

# From Binary Features to Elements: The Case of Scandinavian

Ali Tifrit, Laurence Voeltzel  
*LLing EA3827, University of Nantes (France)\**

## Abstract

In this paper, we show how the *Contrastivist Hypothesis* (Hall 2007, Drescher 2008) can be amended using Element Theory (KLV 1988; Angoujard 1997; Scheer 1999; Backley 2011) and Government Phonology (KLV 1990; Lowenstamm 1996; Scheer 2004). Given the richness of the phenomenology of Nordic languages, this family constitutes our testing ground. While one might expect five different hierarchies, given that Scandinavian languages are distinct languages, what we actually find is one unique hierarchy where the same features are used in the same order. However, if we want a full understanding of the Nordic phenomenology and if we maintain the hierarchy exactly as it is, two difficulties appear: the first one involves motivation, the second one naturalness. In order to overcome the two kinds of difficulties mentioned above, we aim to develop a representation of the obstruent inventory based on unary primes using Element Theory and Government Phonology. The results we get from this hierarchy cannot be considered independently from the syllabic structure. Therefore, we propose a rereading of the phenomenology of Nordic that connects the new elementary representations that we posit to the syllabic constraints. As a consequence, we explore new hypotheses concerning the phonological activity in Scandinavian languages.

## 1. Introduction

*Contrastive Hierarchy* (Drescher 2009) is a way to organize the binary features used to qualify a given phonemic system. The structure we obtain is made up of what can be seen as contrastive features (i.e., playing an active role in the phonology of a given language, cf. *Contrastivist Hypothesis* (Hall 2007)). Even if this method offers a reliable way to access the phonologically active content of segments (thereby allowing us to identify the mechanisms affecting them), we want to show that it becomes problematic when dealing with phenomena whose causes lie beyond the segmental level.

The aim of this paper is to show how this framework can be amended using *Element Theory* (KLV 1988, Angoujard 1997, Scheer 1999, Backley 2011) and *Government Phonology* (KLV 1990, Lowenstamm 1996, Scheer 2004, Pöchtrager 2006, Jensen 1994, Pöchtrager & Živanović 2010). Given the richness of the phenomenology of Nordic languages, this family constitutes our testing ground. We explore here three phenomena, namely spirantization, voicing and preaspiration and see how the contrastivist approach can be helpful for their analysis.

Because it neglects the syllabic level, the contrastivist approach misses strong generalizations concerning the naturalness of these phenomena. While maintaining the contrast at the center of our approach, we aim to show that the unarist framework is, able to cover the results obtained with the contrastivist method, but also to surpass the aporetic use of binary features.

---

\* We are very thankful to Jean-Pierre Angoujard, Catherine Colin, Orin Percus and all the members of the P3 seminar (held at the LLing in the University of Nantes). We are also grateful to the organizers of the Features conference and to our two reviewers for the insightful comments on this paper. All remaining mistakes are ours.



This paper is organized as follows. In section 2, an overview of the systems and processes found in the Scandinavian family is presented. Concentrating on synchronic data, we show the similarities observed in the family. In section 3, we demonstrate how the members of this family unite under a single hierarchy and how it can be used to explain the processes. On the other hand, we also turn to a *critique* concerning the limits of the framework. In the last and the fourth section, we will introduce the hierarchical representation using privative elements and show how it enables to cover the processes and which predictions can be made about the Scandinavian family.

## **2. The Scandinavian linguistic family**

The languages under examination in this paper are standard Icelandic, Faroese, Danish, Swedish and Bokmål<sup>1</sup>.

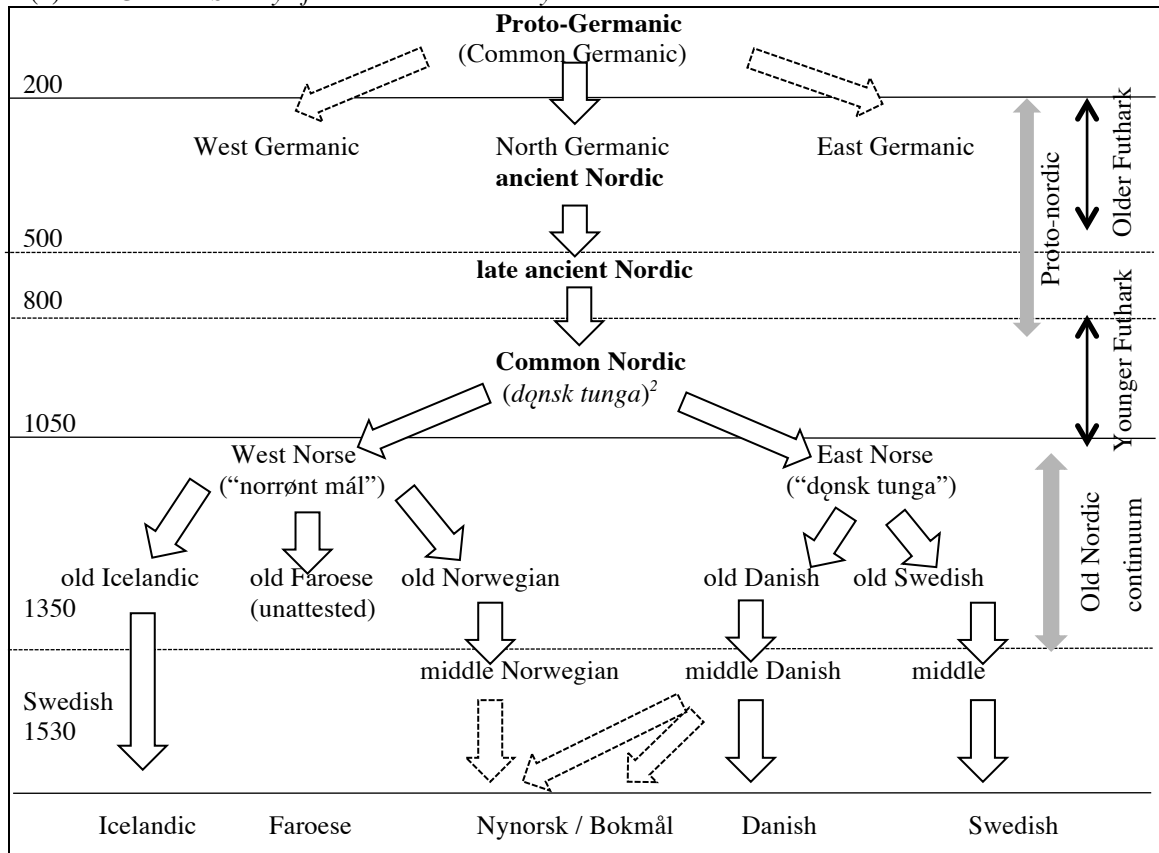
### *2.1. Genetic Typology*

We summarize in (1) the diachrony of the Scandinavian languages. There might be diverging views among the authors (Ottosson 2002, Birkmann 2002, Nielsen 2002, Schulte 2002a, 2002b) about the exact dates of the different linguistic stages, however it is possible to schematize the evolution as in (1).

---

<sup>1</sup>We chose the standardized spoken variety of Norwegian, Bokmål, or as Kristoffersen (2000:7) refers to it: 'Standard East Norwegian'. It is hardly possible to claim that anyone has Bokmål as their mother tongue. However, Norway has two official Norwegian languages and Bokmål represents the high variety: it is the most chosen language by administrations and news media and children learn it very early at school. For more information about the Norwegian linguistic policy, see Kristoffersen (2000).

(1) *General Survey of the Nordic Diachrony*



Modern Scandinavian languages evolved from *Proto-Nordic*, which corresponds to the Nordic branch of *Proto-Germanic*. Until the end of the Viking Age (1025-1050), Scandinavians were assumed to speak the same language, i.e. *Common Nordic*, despite few variations<sup>3</sup>. The discrepancy intensifies thereafter, dividing the linguistic area into two sub-groups: East and West. The continuum of all North Germanic languages spoken between 1100 and the middle of the 14<sup>th</sup> century is referred to as *Old Nordic* (sometimes *Old Norse*<sup>4</sup>). In concrete terms, the split between East and West is mainly reflected in the vowel system (for more details, see Ottosson 2002 and Birkmann 2002).

Regarding the consonants, three major changes occurred in the early Old Nordic period. They are summed up in (2).

- Western Nordic languages dropped initial /v/ in /vr/ clusters, while Eastern languages maintained it<sup>5</sup> (2a).

<sup>2</sup> *dǫnsk tunga* means literally "Danish tongue". This name was given afterwards by the medieval authors (Schulte 2002a:872f, Ottosson 2002:789) to qualify the language spoken on the whole Scandinavian territory between 800 and 1050 approx. Later on, a second name appears in the literature to qualify the language spoken in the western part of Scandinavian after the Viking Age: *norrønt mál*, "Norwegian tongue" (Ottosson 2002:790).

<sup>3</sup> For instance, the East Norse monophthongization, which can still be observed today ('stone': Icelandic *steinn*, Danish *sten*; Indefinite article 'a': Icelandic *einn*, Nynorsk *ein*, Danish *en*) and is assumed to have occurred between 900 and 1000 (Schulte 2002a:873).

<sup>4</sup> Haugen (according to Ottosson 2002:873) and Schulte (2002a) use the noun *Old Norse* to qualify *West Norse* only. However, it is possible to find this terminology as a synonym of *Old Nordic* (Ottosson 2002).

<sup>5</sup> Schulte (2002b:886), Ottosson (2002:791).

- Regressive assimilation in /nasal+C/ clusters<sup>6</sup> was more widely spread in the Western group (2b).
- In opposition to all other languages, Old Icelandic is the only one that kept all the initial /h/ before sonorants<sup>7</sup> (2c).

(2) *Eastern/Western split in Norse*

	East Norse	West Norse	
(a)	Old Sw. <i>vræper</i>	Old Ice. <i>reiðr</i>	<i>angry (wroth)</i>
	Old Sw. <i>vranger</i>	Old Ice. <i>rangr</i>	<i>false, incorrect (wrong)</i>
	Old Sw. <i>vræka</i>	Old Ice. <i>reka</i>	<i>avenge</i> <sub>INF.</sub>
	Old Sw. <i>vriþa</i>	Old Ice. <i>riða</i>	<i>twist</i>
(b)	Old Sw. <i>banker</i>	Old Ice. <i>bekkr</i>	<i>bench</i>
	Old Sw. <i>kliner</i>	Old Ice. <i>klettr</i>	<i>rock, crag</i>
	Old Sw. <i>svamper</i>	Old Ice. <i>svqppr</i>	<i>mushroom</i>
	Old Sw. <i>ænkia</i>	Old Ice. <i>ekkjia</i>	<i>widow</i>
	Old Sw. <i>branter</i>	Old Ice. <i>brattr</i>	<i>steep</i>
(c)	Old Norw. <i>níga</i>	Old Ice. <i>hníga</i>	<i>sink</i> <sub>INF.</sub>
	Old Norw. <i>laupa</i>	Old Ice. <i>hlaupa</i>	<i>run</i> <sub>INF.</sub>
	Old Norw. <i>rósa</i>	Old Ice. <i>hrósa</i>	<i>praise</i>

2.2. *The synchronic data*

In this section, we focus on the synchrony of the modern Scandinavian languages. First, we describe the systems used in those languages and then give the main processes that affect the consonants.

