VALENCE AND SATURATION IN PHONOLOGY

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BOĞAZİÇİ UNIVERSITY

2017

VALENCE AND SATURATION IN PHONOLOGY

Thesis submitted to the

Institute for Graduate Studies in Social Sciences

in partial fulfillment of the requirements for the degree of

Master of Arts

in

Linguistics

by

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Boğaziçi University

2017

DECLARATION OF ORIGINALITY

I, Filiz Mirac Mutlu, certify that

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ABSTRACT

Valence and Saturation in Phonology

I propose a theory of phonology which aims to derive the entire system from one principle, viz. asymmetry, in a non-stipulative way (cf. Di Sciullo, 2005; Dresher and van der Hulst, 1998; Kayne, 1994). Segmental components (features, elements, etc) as commonly employed are unequal in their contribution to phonotactic strength and their role in phonological interactions. Existing theories assume acoustic/articulatory components which stand in no inherent hierarchical relation to one another. They cope with attested asymmetries by arranging these components into feature-geometric nodes (Clements, 1985) or by assigning properties like charm (Kaye et al., 1990). Such arrangement is stipulative since it does not follow from the components themselves. I argue that the architecture of phonology is derivable from dependency relations and these are in turn derivable from the asymmetry principle. I assign place properties to the phonological head (similar to morphological compounds), manner properties within the projection of that head (similar to syntactic phrases), and analyse laryngeal properties, as well as nasality, as operations on existing configurations (similar to case assignment in syntax). Some of the predictions of these representations are the correlation between labiality and voicing (for example cf. Ohala, 2005), phonotactic limitations on consonant clusters, place assimilation phenomena and the special properties of sibilants and laterals. I argue that the asymmetry principle yields not only the system of phonology but what I think of as the core of syntax, argument structure, as well.

ÖZET

Sesbilimde Valans ve Doygunluk

Tüm sistemi tek bir prensipten, asimetriden, koşulsuz olarak elde etmeyi amaçlayan bir sesbilim teorisi öneriyorum (cf. Di Sciullo, 2005; Dresher and van der Hulst, 1998; Kayne, 1994). Yaygınlıkla kullanılan ses parçacıkları (özellikler, elementler, vb.), bir sesin system içerisindeki davranışlarını ve birbiriyle etkileşiminde eşit değildir. Var olan teoriler akustik ya da ses üretimine dayalı parçacıklar kullanırlar ve bu parçacıkların birbiriyle özünde hiyerarşik bir ilişkisi yoktur. Gözlemlenen asimetrileri ifade edebilmek için bu parçacıkları bir yapı içerisinde konumlandırırlar (Clements, 1985) ya da çekme gücü gibi özellikler atarlar (Kaye et al., 1990). Bu tür düzenlemeler parçacıkların doğası gereği ortaya çıkan mantıki sonuçlar değildir. Sesbilimin mimarisinin bağ ilişkilerinden elde edilebilir olduğunu, bu ilişkilerin de asimetri prensibinden elde edilebilir olduğunu iddia ediyorum. Yer özelliklerini sesbilimsel bir başa, biçim özelliklerini bu başa bağlı olan pozisyonlara atıyorum ve ötümlülük özelliklerini bu yapılar üzerinde işlemler olarak analiz ediyorum. Bu modelin bazı öngörüleri, ötümlülük ve dudaksallık arasındaki korelasyon, ses öbeklerinin düzenine dair kısıtlamalar ve [s, l] gibi seslerin özellikleridir. Asimetri prensibinin, sadece sesbilim sistemini değil, fiillerin isimlerle birleşme özelliklerini de ürettiğini savunuyorum.

ACKNOWLEDGMENTS

First and foremost, I would like to thank my supervisor, Markus Pöchtrager. I have treasured every discussion and savoured every challenge that came with a deeper why question. I have been incredibly lucky to have his guidance and friendship. Working with him was among the best experiences I've ever had. My thanks also to my committee members, Aslı Gürer and Aslı Göksel for their valuable comments.

I would like to thank Kadir Gökgöz for offering his friendship, feedback and food through hectic times. Yuni Kim and Eser Taylan gave feedback on parts of the first chapter, for which I am thankful. Many thanks to Christian Huber, Connor Youngberg, Edoardo Cavirani, Elise Michon, Eva Dobler, Faith Chiu, Filiz Rızaoğlu, Hande Sevgi, Noyan Dokudan, Pavel Logacev, Yasin Taşdemir and Süleyman Taşçı for being there to talk to, for cheering me up and supporting me. I would also like to thank our department secretary Gülsüm Abay for always being helpful and friendly. Lastly, I thank my family for their unconditional love and trust in me.

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CHAPTER 1

INTRODUCTION

1.1 A conceptual problem

Phonology is a branch of Linguistics which studies sound systems. Since human speech sounds are also studied in phonetics within a purely physio-biological context, the existence of phonology as a separate discipline hinges on the assumption that there is a cognitive system which works in tandem, or is prior to, this physical system (for example cf Hammarberg, 1976). The modelling of a system requires that the smallest building blocks (primes) are set up, as well as principles restricting their combination. Ideally, a theory of phonology must have primes such that the behaviour of sounds, syllables, etc. must follow directly from those primes. It is even more desirable that these primes themselves be derived from (a) principle(s), rather than being labels for a-priori objects.

All existing theories of phonology share a common problem: The primes are phonetic (acoustic/articulatory) in nature, but divorced from their physical context and inherent relations. To illustrate, sounds produced with the lips (p, b, m) have the feature [+labial] or the element |U| (depending on the particular school of phonology). Ohala (2005) points out that the physical system of the vocal tract, which produces a property such as labiality, is multidimensional and properties like labiality do not stand in isolation; they interact with others. He captures the behaviour of speech sounds by referring to this complex set-up. For instance, he points out that dorsality is not conductive to voicing in plosives while labiality is, for aerodynamic and acoustic reasons respectively; hence the gap for [g] in native Dutch vocabulary and, in contrast, the historical fricativisation of [p] in Japanese. Since the primes of phonological theories are abstract and do not inherently belong in a complex space like in the vocal tract, he argues that they cannot match phonetics in explanatory power, and if they were arranged to mimic the shape of the vocal tract, this would be only redundant. On the other hand, Ohala himself (1992) finds that there are in fact patterns which cannot be explained by physics alone, such as the lack of words beginning with [tl, dl] in English, as in many languages, even though play, blood, clay, glad are fine.

My research programme is to develop a theory of phonology which is built on a principle, deriving the shape and behaviour of sound systems in a non-stipulative way. Rather than stopping at labelling a property and describing its behaviour, I proceed to look inside it to find why it behaves the way it does. As Jakobson et. al. (1952) broke down the phoneme into primes, I break down primes to end up with a single principle that yields them. Furthermore, I aim to derive valence (the combining power of a verb with other grammatical constituents) and valence transformations in syntax from the same principle. I claim that phonology is built on dependency relations, as in syntax (see Tesnière, 1959, 1966; Chomsky, 1970), and these, in turn, are derivable from the higher principle of asymmetry (see also Di Sciullo, 2005; Dresher and van der Hulst 1998; Kayne 1994). In other words, speech sounds and syntactic phrases have the same kind of structure.

Setting up phonological properties, especially manner properties (eg: the difference between [p] and [f]]) as structure to predict their behaviour is a line of research that has been taken up in different frameworks before (Pöchtrager, 2006; Pöchtrager & Kaye, 2013; Schwartz, 2015; Steriade, 1993, inter alia). However, none of the existing models takes this idea to its logical conclusion. They fail to posit a unified mechanism to generate all and only the phonological properties as structure alone. This is a problem because the system is not made up of the same kind of primes; it has both abstract and phonetically-based primes, with different implications for their cognitive status. It is not, for instance, possible to predict the interaction of place and voicing in such a model. Crucially, no existing model directly links structure/manner to phonotactic strength based on a single principle. (Phonotactic strength determines, for instance, where a consonant can occur when two or more consonants are arranged together.) This is problematic because the correlation between manner and strength is well-noted (cf. Jespersen, 1904; Selkirk, 1984), and if it does not follow logically from the representation, then stipulations and additional mechanisms are necessary to capture it.

1.2 Some empirical problems

I look at the component parts of segments and aim to model segmental composition in such a way that multiple (seemingly) unrelated cases of segmental behaviour and inter-segmental interaction follow directly from the model without requiring further stipulations. The implication of this work for linguistic theory in general is that it brings evidence for a common mechanism underlying both segmental (phonological) and phrasal (syntactic) architecture. Both phrases and phonological segments are built on the asymmetrical relations head-comp(lement) and head-(spec)ifier, and both allow the embedding of one phrase in the other. Note that, although these relations are taken from classic Government and Binding models of syntax, comp and spec are only a way of saying the head can have a very close relation with an argument or a more distant relation, and it does not mean that I follow a particular framework religiously. I take Language to be a system based on the principle of asymmetry, hence the inevitable difference between any two arguments one head can take (cf. Di Sciullo, 2005; Kayne, 1994) and, crucially, any operations pertaining to these positions such as case assignment. We will see that the same principle, for phonology, means that markedness effects are not isolated problems but are built into the fabric of the system. That is, the system cannot have two components of equal power, prominence, complexity, etc.

In order to study the behaviour of any system, it is necessary to understand the component parts of that system as well as the principles that shape it. The nature of phonological primes is at the core of any phonological theory. Existing models assume either an acoustic or an articulatory basis for primes. A more cognitive approach to acoustic primes takes them to be the 'mental picture of an acoustic shape' (see Botma et. al., 2010 for a brief summary and discussion of each approach). Another division of opinion concerning primes is whether they are binary valued or privative in nature (cf. Harris, 1994, 1996). The crucial common point to any combination of these possibilities (binary valued/privative, articulatory/acoustic) is that none of them yields primes that are inherently in an hierarchical relation to one another, nor do the primes have much to say about phonotactics. To pick an example, nasals assimilate to following obstruents but not to preceding ones: in+possible > impossible but acme does not become a[kŋ]e. There are at least two observations to be made here.

Firstly, both nasals and plosives are stops, but nasal stops are restricted in their place of articulation by a following plosive while the reverse is not the case. For plosives to exert such influence, they must be stronger. In feature theories, the difference between the two is that of the values [±nas] and [±son]. There is no logical reason why a plus value for nasality (sonorancy) should make the same object weaker, or why this particular weakness should result in assimilation.

Fricatives are also stronger than nasals, since nasals may assimilate to fricatives as well but not vice versa. In some versions of Element Theory, a nasal stop has the nasality/voicing element |L| and a place property. Fricatives, on the other hand have the noise element |h| and a place property. The only difference between a nasal and fricative is the choice of |L| and |h| respectively. There is nothing in the representation of |L| and |h| that yields this strength difference. The problem only gets worse if nasals also have |ʔ| that makes the governee more complex and therefore stronger than the governor. Harris (1997) takes nasals in clusters to lack a place property, acquiring it from the following plosive. There is nothing in the representation of |L| and |h| which says that an expression with the former should acquire its place property in this way, but the latter should not and cannot. To illustrate, [s] in [sp]# never assimilates in place to [p]: *[fp]. In feature theories, such strength asymmetries are explained by sonority and possibly by arranging features into feature-geometric nodes (Clements 1985). Such arrangement does not follow from the features themselves. As a result, the exact arrangement of features is a matter of discussion (cf. Botma 2004, Harris & Lindsey, 1995 and works cited therein). See Harris (2006) for a criticism of sonority. In element theories, the notions of charm (Kaye et. Al, 1990) and complexity (Harris, 1994) amongst others, have been offered to explain asymmetries. For example, charm is the property of an element which determines its combining power and strength. An element can have a negative, positive or neutral charm; elements with the same charm do not combine. The conceptual problem is that there is no principled reason why elements should have the particular charm they have, or have a property like charm at all. Likewise, there is no principle which yields all and only the elements that exist, along with their properties. (This also holds for features). |I| and |U| both have positive charm. One of the empirical problems is that |I| and |U| do in fact combine to yield [y], for instance in French. Complexity means that the more elements an object has, the more phonotactic strength it has. As illustrated in the discussion of |L| vs |h|, it is not necessarily the quantity but the quality of elements that yield different results. I will not go into a detailed criticism of either theory or any of these notions (cf. Pöchtrager, 2006, 2012 on charm and complexity). The crucial problem is why stipulations should be necessary at all to explain the behaviour of phonological primes, instead of their behaviour falling right out of the primes themselves.

Secondly, there is a constraint on the direction of assimilation, which is explained, for example, by reference to constituency structure (Harris, 1994). This requires additional stipulations on the link between melodic primes and such constituent structure (see Jensen, 1994). There is also no reason why any two or more features/elements cannot combine or why one combination should be more natural than the other. Empirically, though, [+nas] and [-cont] do not combine; there are no nasal fricatives (cf. Sole, 2007 and works cited therein). Likewise, in element theory, the combination of |L| and |h| overgenerates nasal fricatives. Note that, among consonants, nasal stops are attested in almost every language and are simply called nasals because (stop) is a redundant property for them. In contrast, nasality associated with non-stops such as glides is i) marked, ii) commonly derived from a pre-existing nasal stop cf (Botma, 2004). Markedness, as well as what is impossible must ideally follow from the same principle that yields primes.

A novel theory in a field rich with different theories and their various flavours must earn its keep by bringing clear, self-consistent solutions to long-standing problems. Another such problem, besides the combinatory restrictions and strength-relevant effects of phonological primes, is the emergence of stops in consonant clusters like [ns, nr], yielding [nts, ndr]. A phonetic explanation is possible for emergent stops but no phonological theory derives them in the correct environments (cf. Recasens, 2011; Ohala, 2005). Yet another problem is lenition in prosodically weak (or intervocalic) positions: Plosives systematically lenite to fricatives in weak positions, but not to nasals (Harris, 1990). Nasals, like fricatives, are more sonorant than plosives so it is not clear why this lenition path is not attested. In recent versions of element theory, voiced plosives have the elements a nasal has (|L|, |ʔ|) plus possibly |h|. Losing |h| should be able to yield a nasal but this does not happen. In the flavours of theory where the difference between nasal stops and voiced plosives is the arrangement of |L| and |ʔ| in the consonant, it is possible to alter such arrangement hence again it is not clear why a nasal stop cannot be derived as a result (cf. Backley, 2012).

The representation of affricates is also a matter of discussion. Weijer (2014) notes affricates are not identical to plosives but does not point out their similarity to nasals: neither can be the second consonant in a configuration C_1C_2# where C_1 is a fricative but both can be C_2 if C_1 is a sonorant: eg: pi[ntʃ] and Swedish na[mn] 'name' are fine but *le[ftʃ], *le[fn] are not. Transcriptions may have sequences like [zm] as in prism. In reality, there is a schwa between [z, m]. This is not the case with Thames. This is not predicted if affricates are regular plosives (Backley, 2011; Kehrein, 2002, i. a.) or a contour segment with the same complexity as a plosive (Harris, 1990, 1994). Szigetvari (1997) notes affricates do not occur before plosives but concludes it is a property of coronal plosives, hence not relevant to the structure of affricates: *[tp, tsp]#. However, neither do non-coronal affricates occur in this position: German *[pft]# does not exist in morphologically simplex words though [pt]# is fine, eg: Konzept ‘concept’. This is a brief selection of the kinds of problems the model will tackle.

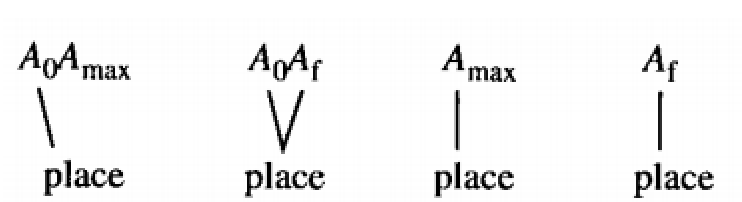
1.3 Partially structural models: Stopness and nasality

In this section I look at some models which partially share the goal of representing phonological properties as positions in a structure.

Plosives such as [p, b, t, d, k, g] have three articulatory phases: catch, hold and release. It is also well noted that nasality is primarily associated with objects where the oral flow completely ceases, i. e. stops such as [m, n].

Steriade (1993) builds Aperture Theory on phonetic insight: She takes segments to be “represented in the phonology as positions defined in terms of degrees of oral aperture”. Stops (plosives, affricates, nasals) have two positions: closure and release. In contrast, continuants have only one position, release. While both fricatives and approximants have only a release point, the former has aperture-cum-friction (A_f) and the latter has maximal aperture (A_{max}). Closure is absence of airflow, designated as (A_0). These positions are like autosegmental nodes in the sense they host segmental properties such as place and phonation.

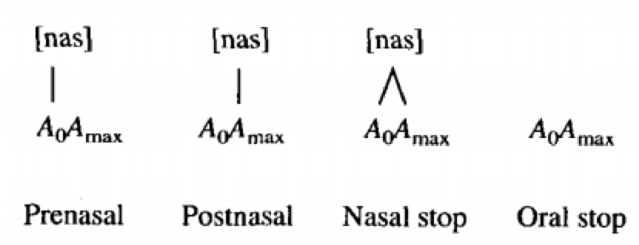
1) Manner properties



Source: Steriade 1993

The leftmost figure shows a plain plosive, where place is associated with closure only. The following figure shows an affricate, where place is associated with both the closure and release. The next figure is the representation of a glide and the rightmost one is the representation of a fricative.

