realisation can be placed on the restricted representation of phonological processes in ET that limits the visibility of underlying structures and the triggers of processes. The structure in (10) represents the nasal vowel as |<u>U</u> A L|, a plain vowel representation with added nasalisation. To complete the assimilation, process the nasal vowel will transfer its nasality to the following nasal segment; the consonant /p/ will transfer its place.

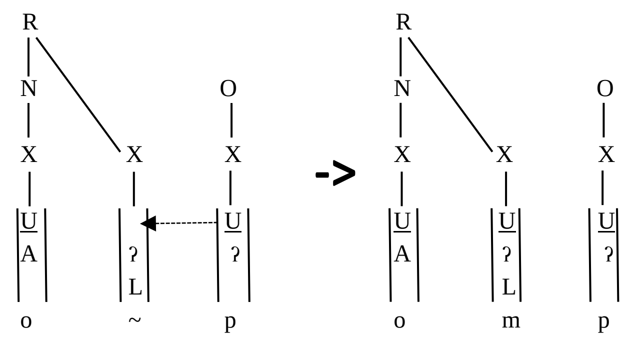
(10) a. ząb [zomp] b. ręce [rence]

N	O	O	N	O	O
X	X	X	X	X	X
|<u>U</u>|	|<u>U</u>| ←	|<u>U</u>|	|<u>U</u>|	|I| ←	|I|
|A|	|ʔ|	|ʔ|	|A|	|ʔ|	|A|
|L| →	|L|		|L|	|L|	|ʔ|
o	m	p	e	n	c

In the structure of (10) it seems as if the nasal has been inserted into the structure, as it is absent from the orthography. This assumption rather suggests insertion of the nasal /m/ and not assimilation of the nasal vowel to the following segment. The nasal consonant portion of the vowels in (10) are not accurately displayed, it is actually not displayed at all as only the surface structure is displayed in ET. The location and structure of the nasal portion that facilitates the assimilation in this representation is unknown. The process could be expressed more accurately if ET accommodated something of an underlying structure like that in FT. In the underlying structure the nasal consonant portion of the vowel could then have been represented by just the elements |ʔ L|. Omitting the place element would make it underlyingly placeless while the |ʔ| element would allow it to assimilate to the following /p/ and therefore it would be able in taking its place of articulation.

The nasal consonant portion of the vowel could also be considered to be realised in the nucleus of the syllable structure; this construction is considered in (11). This representation assigns a location to the nasal portion before the assimilation has taken place. The following consonant can therefore assimilate to the nasal portion since they both contain the |ʔ|-element. The construction in (11) can be realised as such as the nasal vowels are considered to be longer than ordinary vowels, Padgett suggests, and therefore can take up two slots in the nucleus. In this context the vowel is realised under the first x-position of the nucleus and the nasal consonant portion under the second together taking up the two slots in the nucleus. The assimilation will be able to take place as the nasal consonant portion of the vowel is next the consonant in the following onset. In this case the place of articulation will move to the nasal segment after which the then fully realised /m/ would move to the rhyme position, leaving the /o/ in the nucleus. With this representation there is a clear position of where the nasal consonant comes from and what triggers the assimilation process. However, as ET only has one level of representation it only allows the more restrictive representation of *ząb* as in (10) as the correct way of representing the assimilation process of the nasal vowel and the following consonant.

(11) a. b.



Another form of assimilation with the Polish nasal vowels is that of nasal gliding. In contrast to the assimilation of the nasal to the following stop in (10), the nasal segment surfaces as the nasalised glide [w̃] when followed by a fricative. The gliding can be observed in the examples given in (12).

(12)	mąż	[mow̃ʂ]	‘husband’
	wąski	[vow̃ski]	‘narrow (masc. sg.)’
	męski	[mew̃ski]	‘man’s (masc. sg.)’
	węch	[vew̃x]	‘smell’

Padgett explains that place assimilation involves [cont] assimilation. Assimilation to stops and affricates does not cause problems, since the nasal/continuant marking condition states that “if a nasal is specified for [cont] it must be [–cont]” (pp. 481-2). This condition prevents assimilation to fricatives as they are specified for [+cont]. In ET this means that place assimilation involves |ʔ| assimilation and that assimilation to stops and affricates does not cause problems as they both contain |ʔ| in their structures (Backley, 2011, p. 108). In this case this condition also prevents place assimilation to fricatives as they do not contain |ʔ| in their structures. For Polish in environments where assimilation does not occur – before fricatives and word-finally – researchers such as Czaykowska-Higgins (1988) rely on a rule of gliding where