2.2.1. *The systems*

As mentioned in the previous section and as illustrated in (2), consonants show more stability than vowels during the split between East and West. As a consequence, Scandinavian consonantal systems are still very similar, as shown in (3):

(3) *Consonants inventory of Nordic languages*

	labial		coronal		palatal	dorsal		glottal
plosive	p	b	t	d		k	g	
nasal		m		n				
trill				r (Ice, Norw, Sw)				
fricative	f		s	ð (Ice)			ɣ (Dan)	h
approximant				ɹ (Far)	j			
lateral approximant			l					

The table in (3) highlights the fact that Icelandic, Faroese, Danish, Swedish and Norwegian share a vast majority of their consonants<sup>8</sup>. We pointed out the segments that are specific only to a part of the family: (i)

<sup>6</sup> Ibid.

<sup>7</sup> Ottosson (2002:791). Although it includes Norway, the initial /h/ loss is depicted as a typical Eastern process.

<sup>8</sup> For the sake of simplicity, the allophonic realizations and dialectal variations will not be discussed here. For more information about (dialectal) variations see Árnason (2011) and Rögnvaldsson (1990) for Icelandic, Árnason (2011) and Thráinsson et al. (2012) for Faroese, Riad (2014) for Swedish, Basbøll (2005) for Danish and Kristoffersen (2000) for Norwegian.

the voiced interdental fricative can be found in Danish and Icelandic, but its status within each language is different. In Danish, it is an allophone of the dental stop /d/ whereas, in Icelandic, it has a phonemic status and has two phonetic realizations: voiceless [θ] and voiced [ð], (ii) the [-lateral] liquids in the family and inside each language display a large amount of variation. We have selected, in table (3), the most broadly used version. Note that speakers may produce different forms.

2.2.2. *The processes*

We now turn to some active phenomena in the Scandinavian languages. We describe them as they are given in the classical literature (Kristoffersen 2000, Andersson 2002, Barnes and Weyhe 2002, Basbøll 2005, Árnason 2011). We do not present all the processes affecting the Nordic consonants and focus on three major ones: preaspiration, spirantization/occlusivization and voicing, which will be the most relevant for our present discussion.

a. *Preaspiration*

The most intriguing phenomena in the phonology of Nordic languages is probably the Icelandic preaspiration. Underlying voiceless stops geminate are pronounced short and preceded by a glottal fricative (see (4a) below). /voiceless stop+sonorant/ clusters are also affected: they are preceded by a glottal fricative (see (4b) below). Preaspiration is also to be found in Faroese, although it is not as broadly described as the Icelandic one<sup>9</sup>. Faroese voiceless stops and /stop+sonorant/ clusters undergo preaspiration in the same contexts as in Icelandic (see (5a-b) below).

(4) *Preaspiration in Icelandic*

a.	/hne <b>ppa</b> /	[ŋe <b>h</b> pa]	<i>button</i> <sub>INF.</sub>
	/de <b>kk</b> /	[te <b>h</b> k]	<i>tyre</i>
	/nau <b>tt</b> /	[nau <b>h</b> t]	<i>night</i>
b.	/opp <b>na</b> /	[o <b>h</b> pna]	<i>open</i> <sub>INF.</sub>
	/e <b>ppi</b> li/	[e <b>h</b> pli]	<i>apple</i>
	/vatt <b>n</b> /	[va <b>h</b> tn]	<i>water</i>
	/a <b>itt</b> la/	[a <b>h</b> itla]	<i>intend</i> <sub>INF.</sub>
	/sa <b>kk</b> na/	[sa <b>h</b> kna]	<i>miss</i> <sub>INF.</sub>
	/e <b>kk</b> la/	[e <b>h</b> kla]	<i>scarcity</i>

(5) *Preaspiration in Faroese*

a.	/kn <b>app</b> u/	[kna <sup>h</sup> <b>pp</b> u]	<i>up</i>
	/ta <b>kk</b> a/	[ta <sup>h</sup> <b>kk</b> a]	<i>thank</i> <sub>INF.</sub>
	/no <b>tt</b> /	[no <sup>h</sup> <b>tt</b> ]	<i>night</i>

<sup>9</sup> Barnes and Weyhe (2002:194f) mention preaspiration in their chapter, but it does not appear in their transcriptions. Lockwood (1964:7f) also mentions without transcribing it, but minimizes it in saying that "In any case, this preaspiration is no more significant than the aspiration heard after Faroese k, p, t in some positions, i.e. [k<sup>h</sup>, p<sup>h</sup>, t<sup>h</sup>], as also in English". Some authors such as Braunmüller (2007:296) distinguish between Icelandic preaspiration which blocks length and Faroese preaspiration which does not: according to him, Lockwood (1964:7) and Árnason (2011:228), we thus obtain [<sup>h</sup>p:, <sup>h</sup>t:, <sup>h</sup>k:]. As reflected in the transcriptions they give, while the glottal fricative is considered as a full-fledged segment in Icelandic, in Faroese, it just appears as a reflex on the stop. Thereby, it does not occupy a slot in the skeletal tier, which could explain why it does not prevent stops from being long.

b.	/vattn/	[va <sup>h</sup> t̪n]	<i>water</i>
	/sokknir/	[sɔ <sup>h</sup> knɪɹ]	<i>miss</i> INF.
	/tvattla/	[tva <sup>h</sup> t̪la]	<i>intend</i> INF.
	/fattla/	[fa <sup>h</sup> t̪la]	<i>put in a sling</i> INF.

As shown in (6) and (7), preaspiration is not active in Swedish and Bokmål (Kristoffersen 2000, Riad 2014). It is not active in Danish neither, but Danish stop geminates will be discussed more precisely in section 3.3.1.

(6) *Absence of preaspiration in Swedish*

a.	/lɔppa/	[lɔppa]	<i>flea</i>
	/lɔkk/	[lɔkk]	<i>lid</i>
	/pɔtta/	[pɔtta]	<i>potty</i>
b.	/stappla/	[stappla]	<i>stagger</i> INF.
	/vittna/	[vittna]	<i>testify</i> INF.
	/trokkla/	[trokkla]	<i>baste</i> INF.

(7) *Absence of preaspiration in Bokmål*

(a)	/sʊppə/	[sʊppə]	<i>soup</i>
	/sikkrə/	[sikkrə]	<i>sure</i>
	/fettər/	[fettər]	<i>cousin (male)</i>
(b)	/oppn/	[o:p̪n]	<i>open</i> IMP. SG.

b. *Spirantization/occlusivization*

Icelandic voiceless obstruents are subjected to two kinds of changes (Rögnvaldsson 1990, Árnason 2011):

- (i) Spirantization: voiceless stops /p, t, k/ weaken to [f, s, x] when they precede a coronal obstruent (see (8a')).
- (ii) Occlusivization: the voiceless labial fricative /f/ gains strength and surfaces as [p] when it precedes a sonorant (see (8b')).

(8) *Spirantization and occlusivization in Icelandic*

(a)	/skɪp/	[sɔɪp]	<i>ship</i> NOM.	(a')	/skɪp-s/	[sɔɪfs]	<i>ship</i> GEN.
	/bɑut-yr/	[pɑutɪr]	<i>boat</i> NOM.		/bɑut-s/	[pɑus:]	<i>boat</i> GEN.
	/θak/	[θa:k]	<i>roof</i> NOM.		/θak-s/	[θaxs]	<i>roof</i> GEN.
	/taɪp-yr/	[t <sup>h</sup> ɑɪpɪr]	<i>risky</i> MASC.		/taɪp-t/	[t <sup>h</sup> ɑɪft]	<i>risky</i> NEUT.
	/rik/	[ri:k <sup>h</sup> ]	<i>rich</i> FEM.		/rik-t/	[rixt]	<i>rich</i> NEUT.
	/veik-yr/	[vei:kɪr]	<i>weak</i> MASC.		/veik-t/	[veixt]	<i>weak</i> NEUT.
	/ak-a/	[a:ka]	<i>drive</i> INF.		/ak-tɪ/	[axtɪ]	<i>drive</i> IMP. 2PS
	/aɪp-a/	[ɑɪ:pa]	<i>scream</i> INF.		/aɪp-tɪ/	[ɑɪftɪ]	<i>scream</i> PRET. 3PS
	/hlœy:p-a/	[lœy:pa]	<i>run</i> INF.		/lœy:p-tɪ/	[lœyftɪ]	<i>run</i> PRET. 2PS

(b)	/graf-a/	[kra:vɑ]	<i>burry</i> <sub>INF.</sub>	(b')	/graf-nar/	[grɑpnɑr]	<i>burry</i> <sub>PAST PART.</sub>
	/hef-il/	[he:vɪl]	<i>have</i> <sub>INF.</sub>		/hef-lar/	[heplɑr]	<i>grader</i> <sub>PL.</sub>
	/svaifill/	[svai:vɪtʃ]	<i>pillow</i> <sub>NOM.</sub>		/svaif-li/	[svaipli]	<i>pillow</i> <sub>DAT.</sub>

Besides, Icelandic /g/ has five different realizations and four of them are considered as spirantizations (vocalization included) (Rögnvaldsson 1990, Árnason 2011):

- It surfaces as a velar stop word-initially before non-front vowels, word-finally after a consonant or anywhere after a sonorant (see (9a) below).
- Word-initially before unrounded front vowels or palatal glide /j/, a dorso-palatal fricative allophone [ç] surfaces (see (9b) below)
- When it precedes a palatal segment (vowel or glide), /g/ is realized as [j] (see (9c)).
- If it precedes a voiced consonant or intervocalically, it spirantizes as a velar voiced fricative [ɣ] (see (9d)).
- Finally, before a voiceless consonant, it surfaces as a velar voiceless fricative [x] (see (9e)).

Faroese /g/ has a similar behavior and can be realized as a fricative or a glide according to the context (Adams & Petersen 2014):

- Word-initially, before a consonant and before non-front vowels, it surfaces as a voiced velar stop [g] (see (10a) below).
- Before a front vowel, it is realized as the voiced dorso-palatal affricate [tʃ] (see (10b) below).
- After a front vowel or before [i], it is pronounced [j] (see (10c)).
- After rounded velar vowels, it's realized as a labial glide [w] (see (10d)).
- Before the non-round high vowel [u], a labio-dental fricative surfaces (see (10e)).