2) Stops and nasality



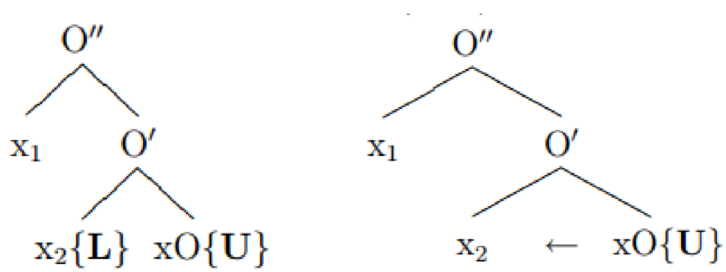
Source: Steriade 1993

One or both of the positions in a stop can hold nasality, as illustrated in (2): closure (yielding prenasalised stops), release (yielding postnasalised stops) and both closure and release (yielding plain nasals), neither position (yielding oral stops).

There is a fundamental problem with the representation of nasal stops and plosives: Their structure is the same yet their phonotactic strength is not (as discussed in section 1.2 and to be further discussed in Chapter 2). This means that phonotactic strength can vary within the same manner (or that manner cannot be derived through a single mechanism, viz. structure). Then, strength must be derived from an additional mechanism, as it is derived from sonority in feature theory and complexity in element theory. Note that the same problem also holds for affricates: The association of place with the release position and as well as closure yields an affricate, but as discussed in 1.1, affricates are not equal in strength to plosives either.

Interestingly, Pöchtrager (2006) develops a very similar distinction in the representation of stops vs non-stops in the framework of Government Phonology, offering a major revision of said framework: GP 2.0. The motivation is the behaviour of consonants rather than phonetics, and builds on Jensen’s (1994) work who argues stops must have an extra position compared to non-stops. Stops (plosives, nasals, and laterals on the basis that they pattern with stops in some languages) have a head position and two dependent positions, in analogy to syntax. In contrast, fricatives have a head position and only one dependent position, and approximants have only a head position. Affricates and other kinds of stops (clicks, ejectives, implosives, etc) are not modelled.

3) Nasal stops vs plosives in GP 2.0



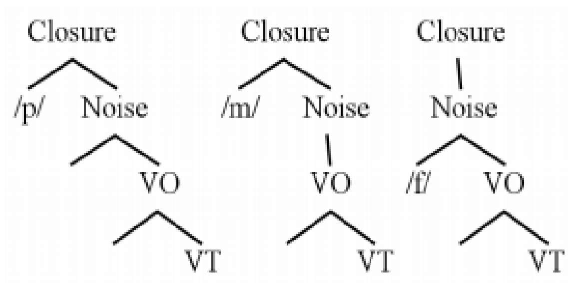
Source: Pöchtrager 2006

The figure on the left represents [m] and the one on the right represents a lenis [b], as in English boy. x0 stands for the onset head, which projects twice to yield a stop. The arrow between the head and the complement of [p] represents a special relationship called control which is not relevant to our discussion. Both [m] and [p] have two layers of structure and same number of nodes, and the element |U| (notation in curly brackets) to stand for labiality. [m] also has the nasality element |L|.

The crucial point is that, nasal stops and plosives have exactly the same number of positions, just as in Aperture Theory, and the difference between nasal stops and plosives is that nasal stops have the nasality element |L| hosted in one of these positions. The representation of plosives vs nasal stops runs into the same problem with Aperture Theory, the addition of [nasality] to a structure has no logical link to loss of strength.

Schwartz (2015) offers a new model, Onset Prominence, where a nasal stop has the position (closure) and plosives have more positions (both closure and noise). Fricatives, like nasal stops, have only one position but these are different in nature: fricatives have only noise.

4) [p, m, f] respectively



Source: Schwartz 2015

The leftmost figure represent [p], followed by [m] and [f]. In terms of the number of positions it has, [p] is more complex than both [m] and [f] while [m] and [f] are equal to one another in complexity. Regarding the representation of stopness vs friction, this is the most similar model to the one proposed here. However, the same problem concerning the relative strength of nasal stops and fricatives holds in Onset Prominence just as it did with the elements |L| vs |h|: There is no principled reason why one of these positions, noise, must yield more phonotactic strength than the other, closure. (Neither is there a single principle which predicts this behaviour along with every other property of stopness and friction, respectively, including lenition phenomena. Schwartz (pc) disagrees with this interpretation). These positions hold melodic primes, such as a place property, similar to both Aperture Theory and GP 2.0.

The model proposed in this thesis does not have any melodic primes whatsoever. The representation of phonological manner is basically identical to the representation of syntactic phrases. The representation of phonological place is basically identical to the representation of syntactic heads, both simplex ones such as rabbit and compounds such as killer rabbit. The representation of phonation and nasality is similar to the representation of syntactic case. Crucially, positions host other segments just as dependent positions in a phrases host other phrases in syntax. The obvious difference is that, if positions host complete segments rather than melodic primes, there are strong predictions on how consonants can come together.

Lastly, structure has a prominent role in dependency-based models such as Radical cv Phonology (van der Hulst, 2015 and works cited therein) or the element-based dependency model (Botma, 2004). However, in these models the nodes themselves do not take on the job of primes. It is the position of the primes (components/elements) within the larger structure that yields a phonological property. In spirit, the model I propose is similar to Radical cv Phonology in that the behaviour of the system is derived from asymmetry. However, the current model differs crucially in its complete lack of melodic primes and in that structural positions within a segment host other segments rather than melodic primes, both points leading to predictions not captured otherwise such as the temporal arrangement of the phases of a plosive and clustering possibilities of consonants, which will be discussed in 3.2 and 3.3 and 3.5 respectively.

CHAPTER 2

STRENGTH RELATIONS

In this chapter I look at cluster phonotactics in morphologically simplex words to isolate the strength of each phonological prime, specifically, place and manner properties. I claim that once the relative strength of two objects has been established, that difference is universal, eg: If [t] is stronger than [n] in a language, it is stronger than [n] in every language. I take cluster to mean a phonological relationship between consonants based on one criterion:

5) If there is a structural relation between A and B, it must hold independently of the vowel context. This means that the sequence is found both at the right edge of a word and within it, eg: lamp, lampoon. ABC is a cluster iff AB, BC are clusters: [str] is a cluster iff [st, tr] are.

The precise nature of said relation between A and B and the resulting configuration is posited in 3.2. For now, all I seek is to find out is which sequences fulfill this condition distribution-wise. Using this criterion, I set out to (re)discover the strength relation between A and B. One clear piece of evidence for strength asymmetry in action, or domination as I shall call it, is that nasals assimilate in place to obstruents but not vice versa: English in+elegant but im+possible. For this, domination must be leftwards, a direction common to vowel-dependent affrication, palatalisation, pre-vocalisation (Operstein, 2010) and the nasalisation, rhotacisation and lowering of vowels in closed syllables. While some of these processes may also be reversed, no process from a segment to its neighbour occurs only to the right. Interestingly, this holds true for syntactic movement as well; for theories assuming movement, it is not debated that leftward movement occurs, but the existence of rightward movement is a matter of debate (cf. Kayne, 1994; Rochemont & Culicover, 1997). For both interaction between neighbouring segments in phonology and for movement in syntax, rightward implies leftward. I conclude left is the default direction for processes between neighbouring segments including domination, and for AB#, B dominates A. The strength of a consonant is measured by the set of objects it dominates, as we will see in (2).

If both #AB and #BA are attested in the same position, such as [rt, tr]# in French (Charette, 1991), one of the pairs implies the existence of the other. Though French has [rt, tr]#, unrelated languages have only [rt]# or #[tr] in these positions and no language has only [tr]#. In light of this implicational relation, I take [rt]# to be the default order for that position, and to determine the domination relation, viz. [t] dominates [r]. The reversed string, [tr]#, is also prone to simplification (Charette, 1991) and is acquired later than #TR clusters (Demuth and Kehoe, 2006).

Table 1 shows domination relations based on data from English, German (Fox, 2005), Italian (Kramer, 2009), Swedish (Holmes & Hinchliffe, 2013; Schadler, 2006), Dutch (Booij, 1999) and Djapu (Morphy, 1983). Read from left to right as BA, B dominates A: The topmost row shows what a plosive can dominate, and under what conditions, eg: A plosive dominates another plosive iff the dominant plosive is coronal. (plosive: T, fricative: F, affricate: TF, nasal: N, liquid: R, sibilant: S)

Table 1. Domination Relations

dominates	T	F	TF	N	[l]	[r]
T	iff coronal	iff coronal or F is S		√	√	√
F		iff coronal		√	√	√
TF				√	√	√
N				iff coronal	√	√
[l]						√
[r]						

Measured by the set of objects B dominates, there is a stronger than relation between manners such that plosive > fricative > affricate ≈ nasal stop > [l] > [r]. Interestingly, nasals and affricates dominate the same set of objects which is not predicted or noted before: Swedish na[mn] 'name' and German da[mpf] 'steam' are fine while [fn, sm, spf, fts]# are not. However, nasals are dominated by all but liquids while affricates are indominable: [mn, ns, nt]# but not *[pft]#. This means strength and dominability are not always in an inverse relation with one another. The details of the phonotactics of affricates and their composition is discussed in 3.4.

Place adds to strength. Coronality makes B dominant for AB# of the same manner: [mn, pt]#. Interestingly, FT#, as one representative of AB#, has more restrictions: If B is not coronal, A is a sibilant (S) (Kristoffersen, 2000): [sp, sk]# but not *[θp, θk]#. Labiality also affects strength. German has #[fl] as in Flug 'flight' but not #[xl]. No language has only [xl] but not [fl] even though it has both [f, x]. English [f] resisted lenition to zero but [x] disappeared. There is no similar evidence for palatality. Hence coronal > labial > dorsal within the manner. Place does not make B dominate above its manner: [nf, rm]# are fine but *[fn, mr]# are not. This means that manner is a more prominent property than place.

Direction is another parameter for cluster phonotactics. For AB# and A, B are fricatives, B can only be a sibilant, eg: Swedish (ett) pro[fs] 'a professional'. Even then, #BA is more common, eg: English [sf]ere. Greek [fθ, xθ] (Arvaniti, 2007) seem to be parallel to [pt, mn]. However, they are not found word-finally in any language to confirm their clusterhood in light of (5). It looks like strength relations in FF# clusters are the same as in other plateau pairs but there is a gap in the environment _#. In 3.5 we will see this gap falls out of the representation of consonants in the model posited. To my knowledge, this problem is not noted before. A phonetic explanation is also difficult as these clusters are fine as long as they arise from morphological complexity: roofs, wives, laughs, etc.

Since both ST# and TS# are attested, dominance must be argued for. Firstly, T > TS > S is a lenition path while S > TS > T is not (Picard, 1994). Secondly, KS implies SK at any position. Lastly, Syrika et. al. (2007) find ST is acquired before TS by Greek children. If the natural direction of domination is leftward and T is the dominant consonant, this is predicted.

Lastly, one type of cluster in a language implies (=>) the existence of another.

6) Implicational relations for AB#: FS=>MN=>RL=>TT =>FT =>ST=>LT =>NT

7) Implicational relations for #AB: Ks => Kn => SN=> Kl => Tr

#Kn is attested in the same environment as #KR and is in an implicational relation with it such that #Kn is the ‘worst’ cluster, #Kl is better and #Kr is the best (Vennemann, 2000). If #Kn is a cluster, it must be the mirror image of nK# which is missing due to nasal homorganicity restrictions. That is, [nk] is not a homorganic cluster hence it is not fine even though [k] is stronger than [n].

CHAPTER 3

THE PROPOSAL

3.1 Valence

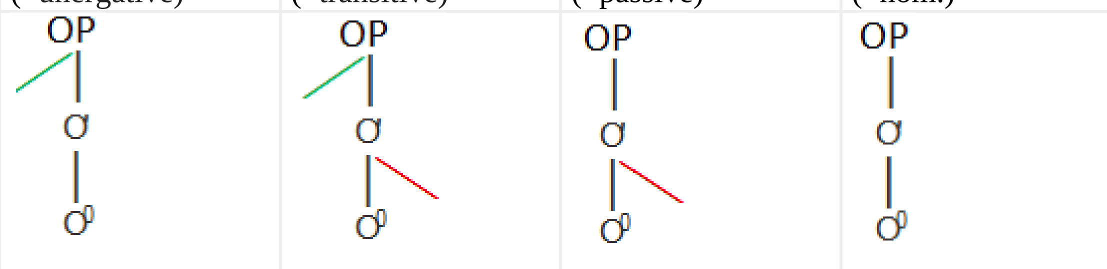
I posit a unique and universal structure for each consonant based on its strength as deduced in (6). I claim that the composition of syntactic phrases and consonants is basically identical. Both are built on dependencies: a head may have a comp(lement), a spec(ifier), both or none. I use the terms spec and comp to express the asymmetry between an external and internal argument respectively and I do not fully subscribe to any particular theory of syntax. The sum total of dependencies equals phonotactic strength. That means, a head with both a spec and comp is stronger than one with only one of the two or neither. This is also where the parallel between syntax and phonology can be seen: If a phonological head has both a spec and a comp, it is like the transitive verbal head 'see'. If it has neither positions, it has zero valence like the verb 'rain' or like a noun of the type 'dragon'. If it has only a comp position, it is like the unaccusative verb 'fall' or the passive 'be seen'. Lastly, if it has only spec, it is like the unergative verb 'run'. Furthermore, valence (i.e. the power of a head to combine with a spec and/or comp) in phonology determines manner. Plosives are the strongest dominants so they must have both spec and comp (8b). Approximants are the weakest so they must have neither (8d). I assume that closeness to the head means more strength and therefore comp is stronger than spec since it c-commands the head. This asymmetry is also relevant for the remaining two manners: Fricatives (stronger) must have comp (8c) and nasals (weaker) spec (8a).

The linear order of dependents is universally unidirectional as will be argued in 3.4. (also cf. Kayne, 1994). The spec is always on the left and the comp on the right. I assume that a consonant is an onset head O^0 that, together with its projections and dependents, forms an onset phrase OP (but onset not meant in the traditional sense). That OP can potentially merge with a nuclear phrase NP (a vowel), but nothing requires the NP to be present; this issue will not be pursued further here. The head of a projection can be empty, like an empty head in syntax, e.g. the empty C head in I know that/0 you did it. (In fact, the head itself has internal structure which expresses place properties. Since this is not immediately relevant here, we will come back to it in section 3.7.)

As we saw, the head projects into an onset phrase. Let us look at the possible projections of an empty onset head O^0.

8) Projections of the empty onset head O^0

a) nasal (~unergative)	b)plosive (~transitive)	c) fricative (~passive)	d) approx. (~nom.)



Note that the above diagram only gives the bare structures without the relationships holding between the head O^0 and its comp and spec, respectively. There are four possible configurations for an XP and four phonologically relevant simplex manners (barring contour segments). Phonetically, there are other degrees of constriction such as the difference in turbulence between [f] and [ɸ]. This difference, however, phonologically remains a minor distinction, stridency, between fricatives rather than a major one such as between fricative and approximant. The number of manners correctly follows from the hypothesis.

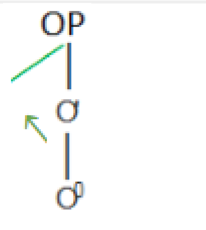
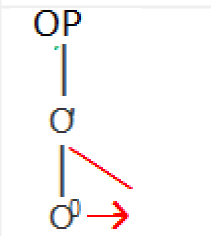
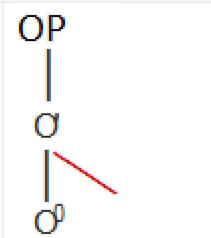
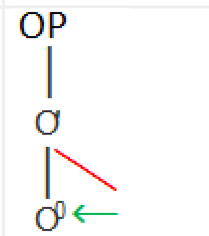
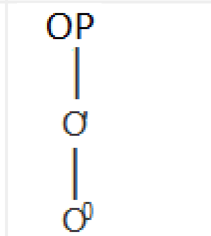
Great care needs to be taken not to conflate stops with plosives. In this model, pure stopness (spec alone) is interpreted as a nasal stop, not a plosive. Another immediate advantage of these representations is that pure stopness (spec) and pure friction (comp) yield a complex object plosive, hence the lack of nasal fricatives. Though phonetics can express this incompatibility (Ohala et. al., 1998), neither features nor elements inherently exclude the combination nasal fricative in the absence of further stipulations.

The structures in (8) also predict possible lenition paths. Losing the external argument position (spec) yields fricativisation in phonology, parallel to passivisation in syntax (8b becomes 8c). The other logical possibility, losing comp, is not attested as a regular process in either syntax or phonology. In syntax, losing the complement (deobjective) is rare and restricted in its semantic scope (Marantz, 1984). Plosives do not systematically lenite to nasals in prosodically weak positions. Valence transformations in syntax and phonology work similarly: The further position spec is lost more easily.

3.2 Case assignment

In 3.1. we saw that the valence of a head O^0 yields different manners and that pure stopness is expressed as a nasal stop. The crucial difference between a nasal stop and a plosive is not nasality/voicing (in fact, plosives can have nasality too, as in prenasalised plosives) but their phonotactic strength, and strength is directly derived from structure. The actual nasality/voicing in nasal stops is derived from a case assignment relation between the head and spec. Likewise, fortisness/aspiration is derived from a case assignment relation between the head and comp.