(13)	a.	blond	[blond]	'blond'	the
		bank	[baŋk]	'bank'	
		pan bog	[pam buk]	'lord god'	
		huragan kolosalny	[huragaŋ kolosalni]	'colossal hurricane'	
	b.	szansa	[šaw̃sa]	'chance'	
		konflikt	[kow̃flikt]	'conflict'	
		konwent	[kow̃vent]	'convent'	

Examples taken from Padgett (1994)

placeless nasal vowel is assigned a default place of articulation (Padgett, p. 482). Therefore, it could be established that Polish carries a general process of default labiovelar place assignment that affects sonorants (Czaykowska-Higgins, pp. 254-5). The nasal gliding will appear in places where the nasal assimilation cannot appear, they are therefore in complementary distribution.

The nasals /n/ and /m/ behave similar to the nasal vowels /ą/ and /ę/ and undergo a similar pattern of place assimilation although under different conditions. In casual speech /n/ will assimilate to the following stop both within and across words. This can be observed in (13). Like the nasal vowels, there is also gliding before fricatives with /n/, as can be seen in (13). Although it is stated that both Polish nasals and nasal vowels undergo the same assimilation process, the nasal portion of the nasal vowels are unspecified for place and therefore can simply receive the labio-velar specification when they are unable to assimilate. However, the nasal /n/ is already specified as coronal or for |I| in Polish and cannot simply receive the default place.

The other nasal, /m/, also undergoes nasal gliding. The assimilation and gliding properties of /m/ are more limited than that of /n/. Both Czaykowska-Higgins (1988) and Padgett (1994) show in their work the possibilities on how rules within FT can represent the restricted gliding process of /m/ and how /m/ is restricted in place assimilation post lexically; ET is able to display this limitation in assimilation through its element structure. Unfortunately, ET does not possess the ability to apply post lexical rules to its structures and cannot clearly explain as to why /m/ is restricted in this case in the same way as FT. Instead of using post lexical rules, ET is able to express this non-assimilation of /m/ through its headedness-based approach that is expressed in the |U|-element.

Unlike /n/, /m/ never assimilates in place of articulation to following stops (i.e. *klamka* 'doorknob' will never be *[klaŋka]). They do become nasal glides in casual speech, but only if followed by a labial fricative (i.e. tramvaj [traw̃vaj] 'tram', but xamski [xamski] 'boorish') (Padgett, 1994). In **Error! Reference source not found.** we can see that the result of /n/ assimilation causes /m/ to have the internal structure |<u>U</u> ʔ L|, which suggests that it should also be a target for assimilating as it contains, like /n/, the |ʔ|-element. The overview in (14) shows the different environments that /n/ and /m/ could be in. (14) Shows the structure of /n/ when found in a cluster with either /s/ or /f/. In this environment /n/ is not able to assimilate and will receive default place in the form of [w̃]. With this case it can be reason that the default place comes from the place of the labial fricative with /n/ is paired with /f/ (or /v/). In the case of /ns/ this cannot be the case as /s/, like /n/ is a coronal segemtn. The structure as shown in (14a) and (b) cannot account for the origin of [w̃] when /n/ is assignment default place. If we move to (14) and (d) the structure contains the nasal-fricative cluster [mv] that causes /m/ to receive a place specification by default giving [w̃]. The processes is rendered as if the default place comes form [v], because it has a labial place element, although this is not the case. The default place most likely comes from an underlying representation that cannot be accounted for in ET. (14) shows the inability of /m/ to assimilate to /s/ (or /z/) but in this case is not replaced by the default place marker [w̃]. The structures of (14d) and (14e) are not able to explain several things. The first thing that it is unable to account for is the ability of /m/ and /n/ to receive default place. The structures as represented do not account for the possibility to insert such a segment without it already being present in the segments. Secondly its is not able

<table>
<tr><td>(14)</td><td>a.</td><td></td><td>b.</td></tr>
<tr><td></td><td>O N O
X X X
|I| |I|/|U̲|
|ʔ| |H|
|L|
n s/f</td><td>-></td><td>O N O
X X X
|U̲| |I|/|U̲|
|H|
|L|
w̃ s/f</td></tr>
</table>

