



universität
wien

MASTERARBEIT / MASTER'S THESIS

Titel der Masterarbeit / Title of the Master's Thesis

Origin of tone and glottalization in the Baltic sea area

verfasst von / submitted by

Charles Shuitian Zhang

angestrebter akademischer Grad / in partial fulfilment of the requirements for the degree of
Master of Arts (MA)

Wien, 2025 / Vienna, 2025

Studienkennzahl lt. Studienblatt /
degree programme code as it appears on
the student record sheet:

UA 066 599

Studienrichtung lt. Studienblatt /
degree programme as it appears on
the student record sheet:

Masterstudium Indogermanistik u. histor. Sprachwiss.

Betreut von / Supervisor:

Univ.-Prof. Mag. Hannes Fellner M.A. PhD

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Abstract

This thesis argues for a ‘glottalization-first’ origin of tone and glottalization for the language varieties spoken in the Baltic sea area. Through reconstruction of the internal history of the Balto-Slavic and Scandinavian language families with respect to their suprasegmental and prosodic features with the help of diachronic trends, typological comparison, and areal considerations, the main contribution of this thesis is an attempt to fit the story of tones and glottalization in the Baltic sea area into the broader body of knowledge developed within the last century around tonogenesis in languages families across the world.

Diese Arbeit vertritt die These eines „glottalisierungsbasierten“ Ursprungs von Ton und Glottalisierung in den im Ostseeraum gesprochenen Sprachvarietäten. Anhand der Rekonstruktion der inneren Sprachgeschichte der balto-slavischen und skandinavischen Sprachfamilien, unter besonderer Berücksichtigung ihrer suprasegmentalen und prosodischen Merkmale, sowie durch diachrone Entwicklungen, typologische Vergleiche und areale Betrachtungen, leistet die vorliegende Arbeit den Beitrag, die Entstehung von Ton und Glottalisierung im Ostseeraum in den größeren Kontext der Tonogeneseforschung einzuordnen, wie sie im letzten Jahrhundert für Sprachfamilien weltweit entwickelt wurde.

1 Introduction

The Baltic sea area is notable in the Indo-European language family for being the locus of development of innovated tonal contrasts, chiefly in the form of distinctive pitch accent types. Indeed, there are still many Balto-Slavic and Scandinavian varieties which show lexically contrastive pitch contours to the present-day. At the same time, there are also related languages in this area which show phonemic glottalization features, another uncommon phenomenon among the Indo-European languages. The appearance of both is not a coincidence: pitch contour contrasts in one language often correspond to contrasts in glottalization in a closely related or geographically adjacent variety. This happens in both Balto-Slavic and Scandinavian despite both families being only distantly related as Indo-European languages. While there have been many investigations into the synchronic nature and distribution of pitch-accent and glottalization in this area, the goal of this thesis is to investigate both the origin and the relationship of the two types of phonetic features from the perspective of diachronic typology, given significant leaps in understanding in tonogenetic phenomena, starting with work done on languages in Southeast Asia over the past 70 years. As word-prominence also figures prominently and interacts with tonal contrasts in the phonological systems of the Balto-Slavic and Scandinavian languages, this thesis will also touch on the typology of stress and tone languages to aid in the investigation. A central question to be answered is the directionality of development: Is it more likely that glottalization or distinctive pitch contour types emerged first, before transmuting into the other type of suprasegmental contrast? How and why did glottalization arise in this area in the first place, if tone came later? This investigation attempts to square careful applications of the comparative method to these languages with cross-linguistically attested diachronic trends, while placing the systems of any reconstructed stages into a sensible typology.

In support of the analysis of the central question of directionality, this thesis addresses various secondary questions including general methodological concerns pertaining to linguistic reconstruction. For example, how much should synchronic phonological analyses play a role in the evaluation of comparative data used diachronically? What roles should the comparative method and typologically informed heuristics play when reconstructing the history of sound changes and systems as whole, especially in the context of suprasegmental features? This thesis also addresses the phonetic mechanism and internal phonological motivations for how glottalization and tonal accents might transmute into each other, both in general and from concrete data in the varieties investigated. Because these varieties are also geographically close to one another, the diachronic typology presented in this thesis will also touch upon how tone, glottalization, and prosodic systems are particularly sensitive to contact-induced development. How many observed similarities can be explained purely through internal motivation of sound change vs. how likely is it that contact brought about these changes? While the focus is principally on examining linguistic data without much reference to external sociolinguistic factors such as population movement and contact, the discussion explores to what degree the hypothesized internally motivated and typologically supported changes observed in Balto-Slavic and Scandinavian parallel each other in connection with the broader areal linguistic context when the systems are examined formally.

2 Thesis structure and methodology

This thesis attempts to build up an evaluation of the theories regarding the origin of glottalization and tone with respect to the languages around the Baltic sea from a typological perspective as follows:

In chapter 3, I will present a brief overview of the basic notions of phonation types, pitch accent, and tone, as well as an overview of the typology of tone and accentual systems, in order to establish a meta-language and set of tools in which to describe the prosodic and phonological systems of the various languages presented in this thesis. The relationship between phonetics and synchronic phonology in the context of these features will also be discussed, since the phonetic relationships between these features also surface abstractly in phonological systems cross-linguistically. The reason for doing this is so that a clear distinction can be made between applying synchronic typology to the various stages reconstructed via the comparative method and applying diachronic typology to the evolution of these stages at a systematic level.

Chapters 4 and 5 go over descriptions of the major types of suprasegmental phenomena in the Balto-Slavic and Northern Germanic languages from a synchronic perspective, before showing comparative data to show correspondences in these language families between glottalization and tonal features. This is done to set the stage for the main question of this thesis of what the origin of glottalization and tones are in this area of the world, as well as the relationship between glottalization and tone. These chapters also illustrate similarities in the prosodic systems between the distantly related language groups from an areal-linguistic perspective.

Chapter 6 presents the meat of the argumentation in this thesis. Beginning with a presentation of how tonogenesis generally occurs across the world's languages, the exposition is narrowed to focus on the type of tonogenesis most relevant to what could have happened in the Baltic sea area. Both comparative data and phonetic explanations are given for the theories of tonogenesis advanced for the language groups that show potentially similar developments as in Balto-Slavic or Scandinavian. A few parallel developments in an areal cluster of languages are also presented in order to show how proximity and contact can play a role in the spread of prosodic system development. Against this backdrop, a glottalization-first approach to the origin of tone and glottalization is advocated for on account of the fact that such a development can be well-supported typologically, and is in some ways more compatible with the systems reconstructed from the comparative data previously described than in a tone-first approach.

As a follow-up, chapter 7 attempts to present possible theories for the origin of the glottalization seen in the Balto-Slavic and Scandinavian languages on the assumption that their respective ancestral proto-languages did not show glottalization in their phonemic inventories, at least not in the form reconstructed for Proto-Balto-Slavic and Proto-Norse. These theories are important to cover in order to complete a full story for how the prosodic systems became the way they are today in the Baltic sea area, and they must also be compatible with the previously presented theories of how new tonal contrasts later appeared in glottalization-conditioned environment. In addition, the chapter presents typological par-

allels both between Balto-Slavic and Scandinavian and in general for the development of glottalization.

Finally, chapter 8 wraps up the main body of the thesis by briefly summarizing some meta-linguistic themes seen throughout the thesis. In particular, the role of typology, internal reconstruction, the comparative method, and areal linguistics in linguistic reconstruction are touched upon.

Overall, this thesis follows the tried-and-true methodology of historical and comparative linguistics, in which attested language data is surveyed, before the comparative method is used to reconstruct the existence of features that can explain the attested language data. Traditionally, in Indo-European studies, these features are then interpreted phonetically (if at all) through the phonetic reflexes found within the language group in question. This work adds a level of rigor to the process by evaluating the interpretation of reconstructed features typologically both by placing the features in the phonological system reconstructed as whole and through comparison with similar cross-linguistically proposed diachronic developments. The conclusion of each step of the evaluation process is presented in each section where the evaluation occurs, ultimately in support of the glottalization-first hypothesis built up in the course of the study.

3 Preliminary notions: phonation, tone, and accent

This chapter presents an overview of the notions of phonation, pitch, tone, accentual systems, and their relationships to each other, along with general typological considerations pertaining to them. These notions are crucial in comparing the reconstructed and current phonological and prosodic systems of the languages of Northern Europe to other language families to gain insight into the origin of those systems.

3.1 Phonation types and pitch

From a phonetic perspective, phonation adds an additional parameter to the production of speech sounds independent of the place and manner of articulation for consonants and the position in vowel space for vowels.

Phonation ^a

The different oscillatory states of the glottis which modify the airstream during speech production.

^aThis term is also used in the wider sense of including any part of the larynx, and also in the narrower sense of referring exclusively to voicing.