9) Case assignment (and potentially agreement) in spec-head and head-comp configurations

a) nasal stop	b) fortis fricative	c) lenis fricative	d) voiced fric.?	e) approximant
				

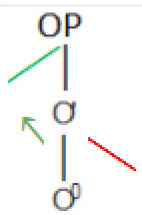
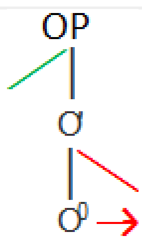
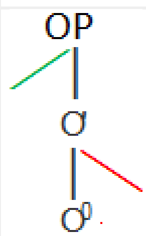
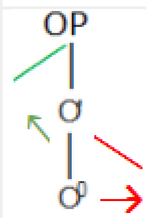
(9a) shows a head-spec configuration (a pure stop). The c-command relation between the two positions allows for an operation that creates a strong link between them, similar to case-assignment in syntax. This operation yields nasality/true voicing. Since nasality is expressed as an operation from the head to spec, and since non-stops do not have spec, they cannot be nasal. (9b) shows a head-comp configuration (a fricative). Case assignment yields a fortis object; it adds to length and provides aspiration. If case is not assigned to comp, the consonant is lenis, i, e., it is shorter (cf. Pöchtrager, 2006) and does not have aspiration. See Vaux (1998) for an analysis of voiceless fricatives as aspirated objects and voiced ones as non-aspirated ones, even in true voicing languages like Spanish. This falls out from the model. The set-up of the system allows the expression of a voiced fricative as an operation from the dependent to the head (9d), parallel to object agreement in syntax. However, it is not clear that there is a phonological distinction between lenis and voiced fricatives. This is an issue I will take up in further work. (9e) shows an OP with no spec or comp (an approximant) which is voiced. I claim that the phonological head, whether in an OP or another kind of phrase, is naturally voiced. In contrast, the argument positions within an OP are voiceless, and can only acquire voicing as the result of an operation (9a, possibly 9d). The dependents in the projection, just as they provide the better part of the strength in an OP, contribute the better part of the voicing property of the whole OP.

Interestingly, though fricatives can be non-case assigned and therefore lenis (9c), the latter is the marked case. More importantly, non-sibilant lenis fricatives tend to display sonorant properties (cf. Bjorndahl, 2015; Padgett, 2002). (Sibilants are discussed in 3.8.) For instance, Turkish [v] alternates with a glide [ʋ] and the historical [ɣ] is either altogether lost or possibly survives as a glide [ɰ] (cf. Taylan, 2015).

Asymmetry is the building principle of the system, not only in the difference between head and comp but also concerning every operation on these positions. While it is possible, though marked and unstable, to have a non-case assigned head-comp configuration (a lenis fricative), there is no head-spec configuration without case assignment. All pure stops are nasal. The weaker configuration (head-spec) has a stronger tendency to have a linking operation to hold it together, than does the stronger configuration (head-comp).

Plosives have both spec and comp, therefore the head can assign case to either. As we saw in section 3.1, a plosive is more than the sum of its parts (it is not a sequence nasal stop+fricative, it is a novel object). Note that in a plosive, the dependents spec and comp have a c-command relation as well (spec c-commands comp). (In section 3.5, we will see how this relation is utilised in phonology.) Since the combination of a stop+fricative has a third relation not found in either of its parts, it should be a more complex object. Also, since each of the two dependents is involved in two c-command relations, one to the head and one to one another, the whole structure is more close-knit and case assignment becomes optional.

10) Case assignment in plosives

<table>
<tr><td>a) voiced/prenas.</td><td>b) fortis</td><td>c) lenis</td><td>d) breathy</td></tr>
<tr><td>
</td><td>
</td><td>
</td><td>
</td></tr>
</table>

(10a) has case assignment only from the head to the spec; it is a truly voiced (and possibly prenasalised) plosive. (10b) has case assignment only from the head to the comp; it is fortis. (10c) does not have case assignment; it is lenis. True voicing languages like French have two plosive sets, voiced (10a) and lenis (10c). Aspiration languages like English have fortis (10b) and lenis (10c) plosives. A language can contrast more sets by having case assignment on both configurations (10d), which yields a breathy plosive such as in Hindi. I assume that further nasality/laryngeal possibilities belong to a higher level, which I will not go into in this paper.

Voicing assimilation is a common process across languages, in Russian and Hungarian among others (see Cho, 1990 and works cited therein). Manner, on the other hand, is not a property that commonly assimilates to that of a neighbouring segment. Laryngeal properties spread more easily than manner. The model predicts that laryngeal properties/nasality (operations between positions) must be more loosely attached to a consonant than manner properties (represented directly by the structure).

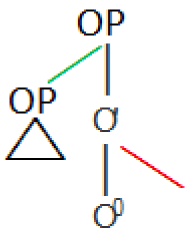
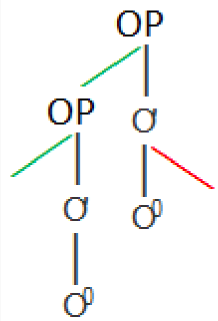
Being able to derive nasality and laryngeal properties as operations on head-spec and head-comp configurations respectively a) captures the correlation between stopness/nasality and friction/aspiration, b) predicts the sonorant-like behaviour of (non-sibilant) lenis fricatives, c) explains why laryngeal properties are more loosely attached to a consonant than manner properties. Furthermore, the model directly derives the temporal order of voicing and aspiration on plosives. The voice bar precedes the stop phase of a plosive and aspiration follows it. The order of spec (left) which produces voicing and comp which produces aspiration (right) predicts the phonetic facts.

3.3 Saturation

In section 3.1 we saw that an onset head O^0 has a certain valence, i. e. it can combine with the argument positions spec and/or comp or none and that each possible combination yields a phonological manner. An argument position can host another phrase, in which case it is saturated (filled) by that phrase. Saturation in phonology yields consonant clusters: The weaker OP (the dominee) saturates an argument position of the stronger OP (the dominant). For instance, embedding [n] at the spec of [t] yields [nt] and embedding [r] at the comp of [t] yields [tr]. If A is embedded at an argument position of B, B directly dominates B.

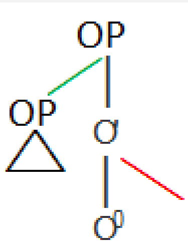
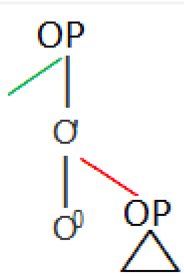
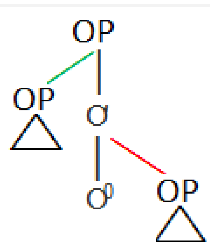
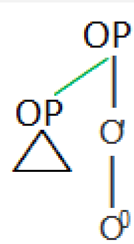
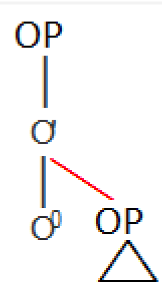
(11a) shows a matrix OP with both spec and comp (plosive). It has an embedded OP in the spec yielding an AB# cluster of the type [mp, nt, sp, pt], etc. (11b) illustrates the internal structure of one possible dominee, a nasal stop (only spec). yielding a nasal+plosive cluster. Note that empty-headed OPs are used for illustration purposes only and the head can be filled (see 3.7).

11) Saturation

a) matrix T and an embedded OP	b) matrix T and an embedded N
	
an AB# cluster	a nasal+plosive cluster

Plosives have two argument positions, spec and comp. This means that they can host an embedded OP (a dominee) in either position, or in both. (12a) shows a matrix plosive T and a dominee in the spec of T. As the the dominee sits to the left of the matrix head, this yields an AB# configuration (a coda cluster), eg: [nt, rt, lt, xt, ft, st, kt, pt, mp, rp, lp, sp, ŋk, rk, lk, sk]#.

12) All and only the possible direct domination relations

a) Matrix T	b) Matrix T	c) Matrix T	d) Matrix N	e) Matrix F
				
eg: NT	eg: TR	eg: NTR	eg: RN	eg: FR

(12b) shows a matrix T and the dominee sits in the comp on the right, yielding the configuration #BA (an onset cluster), eg: #[tr, pl, pr, kl, kr, pn, kn, ps, ks]. (12c) is a matrix T with dominees in both spec and comp, yielding a cluster ABC where B is stronger than both A and C, eg: [ltr, ntr, mpr, mpl, ŋkr, ŋkl, skr, (skl), spr, spl, ptr, ktr].

Nasal stops have only spec therefore they can have a dominee in the spec only, yielding RN# (12d): [rŋ, lŋ, rm, lm, rn, ln, ŋn, mn]. Fricatives have only comp therefore they can have a dominee in the comp only, yielding #FR (12e): #[xr, xl, xn, fr, fl, fn, sr, sl, sn, sm, sf, sx, (sθ)]. This means that the reverse of these, eg: [nr, ls], cannot stand in an immediate domination relation as there is no position to plug in the dominee. The structure of #NR and RF# clusters is explored in section 3.5. In brief, [nr, ls] are really part of the larger structures [n(d)r, l(t)s] respectively (12c). The matrix plosive head is empty and therefore possibly silent. It is realised iff it shares the head (place property) of a dominee. This predicts the existence of emergent stops in the correct environments.

Out of the possible configurations in (12), a language chooses subsets in a principled way. I claim that if a language has domination relations, it will have the strongest dominant T and the weakest dominees R, N. (In section 3.4. we will see that even further restrictions can be at play.) This is because the strength of the dominee is subtracted from that of the dominant, and each language has a minimum strength difference requirement (henceforth MSD). In other words, a smaller strength difference implies a larger one, eg: [st]# with a small difference implies [rt]# with a bigger difference.

Even different lexical categories in a language may have different MSD. To illustrate, Turkish verbal roots have only RT# clusters, eg: kalk ‘get up’, yırt ‘rip’, but Turkish nominals have NT#, ST#, PT# and further possibilities: bant ‘cellotape’, üst ‘top’, zapt ‘seizure’ etc. (12d), with the dominant N, is the next possible configuration, again with its MSD requirement. To continue with the example of Turkish, it has only film ‘film’ and form ‘form’ for RN#. The rhotic varieties of English have RN#, eg: arm, elm, horn, kiln but not MN#. Swedish has both RN# and MN#, eg: namn ‘name’, vagn ‘wagon’. Note that a fricative dominant (12e) yields an onset cluster. The special properties of onset clusters is to be discussed presently. In sum, the language picks the dominant T and optionally less strong ones, setting an MSD limit for each dominant.

The asymmetry of the argument positions spec and comp means that the OPs embedded in them function asymmetrically. This effect is observed in syntax in the different theta roles John has in ‘John kissed Paul’ (agent) and ‘Paul kissed John’ (theme). In phonology, an argument sitting at the weaker spec is relatively weaker and the same argument sitting in the comp is relatively stronger. (The relative strength of these positions is argued for in 3.1.) Therefore there is a greater difference of strength between [r, t] in RT# (with [r] in the spec) than in #TR (with [r] in the comp). Let us label the change in the strength of a consonant, based on where it sits in a matrix OP, with a value (x). In the configuration AB# (12a), the strength difference is B − (A − x), and in #AB (12b), A − (B + x). Since the discussion of the actual mathematical expressions of the structures in this model requires a separate paper, let us assign random numbers to A, B and x for the purpose of providing an example only. If [t] is 19, [r] is 3, and x is 1, [rt] has a strength difference of [17] and [tr] has a difference of 15.

The difference in the strength of the dominee based on its position within the matrix T means that, for a MSD for T and its dominee(s), T can host stronger dominees in the spec than in the comp. For instance, in rhotic varieties of English, [p] can host R, N, S in the spec: carp, help, lamp, lisp. In contrast, it can host only the weakest manner, R, in the comp: pray, play. This is the only model of phonology that predicts the need for a steeper slope in onset clusters from the representation of consonants only. In onset clusters, the set of possible dominees is reduced to coronal sonorants and sibilant fricatives. This further restriction of the dominee to coronality/sibilancy is discussed in 3.8.

In (12c), given an MSD between B and its dominees (A+C), the dominees have to share a finite amount of strength between them. To illustrate, English has #[sp, pl, spl, sk, kl,] eg: speak, play, split, sky, clean but not *#[skl] (except in the medical terms sclerosis, sclera). In chapter II, we saw that labials are stronger than the velars of the same manner and [l] is stronger than [r]. The weakest plosive [k] can dominate both [s] and [r], eg: screen. But if [r] is replaced by [l], the strength difference grows too small. However, if the dominant is stronger, as with [p], the dominee in the comp can be stronger too: split, splendid, splice, splay, splurge, etc.

3.4 Affricates and the homorganicity principle

An affricate has different phonotactics than a plosive (cf. Weijer, 2014). For instance, while English has le[ft], be[st], ap[t], it does not have *[ftʃ, stʃ, ptʃ]#. German has [ʃp]ucken ‘spit’ but not *[spf] and Konze[pt] ‘concept’ but not morphologically simplex *[pf]t. Turkish has giri[ft] ‘intricate’, ra[st] ‘right’, za[pt] ‘seizure’ but not *[ftʃ, stʃ, ptʃ]#. As analysed in chapter II, the strongest dominee an affricate can have is N: German da[mpf] ‘steam’, pri[nts] ‘prince’, Turkish hınç ‘anger’, English hinge. Though there are a few German words with [xts, fts]#, it is a restricted group; only onomatopoeic verbs, eg: seufz(en) ‘to sigh’.

An affricate has a plosive and a fricative portion but, as discussed above, it dominates the same set of objects a nasal stop does: R, N. To my knowledge, this is a parallel not noted before. An affricate looks big but behaves as if small as a dominant. Moreover, though an affricate is weak, it is indominable even by the strongest dominant [t]: German does not have *[pft]# in morphologically simplex words and [tst]# is attested in three words: Arzt ‘doctor’, jetzt ‘now’, letzt ‘last.

A plosive has both comp and spec (13a), and a fricative has comp (13b). An affricate has both a plosive and fricative part, but (approximately) the strength of a nasal stop, which only has spec (13c). One spec (in the plosive) and two comps (one in the plosive, one in the fricative) enter into such a relation that (approximately) the strength of spec remains.

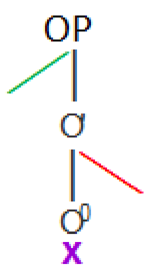
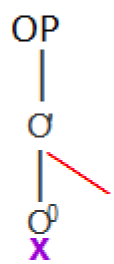
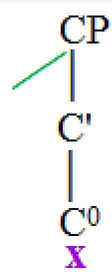
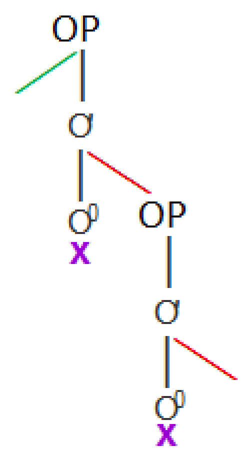
In 3.3 we saw that each domination relation yields a strength difference (dominant − dominee) and that languages have a minimum strength difference (MSD) requirement. My hypothesis is that an affricate is a plosive dominating a fricative (13d) and that is why the strength of the comp of the fricative is subtracted from that of the plosive. As the greater part of the strength of the plosive comes from comp, once it has been subtracted from the total, the remaining strength is not enough to dominate another OP with comp, viz., an obstruent. Note that this is a simplified calculation of strength, but sufficient for the purpose of the current discussion. To my knowledge, this is the only model of affricates that derives their strength directly through their composition.

The configuration (13d) also predicts that an affricate must be indominable: It is the biggest/strongest object (plosive) PLUS the second strongest OP object (fricative) embedded in it: [p[f]]. Therefore, it is too big to fit into even the strongest dominant [t].

The strength difference is plosive − plosive − fricative hence a negative number.

German data support this: *[pft] (14b) is not attested and [tst] is attested in just three words: Arzt ‘doctor’, jetzt ‘now’, letzt ‘last.

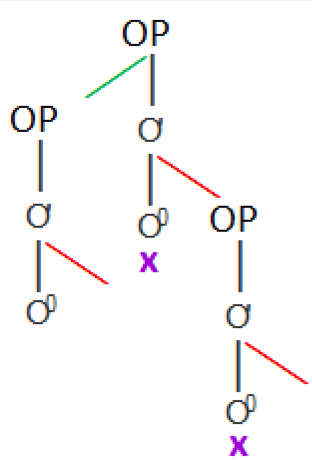
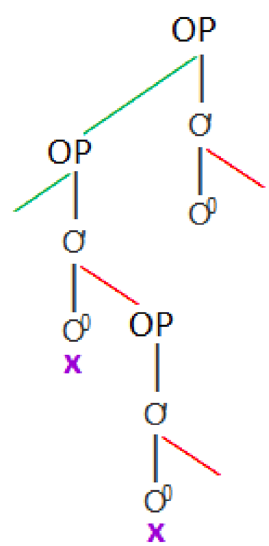
13) The composition of affricates (x is a variable that stands for a place property)

a) plosive, T	b) fricative, F	c) nasal, N	d) affricate, TF
			
the first part of an affricate.	the second part of an affricate	Two strong objects T and F combine to yield strength equal to that of the weak N. (but NOT the actual object N).	The strength of the comp of the dominee (F) is subtracted from the strength of the matrix (T), hence the loss of strength.