(9)	/g/ in Icelandic			(10)	/g/ in Faroese		
(a)	/gʏll/	[kʏtl]	<i>gold</i>	(a)	/gonga/	[kɔŋka]	<i>walking</i>
	/θaung/	[θauŋk]	<i>seaweed</i>		/gɔima/	[kɔi:ma]	<i>save</i> <sub>INF.</sub>
	/sɪgla/	[sɪkla]	<i>sail</i> <sub>INF.</sub>		/nœgduɪ/	[nœktuɪ]	<i>satisfied</i> <sub>MASC.</sub>
(b)	/gefa/	[çe:va]	<i>give</i> <sub>INF.</sub>	(b)	/griftur/	[çɪftuɪ]	<i>married</i> <sub>MASC.</sub>
	/gella/	[çella]	<i>gill (of fish)</i>		/geva/	[çe:va]	<i>give</i> <sub>INF.</sub>
	/gilla/	[çɪtla]	<i>make golden</i> <sub>INF.</sub>		/beginna/	[beçɪn:a]	<i>path</i> <sub>DAT.</sub>
(c)	/degi/	[teɪjɪ]	<i>day</i> <sub>DAT. SG.</sub>	(c)	/spegil/	[spe:çɪl]	<i>mirror</i>
	/magi/	[maɪjɪ]	<i>stomach</i> <sub>NOM. SG.</sub>		/øgin/	[lø:çɪn]	<i>weird</i>
	/þeigym/	[þeɪjɪm]	<i>be silent</i> <sub>INF.</sub>		/aiga/	[ai:çja]	<i>own</i> <sub>INF.</sub>
(d)	/saga/	[sa:çja]	<i>story</i> <sub>NOM.</sub>	(d)	/tjúgu/	[tʃœu:wu]	<i>twenty</i>
	/lag/	[la:ç]	<i>law</i>		/lœugin/	[lœu:wɪn]	<i>law</i> <sub>DEF.</sub>
	/sagði/	[saçðɪ]	<i>say</i> <sub>PRET.</sub>		/mægu/	[mœu:wu]	<i>must</i> <sub>PRES. 1,2,3 PL.</sub>
(e)	/sagt/	[saxt]	<i>say</i> <sub>PAST PART.</sub>	(e)	/løgur/	[lø:vur]	<i>low</i> <sub>MASC.</sub>
	/dag/	[ta:x]	<i>day</i> <sub>ACC.</sub>		/høgur/	[hø:vur]	<i>high</i>
	/lags/	[laxs]	<i>tune</i> <sub>GEN.</sub>		/degur/	[te:vur]	<i>day</i> <sub>NOM.</sub>

Danish stops /d, g/ are also affected by lenition. More precisely, /d/ spirantizes to [ð] and /g/ can have both semi-vocalic realizations [j, w]. This is illustrated in (11a) and (b) below.

The fricative /v/ can have the semi-vocalic realization [w]. This is illustrated in (11c). These lenifications always occur when the target is not syllable initial or stands before a schwa<sup>10</sup> (Basbøll 2005):

(11) *Lenition of /d, g, v/ in Danish*

(a)	/bad/	[pað]	<i>bath</i>	(b)	/bæga/	[pæ:jə]	<i>bake</i> <sub>INF.</sub>
	/bidə/	[pi:ðə]	<i>bite</i> <sub>INF.</sub>		/dka:ga/	[tka:w]	<i>draw</i> <sub>INF.</sub>
	/kɔdə/	[kɔ:ðə]	<i>make disorder</i> <sub>INF.</sub>		/la:ga/	[la:jə]	<i>play</i> <sub>INF.</sub>
	/væd/	[væ:ð]	<i>angry</i>		/lɔ:ga/	[lɔ:'w]	<i>promise</i> <sub>IMP. SG.</sub>
(c)	/av/	[av <sup>?</sup> ]	<i>breeding</i>				
	/hav/	[haw]	<i>sea</i>				
	/læv/	[læ:'w]	<i>law</i>				
	/sav/	[sav <sup>?</sup> n]	<i>loss</i>				

Swedish and Norwegian velar stops have a palatal realization when they precede front vowels: (see (12a) and (13a) below). Since the result is a fricative, it is also considered as an instance of lenition (Kristoffersen 2000, Riad 2014). Moreover, in Swedish, /g/ undergoes semi-vocalization after liquids (see (12)(b)).

(12) Swedish

(a)	/kikare/	[çi:kare]	<i>binoculars</i>	(b)	/bærg/	[bær:j]	<i>mountain</i>
	/køk/	[çøk]	<i>kitchen</i>		/ɛlg/	[ɛlj]	<i>moose</i>
	/gena/	[jɛ:na]	<i>take a short-cut</i> <sub>INF.</sub>		/galge/	[gal:jɛ]	<i>hanger</i>
	/gissa/	[jis:a]	<i>guess</i> <sub>INF.</sub>		/bærga/	[bær:ja]	<i>salvage</i> <sub>INF.</sub>

(13) Bokmål

/kino/	[çi:nu]	<i>cinema</i>
/kyssə/	[çys:ə]	<i>kiss</i> <sub>INF.</sub>
/gyldən/	[jul:n]	<i>golden</i> <sub>INF.</sub>
/gi/	[ji:]	<i>give</i> <sub>INF.</sub>

c. *Voicing*<sup>11</sup>

In Western Nordic (Icelandic and Faroese), voiceless stops are voiced intervocalically: this is illustrated in (14) and in (15). Voicing is not restricted to the Western languages since it could be found in Danish, when stops are not syllable-initial or before schwa (see (16) below). However, Swedish and Bokmål are not subject to voicing (see (17) and (18) below).

<sup>10</sup> According to Basbøll (2005:96), preceding a schwa is equivalent to be in coda: consonants behave the same way in those positions. "The main principle for an intervocalic consonant is that if followed by a full vowel, it is syllable-initial, phonologically speaking, if followed by a neutral vowel, it is syllable-final."

<sup>11</sup> Note that we use "voicing" to describe this phenomenon but it should be underlined that this is a case of neutralization of aspiration, as in most of Germanic languages (for a detailed analysis, see Iverson & Salmons (1995)). Hence the use of the feature [Spread Glottis] in this paper. Scandinavian languages oppose lenis to fortis consonants – we use /b, d, g/ in our phonological forms to represent lenis but these transcriptions do not imply that voicing is contrastive.



- (14) Icelandic  
 /ljɛku/ [ljɛgu] *play* <sub>PRET.</sub> /tapa/ [tapa] *lose* <sub>INF.</sub> /matur/ [madur] *food*
- (15) Faroese  
 /teaka/ [teaga] *take* <sub>INF.</sub> /drepa/ [dre:pa] *kill* <sub>INF.</sub> /sita/ [si:da] *sit* <sub>INF.</sub>
- (16) Danish  
 /hak/ [hag] *notch* /øp/ [øp] *up* /tæt/ [tʰæt] *tired*
- (17) Swedish  
 /sjuka/ [ʃu:ka] *ill* /skrapa/ [skra:pa] *scrape* <sub>INF.</sub> /besluta/ [beslu:ta] *decide*
- (18) Bokmål  
 /kakə/ [ka:kə] *cake* /apə/ [apə] *ape* /skytə/ [ʃy:tə] *shoot* <sub>INF.</sub>

### 3. Contrastive Hierarchy

Since they are sister languages, we do expect North Germanic languages to be similar. This is what the previous section puts forward: the genetic link remains visible today through the phonological activity. Indeed, Nordic languages have similar consonants and are affected by a limited set of mechanisms. The question that now arises is: although Nordic consonants look alike on the surface, are they similar segments? In other words, are they organized the same way in their respective system?

To answer this question, we need to observe the Nordic consonants, not on a phonetic level but from a functional point of view: this is namely what Contrastive Hierarchy (Dresher 2009, Hall 2007) allows us to do. In focusing on the phonological active material of segment, this approach offers the possibility to access the underlying mechanisms operating in the processes.

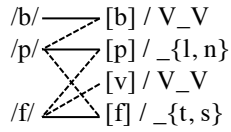
#### 3.1. The method

The main purpose of the Contrastive Hierarchy is to gain access to the phonologically active features of a system. It aims to represent systems as hierarchically organized, where segments do not bear redundant features (i.e. to be filled up by phonetic content) but only those which explain their commitment in processes. The method relies on the Successive Division Algorithm (developed first by Jakobson & Lotz (1949), Halle (1971)). Three steps are necessary to obtain a hierarchical structure that reveals contrastive features (Dresher 2009:25): first, consider all the segments as allophonic realizations of a single phoneme. Second, isolate at least one of the phonemes using a distinctive feature that distinguishes it/them from the rest of the inventory. The inventory is thus split in two: one part is [+F], while the rest is [-F]. Finally, repeat the second step in every subgroup until every segment is isolated from the others. At the end, every segment is specified and contrasts with the rest of the inventory.

The method is based on the functional part of the segments, rather than on their phonetic interpretation, its structure should reveal which phonemes interact within phonological processes. Indeed, phonemes interact in a given language because they behave the same way and thus share contrastive features.

To formalize the segmental interactions within the Scandinavian languages, we use Basbøll's (2005:103) representations, which he calls "integrated subsystems". This way to organize systems comes from the idea that segments that share the vast majority of their content form a subsystem within the global system. We give in (19) an example of an integrated subsystem – namely the Icelandic labials – which we developed using the descriptions of the phenomena as given in the preceding section (see 2.2.2.)

(19) *Integrated subsystem of labials in Icelandic*

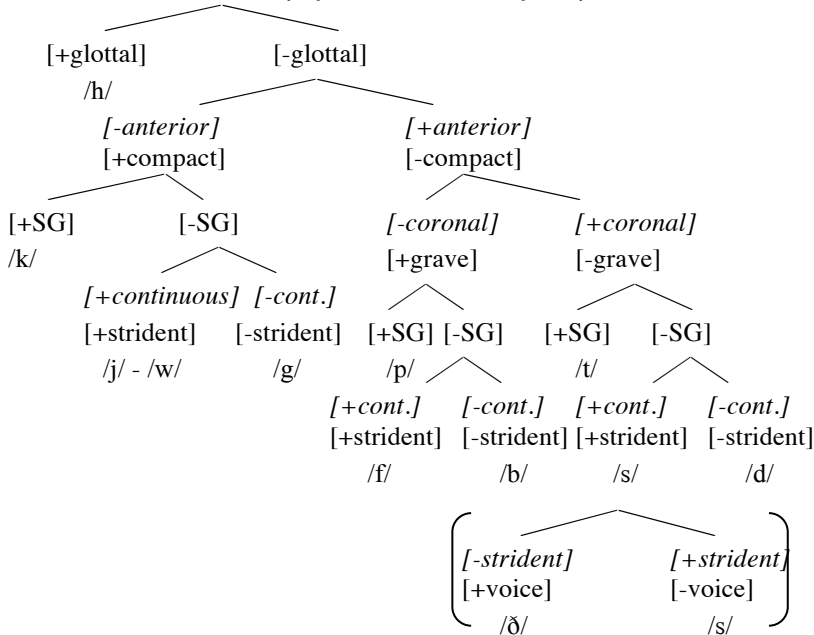


In (19) phonemes are connected to their 'expected' realization— i.e. to the realization they usually take — by full lines. If the line is dotted, then the phonetic interpretation at the other end is restricted to some specific contexts. For example, as shown in (19), /p/ is realized [p] most of the time, except when it appears intervocalically (where it is voiced to [b]), and before a coronal obstruent (where it weakens to [f]). In the same figure, we can see that /f/ is pronounced [f] in the absence of a specific context, but if it sits between two vowels, then it is voiced to [v], and before a sonorant, it strengthens to [p]. Labials are traditionally considered as a natural class, which is confirmed by the phonology of Icelandic: they share properties that make them interact.