Articulatorily, these oscillatory states of the glottis form a continuum termed **glottal stricture** ranging from the glottis being completely closed to not closed at all. However, the continuum is typically divided up into the broad categories listed in table 1.¹

Table 1: Some states of the glottis sorted by stricture (adapted from Ladefoged 1971: p. 8)

Phonetic term	Brief description	Symbols
Voiceless	Vocal cords apart	ᵐ s p h
Murmur/“Breathy voice”	Arytenoids apart, ligamental vocal cords vibrating	ᵐ ʒ ɸ
Modal voice	Vibration of the vocal folds	m z b a
Laryngealization/“Creaky voice”	Arytenoids tightly together, but a small length of the ligamental vocal cords vibrating	ᵐ ʒ ɸ
Glottal stop	Vocal cords held together	ʔ

Acoustically, the various oscillatory states of the glottis induce different kinds of auditory signals. Most notably, vibration of the vocal cords or vocal folds during modal voicing creates a quasi-periodic signal, with an associated harmonic series and fundamental frequency. Perceptually, the fundamental frequency of an auditory signal is the main correlate of **pitch** in the musical sense, which can be varied by the speaker during modal voicing. The other types of phonation which involve vibration of parts of the larynx such as laryngealization or murmur also induce their own distinctive acoustic signals with associated pitch. For example, the frequency of the signal induced by the irregular vibration of the vocal cords in

¹Another continuum concerns **voice onset** (VOT), which describes how long it takes for voicing to start relative to the release of a stop or affricate. This feature is what distinguishes aspirated from voiceless and voiced consonants.

creaky voice is typically within the range of 20-50Hz, which is about two octaves below the frequency of modal voicing (in the range of 100-250Hz).

Phonologically, languages are observed to contrast up to three states of glottal stricture (not necessarily aligning with the categories in table 1), with the majority showing only a contrast between two states, typically categorized as voiced and voiceless. (Ladefoged 1971: p. 18)

Typologically, creaky voice and glottal stop are not distinguished in many languages. Indeed, this is not surprising since they are quite close in the glottal stricture continuum. In fact, **glottalization** is commonly used as cover term for some kind of phonetic feature indicating a constriction of the glottis tighter than that seen in modal voicing, and the non-standard IPA superscripted symbol $\text{◌}^ʔ$ is commonly used for this.

3.2 Register and tone languages

Pitch is commonly used cross-linguistically to convey pragmatic intent or prosody, but is also used in some languages in a phonologically contrastive way. When pitch contrasts are used to distinguish lexical or grammatical meaning, the pitch contrasts are also commonly referred to as as tonal contrasts or simply tone. The following definition provides a way to classify whether a language is tonal based on how embedded the role of pitch contrasts plays in the lexicon.

Tone (Hyman 2006: p. 229)

A language with tone is one in which an indication of pitch enters into the lexical realization of at least some morphemes.

This definition is notably abstract enough to include languages where tone may be present on only a few morphemes of the language, or languages where tone comes with phonetic correlates other than pitch, such as phonation types. A prototypical example of a tonal language where each morpheme in the language carries a tone realized purely by pitch contrasts is Mandarin Chinese:

Table 2: The five tones of Mandarin Chinese

Pitch	Pinyin	IPA	Traditional/Simplified	Gloss
Level	mā	[má]	媽/妈	‘mother’
Rising	má	[mǎ]	麻/麻	‘hemp’
Fall-Rising	mǎ	[mà]	馬/马	‘horse’
Falling	mà	[mâ]	罵/骂	‘scold’
No tone	ma	[ma]	嗎/吗	interrogative particle

In cases where tonal contrasts are also associated with phonation type contrasts in such a way where they cannot be analyzed independently, the term **register** or **pitch register** may be used as well. Languages in Southeast Asia such as Vietnamese or Burmese fall into this category.

Table 3: Burmese pitch-phonation registers (Matisoff 2001: pp. 309–310)

Register	Phonation	Length	Pitch	Example	Gloss
Low	Modal voice	long	low	လံ [là:]	‘come’
High	Breathy voice	long	high; falling when final	လံး [lâ:] ~ [lâ:]	‘mule’
Creaky	Creaky voice	medium	high	လံ [lǎʔ]	‘moon’
Checked	Final glottal stop	short	high	လံဝ် [lǎʔ]	‘fresh’

3.3 Phonological relationship between phonation and tone

In light of the direct phonetic link between phonation types and pitch in terms of how the larynx produces vibrations, it is therefore not surprising that a phonological relationship between phonation-type contrasts and tone appears in the phonology of many languages as well, often surfacing as phonological or morphological alternations between tonal contrasts and different types of phonation or restrictions in their co-occurring distribution.

Concretely, the examples in table 4 from Songjiang Chinese (where tone contours are notated with a starting tone and ending tone out of 5 tone heights numbered 1-5) show that words with initial [t] occur with tone contours in the upper register (3-5) whereas initial [d] occur with tone contours in the lower register (1-3).

Table 4: Tone and voicing in the Songjiang dialect of Chinese (Backley 2011: p. 144)

Voiceless		Voiced	
ti 53	‘low’	di 31	‘lift’
ti 44	‘bottom’	di 22	‘brother’
ti 55	‘emperor’	di 31	‘field’

This constraint on the co-occurrence of voicing on obstruents with regards to tone height in the nucleus already hints that phonation type and tone height can be phonologically connected in some languages.

Furthermore, the data in table 5 from two dialects of Kammu shows how the original initial voicing contrast system present in Eastern Kammu has transphonologized into a tonal system in Northern Kammu, where initial obstruent voicing distinctions have been lost. This is a common pathway for tonal systems to arise cross-linguistically (see chapter 6 for more on the diachronic typology of tonogenesis). What is interesting from a synchronic perspective is that speakers from the two varieties have no trouble understanding each other, and perceptual experiments indicate that speakers of the two dialects are not even aware that such a phonological difference between the two dialects exist, citing lexical differences as the distinguishing factor instead.² (Backley 2011: p. 143)

Obstruent voicing and tone also appear to affect each other phonologically in morphological alternations in some languages. Suma is an example of a language where voiced obstruents cause following vowels to take on a lower tone. For example, imperfective verbs

²Incidentally, I have noticed that the Viennese variety of German (German *Wienerisch*), even for speakers who essentially speak the Austrian Standard German norm, shows a similar tonal development. For many speakers of Viennese, word-initial voicing/aspiration distinctions in obstruents have essentially collapsed, especially in clusters, where speakers are no longer perceptually aware that they have lost the distinction with respect to the Standard German norm where it is preserved. Speakers then have the freedom to voice the initial obstruents with co-occurring lower tone in the following nucleus, ostensibly for emotive purposes.

Table 5: Voicing and tone in two varieties of Kammu (Backley 2011: p. 143)

Eastern Kammu	Northern Kammu	
taan	táan	‘pack’
daan	tàan	‘lizard’
raan	ràan	‘flower’
raan	ráan	‘tooth’
t ^h aan	t ^h áan	‘to clear’

are marked morphologically via a lexical H tone, as in *éé* ‘leave behind’, *kírí* ‘look for’, but if the verb’s initial consonant starts with a voiced obstruent, the tone surfaces as LH, as in *búsi* ‘be bland’ (Backley 2011: p. 158).

These types of synchronic alternations and articulatory/perceptual assimilation-type constraints suggest that obstruents and sonorants share a phonological feature relating both to phonation type and pitch height. Indeed, we have already established the articulatory phonetic basis for such a shared feature in section 3.1. To capture this relationship phonologically, a [stiff vf] feature is often proposed (as in Halle 2003). Table 6 summarizes how [stiff vf] is then realized as either voicing or pitch height depending on whether the rest of the segment is an obstruent or sonorant.

Table 6: Vocal chord stiffness in obstruent/sonorant contexts

	Stiff vocal chords	Slack vocal folds
obstruents:	voicelessness	voicing
sonorants:	high pitch	low pitch

Other phonological theories such as element theory also attempt to capture the observed relationship between phonation and tone. For example, in Backley (2011)’s version of the theory, he proposes that a headed [H] is a phonological element for both aspiration and high tone, while a headed [L] element can be interpreted as both obstruent voicing and low tone.

Hence, we see that a phonologically significant relationship between phonation and tone is strongly attested cross-linguistically, warranting their combined treatment in different phonological frameworks as closely related or even identical features or elements. From a diachronic perspective, this link is strengthened further by widely accepted theories of tonogenesis in several language families across the world as covered in chapter 6, and underlies the main research topic of this thesis.

3.4 Word prosody and ‘pitch-accent’ systems

In addition to pitch being used to realize tone in a lexically contrastive in some languages, most languages also employ pitch to express prominence at various levels of prosodic structure. In fact, the use of pitch for prominence has been observed to form a continuum with the use of pitch for tone. Since this continuum is particularly relevant for the discussion of pitch-accent and tone in Northern Europe, this section defines a number of terms that are often confused or conflated which will make it easier to typologize the phonological systems of the languages discussed in this thesis.

The concept of prosodic prominence is abstractly encoded in phonological systems by a feature defined as follows:

Accent (Hyman 1977: p. 4)

An ‘abstract’ mark where a culmination of prosodic features occurs, thereby marking that syllable (or accent-bearing unit) with greater salience than surrounding syllables.