(14a) is a matrix T with two embedded OPs (dominees). The dominee in the comp shares the same head, indicated by x, as the matrix: It is the fricative portion of an affricate. The OP embedded in the spec is also a fricative. The resulting string would be *[spf, xts, fts, sts, stʃ, ftʃ]. (14b) shows embedding at a depth of two: The highest matrix

T has another T embedded at its spec. The embedded T, in turn, has a fricative embedded at its comp (yielding an affricate). The resulting structure would be *[pft, tst, tʃt]#. In 3.3. we saw that structures at the limit of MSD are marginally attested, as in the medical terms sclerosis, sclera in English. The weight of these structures is the reason why they are not systematically attested but found in a very restricted set of words in one language, German, eg: onomatopoeic seufz(en) ‘to sigh’. Onomatopoeic words can have a lower limit of strength difference, as in English oink which is a superheavy syllable with a non-coronal cluster. Otherwise all such syllables with a long vowel or diphthong AND a final cluster always end in coronals: paint, *paink (cf. Fudge, 1969).

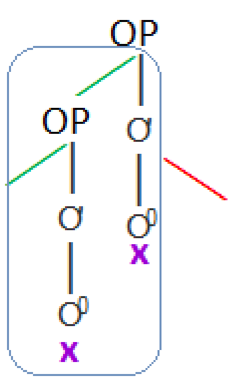
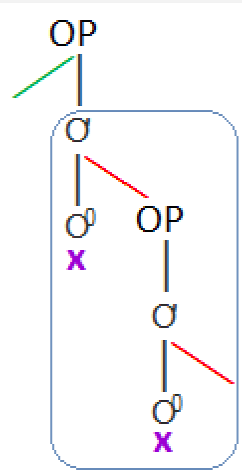
14) Heavy configurations (x at the head stands for a place variable, such as labiality)

a) *[spf, sts, fts, xts, stʃ, ftʃ]	b) *[pft, tst, tʃt]
	

This model of affricates makes a third prediction about the order of the plosive and fricative components. Stops are homorganic to a plosive if they are embedded in the stopness component of it (spec, left), fricatives when they are embedded in the friction component of it (comp, right).

(15) shows two matrix plosives. (15a) has an embedded OP in the spec. The embedded OP has only spec. (15b) has an embedded OP in the comp. The embedded OP has only comp. In both trees, the heads of the matrix and the embedded OP are identical, which means they have the same place property. The blue box in (15a) contains two specs, no comp, and the identical head x. The blue box in (15b) contains two comps, no spec, and the identical head x. Lets us call this kind of configuration identical iteration. These configurations are homorganic, that is, just as stopness and friction repeats twice in the same direction of that component within a plosive (stopness to the left and friction to the right), the head also repeats.

15) Direction of homorganicity

a) Homorganicity of nasals	b) Homorganicity of affricates
	

16) The homorganicity principle: Identical iteration of the projectional position (spec or comp) entails the identical iteration of the head as well. As a result, nasals are

homorganic to the left of a plosive, and fricatives to the right (to be restricted further in sections 3.7, 3.8).

The homorganicity principle (16) scopes over the weaker dominee N cross-linguistically. It can also scope over the stronger dominee F, in which case a language cannot have *[px, tx, tf, kf, pθ, kθ]. To my knowledge, there is in fact no language where such clusters are systematically attested to fulfill the cluster criterion (5), i.e. a cluster must be found both word-medially and at the edge in a morphologically simplex domain. Note that [ps, ks] are attested even though they are not homorganic. In 3.8, we will see why sibilants can remain outside of the scope of (16).

There are languages (Prince languages) where the only type of cluster found is an NT# cluster (Prince, 1984). This restriction on cluster phonotactics can be expressed as follows: Only identical iteration is possible, and only in the weak spec (15a), which creates maximal strength difference as discussed in 3.3. Existing models need to stipulate this restriction. For instance Harris (1997) stipulates that only the nasality element |L| is licensed in a cluster in these languages. This does not follow from the structure of |L| itself since it does not have any structure. In contrast, identical iteration is a phenomenon that emerges from the internal structure of consonants in this model. This is parallel to the case of languages which lack onset clusters but have affricates such as Turkish, eg: [tʃ]an ‘bell’ Again, these languages have a dominee in the comp because it is an example of identical iteration. In section 3.5, 3.7 and 3.8 we will see further examples of the importance of recurring structures in the system.

Lastly, clusters displaying identical iteration behave like a unit, especially if the dominee sits in the position closest to the head, comp (an affricate). This is because identical iteration creates a strong and stable bond between two objects. We will see further effects of such a bond in 3.7 and 3.8.

3.5 Indirect domination

Nasals have only spec and fricatives only comp, therefore they can have an embedded OP in those respective positions only: [rn, sl], i.e. [[r]n] and [s[l]]. This means that their reverse, [nr, ls], cannot form an immediate domination relation as there is no position to plug in the dominee. [nr, ls] are really part of the larger structures [n(d)r, l(t)s] respectively. The matrix plosive head is empty and therefore possibly silent. It is realised iff it shares the head (place property) of an embedded OP. Interestingly, dense and else can be produced as [dɛnts] and [ɛlts] respectively (cf. Berrey, 1940; Clements, 1987; Ohala, 1995; Warner, 2002, inter alia). Likewise, in English, thumle turned into thimble and thunre turned into thunder. Even across words, an emergent stop can appear as in Tam Lin/Tamblin (a traditional ballad's name).

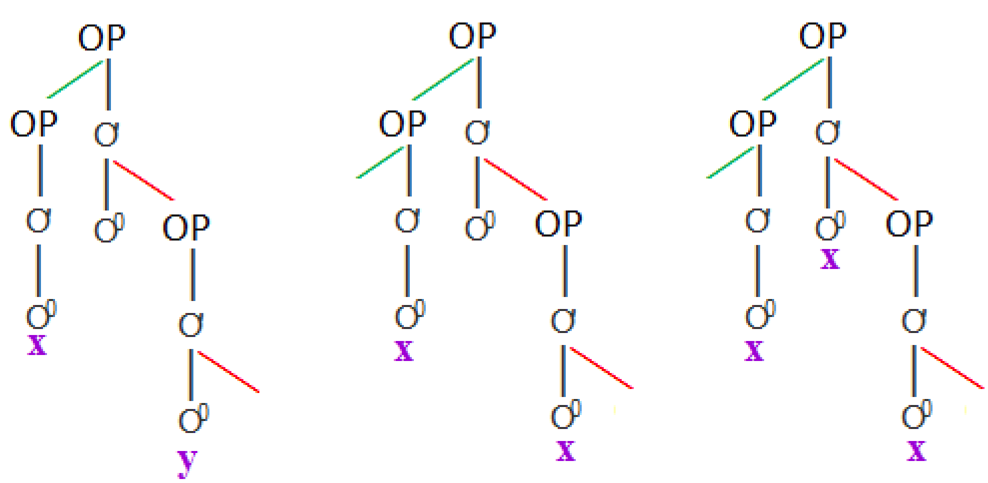
Before we enter the discussion of silent onset heads, it is necessary to refer to the interpretation of an empty head as a place property. We saw in chapter II that velar (or more generally dorsal) is the weakest place property: For instance, German has [fl]ug 'flight' but not *#[xl] where the fricative dominates [l]. I take velarity to be the expression of an empty head. This is based on the strength it adds to a consonant, viz. none. See also Huber (2003) and works cited therein, including Kaye et. al. (1990), Harris and Lindsey (1995) for an analysis of velars as phonologically placeless/empty-headed objects. Below, a velar plosive is represented by [k], though it can have other laryngeal properties as discussed in 3.2.

In chapter II, we saw that there is a c-command relation between the argument positions spec and comp. This allows for a domination relation to be formed between the OPs embedded in these positions. Let us call this indirect domination, since no consonant is embedded in the other, but rather both of them are embedded in a silent matrix OP.

x and y at the head stand for different place properties. (17a) has an empty-headed matrix with, for instance, [r] in the spec and [f] in the comp. [f] indirectly dominates [r] and the matrix head is silent. (17b) has the same matrix, with, for instance, [n] in the spec and [s] in the comp. Both embedded OPs have the same head. The two heads enter into a relation across an empty one. This can result in copying the place property onto the empty head as well. Hence, in (17c), the matrix head is no longer empty and is realised as [t], yielding [nts].

17) Domination in ABC where C is a fricative and C is stronger than A

a) r 0 f   b) n 0 s   c) n t s

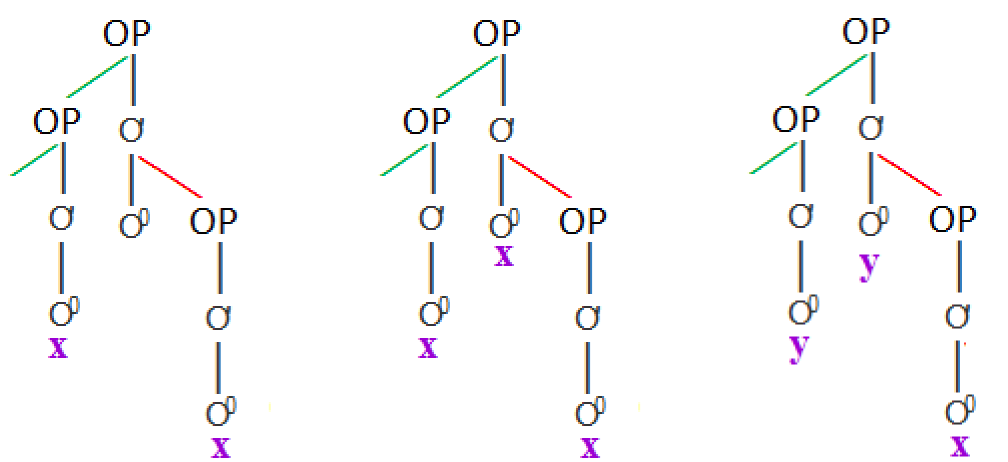


I claim that domination has the following two restrictions: i) A dominee can be dominated only once, even though a dominant can dominate more than once (as discussed in 3.3), eg: in [nts] (17c), [t] dominates [n, s] and therefore [s] cannot indirectly dominate [n]. ii) A realised head dominates any OPs embedded in it, therefore when there is indirect domination, the matrix is silenced, as in [n0s] (13b). Furthermore, if one of the embedded OPs shares it head (place property) with the silent matrix, then the matrix head is no longer empty and becomes realised, thereby dominating both embedded OPs, eg: [nts] (17c).

Note that in this configuration ABC, C is stronger than A. Specifically, C is a fricative in the comp of the matrix T, that is, an example of identical iteration, constrained by the homorganicity principle (16). Now let us look at another logical possibility for ABC, where A is stronger than C.

18) Indirect domination in ABC, where A is a nasal and A is stronger than C

a) n 0 r b) n d r c) m b r

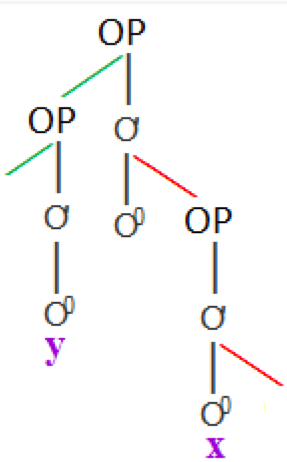
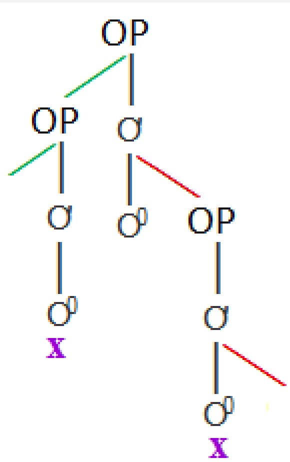
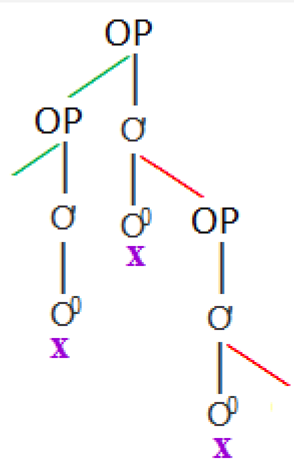


(18a) shows a silent matrix plosive with a nasal stop in the spec. This is an example of identical iteration as well, restricted by the homorganicity principle (16). If the nasal stop shares its head with the matrix, the matrix head is no longer empty so it is realised, yielding [ndr] (18b) and [mbr] (18c). Note that the laryngeal properties of the matrix plosive are not shown in (18).

Crucially, in both (17) and (18), the realisation of the matrix head (an emergent stop) is derived through the same mechanism of place-sharing with the matrix head. This is the only phonological (vs phonetically based) model that derives emergent stops in both rising sonority and falling sonority environments from the representation of the consonants themselves alone (cf. Recasens, 2011; Ohala, 2005).

The model also correctly predicts that nasals differ in their assimilation behaviour before plosives and fricatives. While nasals assimilate to plosives in place, Padgett (1991) lists the three most common types of behaviour with nasal+fricative pairs across languages as: a) The nasal simply does not assimilate, receiving a default place. b) The nasal deletes. c) The nasal assimilates but simultaneously hardens the fricative to a stop or an affricate.

19) Assimilation and fortition (x and y in the head stand for different place properties)

a) n 0 f	b) m 0 f	c) m p f
		

(19a) shows a non-homorganic pair such as [n, f] embedded in a silent matrix. (19b) shows a homorganic pair such as (m, f) in the same matrix. (19c) shows the matrix head sharing the place property x and therefore getting realised.

Nasal assimilation to a plosive is via immediate domination and it is an example of identical iteration, guaranteeing homorganicity (16). In contrast, assimilation to a fricative occurs across the matrix head (19b). This means that it is possible for the nasal stop not to assimilate to a fricative because the two are not in direct domination or identical iteration (19a).

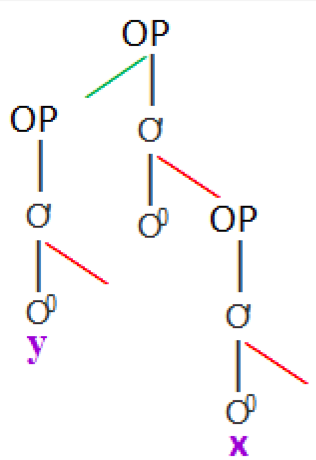
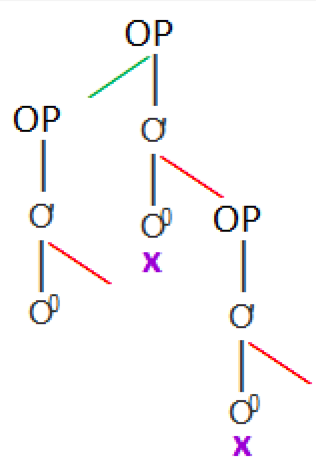
If the nasal stop does assimilate (19b), the sharing of the head (place property) occurs over the empty matrix head. Once place-sharing is a property of the structure, all the available heads can potentially participate in it, therefore creating a chain of identical heads including the matrix one (19c). Place sharing with the matrix head, as well as over it, results in an affricate (19c). The system has a tendency towards recurring structures, of which identical iteration as discussed in 3.4. is one example and chain-sharing of heads (19c) is another. For now, let us observe this as an emergent property of the structures posited. The same tendency will come up in the discussion of place properties in 3.7 and 3.8. The reason for this property is the subject of a separate paper.

The two common patterns, the lack of nasal assimilation to fricatives or assimilation resulting in an affricate, directly follow from the structure of phonological primes themselves, viz. the spec and comp positions and embedding possibilities therein.

The model also correctly predicts the lack of FF# clusters. In chapter II we saw that FF# is not attested in morphologically simplex words though strength-wise they are fine. [f, θ] has the same kind of strength difference as in [p, t] and [m, n]. Articulation-wise they are also fine in morphologically complex words, eg: fifth, roofs.

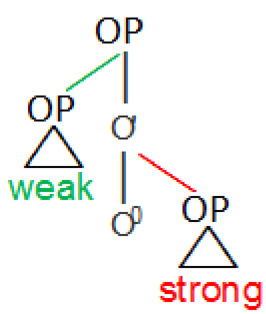
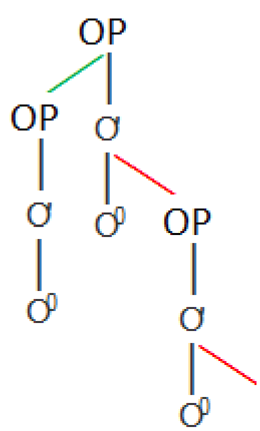
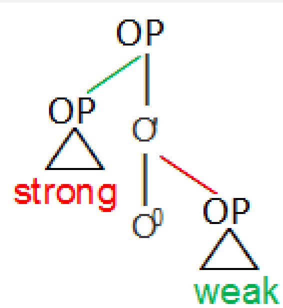
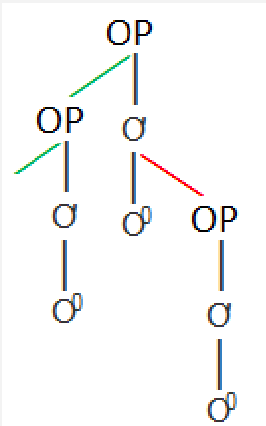
(20a, b) have the same structure where a matrix T has two embedded fricatives. (20a) shows a silent matrix with two embedded fricatives with different heads, such as [f, θ]. (20b) shows a matrix T with a homorganic fricative in the comp, and a non-homorganic fricative in the spec. In section 3.4 we saw that a plosive cannot dominate two obstruents because the weight of the heavy comps of the embedded OPs are subtracted from the weight of the matrix, yielding a number below the MSD limit of attested languages, eg: *[fts, ftʃ]#. If FF# clusters are in the form of ABC where B is the empty matrix head and A, C are fricatives, it follows that they are too heavy, just like *[fts, ftʃ]. The lack of obstruent+affricate clusters and FF# clusters are both derived from the same weight restriction.