<table>
<tr><td>c.</td><td></td><td>d.</td><td>e.</td><td>f.</td></tr>
<tr><td>O N O
X X X
|U̲|
|U̲|
|ʔ|
|H|
|L|
(|L|)
m
f(/v)</td><td>-></td><td>O N O
X X X
|U̲| ← |U̲|
|H|
|L|
(|L|)
w̃
f(/v)</td><td>O N O
X X X
|U̲| |I|
|ʔ| |H|
|L| (|L|)
m
s(/z)</td><td>O N O
X X X
|U̲| |U|
|ʔ| |ʔ|
|L| |H|
m k</td></tr>
</table>

to explain why /m/ is excluded from receiving default place when followed by /s/ or /z/ (14e). The structures of /s/ and /z/ are almost identical to those of the labial fricatives and it does not explain as to why /n/ becomes [w̃] before /f v s z/ and /m/ only before /f v/. Lastly (14f) shows the inability of /m/ to assimilate to a stop. For this Backley falls back on the inherent weakness of coronals (such as /n/) which is a reflection of their non-headedness, |I|. Because of this they are regularly targeted by assimilation processes and often occur in weak positions. On the other hand, |U̲| is a headed element and is therefore seen as inherently strong, in this case it means that the headedness of the element could explain as to why it refrains from assimilating to following non-continuants although they both agree in their possession of |ʔ|. When /m/ is found next to stops in words such as *klamka* 'doorknob' the weaker element of /k/ (unheaded |U|) is not able to "overwrite" the stronger element of /m/, and the spreading is prevented. With the idea of headedness we can return to the structure in (14e) to reassess the argumentation. As mentioned above the |$\underline{U}$| element is inherently strong and therefore not submitted to deletion and spreading. Because the fricatives /s/ and /z/ are coronal they are considered as weaker and therefore are not capable of spreading their place of articulation to the labial segment. This explains why /m/ does not assimilate when before coronal fricatives. Nevertheless, the headedness of |U| in /m/ does not explain why /m/ undergoes default place assignment when occurring before a labial fricative. In Polish, when /m/ is followed by a labial fricative such as /f/ or /v/, it cannot assimilate to that fricative and will thus remain /m/, creating an unwanted nasal-fricative cluster. To avoid this complex cluster /m/ will receive the default place specification [w̃]. When the structures of the segments involved in this hypothetical process are observed in (15) there is no clear indication as to why /m/ would receive the default place marker, as all of them contain the same resonance element |$\underline{U}$|.

(15)

/m/	|$\underline{U}$ ʔ L|
[w̃]	|$\underline{U}$ L|
/f/	|$\underline{U}$ H|

According to Czaykowska-Higgins (1988), that there must a rule that deletes [labial], or in the case of ET, |$\underline{U}$|. This is triggered by the Obligatory Contour Principle which states that identical features are banned in underlying representations. This principle explains for FT as to why /m/ receives the default place before labial fricatives, but since ET only has one level of representation this principle it is unclear whether this principle can be applied here. For an explanation in ET it would seem that the relation to the default place assignment is not situated in the assignment of place but in the deletion of the |ʔ|-element. If we analyse this possible process this phenomenon would no longer be associated with nasal assimilation but rather with obstruent weakening. When /m/ is next to a labial fricative, the fricative could trigger weakening in /m/ through which it loses its |ʔ| property and becomes [w̃]. On the other hand this argumentation suggests that the reason for the deletion of the occlusion in /m/ is the fact that the fricative does not possess an |ʔ|-element. This indicates that the deletion is triggered by an inactive element and would suggest that ET has some sort of binary system. It could be argued that the frication element in this case would trigger the deletion of the occlusion but these two manner elements are not considered to be paired together. Additionally, the default place assignment does not resolve the problem of the nasal-fricative avoidance, at least for ET. The replacement of /m/ by the nasal glide [w̃] does not change the amount of nasality presence in the cluster. As the structures in (15) show both /m/ and [w̃] contain the same nasal element |L| and ET therefore labels them both as nasal elements. If the reason for a default place marker would be implemented to avoid the presence of a nasal-fricative cluster, ET is not able to correctly display the outcome and effectiveness of this process.

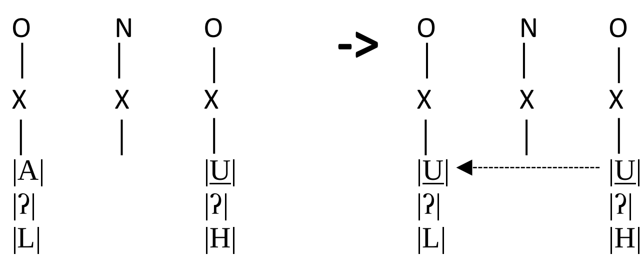
5.1.4 ENGLISH NASAL ASSIMILATION

In contrast to Old English and Frisian, English displays assimilation where nasals pattern together with stops and affricates and take on their place of articulation regardless of the a agreement in |ʔ|. When patterned together with fricatives this assimilation is assumed to not occur, however the assimilation of nasals and fricatives is observed in casual speech. Because it is considered that languages cannot exhibit these qualities (Padgett 1994) ET's restrictive nature makes it challenging to correctly display this behaviour and in order to do so will even further restrict its own grammar.