What does greater salience mean? Common phonetic correlates of accent include enhanced duration, amplitude, or pitch, which are often referred to as **stress** when taken separately or together. Traditionally, when the accent is mainly correlated with pitch, the accent is called a **pitch accent** when looking at things at a purely phonetic level, though this term is ambiguous as it also refers to a set of phonological properties an accent can take on, to be described later in this section. In order to resolve the ambiguity, I will instead use the term **pitch-based accent** in this thesis to emphasize specifically that an accent uses pitch as the primary phonetic correlate³. The term **dynamic accent** is used when the main phonetic correlate of the accent is loudness, as in English. Phonotactically, accent is often correlated with richer vowel contrast, more complex syllable structure, tonal contrast exclusively or richer on the accented syllable (van der Hulst, Goedemans & Rice 2017: p. 162). In addition, there can be only at most one accent in a given domain such as in a word or morpheme (termed **culminativity**), expressing the intuitive idea that something is prominent if it is special or unique in some way in relation to otherwise similar items.

Under this definition, the accent is an abstract property of a prosodic unit such as a word which is distinct from the phonetic cues that signal it to the listener (van der Hulst 1999: p. 4). In the prosodic phrase domain, prominence or accent is usually referred to as **phrasal accent**, which is typically associated with information structure on the syntactic level to denote focused items. The use of pitch in the phrase domain is also termed **sentence intonation**. Pitch prominence used in this way does not convey differences in lexical meaning of individual words.

However, in this thesis, the unqualified term accent will generally refer to **word accent**, that is, the accent in the prosodic word domain. This type of accent is interesting for our purposes as many languages do use word accent to distinguish lexical meaning as well. When word accent is primarily realized through pitch, the line between using pitch to mark accent and using pitch for tone quickly becomes blurred. On the one hand, the use of pitch for accent distinguishes lexical meaning through the position of the prominent syllable (the **syntagmatic** usage of pitch for contrast), while the use of pitch for tone typically invokes the idea of using differing pitch heights or contours to distinguish lexical meaning (the **paradigmatic** usage of pitch for contrast). On the other hand, this dichotomy in usage is not clear-cut. Some languages have a hybrid system where pitch is used syntagmatically to mark a prominent syllable, but at the same time is also used paradigmatically to distinguish between different types of prominent syllables available via contrasting heights or contours.

In order to address this tension between word accent and tone, Hyman (2009) sets up a typological continuum between stress languages and tone languages, where a language

³Note that the term pitch accent in the phonological sense almost always implies that the accent is phonetically pitch-based, so that in many contexts the issue is moot.

is said to have **pitch accent** (phonologically, not phonetically) when it mixes and matches properties of both stress languages and tone languages. Under his definition, a **stress language** is a language with an indication of word-level metrical structure with the property that there is one and only one primary stress per lexical word, where the stress-bearing unit is the syllable. English, Finnish, or Hungarian are languages that fit this criteria. On the other hand, a **tone language** has to have word-level pitch features called tones, placed on morae. Mandarin Chinese is typically taken as a prototypical example of a tone language with very little word-level metrical structure. The phonological systems of Northern Europe studied in this thesis all fit somewhere in the middle of this typological continuum, having some sort of pitch-based accent used both syntagmatically and paradigmatically, so that they can be reasonably termed **pitch-accent languages**.

Some other properties commonly associated with stress resp. tone languages are summarized in table 7 as explained more in detail in (Hyman 2009: p. 216).

Table 7: Stress vs. tone properties

	<i>form</i>	<i>function</i>	<i>system</i>	<i>P-bearer</i>	<i>level</i>	<i>domain</i>
stress	structural	contrastive	syntagmatic	syllable	lexical	output word
tone	featural	distinctive	paradigmatic	mora	URs	input morpheme

Placing a language on such a continuum is usually done on an intuitive level with oftentimes contradictory criteria. However, linguists do have a broad sense of being able to say a particular language is more tonal than another. Figure 8 shows a placement of a few languages on a scale of least tonal (stress language) on the left to most tonal (tone language), where the criteria is based on the percentage of syllables that require a tone feature in that language.

Table 8: A continuum based on ‘tonal density’ (Hyman 2009: p. 213)

English — W. Basque — Tokyo Japanese — Luganda — Mandarin

The term pitch-accent language is broad enough to reasonably refer to any of the languages in between the extremes of English and Mandarin. Therefore, it is impossible to present *the* prototype of a pitch-accent language, since languages intermediate on the continuum mix and match different properties usually associated with stress resp. tone and do not form a coherent class. With this in mind, as prosodic and stress systems tend to cluster geographically, being more prone to cross-linguistic replication in contact situations than segmental phonology (Matras 2009: p. 231), it *does* make sense to talk about what a typical pitch-accent system looks like in a locally areal sense. For a survey on linguistic areas that show convergence in word-prominence features, see (van der Hulst, Goedemans & Rice 2017), which discusses word-prominence from the perspective of areal linguistics. In this light, it is not surprising that the languages around the Baltic sea appear to show similar accentual systems. In fact, as we will see in section 6.1.2, this applies even on the diachronic level, where the development of tones also appears to be extremely susceptible to replication across entirely unrelated language families.

4 Suprasegmental systems of Balto-Slavic languages

This chapter presents the phonological systems of the present-day Balto-Slavic languages with a focus on the prosodic and suprasegmental aspects. The aim of this chapter is to set the stage for a comparative and diachronic analysis for the origin of some of the features seen throughout Balto-Slavic by presenting the range of typology in this area synchronically first. I will give an extended treatment of standard Lithuanian to start with as it has a prototypical pitch-accent system similar not only to many of other the pitch-accent systems in the Balto-Slavic languages but also to the pitch-accent varieties in Scandinavia. Some of the other features in standard Lithuanian such as liquid diphthongs are also common throughout the Baltic-speaking area.

4.1 Standard Lithuanian

Standard Lithuanian (or Aukštaitian, in the sense of high Lithuanian) has a pitch accent system somewhere in the middle of the continuum described in section 3.4, and serves as a prototype for pitch-accent systems in the Baltic sea region. Characteristic F_0 shapes are used over syllables both to accentuate them and to distinguish between accented syllables types. (Dogil & Möhler 1998) Furthermore, pitch contrasts are only used in accented syllables, so that the position of the accent and the place of tonal features are aligned. The accent is **free**, meaning that the accent is not generally fixed to a specific syllable in the word. In addition, the accent is **mobile**, meaning that not only is the accent free, but the accent can shift across inflected forms of the same word.

4.1.1 Syllable weight

Lithuanian, and the Baltic languages more generally, distinguish between light (monomoraic) and heavy (bimoraic) syllables, and the distinction is particularly relevant for the accent system. Like almost all languages, onsets are not moraic. Coda sonorants are moraic, while coda obstruents are not. The possible nuclear types are summarized in table 9^{4, 5}.

Table 9: Possible nuclear types in Lithuanian.

Light	Short vowels	<i>a, e, i, u</i>
Heavy	‘Long’ vowels	<i>ė</i> [e:], <i>o, y</i> [i:], <i>ū</i> [u:]
	‘Nasalized’ vowels	<i>ą, ę, į, ū</i>
	Falling diphthongs	<i>ai, ei, au, iu</i>
	Rising diphthongs	<i>ie, uo</i>
	Liquid and nasal diphthongs	<i>ar, el, im, un</i> etc.

⁴*o* synchronically behaves as the long counterpart of *a*, though the phonetic length of *o* is unclear. *o* is diachronically from Proto-Baltic **ā* (Jasanoff 2017: p. 33).

⁵The nasalized vowels are now pronounced as oral long vowels. Sometimes, they still synchronically alternate with the corresponding vowel plus *n* sequence.

4.1.2 Heavy accented syllable contrasts

Lithuanian contrasts between two different types of heavy accented syllables, as shown in table 10, with the accented syllable underlined. The example *táikiai* versus *taĩkiai* show that the two types are lexically contrastive. A difference in accent type can also be used as a derivational mechanism in some cases, as in the pair *áukštas* ‘tall’ and *aũkštas* ‘floor’.

Table 10: Accented heavy syllable types in Lithuanian.

Name	Type	Examples
<i>tvirtaprāde prīegaidė</i> ‘firm-start accent’	acute	<u>táikiai</u> ‘you aim’ <u>kĩlti</u> ‘to rise’ <u>píenas</u> ‘milk’ <u>pĩlnas</u> ‘full’
<i>tvirtagālė prīegaidė</i> ‘firm-end accent’	circumflex	<u>taĩkiai</u> ‘peacefully’ <u>viĩlka</u> s ‘wolf’ <u>diēvas</u> ‘god’ <u>giĩnklas</u> ‘weapon’

The phonetic study in (Dogil & Möhler 1998) describes the phonetic nature of the two pitch accent types as follows:

- acute: Measurements show that the pitch contour is robustly falling. The pitch starts high and then starts dropping in the middle of the first mora, before it stops dropping the middle of the second mora.
- circumflex: Measurements show that the circumflex accent shows much less pitch movement than the acute accent, and the variance in production is much higher, making it difficult to determine the exact contour of the pitch movement. However, the pitch does generally seem to rise. Hence, many choose to describe the circumflex as either rising or at least as non-falling.