After we proceeded exactly the same way for each subsystem in each North Germanic language, and thus obtain every possible subsystem, we obtain a general scheme of the hierarchies: segments that interact (i.e. that are part of a given subsystem) have to appear under the same branch and share as much specification as possible.

Although they seem very close to each other, Scandinavian languages are distinct languages — we expect then five different hierarchies, in order to illustrate each language. Those hierarchies should be very similar and reflect the previously mentioned genetic link; however, we show in (20) that all North Germanic languages can be illustrated with only one hierarchy. Of course, other orderings are possible but (20) is the most suitable to describe the five languages and the most apt to cover the phenomena discussed here.

(20) *Contrastive Hierarchy of the Scandinavian family*<sup>12</sup>



The same features are required to qualify the consonants of Icelandic, Faroese, Danish, Swedish and Bokmål. Not only the contrastive features are the same, but also the order in which we introduced them is identical. The very last contrast at the bottom of the structure in (20) is necessary for Icelandic only – since it counts an extra phoneme, /ð/, we use an extra contrast, [ $\pm$ voice], in order to distinguish /ð/ from /s/.

It is worth noting that, even though Icelandic hierarchy is not strictly identical to the other Nordic hierarchies, namely because of the presence of the [voice] contrast, they still share the biggest part of their structure. The upper part of the hierarchy that is common to all Nordic languages represents the *core structure* of the family (Compton and Dresher 2011). The contrasts that are specific to a language or to a part of the family are introduced in the lowest part of the structure, leaving intact the similarity of the family.

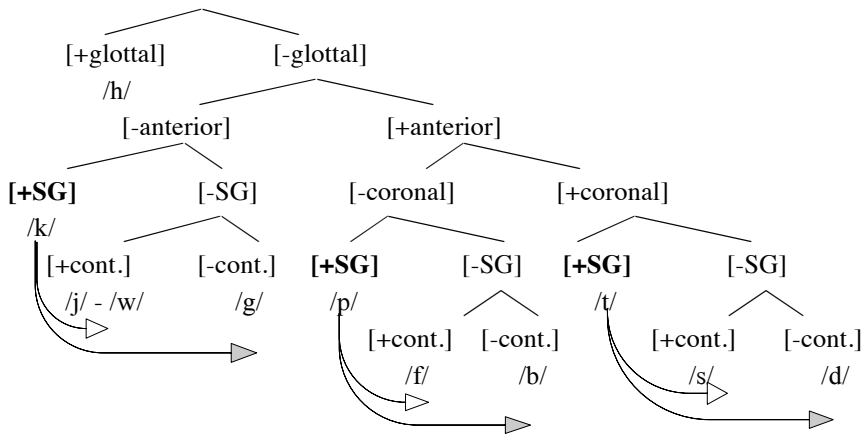
### 3.2. Explaining and unifying the processes within the family

In this subsection, we propose a new reading of the phenomenology in the light of the results we obtained with the Contrastive Hierarchy. We will show that it is possible to give a unified analysis of the phenomena observed in several languages although they are sometimes described as disparate in the literature.

In (21), the phenomena under investigation are represented with help of arrows in (21):

<sup>12</sup> This hierarchy includes both classical (articulatory – in italics) and Jakobsonian features (acoustical). The latter are by nature the closest to elemental representations in the sense of Harris (1994). The link between Jakobsonian and elementary representations will become clearer in section 4.1. where we introduce the advantages of privativity upon binarism.

(21) Unification of the processes across Nordic Languages



**Spirantization** of Icelandic voiceless stops is represented in (21) by the white arrows. It affects aspirated segments only (voiceless stops) and makes them lose aspiration and gain stridency (since [SG] is incompatible with continuousness in these languages). The place of articulation of the target does not intervene here, which means that the mechanism applies uniformly to the whole system. Affected segments go from [+SG] to [-SG, +strident].

The grey arrows in (21) represent the **voicing** phenomenon, which is to be found in Icelandic, Faroese and Danish. Once again, the place of articulation of the targets does not play any role in the triggering of the mechanism. Affected consonants lose aspiration but remain stops, that is, they become [-SG, -strident]. In other words, they become lenis stops, which happen to be interpreted as voiced segment in Germanic languages (Iverson and Salmons 1995). Just as spirantization, voicing applies the same way upon the whole system, as long as the targets is specified for [+SG].

The last phenomenon under investigation here is **preaspiration**. In a previous section (cf. 2.2.2.), we presented this phenomenon as affecting only underlying geminate voiceless stops, voiced geminates do not preaspirate (Árnason 2011, Thráinsson et al. 2012). In Icelandic, once preaspiration occurs, we obtain a simple stop preceded by an aspiration noise – we thus consider that the stop has only one slot to express and that the preceding slot, originally considered as the first part of the geminate, is finally occupied by /h/. Consequently, we analyse preaspiration as a degemination, as illustrated in (22) below:

(22) Preaspiration as a degemination



In (22a), the geminate is represented as two positions (a coda and an onset) sharing the same feature content ([x]). The figure in (22b) represents degemination, where each position is linked to a specific feature for melody. We thus obtain a stop in the coda and a stop in the onset. If we state that the feature content is the same, then the configuration is in violation with the *Obligatory Contour Principle* (Goldsmith 1990). The stop sitting in the coda, traditionally given as a weak position is the one undergoing a structural change – we postulate that the lenition of the first stop ‘deletes’ all its content, exception made of the glottal dimension. Consequently, the glottal fricative causing the pre-aspiration is in fact a voiceless stop that has lost the major part of its content. In the hierarchy, the mechanism can be illustrated by a *pruning* operation right under the first node describing a place or manner of articulation: the [±anterior] node. Here as well, only [+SG] segments are affected, but, by contrast to spirantization

and voicing, preaspiration leads to a unique result: the glottal fricative /h/, no matter what the target is. We illustrate this analysis in (23):

(23) *Degemination and weakening of the coda*



(22) and (23) imply that both part of geminates can be treated independently – this can be viewed as a violation of the so-called *inalterability*. As discussed in Hayes (1986), inalterability is not an intrinsic property of geminates, however they *sometimes* exhibit resistance to some rules that should apply to these consonants if they were single. The whole point is then to propose a notational system that shows, in the formulation of the rule, if it is going to affect single consonants only, or geminates, or both equally. Phenomena that can affect only one part of a geminate are not excluded by Hayes (1986:347); indeed, degemination is a documented fact across languages and ‘Icelandic Pre-aspiration, which converts /pp tt kk/ to /hp ht hk/, but leaves non-identical stop sequences alone’ is one of them.

In the section where preaspiration is treated (see 2.2.2.), we also mentioned that the phenomenon targets /stop+sonorant/. The data illustrating this are repeated in (24) and in (25):

(24) *Preaspiration of clusters in Icelandic*

/hne <b>pp</b> a/	[ <b>h</b> ɛ <b>h</b> pa]	<i>button</i> <sub>INF.</sub>	/o <b>pp</b> na/	[o <b>h</b> pn̥a]	<i>open</i> <sub>INF.</sub>
/de <b>kk</b> /	[tɛ <b>h</b> k]	<i>tyre</i>	/va <b>tt</b> n/	[va <b>h</b> t̥n̥]	<i>water</i>
/na <b>tt</b> /	[na <b>h</b> t]	<i>night</i>	/sa <b>kk</b> na/	[sa <b>h</b> k̥na]	<i>miss</i> <sub>INF.</sub>

(25) *Preaspiration of clusters in Faroese*

/kn <b>app</b> u/	[kna <sup>h</sup> <b>pp</b> u]	<i>up</i>	/va <b>tt</b> n/	[va <sup>h</sup> <b>t̥</b> n̥]	<i>water</i>
/ta <b>kk</b> a/	[ta <sup>h</sup> <b>k</b> ka]	<i>thank</i> <sub>INF.</sub>	/so <b>kk</b> nir/	[sɔ <sup>h</sup> <b>k</b> n̥ɪr]	<i>miss</i> <sub>INF.</sub>
/no <b>tt</b> /	[no <sup>h</sup> <b>t</b> t]	<i>night</i>	/tv <b>att</b> la/	[tvat̥la]	<i>intend</i> <sub>INF.</sub>

We postulate that the underlying forms of those clusters contain geminates. Such an analysis was already proposed by Thráinsson (1978, according to (Árnason 2011)). Indeed, without underlying gemination, we cannot explain why /stop+sonorant/ clusters are affected. This proposal is echoed in the synchrony and the diachrony of Germanic languages: the same words do contain or have contained geminate voiceless stops in (close) related languages. In (26) we give the words *apple* and *water* in various Germanic languages. The reader will note that, the German word *Apfel* does contain an affricate, which is to consider as a single consonant and which reveals a former long voiceless labial stop, before the *High German consonant shift* occurred (Conzelmann 2008):

(26) *Comparison of the words apple and water in various Germanic languages*

Icelandic: /eppli/ [ɛhpli] <i>apple</i>	Icelandic: /vattn/ [vahtn] <i>water</i>
Swedish: <i>äpple</i>	Swedish: <i>vatten</i>
English: <i>apple</i>	Old high German: <i>wazzar</i>
German: <i>Apfel</i>	

Moreover, we would like to point out the fact that it is not possible to meet preaspirated stops where geminates are forbidden (word-initially) – this constitutes our second argument for underlying gemination.

Consequently, the same analysis as the one given in (23) holds for this case of preaspiration too: underlying geminates undergo degemination before the stop in coda loses most of its content and is reduced to the extent of only bearing the [+glottal] feature. We give in (27) the illustration of

preaspiration of /stop+sonorant/ clusters, which is the same as the one given in (23), but with an extra consonant following the geminate:

(27) *Preaspiration in /stop+sonorant+clusters*



We previously showed that spirantization, voicing and preaspiration are mechanisms that target [+SG] segments and that apply regularly to the whole hierarchy. These mechanisms are summarized in (28a):

- (28) (a) spirantization: [(-glottal, ±anterior, ±coronal), +SG, -cont.] → [(...), +cont.]  
 voicing: [(-glottal, ±anterior, ±coronal), +SG] → [(...), -SG, -cont.]  
 preaspiration: [(-glottal, ±anterior, ±coronal), +SG] → [+glottal]  
 (b) occlusivization: [-glottal, -anterior, +coronal, -SG, +cont.] → [..., +SG]  
 /g/ vocalization: [-glottal, +anterior, -SG, -cont.] → [..., +cont.]

The mechanisms described in (28b) could not be generalized, for they only apply to a specific part of the hierarchy. For example, *occlusivization* (presented in (8) in section 2.2.2.), which can be considered as the mirror image of spirantization, affects /f/ only. It means that /p, t, k/ can weaken to [f, s, x] but only /f/ can strengthen to [p]. Occlusivization passes by the swap from a negative to a positive one for the feature [SG] – since Spread Glottis only applies to stops, /f/ automatically surfaces as a stop.