20) Two embedded OPs with comp (obstruents)

a) indirect domination across an empty head	b) an affricate dominates a fricative
	
* f 0 θ	* f t s

We have so far looked at R(T)F#, N(T)F, F(T)F#, #N(T)R clusters. Let us explore the asymmetries between these and further logical possibilities. (21) illustrates a matrix plosive with two embedded OPs (dominees). In (21a), the dominees sit in positions commensurate to their relative strength: The stronger dominee sits in (stronger) comp and the weaker one in (weaker) spec, eg: RkF, NkF, RkN, RkL. Let us call this a strength commensurate configuration. The example illustrates R (no spec or comp) in the spec and F (only comp) in the comp of the matrix. (21b) is the opposite case, where the weak dominee sits in the strong position, eg: LkR, NkR, FkR. Let us call this a non-strength commensurate configuration. The example illustrates N (only spec) in the spec and R (no spec or comp) in the comp of the matrix.

21) Logical possibilities of ABC strings where B is an empty-headed plosive

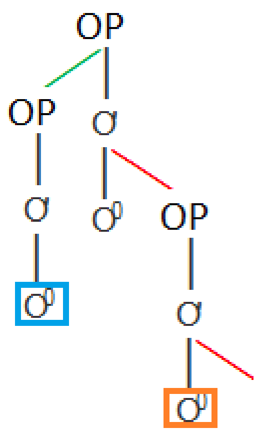
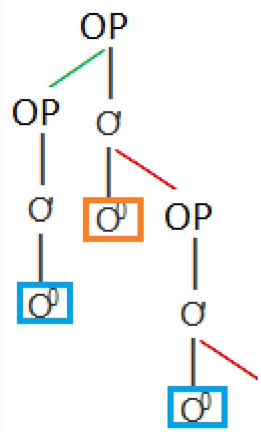
a) weak+strong	eg: R0F#	b) strong+weak	eg: #N0R
			

As asymmetry is the building principle of the system, indirect domination is not equally likely in (21a) and (21b). Strength commensurate configurations yield RF#, NF# clusters while non-strength commensurate configurations rarely yield #NR (if ever). The reason for this is a minimum strength difference (MSD) limit: We saw in 3.3. that a dominee is stronger when it sits in the comp, and weaker when it sits in the spec. Indirect domination has a much better chance of occurring when the indirectly dominating OP is fortified in strength by sitting in the comp, and the dominee is weakened by sitting in the spec so the strength difference between them is as high as possible.

(21a) yields the logical possibilities RkF, NkF, RkN, RkL. Among these, let us consider RkF and NkF first: [rks, lks; rkf, rkθ; nkf, nkθ, nks, mkf; mkθ, mkx; mks] and [rkx, lkx, ŋkx]. These strings have three interesting properties: a) The strong dominee is a fricative in the comp, so BC in ABC is an example of identical iteration. b) The homorganicity principle (16) restricts identical iteration to homorganic pairs NT and TF (but, as mentioned in 3.4., [s] may possibly be outside of the scope of this restriction). c) The strings that are impossible by (16), in fact, do not exist, eg: *[nks]. This means that such configurations are only observed in indirect domination, where the matrix is silent: [r0s, l0s, r0f, r0θ; n0f, n0θ, n0s, m0f; m0s]. We observed before that [s] may fall out of the scope of (16), yielding non-homorganic [ps, ks]. This means that it is possible for the empty head to be realised, as in German Murks ‘bungle’. Note that [mθ, mx] do not exist at all though German Amt ‘office’and Turkish zamk ‘glue’ are fine. In section 3.8 we will see that this is predicted by the theory.

The strings [rkx, rkl] have the same structure as [r0x, r0l], only the relations within them differ (22). A red square contains the dominant, a blue square contains the dominee. In (22a), there is an indirect domination relation between the embedded OPs so the head is silent: [r0x]. In (22b), the head dominates both embedded OPs: [rkx]. It is theoretically possible that different relations on the same structure may be encoded in the lexicon, eg: [r0x] (22a) vs [rkx] (22b). However, this is a very low-level difference, hence not expected to be systematically attested as a means of contrast. This is especially true for strings like [n0s] where the identical heads of the embedded OPs can potentially be shared by the matrix, as discussed regarding (19c), eg: English [prɪnts], where an apparent contrast is easily levelled, eg: prin[t]s vs prints.

22) Same structure, different relations

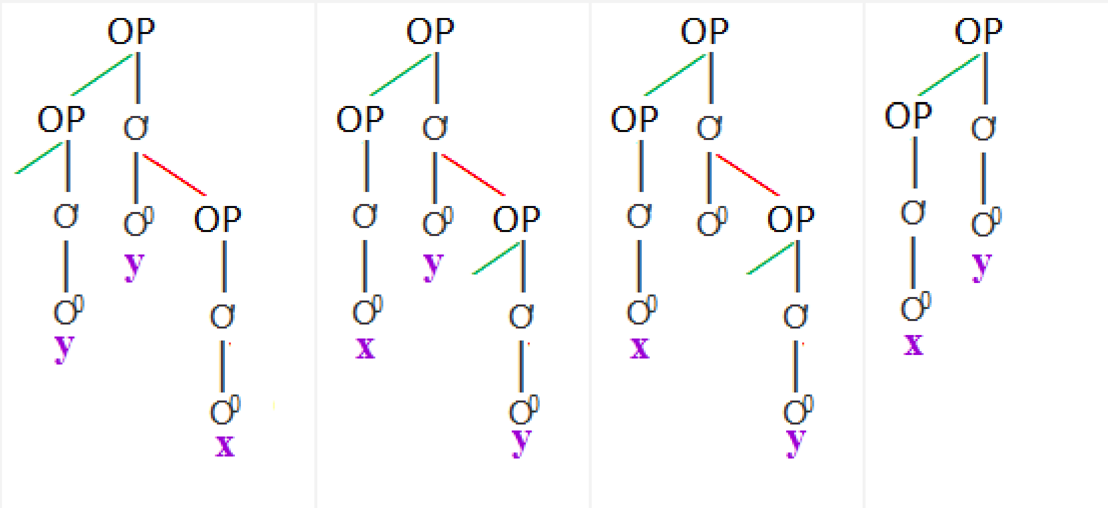
a) r 0 x	b) r k x
	

Lastly, a logical possibility is RkN: [rkn, lkn, rkm, lkm, rkŋ, lkŋ]# are hardly attested in either direct (23b) or indirect (23c) domination. These configurations, if in indirect domination, would yield [rn, ln, rm, lm, rŋ, lŋ] which are derivable through direct domination as well (23d), in which case they have a stronger relation (cutting out the middleman, if you will).

As for direct domination, NTR (23a) is fine, eg: u[mbr]ella, but RTN (23b) is barely attested since NTR has identical iteration (NT) while RTN does not. Also, the distribution of dominees in NTR is such that the heavier N sits in the weakest position (spec), therefore creating the maximal strength difference possible. However, I observe that identical iteration is a more crucial factor on the arrangement of dominees than weight distribution: Just as a language has affricates even when it does not have onset clusters, it can have (21a) where C is a fricative and A is weaker than C. (That identical iteration is such a crucial factor certainly merits further study.)

23) Possible domination relations between T, N, R and R, N

a) m b r	b) r b m	c) r 0 m	d) r m

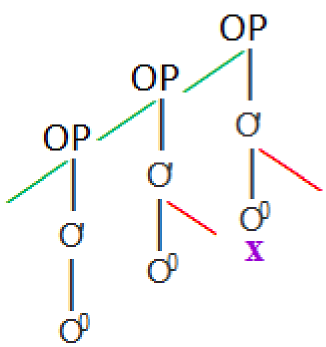
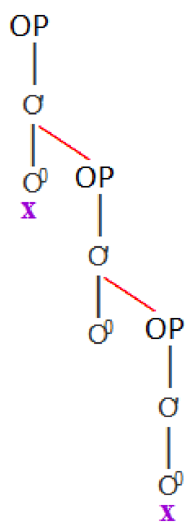
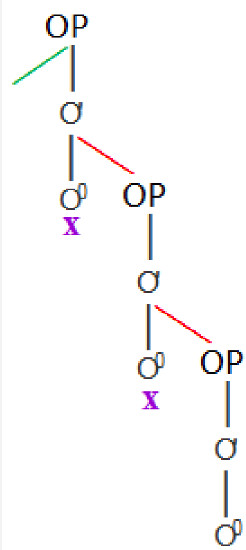


3.6 Embedding at a depth of two

Out of the logical possibilities for ABC, only three exist where the signs < and > stand for weaker than and stronger than respectively: A < B < C (22a), A > B > C (24b, c) and B > C, A. We looked at B > C, A clusters in (19a, b). Let us now look at increasing and decreasing strength relations, eg: [ŋkt]# (24a) and #[sfr, pfr] (24b, c) respectively. Such clusters are the result of embedding at a depth of two. That is, they have the structure of [[[ŋ]k]t], [s[f[r]]] and [p[f[r]]].

(24a) shows a matrix [t] which has [k] embedded in the spec. In turn, [k] has [ŋ] embedded in the spec. The weight of [ŋ] is subtracted from [k], and their combined weight is subtracted from [t]. (24b) shows a matrix [s] with [f] embedded in the comp, which in turn has [r] embedded in the comp. Likewise, (24c) has a matrix [p] with [f] embedded in the comp, and [f] has [r] embedded in the comp. The weight of [r] is subtracted from [f] and the combined weight of [f, r] is subtracted from [s] in (24b) and from [p] in (24c).

24) Embedding at a depth of two

a) ABC# and A < B < C	b) #ABC and A > B > C	c) #ABC and AB is an affricate
		
ŋ k t	s f r	p f r

For sonority accounts, (21a) as in [rts] and (24b) as in [str] are a problem. Both disobey the sonority sequencing principle. Government Phonology cannot express (24a) since what may be called coda onset clusters can only have two members (cf. Harris &

Gussman, 1998; Kaye et. al., 1990). In this model, all and only the possible configurations are predicted from the representation of consonants themselves.

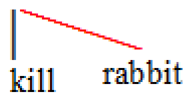
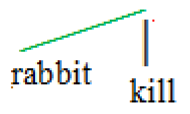
3.7 The onset head and the domain head

In chapter II we observed that coronals are stronger than labials which are in turn stronger than dorsals within the same manner, measured by the set of objects they dominate. The working hypothesis is that strength is derivable from structure alone. Manner is the interpretation of the argument structure (valence) of a head. Place is the interpretation of the head itself. If the head adds to strength, then the head itself must also have internal structure. To draw a parallel with syntax (and morphology), Gandalf and dragon fire are both NPs with zero valence. However, the heads Gandalf and dragon fire are not equally complex: The former is simplex and the latter is a compound. I claim that the same is true in phonology, i.e. that a head can be simplex or complex (corresponding to a compound).

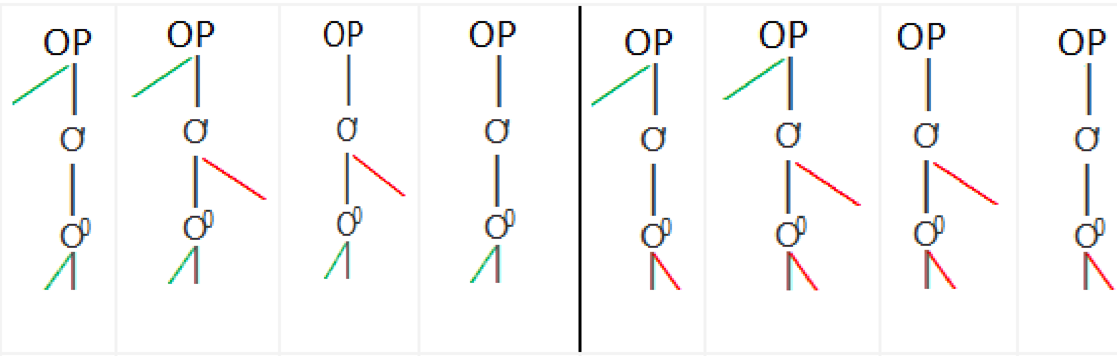
Like in syntax, compounds have a head and a dependent (cf. Di Sciullo, 2005). Furthermore, the dependent can have different functions, parallel to a complement and a specifier. For instance, if the compound rabbit-killer is translated into a phrase, rabbit will be the complement of kill: kills the rabbit. However, for killer rabbit, rabbit will be the specifier of kill: The rabbit kills. (25) illustrates the argument structure relations between the components of these compounds.

Note that this is not the illustration of the actual compound, where the arrangement of the components is the mirror image of the syntactic phrases kills the rabbit and the rabbit kills. In phonology, I assume that the ordering of spec and comp in a compound, just as in a phrase, is the same as in syntax since there are no operations to switch these directions. The only difference between compounds and phrases is that phrases have a bar level that makes adjunction possible, while compounds do not.

25) Argument structure relations within compounds

a) head-comp: rabbit-killer	b) head-spec: killer-rabbit
	

26) Labials and coronals as projections of spec-head and head-comp compounds, respectively

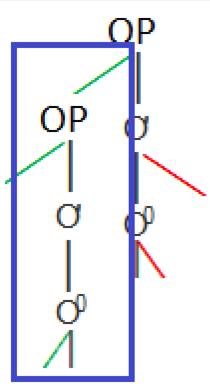
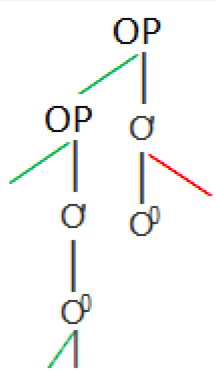
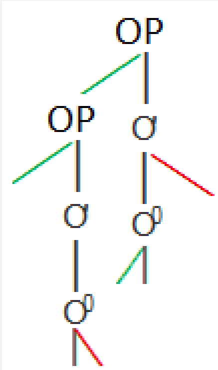


m	p	f	w	n	t	θ	ɾ

The spec-head configuration in the head yields labiality while in the projection it yields stopness. The head-comp configuration in the head yields coronality while in the projection it yields friction. Note that in section 1.2., I pointed out that I use spec and comp to express the different kinds of arguments that a head can have, and that I do not subscribe fully to any particular theory of syntax. (26) shows a simple way of representing the same dependencies at different levels of complexity, the projection and the compound. In upcoming work, I derive them as different kinds of geometrical relations. Nasality/voicing/aspiration are derived as operations on these head-dependent configurations as discussed in 3.2. This means deriving the architecture of phonology from two relations and operations on them, with no stipulated primes. Moreover, these relations are themselves derivable from the asymmetry principle: Two positions can merge at a time but no two can be equal in strength. By the same logic, any further dependents must be weaker than spec (an adjunct).

Isolating a property such as labiality and naming it [+lab] or |U| does not make predictions about its behaviour or its relation to others. The structure of labiality posited here, on the other hand, makes the prediction that it should interact with stopness, as both are derived from the same spec-head relation.

27) Nasal assimilation asymmetries

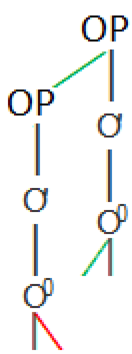
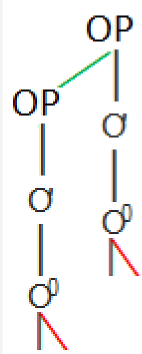
<table>
<tr><td>a) m t</td><td>b) m k</td><td>c) * n p</td></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
</table>

In (27a, b, c), a pure stop is embedded in the stopness component (spec) of a plosive. This is an example of identical iteration. In section 3.4 and 3.5 we saw the special properties of identical iteration and its effect on homorganicity. (27a, b) show the possible structure of the strings [mt, mk] respectively (if they are clusters by the criterion in (5)). German Amt ‘office’, Turkish zamk ‘glue’. Consider the blue box in (27a): There are three spec-head relations, one being within the head of [m]. The identical iteration of the same relation (spec-head) in the head as well as in the projection creates a strong link between these relations. (We will see the same principle coming back in the discussion of sibilants in section 3.8.) This link makes it possible for [m] to stay outside of the scope of assimilation. [m] has structural integrity by virtue of having the same configuration in its projection and in its head. In contrast, [n] has different configurations in the projection (spec-head) and in the head (head-comp) (27c); therefore it has no special integrity and it cannot preserve its place: *[np]#.