Orthographically, acute-accented heavy syllables are marked with either a grave ` or an acute ´ mark on the first element of the heavy syllable, whereas circumflex-accented heavy syllables are always marked with a tilde ã on the second element. The grave mark is used for acute-accented heavy syllables only when a high vowel (*i* or *u*) precedes a sonorant, reflecting a phonetic but not phonemic difference in the exact timing of the pitch drop over syllable in this case. (Petit 2010: pp. 63–64)

4.1.3 Accented light syllables

When a light syllable is accented, the pitch of that syllable is higher than other syllables in the prosodic word. There are no further tonal contrasts possible, so the syllable is only referred to as being accented, with no further qualification. However, the position of the accented syllable can still serve to show lexical contrasts, as exemplified in the partial morphological paradigm in table 11, illustrating the mobile nature of the accent.

Table 11: Short syllable accent minimal pairs: *vis-* ‘everyone/everything’

<i>visas</i>	MASC.NOM.SG	<i>visàs</i>	FEM.ACC.PL
<i>visà</i>	FEM.NOM.SG	<i>visà</i>	NEUT

Orthographically, accented light syllables are always marked with a grave ` mark.

Typical for an accentuation system, there is vowel reduction in non-prominent syllables. Unaccented syllables are also pronounced neutrally with not much pitch movement (similar to the circumflex, i.e. non-falling accent).

4.1.4 Accent on morae or pitch contour over syllables?

A natural way to analyze the different syllable pitch accent types in languages such as Lithuanian with oppositions in pitch contour⁶ in accented syllables is to subdivide the syllable into its moraic constituents, which are then to be considered tone-bearing units. Under this model, the observed syllable accent types can be generated by accentuating moras subject to the following constraint:

- At most one mora in a word is marked as being accentually prominent, usually marked by H (for high pitch/tone).

In an accented light syllable, there is just one mora and no further pitch contour contrasts (V). For accented heavy syllables, the two different pitch contours can be interpreted in the following way:

- The acute accented syllable (falling pitch contour) is interpreted as having an accented first mora (VV).
- The circumflex accented syllable (non-falling pitch contour) is interpreted as having an accented second mora (VV).

Here, the underlining shows which mora is accented with a higher tone. For example, the pitch contour opposition between the previously mentioned contrasting pair *áukštas* ‘tall’ vs. *aūkštas* ‘floor’ could simply be analyzed as an opposition in accent position on morae between *aukštas* ‘tall’ vs. *aukštas*. Note that this is a phonological analysis that partly strips the accent of its phonetic reality, since we talk of abstract accentual units on morae rather than the concrete pitch contours associated to prominent syllables.

While this is a synchronically concise and simple description of the pitch accent in Lithuanian and makes the system easy to compare typologically from a phonological standpoint, this thesis focuses on diachronic development as well. Therefore, the pitch contour descriptions of the accent types are not to be disposed of, since it occurs frequently in historical linguistics that it appears that it is the surface phonetic forms which are subject to change, rather than underlying phonological descriptions stripped of phonetic detail. Furthermore, the simple mora-prominence-based description given here does not generalize easily to the other Baltic varieties, which show more tonal contrasts and even co-occurring features such as creaky voice.

For the purposes of this thesis, the actual pitch contours and other phonetic features associated with a syllable are the key objects of study, since we are investigating the origin of

⁶The traditional term used for the different types of pitch contours of accented syllables in Balto-Slavic studies is **intonation**, as in the phrases *acute intonation* or *circumflex intonation*. Since this thesis tries to compare various prosodic systems of unrelated languages, some of which use the term intonation to mean something completely different, the term intonation is avoided in this thesis.

these features from a diachronic perspective. The mora-based accentual perspective, when applicable, serves only a secondary purpose of being a useful way to understand how a given phonological system functions synchronically. This applies not just to Lithuanian but also to other pitch accent systems found across the Baltic sea area.

4.2 Latvian

In Standard Latvian, the dynamic stress is normally fixed, initial, and importantly, (unlike Lithuanian) independent of tonal contrasts, which can be pronounced on any heavy syllable, not just the metrically prominent one. In fact, there can also be more than one deviant tone per word, as exemplified by the examples in table 12. Since tone and stress are not aligned, Latvian can be said to be more tonal on the stress language/tone language continuum as presented in section 3.4 than a Lithuanian or Tokyo Japanese style ‘pure’ pitch-accent system. Any heavy syllable may bear the tonal distinctions, where the heavy syllables (like Lithuanian) include long vowels and diphthongs, including diphthongs composed of short vowels followed by sonorants (the so-called ‘mixed’ diphthongs).

Table 12: Non-initial and multiple tones per word. (Steinbergs 1977: p. 189)

<i>priēcā:jās</i>	‘he/she/it rejoiced’
<i>tāutiēte</i>	‘countrywoman’
<i>pazāudēt</i>	‘to lose’

The Latvian initial stress system is definitely an innovation, with some asserting its origin in a Livonian substrate, and others advocating for an independent development within Latvian. (Kariņš 1996: p. 14)⁷ The situation is comparable to Czech and Slovak in the West Slavic family, which also innovated fixed initial stress from the formerly free and mobile pitch accent system of Common Slavic still found in South Slavic languages. Unlike Czech and Slovak however, where all inherited suprasegmental features disappeared or only left traces in the form of vowel length (Sussex & Cubberley 2006: p. 152), Latvian kept and further developed its inherited suprasegmental features, reflected as tone and/or creakiness, independently from the initial-shifted dynamic stress.

The three-way tonal distinction prescribed in Standard Latvian is summarized in table 13.

Table 13: The three tones of Standard Latvian

Name		Example	Transcription
<i>stieptā intonācija</i> ‘stretched tone’	level	<i>lōks</i> ‘spring onion’	[lū̯ks] or [lū̯ks̺]
<i>krītošā intonācija</i> ‘falling tone’	falling	<i>lōks</i> ‘arch’	[lū̯ks̺]
<i>lauztā intonācija</i> ‘broken tone’	broken	<i>lōgs</i> ‘window’	[lū̯ks̺]

It is clear from the examples that the tonal contrasts are indeed phonologically relevant and lexically contrastive. (Kariņš 1996: p. 23) describes the phonetic nature of the Standard

⁷Kariņš’s unpublished PhD thesis written at the University of Pennsylvania is notable not just for the dialectal fieldwork it presents but also for the fact that Kariņš himself would later go on to become the prime minister of Latvia.

Latvian tones in long syllables as follows⁸:

- level: A high level tone, which is sometimes slightly rising. The pitch of the following syllable is noticeably lower.
- falling: A high pitch which falls steadily. The pitch of the following syllable is similar to the ending pitch of a syllable bearing a falling tone.
- broken: A falling tone, but with glottalization or laryngealization (creaky voice) on the latter part of the syllable. The second part of the syllable is more quiet than the first.

The type of creakiness associated with the broken tone contour pattern is not uncommon typologically as a co-articulatory feature: the third tone in Standard Mandarin which falls and rises also typically comes with creakiness in the voice, and many authors compare the creakiness of the Latvian broken tone to Danish *stød*. According to Daugavet (2012), Latvian speakers also employ a plain glottal stop to realize broken tone, which is not surprising on account of the fact that creaky voice and glottal stop are quite close on the glottal stricture continuum (see table 1).

However, the prescribed standard three-way contrast has now collapsed in different parts of modern-day Latvia, and it is now only completely maintained in a middle dialect spoken in a restricted area. (Kariņš 1996: p. 22) further notes that he was no longer able to find urban speakers there in 1994/1995 who make the original three-way distinction, and the rural areas which maintain the distinction are also decreasing in size. Table 14⁹ shows how the majority of dialects in Latvia now only show a two-way contrast, though the distribution of distinctions across these two-way-contrast dialects can still be triangulated to recover the original three-way distinction.

Table 14: Development of accentuation patterns across three main Latvian dialects. From (Kariņš 1996: p. 22) following (Rudzīte 1993: pp. 110, 1964).

Middle Dialect (restricted area)	level	falling	broken
Middle Dialect (general area)	level	broken	
Tamian dialect	level	broken	
Western Latgalian dial. (nesēliskās)	falling		broken
Eastern Latgalian dial. (sēliskās)	falling		rising

Notable is the fact that most dialects keep the broken tone, i.e. associate creaky voice with the contour. Even Selonian, which replaced etymological broken tones with a rising tone, accompanies its falling tone with breathy voice (Daugavet 2012), so that phonation still plays a role in reinforcing the pitch contrast. Indeed, we would expect a lower pitch to accompany slacker vocal folds, causing a falling pitch contour.

⁸A much more detailed phonetic study of the tonal contrasts appears in Chapter 5 of (Kariņš 1996).

⁹The table as it appears in (Kariņš 1996: p. 22) has additional rows showing a proposed hypothesis for proto-Baltic and proto-Latvian as well, which I have left out as to not assume a particular diachronic hypothesis.