In English the alveolar nasal /n/ takes on the place of the following consonant. The English nasal /n/ is in ET represented as |A ʔ L| where the |ʔ|-element represents the drop in acoustic energy that nasals, like oral stops, display in their spectrogram. This element is associated as the trigger for assimilation and is in FT represented with the feature [–continuant]. Backley states that English fricatives /f v s z/ do not contain the |ʔ|-element, as they are continuous segments that do not have any occlusion in their realisation. They also do not display the drop of acoustic energy in the spectrum like stops and affricates do (Figure 4.9). In FT they are represented with the feature [+continuant], this feature is extremely similar to |ʔ| in character and behaviour. Because both the consonants and the nasals contain |ʔ| in English they are able to pattern together, and the nasal segment is able to spread to the place of articulation of the following segment. Although oral stops and nasals in English are both produced with some occlusion in the oral cavity that can be observed in their spectrogram – a segments element structure is determined primarily on its phonological behaviour and not on its acoustic properties. To establish if nasals indeed contain |ʔ| they would have to pattern with the oral stops. (16)[3] contains examples of English prepositional phrases where the nasal patterns with the stop in the onset of the following morpheme. This assimilation establishes that /n/ contains |ʔ|.

(16)

in Paris [mp]



[3] Not all structures used in this theses contain the above lying tiers. This is to save space as the number of structures to properly illustrate the concepts would vastly overrule the amount of space on a page. When essential to the explanation the tiers are implemented. When absent, vowels fall under the N-tier while consonants under the O-tier. These tiers alternate each other.

<table>
<tr><td></td><td></td><td>n</td><td>p</td><td></td><td>m</td><td>p</td></tr>
<tr><td>in Greenland</td><td>[ŋg]</td><td>|A|
|ʔ|
|L|</td><td>|U|
|ʔ|
|H|</td><td>-></td><td>|U|◄
|ʔ|
|L|</td><td>|U|
|ʔ|
|H|</td></tr>
<tr><td></td><td></td><td>n</td><td>g</td><td></td><td>ŋ</td><td>g</td></tr>
<tr><td>in Chile</td><td>[ɲtʃ]</td><td>|A|
|ʔ|
|L|</td><td>|I̲|
|ʔ|
|H|</td><td>-></td><td>|I̲| ◄
|ʔ|
|L|</td><td>|I̲|
|ʔ|
|H|</td></tr>
<tr><td></td><td></td><td>n</td><td>tʃ</td><td></td><td>ɲ</td><td>tʃ</td></tr>
</table>

In addition to the examples of assimilation in prepositional phrases, nasals also pattern with stops when within words such as with the prefix *in-* (17) and *con-*(18). The nasal in the prefix assimilates in place to the following stop. When the prefix appears before fricatives, in (17) (18), it does not assimilate and assumes its default place, which for English is coronal and is represented in ET with |A|.

(17)	a.	impale	*inpale	b.	infallible	*imfallible
		impossible	*inpossible		infamous	*imfamous
		implicit	*inplicit		infinite	*imfinite

Examples taken from Padgett (1994) p.471

(18)	a.	complacent	*conplacent	b.	confess	*comfess
		compassion	*conpassion		confirm	*comfirm
		combine	*conbine		convert	*comvert

Examples taken from Padgett (1994) p.473

As previously stated, in FT the feature [–continuant] triggers nasal assimilation, since fricatives have [+continuant] the assimilation fails. In ET it is the element |ʔ|, which behaves similarly to [–continuant], that triggers assimilation. When assimilation can take place, the place element spreads to the place slot in the nasal segment. When |ʔ| is absent, the assimilation fails, and the place element will not spread the nasal segment. This can be observed in (19). Padgett discusses that when the assimilation fails, the nasal segment will be assigned a default place of articulation. This default place is language dependent. For English this place is coronal or |A|. This assumption of a default place can be accounted for in FT as the theory can represent underlying structures that can interpret the existence of the default place. The structure of representation in ET is too restricted to justify this interpretation of the default place. It has to be assumed that in this case the place element of the stop overwrites the coronal place of the nasal. For cases where the stop contains a headed element such as in *impale* in (19) this assumption is not completely out of the ordinary. Because the headed element is regarded as being stronger it should be able to account for the replacement of the weaker coronal |A|. It cannot account for all of the given examples, such as *in Greenland* in (16). Here the place element of the velar /g/ (|U|) is non-headed and can be considered to be of the same strength as the alveolar element in /n/. ET is not able to explain why these place elements are able to overwrite the |A| in the nasal nor if the nasal has an underlying structure that could account for the default place assignment. The concept of default place assignment will be further discussed 5.1.4.