We described *semi-vocalization* of /g/ as active in Icelandic, Faroese, Swedish, Bokmål and Danish: in those languages /g/ can be pronounced [j] or [w] depending on the context (see section 2.2.2.). The other lenis stops of the languages concerned with vocalization, /b, d/, do not exhibit a similar behavior. Thus this leads us to the conclusion that the mechanism at play behind this phenomenon seeks [-anterior, -SG, -continuous] segments exclusively, that is the velar lenis stop.

The illustrations of the phenomena we made with help of the Contrastive Hierarchy allow us to draw a parallel between spirantization and vocalization: in both cases, targets go from [±SG, -strident] to [-SG, +strident], i.e. stops are realized as fricatives. This transition is traditionally used as an illustration of the lenition mechanism (Lass 1984, Anderson and Ewen 1987, Carvalho et al. 2008). Consequently, semi-vocalization and spirantization finally respond to the same unique major change (lenition) and work exactly the same way, which is summed up in (29):

(29) [±SG, -strident] → [-SG, +strident]

In this section, we put forward the fact that Nordic consonants have the same phonological active content – it also means that they should behave the same way and undergo the same changes. This argument holds for some phenomena: /g/ is sensitive to vocalization in all the North Germanic languages and voicing is present in three of the five languages discussed here. On the other hand, we also find processes that are restricted to a single language or to some of them. For example, preaspiration is active in Western Nordic only, we do not find it in standard Danish, Swedish or Bokmål. However, if the consonants of these languages have exactly the same layout, how can the phenomenon be restricted to Icelandic and Faroese only? Obviously, preaspiration is parameterized in Western Nordic and blocked in Eastern Nordic. Nevertheless, even if we do not expect preaspiration in Danish, Swedish and Bokmål, we do not exclude it completely. Indeed, in a previous pilot study (Voeltzel 2011), we recorded native speakers of Danish, Swedish and Norwegian in reading tasks and spontaneous speeches. The aim of the study was to collect first-hand data and to check the distribution of the phenomenology as it is described in the literature. The first observation we could make is that some processes, given as central in the literature

didn't occur<sup>13</sup>. The second, and most important observation for our present concern is that some phenomena, which we did not expect in the languages we were testing, emerged - we give the data in (30) and (31) below:

(30) *Unexpected data recorded in Swedish*

/trettio/	[trehtio]	instead of [trettio]	thirty	
/jettə/	[jehtə]	instead of [jettə]	giant	(x 2)
/stakkarən/	[stahkarən]	instead of [stakkarən]	poor thing	
/vakkert/	[vahkat]	instead of [vakkat]	beautifully	
/pappa/	[pahpa]	instead of [pappa]	daddy	(x 2)

(31) *Unexpected data recorded in Norwegian*

/stakkaəs/ <sup>14</sup>	[stahkaəs]	instead of [stakkaəs]	poor thing
/nittən/	[nihtŋ]	instead of [nittŋ]	nineteen

As shown in (30) and (31), we were able to record preaspiration in the speech of the Norwegian and the Swedish speakers. In the previous data, preaspirated stops surface where there are underlying geminates. The context of the preaspiration recorded in Bokmål and Swedish fits in the scenario we proposed for Icelandic and Faroese. As a consequence, we claim that the same mechanism applies here too: namely, a degemination followed by the weakening of the coda.

Now that we presented a unique hierarchy for all five languages, the data in (30), (31) are less surprising: since Western and Eastern Nordic languages all respond to a unique contrastive structure, there is no such 'East/West boundary' that could restrain the occurrence of preaspiration to the Western group only – Eastern Nordic consonants are just as exposed as the Western ones.

### 3.3. Limits

The representation in (21) has many advantages for the study of phonological activity in languages, like the transparent illustration of processes affecting the consonants and the unification of disparate processes. Contrastive Hierarchy has a dimension that goes beyond simple description and offers explanations of phonological processes showing *how* a change affects the content of the segments.

However, for a full understanding of the Nordic phenomenology and if we maintain the hierarchy exactly as it is in (21), two difficulties appear: the first one involves motivation, the second one naturalness.

#### 3.3.1. No Syllable, No Fun

Neither the hierarchy in (21), nor the contrastivist approach in general, make any reference to the context in which the segments are located. They focus on the segmental level. This leads to a number of questions:

First of all, how do we justify why the processes occur? The hierarchy shows how and to what extent consonants are affected by processes. However, this approach does not reveal the causes of the triggering, which relate to the inter- and intra-constituent relations in syllable structure. As a consequence, we miss the constraints regulating and restricting the processes affecting the segments. This missing piece of the picture has the effect of allowing some overgeneration. For example, in Danish, voicing targets all voiceless stops when they stand in a specific syllabic position – the coda. As reminded in (32) (Basbøll

<sup>13</sup> The Danish speaker didn't voice the voiceless stops where it was expected (in coda).

<sup>14</sup> The speaker we recorded comes from Stavanger where they use the uvular fricative [ɣ] and not [r] (which should be standard for Norwegian).

2005), stops in onset and intervocalically do not undergo voicing. This does not appear anywhere in our hierarchy.

(32) *Treatment of stops in Danish*

phoneme	position		realization	example
/p/	onset	#_	[p <sup>h</sup> ]	/p <sup>h</sup> ellə/ [p <sup>h</sup> elə] <i>pill</i>
		V_V	[p <sup>h</sup> ]	/pap <sup>h</sup> ir/ [p <sup>h</sup> ap <sup>h</sup> iɾ <sup>ʔ</sup> ] <i>paper</i>
	coda	_ə	[p]	/lapə/ [lapə] <i>patch</i>
		_#	[p]	/lap/ [lap] <i>rag</i>
/t/	onset	#_	[t <sup>s</sup> ]	/taskə/ [t <sup>s</sup> askə] <i>bag</i>
		V_V	[t <sup>s</sup> ]	/foto/ [fot <sup>s</sup> o] <i>photograph</i>
	coda	_ə	[t]	/notə/ [no:tə] ( <i>musical</i> ) <i>note</i>
		_#	[t]	/lyt/ [lyt] <i>listen</i> <small>IMP. SG.</small>
/k/	onset	#_	[k <sup>h</sup> ]	/køʂ/ [k <sup>h</sup> øʂ] <i>kiss</i>
		V_V	[k <sup>h</sup> ]	/lak <sup>h</sup> erə/ [lak <sup>h</sup> e:ʔɾ] <i>lacker</i> <small>INF.</small>
	coda	_ə	[k]	/takə/ [takə] <i>thank</i> <small>INF.</small>
		_#	[k]	/hak/ [hak] <i>notch</i>

Secondly, how to deal with long segments? The hierarchy, as it is in (21), does not allow representing the particular situation of geminates. Underlying long consonants are subjected to changes that are different according to languages: in (33), we give examples of voiceless stops geminates for each Nordic language.

(33) *Geminate voiceless stops across Nordic languages*

	V /pp/ V	V /tt/ V	V /kk/ V
Swedish	/lappa/ [lapp <sup>h</sup> a] <i>patch</i> <small>INF.</small>	/fatta/ [fatt <sup>h</sup> a] <i>catch</i> <small>INF.</small>	/takka/ [tak <sup>h</sup> ka] <i>thank</i> <small>INF.</small>
Bokmål	/lappe/ [lapp <sup>h</sup> ə] <i>patch</i> <small>INF.</small>	/fatte/ [fattə] <i>catch</i> <small>INF.</small>	/takke/ [tak <sup>h</sup> ə] <i>thank</i> <small>INF.</small>
Icelandic	/lappa/ [lah <sup>h</sup> pa] <i>patch</i> <small>INF.</small>	/fatta/ [faht <sup>h</sup> a] <i>catch</i> <small>INF.</small>	/θakka/ [θah <sup>h</sup> ka] <i>thank</i> <small>INF.</small>
Faroese	/leappi/ [lea <sup>h</sup> ppi] <i>patch, rag</i>	/kettə/ [tʃ <sup>h</sup> ttə] <i>cat</i> <small>PL.</small>	/teakka/ [tea <sup>h</sup> kk <sup>h</sup> ka] <i>thank</i> <small>INF.</small>
(Danish	(/lapə/ [lapə] <i>patch</i> <small>INF.</small>	(/fatə/ [fatə] <i>catch</i> <small>INF.</small>	(/takə/ [takə] <i>thank</i> <small>INF.</small> )

Underlying (derived from *Old Norse*) voiceless stop geminates should surface long. That is indeed what we can observe in Swedish, Bokmål and Faroese. In Icelandic and in Faroese, we see that preaspiration occurs, which is expected, given the description of the phenomenon given in section 2.2.2. In Danish however, single voiced stops are produced. Danish would match the hierarchy if we consider that there is no underlying geminates. (See Basbøll 2005, Voeltzel 2013).

Focusing on the Nordic geminates, it is yet not possible to distinguish between single and geminate consonants in the hierarchy we built in (20): we cannot explain the mechanisms affecting geminates and restrain them to this specific situation.

3.3.2. *Naturalness*

Spirantization is generally classified as a *lenition* process – fricatives are weaker than stops (Lass 1984). The representation of spirantization that we get from the hierarchy in (21) ([+SG → -SG, +continuous]) does not reflect any *content loss*: on the contrary, segments end up more complex than before undergoing spirantization. This lack of *naturalness* in the representation is not the result of the hierarchical



organization per se, but rather of the use of binary features. Indeed, even if a feature swaps a positive value for a negative one, the feature still counts in the segmental content, making lenition impossible to reflect.

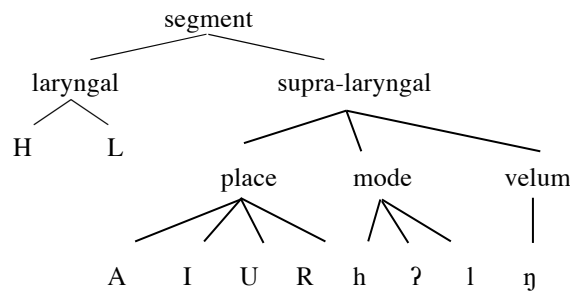
In order to overcome the two kinds of difficulties mentioned above – absence of syllabic structure and lack of naturalness, we aim to develop a representation of the obstruent inventory based on elements using *Element Theory* (KLV 1988, Angoujard 1997, Scheer 1999, Backley 2011) and *Government Phonology* (KLV 1990, Lowenstamm 1996, Scheer 2004). Nevertheless, the hierarchy of elements must not be an exact translation of the hierarchy in (20) – privative elements cannot directly replace binary features under the branching nodes. Moreover, the results we get from this hierarchy cannot be considered independently from the syllabic structure. Therefore, we aim to propose a rereading of the phenomenology of Nordic that connects the new elementary representations that we posit to the syllabic constraints. As a consequence, we explore new hypotheses concerning the phonological activity in Scandinavian languages.