4.3 Samogitian

Samogitian (or Žemaitian, in the sense of low Lithuanian) is the other major dialect group spoken in the north-west of Lithuania, alongside the dialect group that the standard language is based on. Unlike in Latvia, where the tonal systems of dialects across the country can be reconstructed as reflexes of the 3-way contrast system prescribed for Standard Latvian, the tonal systems of dialects in the Samogitian-speaking areas are divergent from standard Lithuanian, and hence can be usefully used as a third point of comparison for the reconstruction of the proto-Baltic system. In some aspects, the systems in Samogitia resemble those of Latvian more than Lithuanian. The main reference for these groups of dialects is the description of the dialect of Kretinga in (Aleksandravičius 2011).

The two standard Lithuanian pitch accent types in long syllables are realized in the following ways in Samogitian:

- **broken tone** (~ standard Lithuanian acute): a rising-falling tone with strong break at its peak realized as a glottal stop, transcribed as $\hat{\circ}$. Here again, the glottal stop may also be realized with creaky voice (Daugavet 2012), so that it makes sense to use the cover term glottalization.
- **sustained tone** (~ standard Lithuanian circumflex): a mostly falling rising-falling tone, transcribed as $\tilde{\circ}$.

Table 15: Acute and circumflex realizations in Lithuanian and Samogitian

Type	Lithuanian	Phonetic value	Samogitian	Phonetic value
Acute	<i>káulas</i> ‘bone’	Falling	Kr. <i>kâuls</i> ‘bone’	Glottalization
Circumflex	<i>laũkas</i> ‘field’	Non-falling	Kr. <i>lāuks</i> ‘field’	Falling

Table 15 shows how the acute and circumflex categories are realized in the two Lithuanian varieties with corresponding word forms. However, the correspondence is not always one-to-one. In the Samogitian dialect group, the accent system has undergone innovation in the form of stress retractions and the emergence of a system of secondary stress. Therefore, setting up true tonal correspondences with the other Baltic varieties require teasing apart some of the recent innovations. Particularly relevant is the fact that phonotactic constraints such as rhythmic structure play a large role in the exact phonetic realization of the two tones: depending on the quantity of the syllable from which the stress was retracted, the acute may have no associated glottalization, for example. This is reminiscent of the phonotactic constraints on *stød* in the Scandinavian languages described in section 5.1. This makes it less clear whether the glottalization is an old inherited feature: a popular theory proposing that it is inherited comes from the fact that the broken tone here corresponds to the broken tone in Latvian, which also shows glottalization, with the suggestion that loss of glottalization on the inherited acute caused a change from rising to falling tone in standard Lithuanian. On the other hand, authors such as (Svensson 2023: p. 61) argue that the innovative nature of the Samogitian prosodic systems makes this theory less straightforward and demonstrates instances where it seems that broken tone correspond also with circumflex accent in standard

Lithuanian due to the innovated stress system, leading to the conclusion that the broken tone is secondary and arose mainly due to prosodic reasons, possibly to reinforce the length of acute monosyllables. This would parallel the proposed origin of *stød* described in section 7.2.

The main takeaway from looking at the prosodic system of Samogitian Lithuanian is that glottalization plays a role here as well, even if it may be innovated, and that the systems in both Lithuanian dialect groups have a common origin, even if the suprasegmental features do not correspond one-to-one. It is also noteworthy that the pitch contour values of the acute and circumflex appear to be reversed between the two Lithuanian varieties.

4.4 Old Prussian

Old Prussian is an extinct Baltic language attested from the 13th century until the 18th century. While it is impossible to know exactly the nature of the accentual system, the *Enchiridion* is written with optional macrons on syllables with diphthongs or long vowels that correspond to accented syllables in their Lithuanian cognates. As in Lithuanian, the position of the ‘accent’ in Old Prussian is free and mobile. Table 16 presents some examples of Old Prussian attestations with macrons with their Lithuanian counterparts.

Table 16: Old Prussian/Lithuanian cognates (adapted from Stang 1966: p. 144 following Jasanoff 2017: p. 65)

acute			circumflex		
Old Prussian	Lithuanian		Old Prussian	Lithuanian	
<i>pogaūt</i>	<i>pagáuti</i>	‘to catch’	<i>ēit</i>	<i>ėiti</i>	‘goes’
<i>boūt</i>	<i>būti</i>	‘to be’	<i>rānkan</i>	<i>rañka</i>	‘hand’
<i>geīwans</i>	<i>gývus</i>	‘alive’ _{ACC.PL}	<i>īmt</i>	<i>iñti</i>	‘to take’
<i>aīnan</i>	<i>vīena</i>	‘one’	<i>piēnkts</i>	<i>peñktas</i>	‘fifths’
<i>soūnan</i> ¹⁰	<i>sūnu</i>	‘son’ _{ACC.SG}	<i>āusins</i> _{ACC.PL}	<i>aūsį</i> _{ACC.SG}	‘ear’

Although there is no direct evidence for how the macron is supposed to be phonetically interpreted, the general assumption is that the authors meant for the macron to mark the place of higher pitch prominence in a diphthong, with the result that a syllable in Old Prussian with the second mora marked (in most cases lexically corresponding to ‘acute’ accented syllables in Lithuanian) should be interpreted as having a rising pitch contour, while syllables with the first mora marked (corresponding to ‘circumflex’ accented syllables) are interpreted as having a falling pitch contour. These are the reverse phonetic contours compared to standard Lithuanian, and are instead more similar to the phonetic contours for the acute and circumflex found in the Samogitian dialects. In section 4.6 we will see that the acute also corresponds to the rising sustained tone in Latvian and the rising tone in Slavic, while the circumflex corresponds to the falling tone in Latvian as well. This hints that Old Prussian retained a more conservative phonetic realization of the tonal contrasts in accented syllables from Balto-Slavic.

¹⁰This form has been changed to the accusative to make the correspondence clearer without needing to cite a dialectal nominative in Lithuanian.

4.5 Slavic

The Slavic languages vary quite considerably from a typological point of view in terms of their prosodic systems. Table 17 briefly summarizes the presence or absence of accent mobility, pitch contrasts, and length contrasts in the major varieties of the South, East, and West Slavic subgroupings. We see that even very closely related varieties such as Bulgarian and Macedonian show a difference in having mobile accent, and some varieties do not show any kind of lexical suprasegmental or prosodic contrasts. None of the modern Slavic languages show lexicalized glottalization features. Despite the variety in prosodic systems, the relatively low time depth of the Slavic language family (with some estimates for the disintegration of Late Common Slavic concurrent with the first Old Church Slavonic texts in the 9th century) has allowed for a secure reconstruction of the majority of Proto-Slavic etyma and morphological processes, including their associated suprasegmental features. Based on this comparative base, Stang's (1957) influential work on Slavic accentology has also been able to establish a consensus around the synchronic prosodic system and morphological accentual paradigms governing the distribution of the reconstructed mobile pitch accent in Proto-Slavic itself, to the point where Proto-Slavic is frequently treated as if it were an attested language in wider Balto-Slavic studies.

However, on the flip side, the Slavic continuum functioned as a mutually intelligible dialect continuum for a very long time, during which many sound changes took effect in a way that is difficult to untangle into chronological layers, making references to the system at a particular moment in time complicated. The description of the reconstructed system in Proto-Slavic that follows tries to capture the features that were true throughout, otherwise emphasizing the system at its later stages in time which more closely resembles the situation in the later differentiated varieties.

Table 17: Prosodic typology in the Slavic languages (after Sussex & Cubberley 2006: p. 154)

Language	Accent mobility	Pitch contrast	Length
Proto-Slavic	✓	✓	✓
Bulgarian	✓		
Macedonian	Fixed penultimate		
B-C-S-M	✓	✓	✓
Slovenian ¹¹	✓	✓	✓
Belarusian	✓		
Ukrainian	✓		
Russian	✓		
Czech	Fixed initial		✓
Slovak	Fixed initial		✓
Sorbian	Fixed initial		
Polish	Fixed penultimate		

Generally speaking, the reconstructed system for Proto-Slavic resembles the pitch-accent system seen in Lithuanian, showing all three dimensions of accent mobility, pitch contrast, and nuclear length. For full prosodic words, the accent is free and mobile, though the kinds

¹¹Slovenian shows the additional constraint that only accented syllables may be long.

of lexically relevant tonal contrasts available depend not only on the length of the syllable as in Lithuanian, but also on whether the syllable is initial or non-initial. (Sussex & Cubberley 2006: p. 151)

In Proto-Slavic, for most purposes, only long, accented, and initial syllables retained a salient two-way tonal contrast between rising (“acute”) and falling (“circumflex”) pitch contours. The rising accent is the marked feature. When a short initial syllable is accented, the pitch contour is always reconstructed to be falling. In non-initial accented syllables of either length, the pitch contour is always reconstructed to be rising.¹² Table 18 summarizes the reconstructed possible configurations of pitch contrast, length, and position for accented syllables, along with some examples transcribed in an orthographic system reminiscent of the tonal transcription systems for Slovenian and B-S-C-M, where length and accent type are combined into one orthographic unit as well. Indeed, these Southwest Slavic languages are also accentually the most conservative in the wider Slavic family, retaining in large part accent mobility, pitch contrast, and vowel length.