(19) i[mp]ale infallible

<table>
<tr><td>O</td><td>N</td><td>O</td><td></td><td>O</td><td>N</td><td>O</td><td>O</td><td>N</td><td>O</td></tr>
<tr><td>X</td><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>|A|</td><td></td><td>|$\underline{U}$|</td><td>-></td><td>|$\underline{U}$|</td><td></td><td>|$\underline{U}$|</td><td>|A|</td><td></td><td>|$\underline{U}$|</td></tr>
<tr><td>|ʔ|</td><td></td><td>|ʔ|</td><td></td><td>|ʔ|</td><td></td><td>|ʔ|</td><td>|ʔ|</td><td></td><td>|A|</td></tr>
<tr><td>|L|</td><td></td><td>|H|</td><td></td><td>|L|</td><td></td><td>|H|</td><td>|L|</td><td></td><td>|H|</td></tr>
<tr><td>n</td><td></td><td>p</td><td></td><td>m</td><td></td><td>p</td><td>n</td><td></td><td>f</td></tr>
</table>

Furthermore, ET is too restrictive to display some of the assimilation processes that occur between fricatives and nasals in English casual speech. As displayed in (17) and (18) the assimilation between nasals and fricatives does not trigger assimilation and assigns the coronal default place. However, in casual speech, assimilation to fricatives is not completely unheard of. In expressions such as *in France* the nasal is observed to assimilate to the place of the fricative producing *i*[m f]*rance* (20). This is also found in its contrastive fricative /v/ and in the dental fricative /ð/ (20). The assimilation between these fricatives and /n/ goes against the statements established in the previous paragraph as the place of the fricative is able to assimilate while the nasal and fricative do not agree in their possession of |ʔ|. The assimilation of /n/ to a fricative questions the structure of both the fricative and the nasal. As shown in (16), (17) and (18) there is evident assimilation of /n/ to stops, this behaviour cannot contradict that /n/ contains |ʔ|. So, for /n/ to take on the place of articulation of /f/, /f/ would need to contain the |ʔ|-element. If /f/ would be in possession of the |ʔ|-element it would also allow for stops to assimilate to its place of articulation. This assimilation between stops and /f/ is however not observed *set forward* /sɛt fɔːwəd/ or *make flee* /meɪk fliː/. The asymmetry of assimilation between stops and fricatives in English makes that /f/ would have to have two different element structures: one that includes |ʔ| in its structure to trigger assimilation with /n/ and one that excludes it to block assimilation to stops. This dual structure of segments restricts the grammar of ET by allows segments to acquire multiple representations that could overlap with other segments. If two consonants would exhibit different behaviour but inhibit the same element representation it would allow for the grammar to make rules or restrictions to explain the duality of the two available representations. Now for /f/, which would take on the structure of |$\underline{U}$ A ʔ $\underline{H}$| in the case of assimilation to /n/, this alternative representation will not intervene with any other existing representations in the language that could assume an onset position; therefore it cannot be confused with the representations of other sounds in the language.

(20)

invariable	[mv]	|A|	|U|	->	|U| ←	|U|
		|ʔ|	|A|		|ʔ|	| |
		|L|	|H|		|L|	|A|
						|H|
		n	v		m	v
in the Hague	[n̪ð]	|A|	|I|	->	|I| ←	|I|
		|ʔ|	|ʔ|		|ʔ|	| |
		|L|	|H|		|L|	|H|
		n	ð		n̪	ð
in France	[mf]	|A|	|U|	->	|U| ←	|U|
		|ʔ|	|A|		|ʔ|	| |
		|L|	|H|		|L|	|A|
						|H|
		n	f		m	f

5.1.5 DUTCH NASAL ASSIMILATION

Similar to English, Dutch also has nasals that interact with both fricatives and stops. The extent to which the assimilation occurs in Dutch is much more frequent than that in English, creating more homorganic clusters in the language. Like English, nasal assimilation is found in the interaction of obstruents preceded by a nasal-final prefix which is not always homorganic underlyingly (21). The assimilation is in cases where the consonant following the prefix in- is a labial consonant the assimilation is reflected in the language's spelling such as *impliciet*. Though if the following consonant is not labial but for example velar this change is not reflected in the spelling. This change in spelling is only found with the use of the Latin negative prefix in-. The examples in (21) also show the alveolar nasal /n/ also patterns with stops (*intolerant*, *inconsistent*) this establishes that, like English, the nasal contains the |ʔ|-element.