4. From Features to Elements

4.1. Binary vs. Unary Hierarchy

The transition from features to elements could mean a replacement of binary objects with unary objects. Such an approach has already been considered by Harris (1994), Harris & Lindsey (1994), Nasukawa & Backley (2005) and Angoujard (2006) who adapt Feature Geometry (Clements 1985) to elements. The structure is given in (34)<sup>15</sup>:

(34) Feature Geometry applied to elements

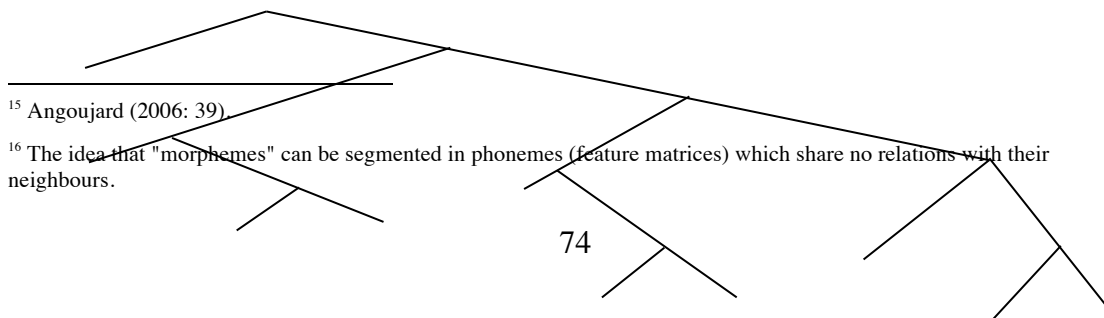


Such an adaptation is viable if we consider, like Harris (1994), that each element refers to a phonetic property – namely, if we read elements exactly the same way we read features. However, it is not compatible with the contrastivist approach, mainly because it does not take into account contrasts to contrast and aim to represent every property of sounds.

Next, it falls on what Jensen (1994:72) called "The Neo-Segmentalist" approach to elements: in other words, reconducting the pre-autosegmental hypothesis of Absolute Slicing<sup>16</sup>.

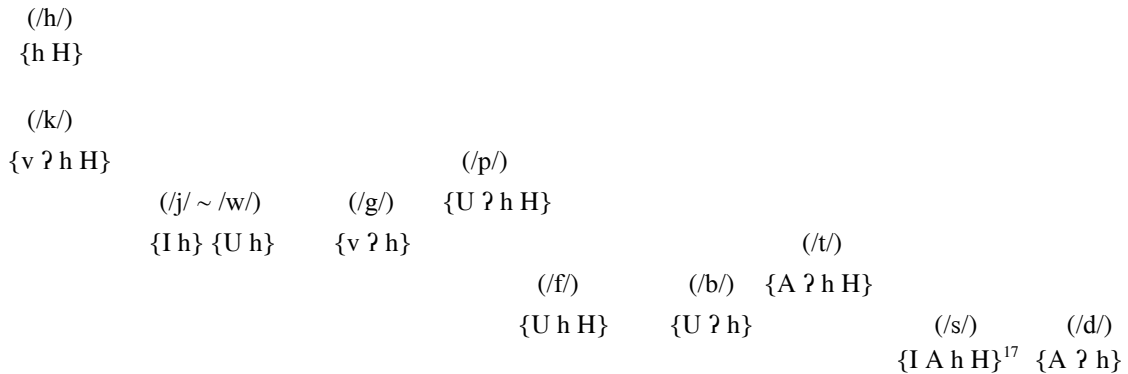
Now, if we combine the *Elements Theory* and the structure of the previously given hierarchy, we obtain the representation in (32), i.e. a tree whose branches host matrices filled with elements:

(35) Translation of the binary hierarchy into elements



<sup>15</sup> Angoujard (2006: 39).

<sup>16</sup> The idea that "morphemes" can be segmented in phonemes (feature matrices) which share no relations with their neighbours.



The matrices used in this figure come from Árnason (2011).

- Labials have {U}, velars have {v}, palatals have {I} and dentals have {A}.
- All consonants have noise, {h}.
- Only stops bear a specific element that differentiates them from fricatives: {?}.
- *Lenis* and *fortis* are distinguished through the aspiration element {H} – no mention of voicing is made here, given that voice is not a salient contrast for stops in Germanic languages.

#### 4.2. Why the New Hierarchy cannot be a Simple Translation into Elements

The representation given in (35) can prove problematic for many reasons:

First, the global architecture of the Contrastive Hierarchy is obtained through successive splits – each node corresponds to a feature and divides in two branches, one for each value. Thus, it is conceived to host binary objects – yet, in (35) we placed unary objects in it.

Secondly, if we leave aside the issue caused by the structure made for binary features and used for privative elements, we lose the justification of the organization of the nodes. The relevance of the sub-groups in (20) (/k, j~w, g/, /p, f, b/, /t, s, d/) relies on the integrated sub-system method we used following Basbøll (2005). In the classical generativist framework, segments within a sub-system share a vast majority of their content – which is why they interact so easily. If we use elements, we still see the links between the members of a same sub-group, however the relations between the subgroups seem now totally arbitrary. In (35), why is the node for labials related to the node for coronal, both being opposed to the node for velar? The Nordic phenomenology exhibits processes connecting the segments within each class, but nothing indicates that labials and coronal are anyhow connected.

There must be a correlation between a hierarchy and the phenomenology it explains. If we admit that the way sub-groups are organized has no other reason for being than allowing the Contrastive Hierarchy to justify the phenomena, then we have to modify this organization to represent the mechanisms the most accurately possible. As a consequence, it could imply the coexistence of various hierarchies within a single language, in order to take account of all the phenomena – such a procedure would be in discord with the contrastivist approach.

To illustrate this, let's turn to a phenomenon broadly present in all Scandinavian languages – namely merger. Some underlying clusters surface as one single segment, which gathers properties from both underlying consonants. This is illustrated in (36) with the merger of the cluster /sk/ into a palatal fricative before front vowels (see (36a)), and the clusters /fn/, /vn/ into a nasal bilabial before /d/ (see

---

<sup>17</sup> Árnason (2011:112): "Given that it [s/] is a very 'rich' sound, having a rather dense spectral profile, it would seem appropriate to see it as a mixture of resonance elements, that is A (for 'mass') and I ('dip' for diffusion), along with h and H [...]"

(36b)). As you can see, in the case of /sk/-cluster, the result of the merger may vary according to the language: [ʃ] or [f]. However, the mechanism itself stays the same in Faroese, Bokmål and Swedish.

(36) *Merging in Nordic Languages*

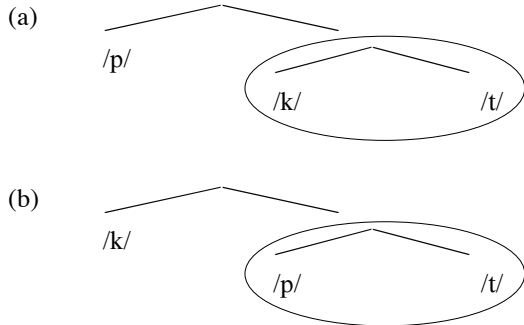
	(a)		(b)	
Icelandic			/nefn̥d/	[nɛmt̪] <i>committee</i>
	(unattested)			
Faroese			/nevnduː/	[nɛmtuː] <i>name</i> PAST PART.
	/skyt/ [ʃɛit] <i>shoot</i> PRET.	/skifta/ [ʃifta] <i>change</i> INF.		
Swedish			(unattested)	
	/sked/ [ʃɛ:d] <i>spoon</i>	/skiva/ [ʃi:va] <i>record</i> INF.		
Bokmål			(unattested)	
	/sky/ [ʃy:] <i>cloud</i>	/ski/ [ʃi:] <i>ski</i>		

On the one hand, in order to justify the partnership between /s/ and /k/ in the cluster /sk/ and explain why they interact during merger, we could place coronals and velars under the same node of the hierarchy, as shown in (37a). Thus, we leave aside labials, which do not intervene in this merger.

On the other hand, if we now consider the second case of merger exposed here, this time the labials interact with the coronals – velars do not come into play here. This would lead to a hierarchy like the one in (37b).

Faroese shows both types of mergers – it means both hierarchies in (37) would be required to take accurately account of the partnerships of Faroese. In other words: a single language could answer to several hierarchies. This is however not what is aimed with the contrastivist approach.

(37) *Various nodes organization in the hierarchy of Faroese*



A third issue caused by the hierarchy in (35) is the opacity to some processes that we could previously explain with the original hierarchy. Let's take the example of the semi-vocalization of /g/ that can surface either as a palatal glide [j] or as a labio-velar glide [w] in every Nordic language. Data are recalled in (38):

(38) *Semi-vocalization of /g/*

		/g/ → [j]	/g/ → [w]
Icelandic	/deg/ [teij̥] <i>day</i> DAT. SG.	/θeig̥ym/ [θeij̥ym] <i>be silent</i> INF.	(unattested)
Faroese	/spegil/ [spe:jil] <i>mirror</i>	/aiga/ [ai:ja] <i>own</i> INF.	/m̥augu/ [m̥u:wu] <i>must</i> PRES. PL.
Danish	/lɔgə/ [lɔjə] <i>play</i> INF.	/blɔj/ [plɔj̥] <i>pale</i>	/lɔg/ [lɔ:w] <i>sorrow</i>
Swedish	/bærg/ [bær:j] <i>mountain</i>	/ɛlg/ [ɛlj] <i>moose</i>	(unattested)
Bokmål	/gi/ [ji:] <i>give</i> INF.	/gyldən/ [jul:n] <i>begin</i> INF.	(unattested)

While in the features hierarchy (see (20)), the velar stop /g/ and the glides share most of their content and differentiate in only one feature value, in Árnason's framework, these segments share nothing. This is what we illustrate in (39):

(39) *Semi-vocalization of /g/ according to Árnason*

	/g/	→	[j]/[w]	
(a)	[-anterior, -SG, -continuous]		[-anterior, -SG, +continuous]	
(b)	{v ? h}		{I h}/{U h}	

Because he uses the {v} element to qualify the place of articulation in /g/, Árnason<sup>18</sup> loses the link between the velar stop and the dorsal glides, which interact within the Scandinavian languages though. Not only /k, g, j, w/ do not form a natural class anymore, but we also lose the transparency and the explanation on the semi-vocalization of /g/. The transition from stop to semi-consonant counts as lenition – the result must be "simpler" as the original consonant and what is left in the lenified segment's content must already be present in the stop's structure. In (39b), we clearly see that it is not the case. Instead, we would have to admit that /g/ lost all its content and gained {I} or {U}. This case would be in violation of the *Extended Projection Principle (EPP)* and complies with no existing phenomenon.

(40) Extended Projection Principle (Scheer 1999:214)

Observable objects on the surface have a lexical origin or are the result of a derivation based on lexically present material. "Nothing falls from heaven".

The same violation of *EPP* holds for spirantization in Icelandic, which we sum up in (41a):

(41) *Spirantization in Icelandic*

(a)	/p, t, k/ → [f, s, x]	/_ t, s	
(b)	/p/ → [f]	/t/ → [s]	/k/ → [x] <sup>19</sup>
	{U ? h H}	{A ? h H}	{I A h H} {v ? h H} {v h H}

Spirantization also counts as a lenition process, since stops become fricatives, and thus lose part of their content. The place of articulation has nothing to do here, since only the manner matters.