Table 18: Proto-Slavic reconstructed accent types (following Jasanoff 2017: pp. 43–44)

Pitch contour	Length	Notation	Position	Examples
rising (“acute”)	long	ǃ	any	* <i>dǃti</i> ‘to give’, * <i>vǃrna</i> ‘crow’
falling (“circumflex”)	long	ô	initial	* <i>mêso</i> ‘meat’, * <i>gôlvy</i> ‘heads’ _{NOM-ACC.PL.}
rising	short	ò	non-initial	* <i>vedetò</i> ‘leads’, * <i>naròdò</i> ‘people’
falling	short	ö	initial	* <i>vèdò</i> ‘I lead’, * <i>nòsò</i> ‘nose’

4.6 Lexical correspondences: Reconstructing an acuteness feature

Although the prosodic systems of the Balto-Slavic languages vary substantially in how they function synchronically, as was the case for within Slavic itself, it is still possible to set up systematic correspondences between cognates in a way that reveals information about how the suprasegmentals of these languages are diachronically related. What is interesting when applying the comparative method at the Balto-Slavic level is that a clearer picture of how the prosodic system synchronically functioned in Balto-Slavic requires not only the comparison of individual etyma but also of entire paradigmatic types. Focusing on the correspondence between Lithuanian and Latvian, table 19 shows how the three tones in simple, monosyllabic base nouns in Latvian correspond to three out of four accent paradigms in nouns in Lithuanian:

The basic correspondences shown here are that monosyllabic nouns with level tone in Latvian correspond to fixed acute (falling) accent nouns in Lithuanian, while monosyllabic nouns with falling tone in Latvian correspond to fixed circumflex (rising) accent nouns in Lithuanian. As a reminder, Latvian words always show initial stress, while heavy syllables carry different tones, whereas Lithuanian words only show tonal contrasts on the accented heavy syllable.

¹²Although long, accented, and non-initial syllables did originally show a marginal tonal contrast between rising and falling in earlier Proto-Slavic, due to retraction processes involving falling accents and the tendency to shorten non-initial syllables, all non-initial accented syllables ended up showing a rising pitch contour by the time of Late Common Slavic. (Jasanoff 2017: p. 44)

Table 19: Lithuanian and Latvian cognates; (M) indicates a word in the mobile stress paradigm in Lithuanian (Kariņš 1996: p. 19)

Latvian	Lithuanian	gloss
vīrs	výras	man
liēpa	líepa	linden tree
māte	mótina	mother
saūle	sáule	sun
uōla	úola	egg
diēgs	díegas (M)	thread
dzīvs	gývas (M)	alive
puōds	puódas (M)	pot
siēts	siétas (M)	sieve
uōga	úoga (M)	berry
dràugs	draūgas	friend
àuskars	aūskaras	earring
dzìmt	gĩmti	to be born
raìbs	raības	colorful
sveìks	sveīkas	healthy, well

The correspondence for nouns showing the broken tone is more complicated: monosyllables in Latvian showing the broken tone correspond to mobile accent nouns in Lithuanian, where the accent alternates between the root syllable, surfacing as acute, and the ending, where it surfaces with as a circumflex, unless the syllable is light, in which case the contrast between circumflex and acute is neutralized. Table 20 shows this inter-paradigmatic correspondence in more detail, where the accentuation pattern class numbers for Lithuanian are annotated to make the correspondence with the Latvian tonal types clearer.

The main takeaway is that it's not possible to set up a straightforward correspondence just between the types of tonal contrasts we find in heavy syllables between Latvian and Lithuanian. The position of the mobile accent in Lithuanian also plays a role in the type of tone that surfaces in Latvian, as demonstrated by the correspondence between the broken tone nouns in Latvian and the mobile accent paradigm type nouns in Lithuanian. Although the details get more complicated with more complex words, the fundamental observation is that the position of the accent and the type of tonal contrast shown on heavy syllables have to be treated as independent variables in Proto-Baltic.

Even synchronic analysis within Lithuanian point to the pitch contour type in heavy syllables in Lithuanian functioning independently (in the sense of “acuteness” being a property of the morpheme itself) from the position of the accent in morphological alternations where the position of the accent changes. This type of alternation situation comes up often¹³ and is usually explained in general in historical linguistics by internal reconstruction

¹³For an example of a similar (but simpler) situation, the alternation of *ue* vs *o* in some Spanish verbal paradigms such as in *'puedo* ‘I can’ vs *po'demos* ‘we can’ for the verb *po'der* ‘to be able to’ leads to an internal reconstruction in which the root of the verb is lexically specified as **pɔd-*, where **ɔ* later broke into *ue* in stressed syllables and is neutralized to *o* otherwise, causing the alternation to mirror the stress mobility. This hypothesis is confirmed by the reconstruction of Proto-Romance and the Classical Latin vowel system, illustrating how comparative evidence can often corroborate a suspected internal reconstruction. (Alkire & Rosen 2010:

Table 20: Lithuanian and Latvian nominal paradigm comparison. Adapted from (Kariņš 1996: p. 17)

		Lithuanian acute (falling)	Latvian level	Lithuanian acute (falling)	Latvian broken	Lithuanian circumflex (rising)	Latvian falling
SG	NOM	výr-as	vīr-s	diég-as	diêg-s	draũg-as	draũg-s
	GEN	výr-o	vīr-a	diég-o	diêg-a	draũg-o	draũg-a
	DAT	výr-ui	vīr-am	diég-ui	diêg-am	draũg-ui	draũg-am
	ACC	výr-ą	vīr-u	diég-ą	diêg-u	draũg-ų	draũg-u
	LOC	výr-e	vīr-a:	dieg-è	diêg-a:	draug-è	draũg-a:
PL	NOM	výr-ai	vīr-i	dieg-aĩ	diêg-i	draũg-ai	draũg-i
	GEN	výr-ų	vīr-u	dieg-ų	diêg-u	draũg-ų	draũg-u
	DAT	výr-ams	vīr-iem	dieg-áms	diêg-iem	draũg-ams	draũg-iem
	ACC	výr-us	vīr-us	diég-us	diêg-us	draug-ùs	draũg-us
	LOC	výr-uose	vīr-uos	dieg-uosé	diêg-uos	draũg-uose	draũg-uos
	Gloss	‘man’		‘thread’		‘friend’	
	Class	1		3		4	

analyses which posit an independent feature as having existed in the past (in this case, “acuteness”), but which was then later neutralized in certain contexts (here, in unstressed syllables), leading to such synchronic alternations (see Jasanoff 2017: p. 36 for more on the Lithuanian-internal analysis of the autonomy of acuteness).

As an example of how Proto-Slavic can also serve as another point of triangulation, table 21 adds cognate forms to the Latvian broken tone ~ Lithuanian class 3 correspondence already discussed. Here, the circumflex in Proto-Slavic appears to regularly correspond to the position of the acute accented syllable in Lithuanian for class 3 nouns. It is important to note that acute accented syllables in Lithuanian can also correspond to Proto-Slavic acute accented syllables in other accentual paradigms, so again, correspondences between accent type cannot be made without reference to the paradigms the forms function in.

Table 21: Latvian - Lithuanian - Slavic correspondences (Jasanoff 2017: p. 63)

Latvian	Lithuanian	Slavic
<i>galva</i> , acc. <i>galvu</i> ‘head’	<i>galvà</i> , acc. <i>gálvą</i>	* <i>golvá</i> , acc. * <i>gôlvą</i>
<i>dzīvs</i> , fem. <i>dzīva</i> ‘alive’	<i>gývas</i> , fem. <i>gyvā</i>	* <i>žīvъ</i> , fem. * <i>živá</i>
<i>jaūns</i> , fem. <i>jaūna</i> ‘young’	<i>jáunas</i> , fem. <i>jaunà</i>	* <i>jūnъ</i> , fem. * <i>juná</i>
<i>zvērs</i> , fem. <i>zvēri</i> ‘wild animals’	<i>žvēris</i> , acc. <i>žvéri</i>	* <i>zvěrbъ</i>
acute continued by broken tone in originally mobile paradigms	class 3 (acute mobile)	acute continued by circumflex in root-accented mobile forms (Meillet’s Law)

Hence, reconstructed Proto-Baltic, and by further corroboration of the Slavic data, Proto-Balto-Slavic, is assumed to have at least three independent features which interacted and created the different tonal and phonation reflexes seen in the prosodic systems of the Balto-Slavic languages:

1. There was some type of free and mobile pitch or stress accent reflecting the Proto-Indo-European pitch accent (cognate to the pitch accent in Ancient Greek and Vedic Sanskrit, and also reflected as voicing contrasts in Germanic via Verner's law). This means that there was an accentually prominent syllable per prosodic word.
 - Some authors such as Jasanoff (2017) also recognize a 'left marginal accent', which was a default type of initial accent that surfaced when the lexically specified accent was not present on the initial syllable.
2. There was an lexically specified phonological pan-syllabic feature called **acuteness**, so named as it is frequently associated with the acute accent in Lithuanian. This feature can furthermore be specified on any and also potentially on more than one syllable in a word.
3. There was a length distinction between short and long vowels.