(21)

impliciet	/ɪnplisit/	[ɪmplisit]	'implicitly'
intolerant	/ɪntolərɑnt/	[ɪntolərɑnt]	'intolerant'
inconsistent	/ɪnkɔnsistɛnt/	[ɪŋkɔnsistɛnt]	'inconsistent'
onfatsoenlijk	/ɔnfɑtsunlək/	[ɔɱfɑtsunlək]	'indecent'
onmogelijk	/ɔnmoɣələk/	[ɔmoɣələk]	'impossible'
onwaar	/ɔnʋar/	[ɔɱʋar]	'untrue'
onjuist	/ɔnjœyst/	[ɔɲjœyst]	'incorrect'

Examples taken from Taalportaal

On the other hand (21) and (22) also show examples in which /n/ assimilates to fricatives and glides (*onfatsoenlijk, onwaar*). The processes in (22) realise the assimilation with the structures of the segments as they are described in Backley. It can be observed that in this situation the assimilation could not take place as the segments do not agree in occlusion represented by the empty vertical brackets in /f/, / ʋ/ and /j/. Although their disagreement theoretically disallows for their assimilation in practice it takes place

(22)

onfatsoenlijk [ɱf] |A| |U̲| -> |U̲| ← |U̲|
|ʔ| |H| |ʔ| |H|
|L| |L|
n f ɱ f

onwaar [ɱʋ] | | |U̲| -> |U̲| ← |U̲|
|A| |A| |A| |A|
|ʔ| | | |ʔ| | |
|L| |L|
n ʋ ɱ ʋ

onjuist [ɲj] |A| |I̲| -> |I̲| ← |I̲|
|ʔ| | | |ʔ| | |
|L| |L|
n j ɲ j

nonetheless, therefore the nasal has been assigned its assimilated form. The possibility of glides and fricatives to contain the |ʔ|-element comes from the idea that assimilation to other segments can only take place when they belong to the same natural class. In this case, it is unclear whether /n/ belongs to the natural class with |ʔ| or the one without. Where additionally, the assimilation of /n/ to both stops and fricatives could also be the result of an unexpected representation of fricatives and glides, where these segments contain the |ʔ|-element.

To look at this issue in more detail it is important to examine the construction of glides and fricatives as mentions in Backley's work. Backley promotes the aspect of ET that allows all elements to be used by either vowels or consonants. Nonetheless he divides the six elements in two sets and labels them as vowel and consonant elements. In his discussion on glides there is no mention of the possibility of consonant elements to be available in the representation of the glide (pp.65-9). His discussion focuses on the use of the vowel elements in glides but excludes the possibility of the implementation of any consonant elements. He reasons that the absence of |ʔ H L| in the structure of glides makes it unstable, prompting them to be able to alternate with vowels. The origins of approximants is also linked to the suppression of the |ʔ| (and |H|)-element (p.127). This relation hints to an absence of consonant elements in glides. When looking at the glide /j/, which is established by Backley to be acoustically and phonologically similar to [i], is represented by the single |I̲|-element. When |ʔ| would be added to its structure to account for the assimilation to the nasal, its acoustic pattern would turning it into a palatal stop. This change would cause it to no longer fit the sound pattern presented by the segment being that elements in this theory are organised on a single level and therefore are directly mapped onto acoustic patterns. While it would fit the segment's phonological behaviour, this alteration would defeat the purpose of linking /j/ to the spectral pattern of [i] trough which its derived its element. This argumentation not only applies to glides but to fricatives as well: its sound pattern would no longer resemble its structure if a |ʔ|-element would be added purely for the sake of the assimilation. Although Backley denies this possibly of adding consonant elements to glides by the lack of addressing the topic, the addition of |ʔ| to the representation of glides would explain the possibility of an assimilation process between fricatives and glides in Dutch.