As shown in (30)(b), while the weakening of /p/ into [f] and of /k/ into [x] is rendered clearly, the spirantization of /t/ is abstruse. Indeed, the term of lenition is not justified here since the weakened segment has exactly the same number of elements as its occlusive counterpart. Plus, /s/ gains an extra property in its place of articulation, namely {I}.

#### 4.3. An Element Hierarchy

In order to develop a consistent unary hierarchy that overcomes the difficulties we just mentioned, we must not use elements as a translation of features. Indeed, elements allow more plasticity than features and allow us to stand out from the phonetical "reality". The representations that we use for segmental content are mostly based on KLV 1988, Harris 1994, Scheer 1996, 1999, Angoujard 1997, 2006 and Árnason 2011. They are summed up in (42), below:

(42) *Element representations of the Nordic consonants*

<sup>18</sup> We also find {v} for velarity in Harris (1994) and Angoujard (2006). Scheer (1999) uses another element for it: {U}. Labiality is then noted with {B}.

<sup>19</sup> We consider [x] as an allophone of /g/ - as a consequence, it contains the same elements except the occlusion.

coronals:	{I}	/d, t, s, n/
labials:	{U}	/b, p, f, v, w, m/
dorsals:	{I U}	/g, k, j, ŋ/
stops:	{? h}	/d, t, b, p, g, k, m, n, ŋ/
fricatives:	{h}	/s, f, v/
aspirated (voiceless):	{H}	/p, t, k/
nasals:	{N}	/m, n, ŋ/
liquids:	{R}	/l, r/
trill:	{T}	/r/

- Every consonant contains noise: {h} – the distinction between fricatives and stops is made through the occlusion element.
- On the same model as Árnason, we use {H} to mark aspiration on the *fortis*. We won't use the element, {L}, for lenis consonants, i.e. voiced stops<sup>20</sup>. Following Iverson and Salmon (1995), voice is not contrastive among the stops in Germanic languages.
- Contra most of the authors we just quoted, we use simultaneously {I} and {U} for velarity and do not make any use of {v}. Indeed, Faroese and Danish phonology show processes where velar /g/ can surface either as /j/ or as /w/, i.e. as a *palatal* glide or as a *labial* glide (see (43) and (44)):

(43) *Faroese*

/speɡɪl/	[spe:jɪl]	<i>mirror</i>	/tjæugʊ/	[tʃæu:wʊ]	<i>twenty</i>
/lœɡɪn/	[lœ:jɪn]	<i>weird</i>	/lœugɪn/	[lœu:wɪn]	<i>law</i> DEF.
/aigə/	[ai:jə]	<i>own</i> INF.	/mæugʊ/	[mæu:wʊ]	<i>must</i> PRES. 1,2,3 PL.

(44) *Danish*

/bœɡə/	[pœ:jə]	<i>bake</i> INF.	/dʁæɡə/	[tʁæ:w]	<i>draw</i> INF.
/læɡə/	[læ:jə]	<i>play</i> INF.	/lœɡ/	[lœ:w]	<i>promise</i> IMP. SG.

In keeping with the Extended Projection Principle, we assume that if /g/ can generate segments containing {I} or {U}, those two elements have to be active in its content.

There is yet no agreement in Element Theory about the content of velars: Scheer (1996), proposes that they contain {vU}, Harris (1994) suppose that they are empty {@} while Backley (2011: 79sq) argues that, because they seem to be opposed to labials in some languages, they should be headedless {U}. Schwartz (2010), in an extended version of GP 2.0, gives strong phonetic arguments that they should contain only {I}.

Here, the hypothesis that velars contain {I} and {U} has strong support if we look at the diachrony of French for example, where Latin /g,k/ (*fakta*, *noctem*, *pigmentu*) can lead through "vocalic resolution" to Gallo-Romance /w,j/ (*fajta*, *nojte*, *piumentu*) (Bourciez E. & Bourciez J. (1967). Romanian lenition of Latin clusters /kt,ks/ leads respectively to /pt,(p)s/ (lat. *noctem* > roum. *noapte*, lat. *pectus* > roum. *piept*, lat. *coxa* > roum. *koapsa*, lat. *frixit* > roum. *friipse* (Sala, 1970 : 24, Nandris, 1963 : 152-153 ).

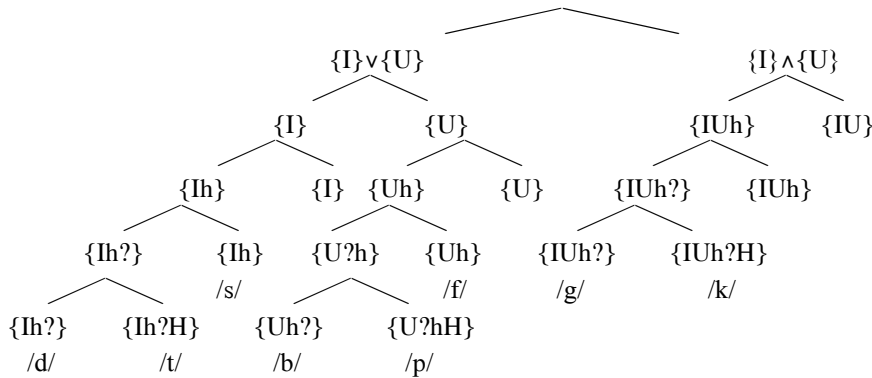
Another argument comes from acquisition and pathology. In fig. (20), we deliberately used the jakobsonian featural system. In Jakobson (1941) it is argued that the child acquires her phonological system in a stratificational way. Concerning consonants, the [+diffuse] feature comes first, then [±grave] and then [+compact]. In other words, the first consonant is an undetermined [coronal/labial] (a diffuse consonant) then the child acquire the [coronal]~[labial] opposition ([+acute] and [+grave], respectively). The next step is the split between the [saturated]/[diluted] consonants which splits the consonants in velars, [compact], versus labials and coronals, [diffuse]. There is an implicational relation in the order of

<sup>20</sup> See Brandão de Carvalho (2002) for a discussion about {L} and arguments to dismiss this element. See also Nasukawa (2005).

acquisition of these features. In the jakobsonian perspective, pathology displays the reverse order. Tifrit & Prince (2012, 2013) show that there is a tendency in patients' productions to "substitute" dorsals by coronals (in the majority of cases) and labials. They argue that jakobsonian [compact] is the union of [acute] and [grave] and translates in Element Theory as the union of {I} and {U}: velars are represented as {IU}.

The glottal fricative /h/ has no place of articulation – as a consequence, it does not bear neither {U} nor {I} in its internal structure. Since it is a fricative and aspirated, we give it the following content: {H h}. This last segment does not appear in the hierarchy we are about to present. We focus here on the oral obstruents.

(45) *Elements hierarchy for Nordic languages*



In (45), the first division of the hierarchy leads either to the disjunction of the elements {I} and {U} or to their conjunction. We thus find in the left part of the tree segments bearing either {I} or {U}, meaning the labials and the coronals respectively. On the right part, we find segments that have simultaneously {I} and {U} – in other words, the velars. These elements, which are essential in the segmental representations are the first to appear. The other ones, used to qualify the place of articulation, are added progressively.

The second level of division introduces the noise element {h} that we find in every consonant, except semi-consonants. This stage allows us to distinguish /j/ and /w/ from the rest.

At the third level comes the occlusion element {?}. This is where the fricatives stand out.

At the bottom of the hierarchy, all the stops remain – they are differentiated through the aspiration element. For the reason mentioned previously, there is no need for a voicing element: the main contrast is between lenis and fortis. Lenis consonants are interpreted as voiced or unvoiced, but always non-aspirated.

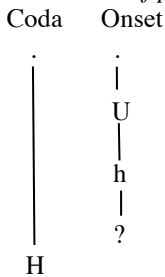
This approach permits a unified account of the Nordic phenomenology. The whole family has the same active content - it means that the mechanisms apply the same way in the five languages. Some phenomena, like preaspiration here, are not active in the whole family but remain latent. In other words, preaspiration is expected in standard Icelandic and Faroese only, however, it can be spontaneously triggered in Swedish and Norwegian and when it does, the process works exactly the same as in Western Nordic.

The Contrastive Hierarchy, as it is proposed in Dresher (2009), can lack some important aspects for a full understanding of the Nordic phenomenology. The first critique is addressed to the absence of the syllabic structure in the representation. As a consequence, the hierarchy by itself does not allow to understand the origins of the mechanisms: why and where are they triggered? How to deal with length? The second critique we formulated is not attributable to the hierarchical method itself, but rather to the use of binary features: the two major mechanisms from which almost all phenomena originate (lenition and fortition) cannot be clearly rendered.

The new representation of the hierarchy we propose allow us to fully assess content gain or loss and to overcome the naturalness issue mentioned previously:

- first, spirantization of /t/ into /s/ is now rendered by the loss of the occlusion element {I ? H h} → {I h}
- this fits into the lenition scenario. The same remark holds for the voicing process, which also counts as a lenition mechanism: [+SG] → [-SG, -continuous]. If we now illustrate "voicing" of /t/ with elements, the weakening is now described as content loss: {I ? H h} → {I ? h}. Loosing {H} element turns the fortis consonant into a lenis.
- second, preaspiration is now clearly rendered: dissociation of the geminate leads to a preaspirated lenis meaning that {H} element stays in Coda, while the remaining elements are associated to the onset. In this case again, the consonant is neither voiced nor unvoiced. By the way, it explains why lenis consonants are not concerned with preaspiration: they are devoid of {H}. (And if it contains {L} in certain languages, degemination is predicted to be impossible: {L} could not attach to a position alone for it would be uninterpretable.)

(46) *Representation of preaspiration*



- third, even if voicing is phonetically attested, it is to be interpreted as neither voiced nor unvoiced.

The lower we get in the hierarchy the more specified the segments. By the way, this elementary hierarchy predicts that melodic elements, the higher elements in the structure, should have more weight. In our view, this means that these elements are more prone to be heads. In other words, they are the last affected elements in lenition processes. All the phenomena we have explored here do respect this principle: the last element to be expelled is either {I}, {U}, or both.

5. *Conclusion*

In this paper, we presented the North Germanic family from a diachronic and a synchronic point of view. We stated namely that the 'sister' status of the five Scandinavian languages can still be accounted for today without any consideration of the history of this family: Icelandic, Faroese, Danish, Swedish and Norwegian have almost identical consonantal systems, which are affected by the same mechanisms. This last point could be revealed with the help of the Contrastive Hierarchy method: indeed, we were able to represent all five Nordic consonantal systems with only one hierarchical structure.

In addition to the consequence it carries for the genetic typology of Scandinavian, the unique hierarchy allows us to improve our understanding of the Nordic phenomenology.

We showed that in order to fully develop this hypothesis, the unary hierarchy cannot be a simple transposition of the binary hierarchy. The unary hierarchy we proposed puts forth the phonological active material at play in the scandinavian processes and uses a restrictive set of elements. The hierarchy explains why segments are targets of processes and how classes of segments interact. This proposition is a contribution to the debate between Dresher (2014) and Scheer (2010) on the possibility to apply the contrastivist approach to Element Theory. Eventually, we showed that the contrastivist approach is compatible with elements and provides opportunity to get rid of the problems linked to the use of binary features.