In section 3.5., I pointed out that [m] cannot be indirectly dominated by [x, Ɵ]. This is interesting because [m] can be directly dominated by non-homorganic [k, t], and [n] can be indirectly dominated by non-homorganic [f]: German fünf ‘five’. With [m], while direct domination possibilities increase as discussed above, indirect domination possibilities become more restricted. The interlinking stopness/labiality in [m] means [m] must share either stopness or labiality with a (non-sibilant) dominant. In 3.8., the phonotactic strength of [s] is derived through the same principle that makes [m] stable.

(28a) shows a matrix OP with a spec-head configuration in both the projection and the head: [m]. (28b) shows a matrix OP with a spec-head configuration in the projection (pure stop) but a head-comp configuration in the head (coronal): [n]. The embedded OP in (28a,b) is a unary branching tree with a head-comp configuration in the head: [r]. As discussed in chapter II, [n] is stronger than [m], eg: Swedish namn ‘name’ but not *nanm. As discussed in 3.3., for the same dominee, a stronger dominant makes a better cluster because of the higher weight difference between the two. However, an interesting implicational relation exists between [m] and [n] as dominants: The existence of Rn# implies the existence of Rm#. For instance, Turkish has film ‘film’ and form ‘form’ but not *Rn#. To my knowledge, there is no language which has Rn# but not Rm#. Since [m] has structural integrity as discussed in (27), it is a better dominant than for liquids despite being weaker than [n]. This is an example of structural integrity being more crucial than weight difference. In 3.5 we saw such another example: the existence of affricates in languages with no onset clusters, eg: Turkish [tʃ]an, ‘bell’.

28) Asymmetries in RN# clusters

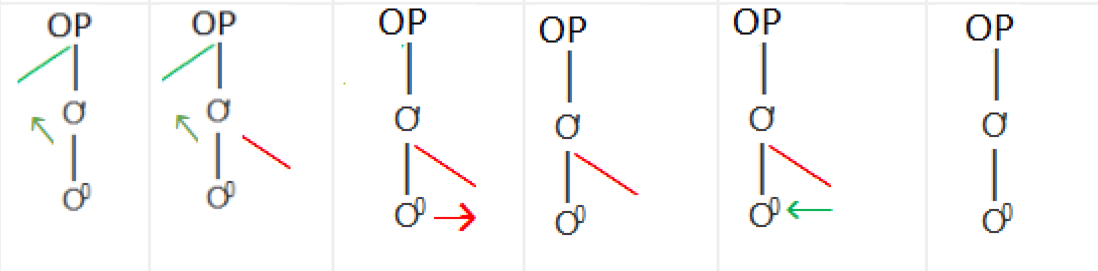
a) rm	b) rn
	

If labiality and stopness are derived from the same configuration spec-head, and if nasality/true voicing is an operation on this configuration, then the prediction is that there should be a correlation between labiality and voicing as well. The same operation that yields voicing in the projection can also exist within the compound, adding a degree of voicing. This is in fact the case. Labial obstruents are more compatible with voicing than coronals, and coronals more so than velars. Namely, if there is a gap in the set of voiced and voiceless plosives, [p, g] are likely to be missing. (Gamkrelidze, 1978;

Ohala, 2005). No existing model captures this correlation. The further asymmetry between coronals and velars also falls out from the model.

29) Case assignment (and potentially agreement) relations on velars

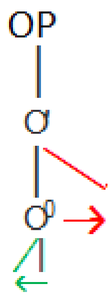
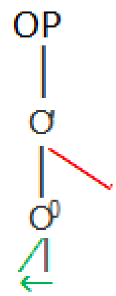
a) ŋ	b) g	c) x	d) (lenis) ɣ	e) (voiced?) ɣ	f) ɰ



In section 3.2. we saw that the phonological head is naturally voiced, as in approximants (29f). In contrast, dependent positions are naturally voiceless and they can only be voiced through an operation. True voicing/nasality on stops and plosives is derived as a case assignment operation from the head to spec (29a). It is not clear if fricatives can be truly voiced at all, and if they can, this can be derived as an agreement operation from the comp to the head. Fricatives can be fortis or lenis (29c, d) respectively. Though the dependents in the projection yield the better part of the voicing property of an OP (as well as its strength), the head also contributes to it. Since velars are empty-headed, there is no voicing support that comes from the head and therefore they are the least compatible with voicing. Coronals, logically, fall in the middle since they are not empty-headed but they are not associated with a voicing configuration either.

Another well-observed asymmetry of phonology is that [v] is more sonorant than other voiced/lenis fricatives (Bjorndahl, 2015; Padgett, 2002). This follows from the representation:

30) [f, v] with operations from the head to the dependent

a) f	b) v
	

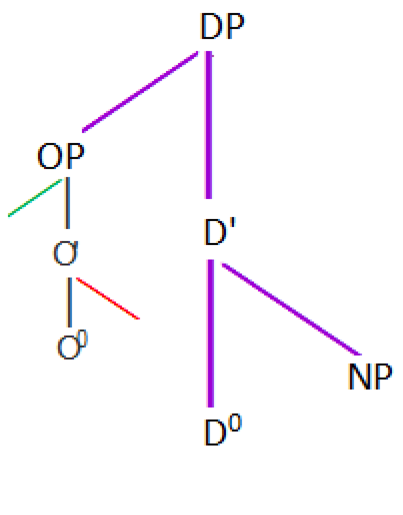
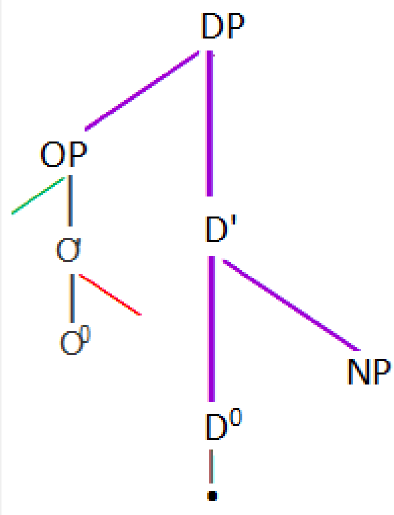
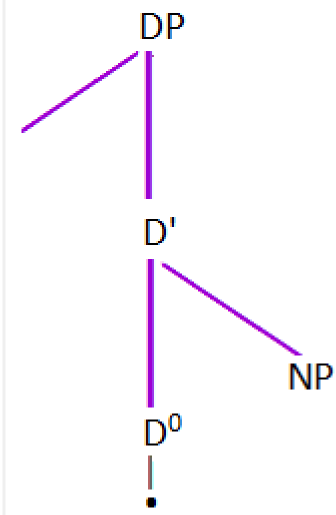
(30a, b) shows fricatives. In (30a), there is a case assignment operation from the onset head to comp; it is fortis. In (30b), there is no such operation; it is lenis. In both (30a, b), the head is a spec-head configuration (labiality) with an operation from the head to the spec. In the projection, this operation yields nasality and true voicing. In the compound, it also adds a degree of voicing. In section 3.2 we saw that taking away case assignment makes a configuration weaker, hence non-sibilant lenis fricatives are prone to lenition and display sonorant-like behaviour. [v] is even more prone to this effect. Labiality contains an operation in the opposite direction (leftward from the head to spec) to that which links the component parts of a fricative together in principle (rightward from the head to comp). Lenis labial fricatives are the least fricative-like since they lack the operation that creates a strong bond in a fricative configuration as well as containing a head with the opposite dependency relation and operation (30b).

Ohala rightly points out that existing models of phonology cannot capture place-voicing correlations. He also argues that the only way to capture them is to posit an abstract model (claimed to exist in the mind) which mimics the physical model, in which case the abstract model becomes redundant in any case. This model, however, is not made up of phonetic properties and their stipulated arrangement. Instead, it is built on the abstract configurations that yield the architecture of syntax (and syntagmatic morphology) as well. What is surprising is that such architecture, when applied to phonology, should fit in seamlessly with the physical facts.

Applying the same logic, coronality, friction and aspiration must be correlated as well since they all rely on a head-comp configuration. The correlation between friction and aspiration is discussed in 3.2. The correlation between friction and coronality is observed in the inventory of human speech sounds: Sibilants are a subtype of coronal fricatives with special properties. There is no other place property that gives rise to such a significant distinction in fricatives. In section 3.8 I will discuss the composition and behaviour of sibilants.

The one remaining possibility is a simplex head: Not empty, but not a compound either, similar to a single lexical item such as ‘Gandalf’. This, I claim, is palatality. In chapter II, we saw that palatality does not add to strength. Since strength is derived from dependency relations, and a simplex head does not contain dependency relations, palatality must be a simplex head. Furthermore, there is an asymmetry between a simplex head and a compound head such that the simplex head cannot head an onset phrase. I will presently argue that palatality, uvularity, pharyngeality, retroflexion, secondary articulation and the glottals [h, ʔ] all belong to a higher level than the onset phrase, which I shall call the domain phrase (cf. Kehrein & Golston, 2004). In upcoming work, all of the properties recounted are derived using the existing configurations at this higher level.

31) The domain projection and minor place distinctions, eg: palatality

<table>
<tr><td>a) velar OP, empty D^0</td><td>b) velar OP, simplex D^0</td><td>c) no OP, simplex D^0</td></tr>
<tr><td>
</td><td>
</td><td>
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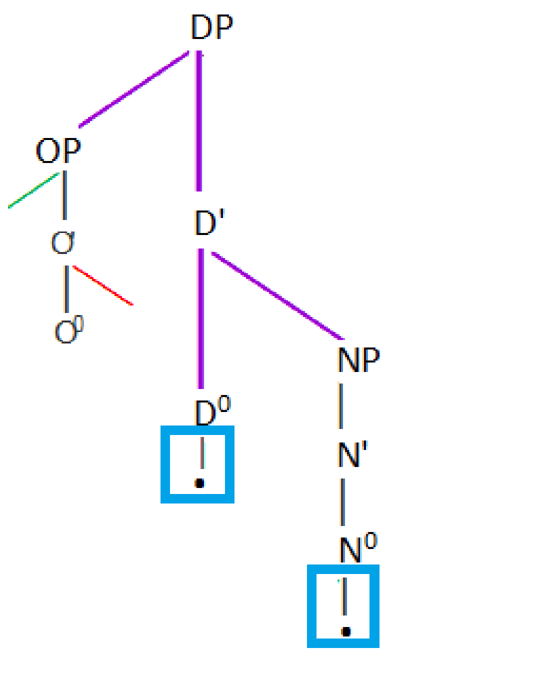
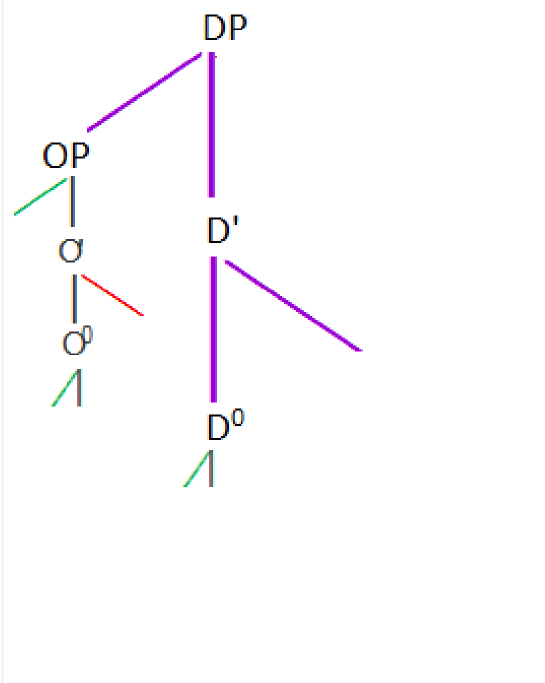
</table>

(31) shows a domain head D^0 projecting to a domain phrase, DP. The domain is the projection of the link between an onset and a nucleus (nuclear phrase). The domain head has these selectional properties: It takes an OP as an external argument (in the spec), and it takes an NP as an internal argument (in the comp). Note that a DP does not have to have both argument positions; it can go through valence transformations. An existing position does not have to be saturated either; it may be empty.

The domain head in (31a) is empty but the same head in (31b) is filled by a simplex object, palatality, indicated by only a dot to indicate the simplex head as opposed to compounds which have two positions. Note that the possible configurations within the head are the same for all phonological projections, with possible further restrictions such that the onset head cannot be simplex. Let us consider minor place distinctions in light of (31). Dorsals alternate with one another based on the vowel context. For instance, Turkish has [c] around front vowels and [k] around back vowels, eg: [c]el 'bald' vs [k]al 'stay' (cf. Göksel & Kerslake, 2005). This is because the domain head c-commands the nucleus and can enter into an exchange with it.

32) Palatality and labiality in the domain head

a) palatality climbs from N^0 to D^0	b) labiality in both O^0 and D^0
	

Palatality climbs from the nucleus to the domain head, and the result is a palatalised [kj] (32a), which I claim is the same object as [c]. The OP itself, on the other hand, does not alternate at all, it remains empty-headed. The prediction is that palatalised palatals should not exist since the addition of such a property happens at the domain head and this mechanism has already been used (32a). The UPSID database reveals a total of zero palatalised palatals. In contrast, labialised labials exist in six languages, including Irish. This is because labials have a labial onset head and combine with a labial domain head to have more of the same property (32b), but palatals have an empty onset head (32a) and the domain head is the only source of palatality.

The following alternations do not occur in any language to my knowledge: [k, p; k, t]. This is because the onset head does not directly see the nucleus (32a, 32b) and a place property from the nucleus cannot move into it, filling the empty dorsal with labiality. Further examples of vowel/minor place property interaction are as follows: Uvulars are compatible with only low vowels in Quechua (Gallagher, 2016) and Iraqi Arabic (Bellem, 2007). Likewise, retroflexes are compatible with only back vowels in unrelated languages: Yadhaykenu dialect of Uradhi (Australian), Sinhala (Indo-Aryan) and the Molinos dialect of Mixtec (Oto-Manguean) (Hamann, 2003). Plain coronals and labials do not exert a comparably strong influence on neighbouring vowels. The exhaustive modelling of these properties is the subject of a separate paper.

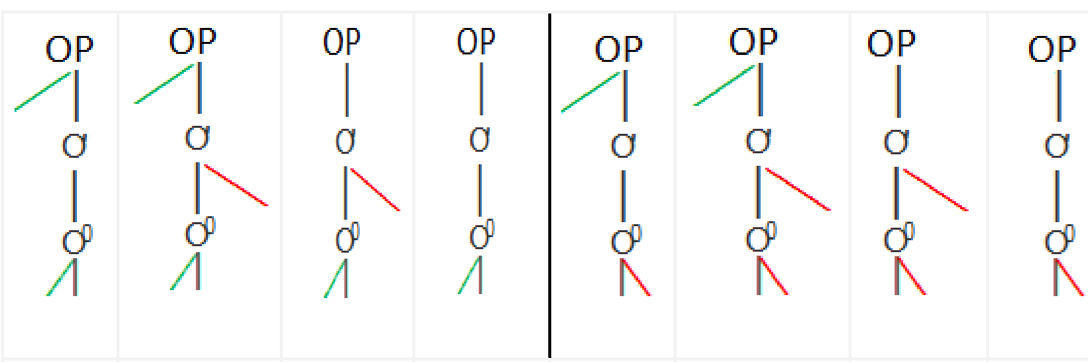
It is Pöchtrager's crucial insight that place, like manner, can be derived from structure (2006). He develops a version of Government Phonology, GP 2.0, where he reinterprets the coronality element |A| (cf. Broadbent, 1991) as a binary branching structure, specifically as head-adjunction where the head splits into two nodes. Though GP 2.0 has head-dependent relations, it is not built on the asymmetry principle which yields spec and comp as positions of asymmetrical strength and direction in this model. Neither does it exploit the phrase vs compound asymmetry for manner and place respectively. Therefore it does not lend itself to express both |A| and |U| as complex objects (as opposed to |I|). Likewise, stopness vs friction are not expressed as different kinds of simplex configurations. Instead, stops are more complex than fricatives. A similar view of manner is also found in Steriade's Aperture Theory (1993). Interestingly, both Pöchtrager (2006) and Steriade (1993) take the bare skeleton of plosives and nasal stops to be identical. This makes it impossible to relate structure directly to phonotactic strength.

What makes the theory I introduce stronger is a) the asymmetry principle which, among other things, means spec and comp have unequal strength and sit in opposite directions with reference to the head b) the main hypothesis that strength is the most important property of a consonant and that it is only derivable from structure c) the complete parallel to syntax including recursion by embedding an OP in another OP (at a depth of two).

3.8 Complex compound heads: sibilants and laterals

In 3.7 I derived labiality and coronality as compound heads with different kinds of argument structure relations between the head and the dependent. A spec-head (hereafter SH) relation yields a compound like killer rabbit (where rabbit is the external argument of kill). A compound head of this type corresponds to labiality. Likewise, a head-comp relation (hereafter HC) yields a compound like rabbit killer (where rabbit is the internal argument of kill). A compound of this type corresponds to coronality. I repeat (25) as (33).

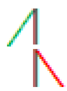
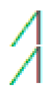
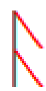
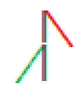
33) Labials and coronals as projections of spec-head and head-comp compounds, respectively



m	p	f	w	n	t	θ	ɾ

In this section I will discuss the kinds of complex compounds that can be derived by embedding one compound in the other at a depth of one. The logical possibilities are to combine a SH and HC compound or to combine either with itself.