If we assume that the solution to this would simply be the addition of the |ʔ|-element to the representations of glides and fricatives, we would run very quickly into several difficulties. The first where the addition of |ʔ| to /f/ would create |U ʔ H|, which at first glance would be suitable to induce the assimilation in these examples without causing too much issue to the grammar. When in fact this solution severely clashes within the grammar of ET for the simple reason that the alternate version of /f/ would have the exact same element structure as /p/. This overlap of representations could not be allowed in ET as there are no other ways of distinguishing these segments in the skeletal structure. Similar to the analysis of English assimilation in 5.1.4, the concept of having multiple representations for the same segments limits the already very restrictive grammar of ET. In addition, these alternative representations would have to be implemented with the aid of certain rules as one cannot predict the representation from an isolated segment. Only when interacting with segments in close approximation would one be able to establish its structure. Moreover, the different representations of the same segment means that the same segment would be placed in different natural classes depending on the segments it contains, so for /f/ the |U H|-version would be placed in the labial and the fraction class, while the |U ʔ H|-version would be placed in those classes and additionally in the occlusion class together with stops. On the other hand, when following Backley's reasoning – that a segment's structure should be based on its behaviour – makes a lot of sense that segments can have more than one realisation. However, instead of restricting the theory this would cause overgeneration: 'predict[ing] the possibilit[ies] of many phonological processes, and therefore many grammars, that we simply do not observe' (p. 9). A language would need a clear foundation of element structures that describes the phoneme index of a language. This index could be consulted to predict the outcome of the phonemes of certain phonological processes. The phonemes present in these outcomes would then fit a certain element structure that is assigned to them in the index. These predictions cannot be made if a segment would have to representations.

With this in mind it is difficult to provide a solution or in depth reasoning on how ET could describe this articulatory processes. These articulatory processes are accounted for in FT, specifically within feature geometry (Booij, 1995). This means that the processes can be accounted for with phonological theories, just not theories that fully reject articulatory based phonology.

5.1.6 DUTCH MANNER ASSIMILATION

(23)

a.	*illegaal*	[in[legaal]]	/ɪnləɣal/	[ɪləɣal]	‘illegal’
	irregulair	[in[regulair]]	/ɪnreɣylɛ:r/	[ɪreɣylɛ:r]	‘irregular’
	collaboratie	[con[laboratie]]	/kɔnlabɔratsi/	[kɔlabɔratsi]	‘collaboration’
	correlatie	[con[relatie]]	/kɔnrəlatsi/	[kɔrəlatsi]	‘correlation’
b.					
	inrijden	/ɪnrɛidən/	[ɪnrɛidə]	[*ɪrɛidə]	‘to run in’
	inleven	/ɪnlevən/	[ɪnlevə]	[*ɪlevə]	‘to empathise’

Examples taken from Taalportaal

In addition to nasal place assimilation, Dutch exhibits another form of assimilation that cannot be accounted for with ET. This form of assimilation is manner assimilation. This behaviour can be observed in non-native prefixes ending in /n/ (*in*-, *con*-) when followed by the phoneme /l/ or /r/ (23). In these contexts /n/ assimilates completely to the following phoneme where after it undergoes degemination (24). The assimilation of /l/ to /n/ is not completely unreasonable, as /l/ can actually contain |ʔ| in its structure as was observed in Figure 4.7. According to a study on the [continuant] specification of lateral liquids by Mielke (2005) it becomes apparent that lateral liquids can pattern with both [+continuant] as well as [– continuant] segments and they do this with surprising even-headedness: 55% with [+continuant] and 45% [–continuant]. This means that laterals and nasals should also be represented in these proportions in ET although their phonological behaviour has to be considered to be established on a language by language basis. Mielke also explains how three other feature theories can account for the lateral and nasal ambivalence across different languages. His explanations on the ambivalence of these segments in the more liberate grammar of FT do not translate to the restrictive grammar of ET; and unfortunately do not bare of much use to explain these processes in ET. For the manner assimilation in *correlatie* it can be argued that for the manner assimilation to take place the two segments do not need to agree in |ʔ|. Here the absence of |ʔ| in /r/ could be said to cause the |ʔ| in /n/ to delete. This might seem to be a fitting solution, but by stating this it is established that the absence of |ʔ| in /r/ can trigger |ʔ|-deletion. This suggests that the absence of |ʔ| can act as an active property in the phonology, which relates it to the binarity that is observed in FT where negative feature are labelled as active properties of segments. Since ET does not consider absent elements as active property it is difficult to conclude to what extend /r/ is capable to trigger the deletion of two elements in /n/ while only containing the |A|-element itself.