**References**

- Adams, Jonathan & Petersen, Hjalmar P. 2014. *Faroese. A Language Course for Beginners. Textbook and Grammar*. Stiðin, Tórshavn.
- Anderson, John M. and Ewen, Colin J. 1987. *Principles of dependency phonology*. Cambridge University Press, Cambridge, New York.
- Andersson, Erik. 2002. "Swedish", in Ekkehard, König. and van der Auwera, Johan, *The Germanic Languages*. Routledge, Londres - New York: 271-312.
- Angoujard, Jean-Pierre. 1997. *Théorie de la syllabe. Rythme et qualité*. CNRS Editions, Paris.
- Angoujard, Jean-Pierre. 2006. *Phonologie déclarative*. CNRS Editions, Paris.
- Árnason, Kristjan. 2011. *The Phonology of Icelandic and Faroese*. Oxford University Press, New York.
- Backley, Phillip. 2011. *An Introduction to Element Theory*. Edinburgh University Press, Edinburgh.
- Barnes, Michael P. and Weyhe, Eivind. 2002. "Faroese", in Ekkehard, König. and van der Auwera, Johan, *The Germanic Languages*. Routledge, Londres - New York: 190-218.
- Basbøll, Hans. 2005. *Phonology of Danish*. Oxford University Press, New York.
- Birkmann, Thomas. 2002. "From Ancient Nordic to Old Nordic: Definition and Delimitation of the Period", in Bandle, Oscar et al., *The Nordic languages*. Volume 1. de Gruyter, New York - Berlin: 691 – 698.
- Bourciez, Edouard and Bourciez Jean. 1967. *Phonétique française : Etude historique*. Klincksieck, Paris.
- Braunmüller, Kurt. 2007. *Die skandinavischen Sprachen in Überblick*. Francke, Tübingen – Bâle.
- Carvalho, Joaquim Brandão de. 2002. *De la syllabation en termes de contours CV*. Habilitation à diriger des recherches, Ms.
- Carvalho, Joaquim Brandão de. 2008. "From Positions to Transitions: A Contour-based Account of Lenition", in Carvalho, Joaquim Brandão de et al., *Lenition and fortition*. Mouton-DeGruyter, Berlin: 415-445.
- Carvalho, Joaquim Brandão de, Scheer, Tobias et Ségéral, Philippe. 2008. *Lenition and fortition*. Mouton-De Gruyter, Berlin.
- Clements, Nick, G. 1985. "The Geometry of Phonological Features," *Phonology Yearbook 2*: 225-252.
- Compton, Richard J. and Dresher, Elan B. 2011, "Palatalization and 'Strong i' across Inuit Dialects" *The Canadian Journal of Linguistics / La revue canadienne de linguistique*, Vol. 56 2: 203–228.
- Conzelmann, Jochen. 2008. "Erläuterungen zur mittelhochdeutschen Grammatik". (<http://www.freidok.uni-freiburg.de/volltexte/2075/>)
- Dresher, Elan B. 2009. *The Contrastive Hierarchy in Phonology*. Ms.
- Dresher, Elan B. 2014. *Contrastive Hierarchies in Element Theory*. Talk given at the *Theoretical Issues in Contemporary Phonology: Reading Tobias Scheer*. EHESS, Paris.
- Goldsmith, John. A. 1990. *Autosegmental and Metrical Phonology*. Blackwell, Cambridge.
- Hall, Daniel C. 2007. *The Role and Representation of Contrast in Phonological Theory*. Doctoral Dissertation, University of Toronto. Ms.
- Halle, Morris. 1971. *The Sound Pattern of Russian*. Mouton & Co, The Hague.
- Harris, John. 1994. *English Sound Structure*. Blackwell, Oxford – Cambridge.
- Harris, John and Lindsey, Geoff. 1994. The Elements of Phonological Representation, in Durand, Jacques and Katamba, Francis, *New Frontiers in Phonology*. Longman, Harlow.
- Hayes, Bruce. 1986. "Inalterability in CV Phonology", in *Language* 62 2, 321 – 351.
- Huber, Dániel. 2006. *On the Representation of Coronals and Velars Across Theories*. Ms.
- Huber, Dániel and Balogné Bérces, Katalin. 2010. [voice] and/versus [spread glottis] in the Modified Leiden Model, in *Acta Linguistica Hungarica* 57 4: 444 – 457.
- Iverson, Gregory K. and Salmons, Joseph C. 1995. "Aspiration and laryngeal representation in Germanic", in *Phonology* 12 3: 369 – 396.
- Jakobson, Roman. 1969. *Langage enfantin et aphasie*. Les éditions de minuit, Paris.
- Jakobson, Roman and Halle, Morris. 1956[2002]. *Fundamentals of Language*. de Gruyter, Berlin – New York.
- Jakobson, Roman and Lotz, John. 1949. Notes on the French Phonemic Pattern, in *Word* 5, 151 – 157.



- Jensen, Sean. 1994. "Is ? an Element? Towards a Non-segmental Phonology", in *SOAS Working Papers in Linguistics and Phonetics* 4: 71 – 78.
- Kaye, Jonathan, Lowenstamm, Jean and Vergnaud, Jean-Roger. 1985 [1988]. "La structure interne des éléments phonologiques : une théorie du charme et du gouvernement", in *Recherches Linguistiques de Vincennes* 17: 109 – 134.
- Kaye, Jonathan, Lowenstamm, Jean and Vergnaud, Jean-Roger. 1990. "Constituent Structure and Government in Phonology", in *Phonology* 7. Cambridge University Press, Cambridge: 193 – 231.
- Kristoffersen, Gert. 2000. *The Phonology of Norwegian*. Oxford University Press, New York.
- Lass, Roger. 1984. *Phonology. An Introduction to basic Concepts*. Cambridge University Press, Cambridge, New York.
- Lockwood, William B. 1964. *An Introduction To Modern Faroese*. Munksgaard, København.
- Lowenstamm, Jean. 1996. "CV as the Only Syllable Type", in Durand, Jacques and Laks, Bernard, *Current trends in phonology: Models and Methods*. Salford – Manchester, ESRI: 419 – 441.
- Nasukawa, Kuniya and Backley, Phillip. 2005. Dependency Relations in Elements Theory, in Kula, Nancy and van de Weijer Jeroen, *Papers in Government Phonology. Special Issue of Leiden Papers in Linguistics* 2.4: 77 – 93.
- Nandris, Octave. 1963. *Phonétique historique du roumain*. Klincksieck, Paris.
- Nielsen, Hans F. 2002. "Delimitation of Ancient Nordic From Common Germanic and Old Nordic", in Bandle, Oscar et al., *The Nordic languages. Volume 1*. de Gruyter, Berlin – New York: 615 – 619.
- Ottosson, Kjartan. 2002. "Old Nordic: a Definition and Delimitation of the Period", in Bandle, Oscar et al., *The Nordic languages. Volume 1*. de Gruyter, Berlin – New York: 787 – 793.
- Pöchtrager, Markus A. 2006. *The Structure of Length*. Doctoral Dissertation, University of Vienna. Ms.
- Pöchtrager, Markus A. and Živanović, Sašo. 2010. "GP 2 and Putonghua too", in *Acta Linguistica Hungarica* 57 4: 357 – 380.
- Riad, Tomas. 2002. "The phonological systems of Old Nordic II: Old Swedish and Old Danish", in Bandle, Oscar et al. *The Nordic languages. Volume 1*. de Gruyter, Berlin – New York: 896 –911.
- Riad, Tomas. 2014. *The Phonology of Swedish*. Oxford University Press, New York.
- Rögnvaldsson, Eiríkur. 1990. *Íslensk hljóðfræði handa framhaldsskólum*. Ms.
- Sala, Marius. 1970. *Contributii la fonetica istorica a limbii române*. tr. fr. : Contributions à la phonétique historique du roumain, (1976). Klincksieck, Paris.
- Scheer, Tobias. 1996. Une théorie de l'interaction entre consonnes. Contribution au modèle syllabique CVCV, alternances e-ø dans les préfixes tchèques, structure interne des consonnes et la théorie X-barre en phonologie. Doctoral Dissertation, University of Paris 7.
- Scheer, Tobias. 1999. "A Theory of Consonantal Interaction", in *Folia Linguistica* 32: 201 – 237.
- Scheer, Tobias. 2004. *A lateral theory of phonology. Vol 1: What is CVCV, and why should it be ?*. de Gruyter, Berlin.
- Scheer, Tobias. 2010. How to marry (structuralist) contrast and (generative) processing (review of Drescher 2009, The Contrastive Hierarchy in Phonology), in *Lingua* 120: 2522 – 2534.
- Scheer, Tobias and Ségéral, Philippe. 2001. "La coda-miroir", in *Bulletin de la Société de Linguistique de Paris* 96: 107 – 153.
- Schulte, Michael. 2002a. "The various old nordic dialects, their systems and their typology: A general survey of the classical Old Nordic of the High Middle Age", in Bandle, Oscar et al., *The Nordic languages. Volume 1*. de Gruyter, Berlin – New York: 871 – 882.
- Schulte, Michael. 2002b. "The phonological systems of Old Nordic I: Old Icelandic and Old Norwegian", in Bandle, Oscar et al., *The Nordic languages. Volume 1*. de Gruyter, Berlin – New York: 882 – 895.
- Schwartz, Geoff. 2010 Auditory Representations and the Structures of GP2.0, in *Acta Linguistica Hungarica* 57 4: 381–397
- Thráinsson, Höskuldur. 2002. "Icelandic", in Ekkehard, König. and van der Auwera, Johan, *The Germanic Languages*. Routledge, Londres - New York: 142-189.

- Thráinsson, Höskuldur, Petersen, Hjalmar, Jacobson, Jógvan í Lon, Hansen, Zakaris S. 2012. Faroese. An Overview and Reference Grammar. Faroe University Press, Linguistic Institute, University of Iceland, Tórshavn – Reykjavík.
- Tifrit, Ali and Prince, Typhanie (2012). Aphasie: contraintes vs gouvernement. Le cas des clusters, in Neveu, Franck. et al. (eds.). *5e Congrès mondial de linguistique française*. Institut de Linguistique Française & EDP Sciences, Paris: 1643- 1658.
- Tifrit, Ali. and Prince, Typhanie. 2013. Substitutions in Aphasia: Defining the Complexity of Stops. *Old World Conference in Phonology OCP*. Booklet of abstract, Istanbul.
- Venås, Kjell. 2002. "Previous attempts at establishing periods in Nordic language history", in Bandle, Oscar et al., *The Nordic languages*. Volume 1. de Gruyter, Berlin – New York: 31 – 38.
- Voeltzel, Laurence. 2011. Hiérarchie contrastive: une typologie des obstruantes dans les langues scandinaves. Master Dissertation, University of Nantes.
- Voeltzel, Laurence. 2012. Aspects de la morpho-phonologie des langues scandinaves : hiérarchie, complexité, latéralité. Master Dissertation, University of Nantes.
- Voeltzel, Laurence. 2013. *Geminates: from Old Norse to Scandinavian Languages*. Generative Linguistics in the Old World, University of Lund.