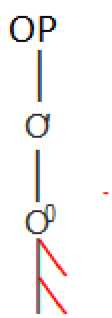
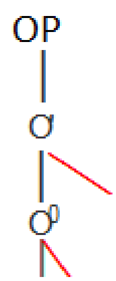
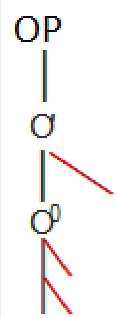
34) Logical possibilities for combining compounds

a) SH+HC	b) SH+SH	c) HC+HC	d) *HC+SH
			

(34a) shows a complex compound with both a spec-head and a head-comp relation. This is similar to the structure of a plosive (see 33). (34b) shows a head with two external arguments. (34c) shows a head with two internal arguments. As with everything else discussed so far, there is an asymmetry between an external argument and internal argument regarding its ability to combine with a head twice: There is no verb with two external arguments (two subjects) while there are a few verbs with two internal arguments (two objects): I gave the dragon the gold. I claim that this is the same in phonology; a head can have two internal arguments but not two external ones. There is only one way of combining SH and HC (34a). In (34d), there is a head which has an external argument closer than (what is supposed to be) an internal argument, an impossible configuration. This also means that spec is necessarily above the comp once they are merged and there is no need to refer to the bar level to define them or to describe their relative positions.

An immediate prediction regards the types of coronals attested in the inventory of human speech sounds. HC on its own in the head yields coronality (33). Combining it with itself (34c) results in a head plus two internal arguments, that is, two dependency relations. In section 3.1. we saw that dependency relations yield strength. This means that the possibility of combining HC with itself must mean the possibility of having more coronals of different degrees of strength. There is in fact a strength difference between two coronals of the same manner, [θ, s] and [ɾ, r].

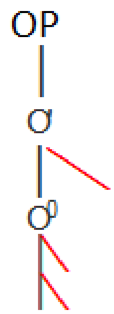
35) Projections of a single and repeating compound with a head-comp relation in it

a) [ɾ]	b) [r]	c) [θ]	d) [s]
			

Let us compare (35c, d). The valence of the onset head is the same; both are fricatives. They both have at least one HC configuration within the head; both are coronals. However, in (35d), the head of the compound has two internal arguments, not one. Since strength is derived from dependency relations, this configuration must yield a stronger coronal fricative than [θ]. There is in fact such an object, a sibilant. To illustrate, [s] but not [θ] can dominate [f] in morphologically simplex words, eg: Swedish (et) pro[fs] 'a professional' and English [sf]ere. Likewise, smile, snail are fine but not *[θm]ile, *[θn]ail. Moreover, the behaviour of [θ] is parallel to the behaviour of [t] concerning further restrictions: English does not have #[tl] clusters, neither does it have #[θl]. Since [s] has a different head than [t], it is not restricted in the same way, eg:[sl]eep. (35a) shows a simple rhotic and (35b) shows a complex rhotic. In languages where taps (35a) alternate with another kind of rhotic, taps are found in the weaker position. For instance, Persian has intervocalic taps but word-initial and final trills (Lindau & Ladefoged, 1986). Also, trills (35b) are phonetically larger objects than taps since the former involves multiple instances of contact between the articulators, while the latter involves only one such contact.

An interesting property of [s] is that it has three HC configurations, one in the projection and one in the head, and no SH configuration (36a). Let us call this a HC-only configuration. In 3.7., we saw that [m] (36b) has more structural integrity than other nasals because it has a SH configuration both in the projection and in the head, and nothing else; a SH-only configuration. Just as [m] is the epitome of stopness/labiality, sibilants are the epitome of friction/coronality. [m] and [s] are stable by virtue of being the most complex SH-only and HC-only configurations respectively. Other pure nasals and fricatives are constrained by the homorganicity principle (16): Identical iteration of the projectional position (spec or comp) entails the identical iteration of the head as well. As a result, nasals are homorganic to the left of a plosive, and fricatives to the right. Since [m, s] are stable, they can remain outside of the scope of this restriction, eg: axe, glimpse, German Amt ‘office’ and Turkish zamk ‘glue’. Both the homorganicity principle and the only objects outside of its scope are the result of the same tendency of structures to recur. Since [m, s] already contain such recurrence of structure, they resist assimilation.

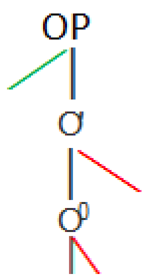
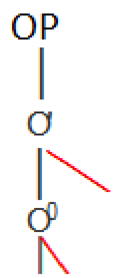
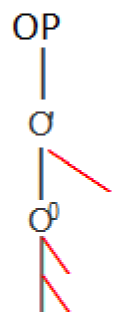
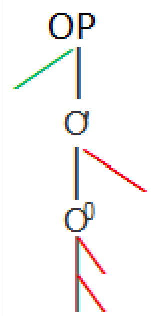
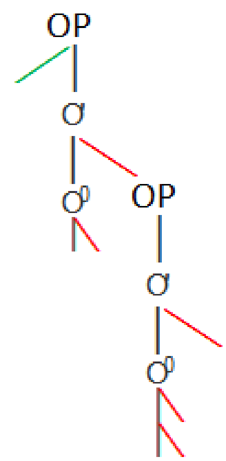
36) Identical configurations in the projection and in the head

<table>
<tr><td>a) s</td><td>b) m</td></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Note the lack of an object sibilant plosive. Articulatory impossibility is easy to circumvent, stopness and sibilancy combine in [ts]. However, we saw in section 3.4. that [ts] has the phonotactic strength of an affricate (37e), not that of a plosive. There is in fact no sibilant plosive (37d). The building principle of the model yields this gap. At every level and concerning every operation, there is asymmetry in the system. I claim this includes the complexity within the projection and the head as well.

There is a relationship between the complexity of the head and the complexity of the projection as follows: If a head has only one dependency within it (eg: plain coronal) it must have a maximum of two dependents in its projection. This means, plain coronals and labials project up to a plosive (as well as smaller projections). On the other hand, if the head has two dependencies within it (eg: sibilant), it must have a maximum of only one dependent in its projection. This means, it cannot project to a plosive. Let us call this the asymmetry of complexity. Note that this asymmetry means that an OP has three dependencies in it. I will come back to this number in this section and discuss its importance.

37) Asymmetry of complexity

a) [t]	b) [θ]	c) [s]	d) non-existent	e) [ts]
				

(37) illustrates existing and hypothetical coronal obstruents. (37a) shows [t]. [t] has an onset head with two dependents, and within it there is a compound head with one dependent only. The OP contains a maximum of three dependencies. It may lose a dependent to yield (37b), [θ] but it cannot gain one. In (37b), neither the onset head nor the compound head within it has more than one dependent. (37c) shows a fricative with a complex compound head. The onset head has one dependent only. Within it, the compound head has two dependents. This is a possible configuration. In (37d), both the onset head and the head of the compound within it have two dependents. This is not a possible configuration. (37e) shows a matrix [t] (37a), with [s] embedded in its comp (37c), yielding the affricate [ts].

In light of (37), [s] is not only stronger than [θ] but it is crucially different from it in its relation to [t]: Losing the spec position from [t] (37a) yields [θ] (37b). In other words, [θ] is a derivable fricative. It is a subtree of [t] and [t] is its supertree. In contrast, [s] (37c) is not derivable from a larger OP; it is a prime fricative with a unique head. This makes [s] different from [f, x] as well since [f, x] are subtrees of [p, k] respectively. To draw an analogy with syntax, [s] is like an unaccusative verb, eg: fall while [θ, f, x] are like passives, eg: be seen. While fall is not derived from a verb with higher valence, be seen is possibly derivable from see.

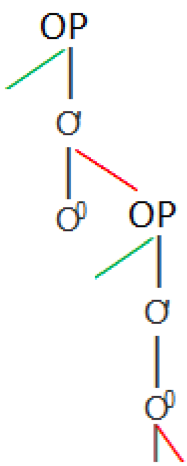
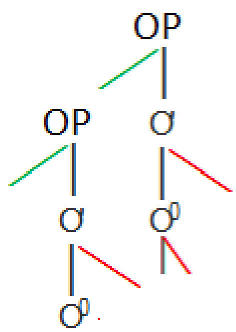
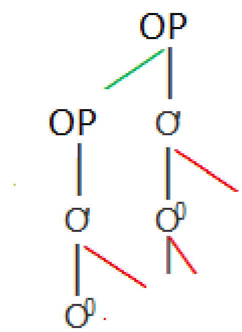
Differentiating between prime and derivable fricatives makes it possible to understand further asymmetries of cluster phonotactics. I observe that derivable fricatives in FT# clusters are restricted by what their supertrees can do. That is, the dominant must be coronal just as in same-manner pairs. [pt, ft, kt, xt] are fine but [fk, xp]# are not even though [k, p] are stronger than [f, x].

38) The supertree effect: Subtrees contain the potential of becoming their supertrees. For a string of AB, if the heads of both A and B project up to the highest level they can, AB must still yield a grammatical string.

Since domination is primarily dependent on valence, altering valence can alter the domination relation between A and B. What matters is that some domination relation is possible in the original linear order, AB. For instance,*[fk, θp]# are not good since *[pk, tp]# are not good. #[kn, xn] and [xt]# are good clusters because if every head projected to their maximum capacity, the result would be [kt]#, which is good.

(39a) shows an empty-headed (velar) plosive with a dominee in the comp. The dominee is [n]: The head is a HC compound (coronal). The velar already has the highest possible valence. If the valence of the coronal increases, as in (39b), it can become the matrix and dominate [k] in the same linear order since [t] is stronger than [k]. This is because it has a compound head and the velar has an empty head. Likewise, since dominates [k], it can also dominate the smaller [x] in the same position (39c).

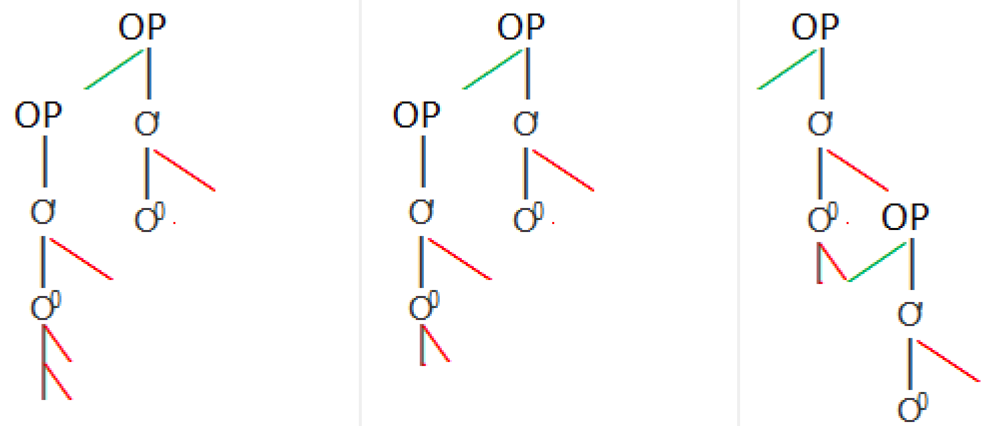
39) Domination relations for a velar-coronal string

<table>
<tr><td>a) [kn]</td><td>b) [kt]</td><td>c) [xt]</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

By the same logic, *#[km, pŋ] are not good because the fully branching *[kp, pk]# are not. A subtree is a potential supertree, especially if it can be derived through lenition; that is, if it is a fricative. (In contrast, nasals are not derived through lenition, an asymmetry captured in 3.1). A language chooses a set of objects which (38) scopes over: fricatives, nasal stops or both. Since [s] is a prime fricative and does not project further into a plosive, it is free in its behaviour in light of (38): cla[sp], a[sk]# are fine since the head of [s] cannot project further to yield an ungrammatical cluster. In contrast, [θp, θk]# are not good clusters because [tp, tk] are not .

40) Supertree effect for [sk] vs [θk, tk]

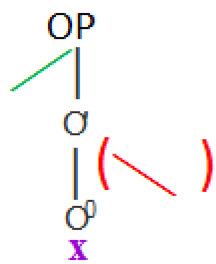
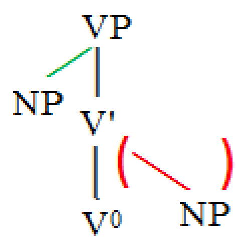
a) s k	b) θ k	c) t k



(40a) shows [s] embedded in the spec of [k]. The dominant is an empty-headed plosive and the fricative dominee has a HC+HC compound in its head. This head cannot project to a plosive as discussed in (37), hence the configuration cannot become ungrammatical. (40b) shows [θ] embedded in the spec of [k]. The head of the dominee, a HC compound, can project to a plosive. This yields (40c), [tk] where the dominant hosts a dominee of the same manner in its comp. In 3.3. we saw that the dominee is stronger in the comp and a language has a limit on how little the weight difference between the dominant and the dominee can be. This means clusters like [tk] are the least possible ones in such a configuration, along with their subtrees.

A final observation on head-projection interrelations is that a nasal stop, without exception, has a plosive counterpart in the inventory of human speech sounds: [n, t; m, p; ŋ, k; N, q] (41a). Interestingly, it is again possible to draw a parallel with syntax: An unergative verb can optionally take a complement and thus become transitive, eg: I walked these streets (41b). For a head, having the further dependent spec implies the possibility of having the closer comp. This implicational relation means that a complex compound head cannot project into a nasal stop either.

41) Implicational relations between argument positions (x stands for a place property)

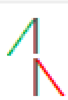
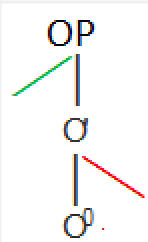
<table>
<tr><td>a) N implies the existence of T in the system</td><td>b) I walked (these streets)</td></tr>
<tr><td>
</td><td>
</td></tr>
</table>

In element theory, coronals have the common property of having the element |A| (cf. Broadbent, 1991). In Particle Phonology, Schane (1984) assumes that there can be more than one |A| in a vowel, unlike |I| and |U| but does not discuss the asymmetry. Pöchtrager (2015) argues |A|-ness in a vowel is derived from the layers of structure it has. A vowel, he argues, can have four layers of structure corresponding to two X-bar projections. This analysis brings a unified analysis to vowel reduction patterns as well as information loss in a wider context. The 'repeating' possibilities of |A| in consonants, however, has not been explored. Four degrees of openness in vowels are observed (i, e, ɛ, æ) hence the limit four on the number of layers, but this number is not derived from a principle. I disagree with the analysis that simple [i, u] have any layers of structure therefore I take said limit to be three.

Interestingly, three is also the limit on the arguments a verb can have (except bet, which has four arguments: I bet you ten quid it's not going to happen.). The question, then, becomes not a restriction on the number of a particular phonological structure to repeat, but a limit on the complexity of a minimal domain, such as the verb phrase in syntax or a consonant (onset phrase) as discussed in (37) or vowel (a nuclear phrase, which is outside of the scope of this paper) in phonology. My hypothesis is that the complexity of argument structure and phonological objects has a cognitive basis and that it is restricted by the number of items that can be rapidly subitised (cf. Kaufman et. al., 1949, Saltzman & Garner, 1948). This issue will be pursued in upcoming work.

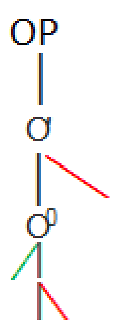
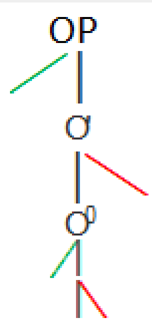
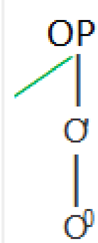
That coronality dominates within the manner (as discussed in chapter II) and combines with itself to create sibilants yields a coronal-abundant pattern of clusters in light of (38). Pöchtrager (2006) takes note of this heavily coronal nature of clusters and posits the mechanism of A-licensing to explain cluster phonotactics. A-licensing, though, works only in tandem with headedness (Pöchtrager, 2012). I will not discuss the details of either mechanism since the main problem lies in the necessity of stipulating interacting mechanisms even though the logical link between them does not follow from a principle. In this model, the few constraints posited, such as the homorganicity principle (16) and supertree effect (38) are directly linked to the set-up of the system and that, in turn, follows from the asymmetry principle.

42) SH+HC and the emergence of complex objects

a) SH+HC compound	b) plosive
	

In (34) I posited two possible configurations for a complex compound head: It can be a head with an external and internal argument, or it can be a head with two internal arguments. We have seen that the latter configuration yields trills and sibilants. The remaining possibility is SH+HC and it must yield a phonological property (42a). We saw in section 3.2. that the combination of SH and HC in a projection yields a complex object plosive which is more than the sum of its parts pure stop+fricative . This is because it has a c-command relation between the spec and comp which comes into existence only as a result of merging the two configurations (42b). SH in the head on its own yields labials and HC in the head on its own yields coronals. Similarly, the combination SH+HC in the head must yield not a labio-coronal but a novel object.