(24)

<table>
<tr><td>a.</td><td>illegaal</td><td>[ll]</td><td>|A|
|ʔ|
|L|

n</td><td>|A|
|I|
|ʔ|

l</td><td>-></td><td>|A| ←
|I| ←
|ʔ|
|L|

l</td><td>|A|
|I|

|ʔ|

l</td></tr>
<tr><td></td><td>correlatie</td><td>[rr]</td><td>|A|
|ʔ|
|L|

n</td><td>|A|
| |
| |

r</td><td>-></td><td>|A| ←
|ʔ|
|L|

r</td><td>|A|
| |

r</td></tr>
<tr><td>b.</td><td>inrijden</td><td>[rn]</td><td>|A|
|ʔ|
|L|

n</td><td>|A|
| |
| |

r</td><td>-></td><td>|A|
|ʔ|
|L|

n</td><td>|A|
| |
| |

r</td></tr>
<tr><td></td><td>inleven</td><td>[nl]</td><td>|A|
|ʔ|
|L|

n</td><td>|A|
|I|
|ʔ|

l</td><td>-></td><td>|A|
|ʔ|
|L|

n</td><td>|A|
|I|
|ʔ|

l</td></tr>
</table>

Because of the ambivalence of laterals and nasals, the spreading that can occur between the two is not a novel theme and the full assimilation of /n/ to /l/ in *illegaal* (24) is not surprising. What, however is surprising is the absence of assimilation when the prefix *in*- is native instead of non-native (23). In this environment assimilation does not take place. This situation looks very similar to the assimilation in Frisian where the [l] does not trigger place assimilation of /n/ as it lacks |ʔ|. However in the case for Dutch the /n/ is assigned a default place, in contrary to Frisian where the nasal was deleted and the nasalization moved to the preceding vowel (7). ET cannot account for the different behaviour of the native and non-native /n/ within Dutch. As just established the /l/ in Dutch contains a |ʔ|-element that enables it to assimilate to the nasal element /n/ as was observed in *illegaal* in (24). It is therefore very contradictory that within the same language and with the same consonant cluster these are suddenly unable to assimilate (24). This again shows that the grammar of ET is too restrictive to account for these articulatory processes.

6. Conclusion

The starting point of this thesis was to critically asses the assumptions made in Backley's ET. As I had established for my paper Backley's version of ET would function perfectly within his limits but would appear to be too restrictive when applied to phonological processes outside of the bounds of his literature. This restrictiveness in the grammar could be proved by using ET to specifically target articulatory processes. My hypothesis was that since ET is a purely acoustically based theory, describing articulatory processes would oppose to be a challenge for ET. Additionally, due to Backley's limited instructions regarding the representation of the acoustic patterns – which lay the foundation to his theory – my intention was to verify the legitimacy of his foundational claims. That perhaps the limiting capabilities of ET would find its origin in its establishment. With the analysis of the spectrograms of the resonance elements, I found that the spectral patterns that were extracted for each of the elements Backley's interpretation was very similar to mine. With only a slight differences in each of the spectral patterns that would represent the vowel elements. However when analysing the spectrogram of manner element |ʔ| it clearly displays a drop in energy as is characteristic for oral occlusion, however when Backley provides examples from Frisian where apparently /l/ does not contain |ʔ| the contribution of the acoustic analysis fails. He suggests that his theory which is completely acoustically based cannot build its foundation on the analysis of acoustic patterns. This reasoning made me question the validity of the manner elements as apparently they are not dependent on their acoustic behaviour but on their phonological behaviour.

This concern towards manner elements is extended to their implementation in describing articulatory processes. They are able to account for basic assimilation processes between alveolar nasal /n/ to following stop, on the bases that they agree in occlusion. However when ET is presented with data that strongly deviates from that represented in Backley it is found to be too restrictive. It is not able to account for the ability of alveolar nasals to assimilate to both stops and fricatives within Dutch and English, as it cannot explain element spreading when there is no agreement in occlusion between /n/ and fricatives. It also comes short when it needs to account for the assignment of default place to prevent unwanted nasal-fricative clusters. In these cases where ET is too limited to explain the behaviour exhibited in the phonological processes FT is able to account for them with rules and underlying representations. ET shows that its restrictive nature does not allow it it to describe processes on several different levels. With the information Provided by Backley it was not possible to correctly interpret the articulatory processes as presented in this thesis and therefore it can be established that the grammar of Backley's Element Theory is too restrictive.

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