This model has enough parameters to generate the different reflexes seen in the Balto-Slavic language via different retraction processes and analogical levelling in the individual histories of the Balto-Slavic languages. For example, table 22¹⁴ shows one proposed reconstruction of how syllable weight, acuteness (here marked with an underline), and accent position (here marked by the *◌̇* diacritic, whose absence leaves a 'default' or 'left-marginal' stress on the first syllable marked by the *◌̈* diacritic) in Proto-Balto-Slavic interact and get reflected into Lithuanian, Latvian, and Proto-Slavic. In this reconstruction, the accent types are also associated with the accentual mobility of the paradigm: the first three lines are associated with immobile lexical accent in the paradigm (with corresponding Proto-Balto-Slavic nom. sg. forms **várṇā*, **pāistā*, **blūšā*) and the second three lines with mobility in the paradigm (with corresponding Proto-Balto-Slavic nom. sg. forms **galvā*, **žeimā*, **krušā*). These examples also illustrate how acuteness can be associated with more than one syllable in a word. In this case, a form like **galvā* is marked for acuteness both on the root syllable and on the nominative singular inflectional ending.

How exactly were these features phonetically realized? In terms of the accent, the position and nature of the mobile accent is generally agreed upon, not only from comparison within the Balto-Slavic language family, but also due to the accent having counterparts in other Indo-European languages. Table 23 below shows that the position of the Balto-Slavic accent can be meaningfully compared across Indo-European languages in many cases:

Hence, the reconstructed accent in Balto-Slavic is taken to ultimately reflect the mobile and free accent reconstructed for PIE, which is commonly taken to have prominence expressed mainly by pitch on the basis of descriptions of contemporary grammarians on the nature of the accent attested in the earliest Ancient Greek and Vedic texts. However, to complicate matters, there are a plethora of proposed sound laws for Balto-Slavic, which obscure many of the correspondences regarding the position of the accent reconstructed in Balto-Slavic and the mobile accent reflected in other Indo-European language. For more

¹⁴For an explanation of the accentual paradigms in Proto-Slavic, see (Stang 1957).

¹⁵The diacritic *◌̇* in Proto-Slavic forms in this table denotes the position of the accent without committing to its pitch contour type.

Table 22: One possible reconstruction of the prosodic system in Balto-Slavic (Jasanoff 2017: p. 72)

description	Proto-BSl.	Lith.	Latvian	Proto-Slavic
acute long nucleus lexical accent	* <i>várnān</i>	<i>várną</i> acute	<i>vārnū</i> level tone	* <i>vórnŋ</i> long rising (acute)
non-acute long nucleus lexical accent	* <i>páistān</i>	<i>piēstą</i> circumflex	<i>pìestu</i> falling tone	* <i>pěstŋ</i> ¹⁵ > * <i>pěstŋ</i> AP b (w. Dybo's Law)
short nucleus lexical accent	* <i>blušān</i>	<i>blùsą</i> (simple accent)	<i>blusu</i> (simple accent)	* <i>bl̥xŋ</i> > * <i>bl̥xŋ</i> AP b (w. Dybo's Law)
acute long nucleus left marginal accent	* <i>gǎlvān</i>	<i>gálvą</i> acute	<i>gálvu</i> broken tone	* <i>gôlvŋ</i> long falling (c'flex)
non-acute long nucleus left-marginal accent	* <i>žėimān</i>	<i>žiẽmą</i> circumflex	<i>zìemu</i> falling tone	* <i>zîmŋ</i> long falling (c'flex)
short nucleus left-marginal accent	* <i>krūšān</i>	<i>krūšą</i> (simple accent)	<i>krušu</i> (simple accent)	* <i>kr̥sŋ</i> short falling

Table 23: Correspondence of accent position in Indo-European (Halle 2003: p. 160)

Vedic	Russian	Lithuanian	
b ^h rá:tar	brát-a	bról-is	'brother'
	ív-a	iev-a	'willow'
ni:d-ám	gne:zd-ó	lizard-áms	'nest'
ras-á:	ras-á	ras-à	'dew'

on how the position of the Indo-European accent developed into the Balto-Slavic languages, see (Jasanoff 2017) and (Svensson 2023).

The position of where the acuteness feature was specified in any given word is also fairly securely reconstructable on the basis of the reflexes in the Balto-Slavic languages. However, the question of what the nature of the abstractly reconstructed acuteness feature was is much less straightforward to answer, given that, from a phonological point of view, there doesn't seem to be a similar feature in other ancient attested Indo-European languages that also conditioned various tonal contrasts or register-type phonation. Section 6.2 attempts to address the phonetic and phonological nature of the acuteness feature, while section 7.1 discusses the possible Indo-European origins of the feature.

5 Suprasegmental systems in Scandinavian languages

Like other Germanic languages, the Scandinavian languages all use pitch-based accent at the sentence level quite pervasively for focus intonation. However, similar to the Balto-Slavic languages, the Scandinavian language area is also home to varieties with contrastive pitch-accent types at the word level. Furthermore, there are other varieties that show a phonemic suprasegmental glottalization feature instead of the word-level pitch accent. Because the Scandinavian language area still forms a cohesive dialect continuum where the demarcation between the pitch-accent varieties and glottalization-feature varieties are not necessarily cleanly delineated by national linguistic borders (i.e. Danish, Swedish, Norwegian), this chapter summarizes the suprasegmental systems according to type of system rather than language spoken.

5.1 *stød*

stød is a suprasegmental feature found in some Scandinavian varieties (mainly in Denmark) such as standard Danish. It is typically phonetically realized with creaky voice or as a glottal stop and commonly denoted in phonetic transcription by the superscripted symbol $\text{◌}^?$. The feature is contrastive, as shown in the following table:

Table 24: Danish: *stød* and no-*stød* pairs (Riad 2003: p. 263)

<i>stød</i>			no <i>stød</i>		
hund	[hun [?]]	‘dog’	hun	[hun]	‘she’
vend	[ven [?]]	‘turn!’	ven	[ven]	‘friend’
læser	[lɛ: [?] sɐ]	‘reads’	læser	[lɛ:sɐ]	‘reader’
hænder	[hɛn [?] ɐ]	‘hands’	hænder	[hɛnɐ]	‘happens’

Additionally, there are certain phonological and phonotactic constraints called *stød*-basis for when *stød* can surface in a word. In standard Danish, the syllable must be stressed, word-final, and bimoraic (heavy), where the second mora is a non-word final sonorant or a vowel, so that large amounts of the lexicon do not show *stød*. This constraint also results in alternations such as singular *hus* [hu:[?]s] ‘house’ vs. plural *huse* [‘hu:sə] ‘houses’, or definite *loven* [lɔw[?]ɐ] ‘the law’ vs. *lov* [lɔw] ‘a law’. Phonetically, *stød*-basis can be explained by the fact that creaky voice is acoustically associated with a frequency so low that the individual peaks and troughs of the sound wave can be discerned as ‘creaks’, so that the syllable needs to be sonorous for long enough and loud enough for the creakiness to be discernible.

On account of these constraints on *stød* and its general lexical distribution, we say that having *stød* is marked whereas not having *stød* is unmarked.

5.2 Pitch accent

Other Scandinavian varieties, including many southern Danish dialects, generally show some kind of pitch-based accent feature at the word level, where phonetic contrasts are made with the use of pitch on the prosodically prominent syllable in the word, in other words, where the primary stress lies. As in the Balto-Slavic languages, lexical items can

show different pitch contour types, making these varieties pitch-accent languages in the sense described in section 3.4. The two pitch accent types found in Scandinavia are abstractly labeled Accent 1 and Accent 2, where the concrete pitch contours assigned to each depend on the exact variety spoken. In particular, while accent 1 is realized as a sharp falling pitch contour on the stressed syllable and accent 2 is realized as a gradual falling pitch contour over potentially several syllables in Standard Swedish, the phonetic realizations of the two accent types vary widely across Norwegian dialects. Table 25 shows some word pairs that are distinguished by pitch contour. Even the number of syllables required to show a contrast in pitch contours can differ: some varieties make a distinction even between monosyllables, as in South Jutlandic (see table 27), whereas others like Standard Swedish require two syllables to show contrastive tonal contours. In addition, different varieties exploit pitch accent to differing degrees, but for the most part the use of pitch accent for lexical contrast is quite marginal. Some dialects (especially those in language contact situations) of Swedish and Norwegian have lost the pitch accent opposition entirely.

Table 25: Swedish: Accent 1 and Accent 2 pairs (Gårding 1977)

Accent 1			Accent 2		
and-en	[¹ andən]	‘duck-the’	ande-n	[² andən]	‘spirit-the’
tank-en	[¹ taŋkən]	‘tank-the’	tanke-n	[² taŋkən]	‘thought-the’

Accent 1 is unmarked, while accent 2 is the marked, on account of accent 1 typically being a plain stressed syllable (Riad 1998).