43) Laterality and its place in the system

a) r	b) l	c) ɬ	d) *plosive	e) n	f) ŋ
					

The unary projection of this head (43b) must be stronger than a rhotic (43a) since it has a more complex head. Since it is a unary (43b) projection, it must be naturally voiced as discussed in 3.2 and 3.7. (The phonological head is naturally voiced in the absence of dependents in an onset phrase.) It must have a fricative (43c), but not a nasal or plosive (43) counterpart as discussed in (37). It must be weaker than [ŋ]. This is because phrases are a higher level of complexity than compounds and the asymmetry between them cannot be levelled: A binary branching tree is stronger than a unary branching one. All of this is a fair description of [l]. It is stronger than [r], eg: earl but not *ealr. It is weaker than [ŋ], Djapu has [lŋ]# clusters (Morphy, 1983) but no language is reported to have [ŋl]#. [l] has a fricative counterpart [ɬ] (43c) but there is no lateral nasal or plosive. It is possible to deduce the existence and properties of an object of the strength of [l] from the set-up of the system.

It is even more interesting that the affinity of [l] with stopness also follows from its structure: The head contains a SH configuration, which yields stopness in the projection. In 3.7 and this section we have seen that the same configuration has similar properties at different levels (but, crucially, different strength). Also consider (43e), which shows [n], with a spec in the projection and a HC compound in the head. In Turkish, a string a[nl]a 'understand' can assimilate to a[nn]a (Göksel & Kerslake, 2005). Likewise, ya[ln]ız 'alone' can assimilate to ya[nn]ız. The affinity between [l, n] is predicted since they have the same configurations, albeit at different levels. It is crucial to be able to differentiate between the two levels of composition, the head and the projection, to understand how [l] can pattern with such different objects as stops and [r]. Note that HC can possibly combine with itself at a depth of one to yield degrees of coronality (dark and light [l]s) and (43b) is a generic [l].

Lastly, lateral fricatives are typologically much more rare compared to sibilants. A survey of the UPSID database reveals that 53 languages have lateral fricatives and 397 languages have sibilants. This corresponds to 11.75% and 88.03% of all the languages in the database respectively. In this section I have argued that HC has the potential to merge with itself. If it does so in [ɬ] (43c), this would yield three head-dependent configurations in the head only: two HCs and one SH. Having a further head-dependent configuration in the projection would make this OP very complex, roughly similar to a verb phrase with four arguments. There is only one such verb, bet. The typological rarity of [ɫ] follows from its potentially superheavy structure. As mentioned in this section, four is the upper limit of the number of objects which can be subitised. Argument structure and phonological objects are limited in their complexity such that they cannot have a number of dependencies above this limit and the upper limit itself is rarely attested. This is because even for objects that can be subitised, there is a small lag of processing time for each additional object (Trick & Pylyshyn, 1994).

In element theory, Harris (1990) and Pöchtrager (2006) take [l] to be a stop. There is no principled reason why it should be the only (non-nasal) stop to be spontaneously voiced (as understood in the traditional sense, not in the narrower sense of section 3.2.). It is also unclear, if nasal stops are assumed to be spontaneously voiced, what the link between nasality and spontaneous voicing is. Neither is it clear what the correlation between spontaneous voicing and phonological structure is. There is also no reason, in the absence of further stipulations, why [l] should pattern with approximants in branching onsets, eg: [pr]ay, [pl]ay, [tw]in. The crucial property of [l] is that it does not pattern with only stops or only approximants; it patterns with both. Moreover, though it patterns with stops in certain languages, it has the closest phonotactic strength to [r] in every single language. Note that the configuration SH+HC in the head corresponds roughly to the combination of |U| and |A| in element theory and [l] has been argued to have both elements (and not |ʔ|) (Balcı, 2006; Pöchtrager, 2001). However, since the elements |U| and |ʔ| have nothing in common, the tendency of [l] to pattern with stops does not follow from an elemental representation.

CHAPTER 4

CONCLUSION

I have argued that the architecture of phonology is derivable from dependency relations and these are in turn derivable from the asymmetry principle. I have placed place properties within the phonological head, manner properties within the projection of that head, and laryngeal properties, as well as nasality, as operations on existing configurations. I have argued that the asymmetry principle yields not only the system of phonology but what I think of as the core of syntax, argument structure, as well. Deriving both phonological and syntactic dependencies from a common principle is an entirely different proposition than trying to base a model of phonology on a syntactic one. I asked and tried to answer meta-theoretical questions such as: i) Why should there be a head, spec and comp? ii) Why are passivisation and fricativisation so common, but not deobjectives and lenition to nasal stops? iii) Why is there a complexity limit on the argument structure of verbs and the size of consonants and vowels? I derived the first two properties of the system from the asymmetry principle: Two positions can merge at a time, but no two can be of equal strength. Hence there must be an asymmetry between a head and a dependent, as well as between the dependents. Neither can they be equally strong in their relation to the head, therefore the further position spec is lost more easily than the closer comp. As for (iii), I linked the limit on the number dependencies in the argument structure, as well as in a consonant or vowel, to the capacity of the human mind to subitise four objects at most.

The advantage of this theory is not that it is minimal. The advantage is that representing primes as configurations makes it possible to a) find correlations between the same kind of configuration at different levels of complexity, eg: the correlation between manner, place and laryngeal properties, as discussed in 3.2, 3.7 and 3.8. b) link these configurations to one another using the available positions in them, eg: possible domination relations as discussed in 3.3, 3.4 and 3.5 This means making testable predictions on the correlations and interaction of phonological primes. The model, in this regard, is surprisingly accurate. At this point I do not know why the model should fit in seamlessly with the set-up of the vocal tract, since it is not based on the properties of the vocal tract but the behaviour of phonological objects. Interestingly, the model achieves this close-fit where existing models, which use phonetically motivated primes, do not (cf. Ohala 2005).

REFERENCES

Arvaniti, A. (2007). Greek phonetics: The state of the art. *Journal of Greek linguistics*, *8*(1), 97-208.

Backley, P. (2012). Variation in element theory. *Linguistic Variation*, *12*(1), 57-102.

Backley, P. (2011). *An Introduction to element theory*. Edinburgh, UK: Edinburgh University Press.

Balcı, E. (2006). *A government phonology analysis of Turkish consonants*. PhD thesis, Boğaziçi University.

Berrey, L. (1940). Southern mountain dialect. *American Speech*, *15*(1), 45-54.

Bellem, A. (2007). *Towards a comparative typology of emphatics*. PhD thesis, University of London.

Bjorndahl, C. (2015). The phonetics and phonology of segment classification: A case study of /v/. In E. Raimy & E. Cairns (Eds): *The Segment in Phonetics and Phonology*, 236-251. Oxford, UK: Wiley-Blackwell.

Booij, G. (1999). *The phonology of Dutch (Vol. 5).* Oxford, UK: Oxford University Press.

Botma, E.D. (2004). *Phonological aspects of nasality: An element-based dependency approach.* Utrecht, Netherlands: 'Landelijke Onderzoekschool Taalwetenschap.

Botma, B., Kula, N. & Nasukawa, K. (2010). Features. In Botma, B., Kula, N., & Nasukawa, K. (Eds): *Bloomsbury companion to phonology, (pp. 33-63).* New York, NY: Bloomsbury.

Broadbent, J. (1991). Linking and intrusive r in English. *Working Papers in Linguistics* 3, 281-301. London, UK: University College London.

Charette, M. (1990). Licence to govern. *Phonology*, *7*(1), 233-253.

Cho, Y.M. (1990). A typology of voicing assimilation. In *Proceedings of the Ninth West Coast Conference on Formal Linguistics 141*, 155-171.

Clements, G. N. (1985). The geometry of phonological features. *Phonology Yearbook* 2, 225-252.

Clements, G. N. (1987). Phonological feature representation and the description of intrusive stops. In A. Bosch, B. Need & E. Schiller (Eds.): *Papers from the 23rd regional meeting of the Chicago Linguistic Society, part 2: Parasession on autosegmental and metrical phonology*, (pp. 29-50). Chicago, IL: Chicago Linguistic Society.

Demuth, K. & Kehoe, M. (2006). The acquisition of word-final clusters in French. *Catalan Journal of Linguistics, 5*(1), 59-81.

Di Sciullo, A. M. (2005). Decomposing compounds. *SKASE Journal of Theoretical Linguistics, 2*(3), 14-33.

Dresher, B. E., & van der Hulst, H. (1998). Head–dependent asymmetries in phonology: Complexity and visibility. *Phonology*, *15*(3), 317-352.

Fox, A. (2005). *The structure of German*. Oxford, UK: Oxford University Press.

Fudge, E. C. (1969): Syllables. *Journal of Linguistics*, *5*(1), 253–286.

Gamkrelidze, T. V. (1975). On the correlation of stops and fricatives in a phonological system. *Lingua*, *35*(3-4), 231-261.

Göksel, A. & Kerslake, C. (2004). *Turkish: A comprehensive grammar.* London, UK: Routledge.

Hammarberg, R. (1976). The metaphysics of coarticulation. *Journal of Phonetics*, *4*(1), 53–363

Harris, J. (1994). *English sound structure*. Oxford, UK: Blackwell.

Harris, J. (1996). Phonological output is redundancy-free and fully interpretable. In J. Durand & B. Laks (Eds.): *Current Trends in Phonology: Models and Methods,* (pp. 305–332). Manchester, UK: European Studies Research Institute.

Harris, J. (1997). Licensing inheritance: An integrated theory of neutralisation. *Phonology 14*(1), 315–370.

Harris, J. (2006). The phonology of being understood: Further arguments against sonority. *Lingua, 116*(10), 1483-1494.

Harris, J. and Gussman, E. (1998). Final codas: Why the west was wrong. Structure and interpretation. In E. Cryran (Ed.): *Studies in Phonology*. Lublin, Poland: Folium.

Harris, J. and Lindsey, G. (1995). In J. Durand & F. Katamba (Eds.): *The elements of phonological representation. Frontiers of Phonology,* (pp. 34-79). Harlow, Essex: Longman.

Hamann, S. (2003). *The phonetics and phonology of retroflexes*. PhD thesis, Netherlands Graduate School of Linguistics.

Holmes, P. and Hinchliffe, I. (2003). *Swedish: A comprehensive grammar.* London, UK: Routledge.

Huber, D. (2003). Velars and empty-headedness in Government Phonology. *Rivista di Grammatica Generativa*, *28*(1), 45-56.

Jakobson, R., Fant, G., Halle, M. (1952). *Preliminaries to speech analysis: The distinctive features and their correlates.* Cambridge, MA.: MIT Press.

Jensen, S. (1994). Is ʔ an element? Towards a non-segmental phonology. *SOAS Working Papers in Linguistics & Phonetics*. *4*(1), 71-78.

Kaufman, E.L., Lord, M.W., Reese, T.W., & Volkmann, J. (1949). The discrimination of visual number. *The American Journal of Psychology*. *62*(4), 498–525.

Kaye, J, Lowenstamm, J. & Vergnaud, J. R. (1990). Constituent structure and government in phonology. *Phonology Yearbook*, *7*(1), 193-231.

Kaye, J., Lowenstamm, J. & Vergnaud, J. R. (1985). The internal structure of phonological elements: A theory of charm and government. *Phonology Yearbook* 2, 305-328.

Kayne, R. S. (1994). The antisymmetry of syntax. *Linguistic Inquiry Monograph Twenty-Five*. Boston, MA: MIT Press.

Kehrein, W. (2002). *Phonological representation and phonetic phasing: affricates and laryngeals, (Vol. 466).* Berlin, Boston: De Gruyter.

Kehrein, W., & Golston, C. (2004). A prosodic theory of laryngeal contrasts. *Phonology*, *21*(3), 325-357.

Kramer, M. (2009). *The phonology of Italian*. Oxford, UK: Oxford University Press.

Kristoffersen, G. (2000). *The phonology of Norwegian*. Oxford, UK: Oxford University.

Lindau, M. & Ladefoged, P. (1986). Variability of feature specifications. In In J. S. Perkell and D. H. Klatt (Eds.): *Invariance and variability in speech processes*, (pp. 464-467). London, UK: Psychology Press.

Maddieson, I. & Precoda, K. UCLA phonological segment inventory database (UPSID), http://web.phonetik.uni-frankfurt.de/upsid.html, retrieved March, 2016.

Morphy, F. (1983). Djapu, a Yolngu dialect. In R. Dixon & B. Blake (Eds.): *Handbook of Australian languages*, (pp. 1-188). Canberra, Australia: Australian National University Press.

Ohala, J.J. (1997). Emergent stops. *Proceedings of the 4th Seoul International Conference on Linguistics, [SICOL] 11-15 Aug 1997. 4*(1), 84-91.

Ohala, J.J. (2005). Phonetic explanations for sound patterns. In W. J. Hardcastle & J. M. Beck (Eds.): *A figure of speech: A festschrift for John Laver*, (pp. 23-38). London, UK: Erlbaum.

Ohala , J. J., Solé, M.J. & Ying, G. (1998). The controversy of nasalized fricatives. *Proceedings of the 135th Meeting of the ICA/Acoustical Society of America*, *13*(1), 2921-2922.

Operstein, N. (2010). *Consonant structure and prevocalization*. Amsterdam, Netherlands: John Benjamins.

Padgett, J. E. (2002). Russian voicing assimilation, final devoicing, and the problem of [v]. *Natural language and linguistic theory. 17*, 267-302.

Padgett, J. E. (1991). *Stricture in feature geometry*. PhD thesis, Umass Amherst.

Picard, M. (1994). *Principles and methods in historical phonology: From Proto-Algonkian to Arapaho.* Montreal, Canada: McGill-Queen's Press.

Pöchtrager, M. A. (2001). *Finnish consonant gradation.* MA thesis, University of Vienna.

Pöchtrager, M. A. (2006). *The structure of length*. PhD thesis, University of Vienna.

Pöchtrager, M. A. (2012, April). *Till death do us part: What keeps clusters together?.* Paper presented at the SOAS Linguistics Department Seminar, SOAS, London.

Pöchtrager, M. A. (2015, May). *Vowel reduction: Sawing off the branch you're sitting on.* Paper presented at the 23rd Manchester Phonology Meeting, University of Manchester, Manchester.

Prince, A. S. (1984). Phonology with tiers. In M. Aronoff & R. T. Oehrle (Eds): *Language sound structure: Studies in phonology presented to Morris Halle by his teacher and students,* (pp. 234–244). MIT Press, Cambridge MA & London

Recasens, D. (2011). Articulatory constraints on stop insertion and elision in consonant clusters. *Linguistics, 49*(5), 1137-1162.

Rochemont, M. and Culicover, P.W. (1997). Deriving dependent right adjuncts in English. In D. Beermann, D. LeBlanc, & H. van Riemsdijk: *Rightward movement,* (pp. 279-300). Amsterdam, Netherlands: John Benjamins.

Saltzman, I.J., & Garner, W.R. (1948). Reaction time as a measure of span of attention. *The Journal of Psychology. 25*(2), 227–241.

Schadler, D. (2006). Morphonotaktik im Schwedischen. *Wiener Linguistische Gazette. 73*, 1-19.

Schane, S. A. (1984). The fundamentals of particle phonology. *Phonology Yearbook* 1, 129-155.

Schwartz, G. (2016). On the evolution of prosodic boundaries–parameter settings for Polish and English. *Lingua*, *171*, 37-73.

Sole, M. (2007). The stability of phonological features within and across segments: The effect of nasalization on frication. In P. Prieto, J. Mascaró , & M. J. Solé (Eds.): *Segmental and prosodic issues in Romance phonology*, (pp. 41-65). Amsterdam, Netherlands: John Benjamins.

Steriade, D. (1993). *Closure, release, and nasal contours*. San Diego, CA.: Academic Press.

Syrika, A., Nikolaidis, K., Edwards, J., & Beckman, M. (2007, August). Acquisition of consonant clusters by Greek-speaking children: The case of initial/s/-stop and stop-/s/sequences. Poster presented at the *8th ICGL Conference*, University of Ioannina, Ioannina, Greece.

Szigetvári, P. (1997). On affricates. In A. B. Farkas (Ed.): *Proceedings of the First Symposium of Doctoral Students in Linguistics.* Budapest: Akadémiai Kiadó.

Taylan, E. (2015). *The phonology and morphology of Turkish*. Istanbul, Turkey: Boğaziçi University Press.

Trick, L.M., & Pylyshyn, Z.W. (1994). Why are small and large numbers enumerated differently? A limited-capacity preattentive stage in vision. *Psychological Review*. *101*, 80–102.

van der Hulst, H.G. (2015). The opponent principle in RcvP: Binarity in a unary system. In E. Raimy & C. Cairns (Eds.): *The segment in phonetics and phonology*, (pp. 149-179). Oxford, UK: Wiley-Blackwell.

van de Weijer, J. (2014). Affricates in English as a natural class. In J. Caspers, Y. Chen, W. Heeren, J. Pacilly, N. O. Schiller, E. van Zaten (Eds.): *Above and beyond the segments: Experimental linguistics and phonetics,* (pp. 350-358). Amsterdam, Netherlands: John Benjamins.

Vaux, B. (1998). The laryngeal specifications of fricatives. *Linguistic Inquiry*, *29*(3), 497-511.

Vennemann, T. (2000). Triple-cluster reduction in Germanic: Etymology without sound laws? *Historische Sprachforschung / Historical Linguistics*, *113*(1/2), 239-258.

Warner, N. (2002). The phonology of epenthetic stops: Implications for the phonetics-phonology interface in optimality theory. *Linguistics*, *40*(377), 1-28.