5.3 Lexical correspondences between pitch accent and *stød*

The phonetic constraints governing when *stød* can appear and where pitch accent is allowed to occur in a word differ in many important respects, such as the fact that *stød*-basis is related to segmental sonority conditions and pitch accent is necessarily constrained to only one metrically prominent syllable in a given word. Nevertheless, it is well known that Accent 1 and *stød* do generally correspond in simple forms (i.e. non-compound words with one metrically prominent syllable) when the *stød*-basis constraint is not at play, while words with Accent 2 correspond to words without *stød*. The following table illustrates some examples of the correspondence for different types of non-compounds forms:

Table 26: Word accent correspondences (Wetterlin & Lahiri 2015: p. 54)

a. NOUNS	Norwegian	Swedish	Danish	Gloss
monosyllabic	arm ₁	arm ₁	arm [?]	arm
disyllabic A2	'sommer ₂	'summar ₂	'sommer	summer
disyllabic A1	kon'jakk ₁	'konjak ₁	'kogn [?] ak	cognac
monosyllabic + definite article	'arm=en ₁	'arm=en ₁	'arm [?] =en	arm=the
disyllabic A1 + definite article	kon'jakk=en ₁	'konjak=en ₁	'kogn [?] ak=en	cognac=the
disyllabic A2 + definite article	'sommer=en ₂	'summar=en ₂	'sommer=en	summer=the
monosyllabic + inflection	'arm-er ₂	'arm-ar ₂	'arm-e	arms
monosyllabic + inflection + definite article	'arm-e=ne ₂	'arm-ar=na ₂	'arm-e=ne	arms=the
b. VERBS				
Imperative	stem ₁	stäm ₁	stem [?]	tune!
Infinitive	'stemm-e ₂	'stämm-a ₂	'stemm-e	to tune
Prefix unstressed	be-'stemm-e ₁	be-'stämm-a ₁	be-'stemm [?] -e	to decide

For compound forms, the interactions are quite different and hence not as comparable across varieties, especially given the aforementioned constraints: *stød* can surface multiply on the individual components of a compound word in Danish, whereas the pitch accent varieties each have different rules for what pitch accent type might surface over the entire compound.

In Denmark itself, we have what is arguably an even clearer set of correspondences between Standard Danish and South Jutlandic when it comes to *stød* and tonal contrasts. Table 27 shows how *stød* in Standard Danish corresponds to low tone and absence of *stød* corresponds to high tone in South Jutlandic monosyllables. The South Jutlandic transcriptions come from (Jespersen 1906: p. 128).

Table 27: Standard Danish and South Jutlandic correspondences

Standard Danish	IPA	South Jutlandic
<i>dag</i>	['tɛ [?]]	['tåw]
<i>dage</i>	['tɛ:ə]	['tåw]
<i>liv</i>	['liw [?]]	['lÿw]
<i>lyve</i>	['ly:və]	['lÿw]

Since the presence or absence of *stød* appears to etymologically correspond to a tonal opposition in pitch-accent varieties of North Germanic, the question of where these features came from arises naturally, given that the other Germanic languages have no such features. Even Old Norse is typically not assumed to have either suprasegmental feature (Icelandic shows neither as well), so unlike in the case of Proto-Balto-Slavic with acuteness, it is more difficult to reconstruct a coherent stage with an abstract feature that originated both the *stød*-

varieties as well as the pitch-accent varieties. Nonetheless, section 6.3 attempts to answer the question of which feature came first and what their relationship is to each other.

6 Development of pitch contrast: a diachronic typology

In considering the diachrony of tone and glottalization in the Baltic sea area, we should turn to advances made in the understanding of the diachrony of tone in other language families over the past century. In his seminal work on the origin of tones in Vietnamese, Haudricourt (1953) (1954) established that tone systems are not unchanging characteristics of a language or the family it belongs to, and are susceptible to being innovated, being lost, or borrowed in words from unrelated languages just as other phonetic features are. Concretely, Haudricourt showed systematic correspondences between segmental features and tone contours between Vietnamese and other potentially related languages, ultimately proposing that the tones seen in Vietnamese were innovated from a toneless proto-language, in a process now known as **tonogenesis**¹⁶. Since then, a consensus has formed that the emergence of tonal systems in the mainland Southeast Asia area was an areal phenomena, and that the development of tone systems is generally susceptible to spreading through language contact. Additionally, a wide variety of tonogenetic events have been recorded from all over the world, including those that are currently in-progress.

In an attempt to create a comprehensive diachronic typology over the types of evolutionary paths that can lead to tone systems, Hyslop (2022) surveys 73 different tonogenetic events worldwide in terms of syntagmatic position of trigger (onset, nucleus, code), manner of trigger (e.g. stop, fricative, glide), and laryngeal setting of trigger (e.g. glottalization, aspiration, voicing). She also distinguishes between strict and broad tonogenesis, where **strict tonogenesis** refers to how pitch becomes phonologized in a previously toneless system, while **broad tonogenesis** includes cases where existing pitch contrasts are restructured or amplified.

Despite the diversity of these evolutionary paths, the triggers and conditions for new pitch contrasts are generally associated with segmental features involving phonation-based distinctions or laryngeal/glottal action which induce contrasts in pitch. More specifically, the following phonetic contrasts are listed in (Michaud & Sands 2020) as showing tonogenetic potential:

- glottalized vs plain segments
- voiced vs unvoiced obstruents
- aspirated vs unaspirated segments
- geminates vs simple consonants
- tense vs lax phonation
- laryngeal contrast on stops vs fricatives and sonorants

These contrasts frequently cause pitch perturbations in the surrounding vowels due to the aerodynamic and acoustic properties of the glottis during articulation, as discussed in

¹⁶Term coined by Matisoff (1973).

section 3.1. Over time, such perturbations can be reanalyzed by listeners as contrastive pitch features, especially when the original conditioning segments are weakened or lost.

With this backdrop in place, the next sections will specifically describe cases of tonogenesis particularly relevant for reconstructing the emergence and development of tone systems in the Baltic sea area. Namely, languages that are suspected to have developed tonal contrasts from coda or rhyme-based phonation-type contrasts involving glottalization present similarities to the observed distribution of system types in what we can reconstruct for Balto-Slavic languages and Scandinavian languages. These similarities lead to possible explanations for how known phonetic triggers and positional factors can account for the suprasegmental developments observed in the Baltic sea area.

6.1 Tonogenesis by loss of laryngeal consonants

6.1.1 The classic prototype: Vietnamese

To introduce the classic prototype for this kind of tonogenesis, we start with the development of tone in Vietnamese from Proto-Viet-Muong. Proto-Viet-Muong is reconstructed to be toneless¹⁷ and showed a three-way contrast in rhyme endings between $-\emptyset$, $^{-}$ (constricted voiced ending rhyme, i.e. glottalization), and $-h$ (laryngeal spirant ending). (Ferlus 2004: p. 298)

The first stage in the history of Vietnamese tonogenesis is illustrated in table 28. A four way tonal contrast was created as a result of different phonation types in the syllable rhyme.

Table 28: First tonal split in Vietnamese: coda conditioned contrasts

Proto-Viet-Muong		Middle Vietnamese	Possible value
<i>*ta</i>	>	<i>*ta_A</i>	mid
<i>*ta^ʔ</i>	>	<i>*ta_B</i>	rising
<i>*tah</i>	>	<i>*ta_C</i>	falling
<i>*tap, *tat, *tak</i>	>	<i>*tap, *tat, *tak</i>	no tone

The reconstructed tone contour values for A, B, and C are not clear, but based on their eventual reflexes into Modern Vietnamese, Haudricourt (1954) supposes that the coda glottal stop or glottal constriction (glottalization) is anticipated by an increase in vocal fold tension in the preceding vowel, creating a rise in pitch on the vowel. In contrast, the laryngeal $-h$ is anticipated by the slackening of the vocal folds in the preceding vowel, causing a drop in pitch on the vowel. In summary, we see that the coda syllable appears to modify the end of the pitch contour of the syllable. Once the cue for the phonation type of the coda consonant got reinforced by the tonal contrast on the syllable as well, the coda feature dropped out. As Proto-Viet-Muong was toneless, this first tonal split is an instance of strict tonogenesis.

To finish out the story of tonogenesis in Vietnamese for the sake of completeness, table 29 illustrates how initial voicing contrasts conditioned more tonal contrasts before initial voicing itself was lost. The resulting modern tones in Northern Vietnamese are described in

¹⁷Vietnamese is part of the larger Austroasiatic language family, the majority of which have no tones.

table 30. The structural split between the six Northern Vietnamese tones into two groups was discovered quite early on the basis of Chinese loanwords by Maspero (1912: pp. 95–96) before Haudricourt (1954) interpreted the groups as reflexes of former initial voicing distinctions. As Middle Vietnamese already had a four-way tonal opposition (A, B, C, and no tone), the second tonal split is an instance of broad tonogenesis.

Table 29: Second tonal split in Vietnamese: initial conditioned contrasts

Middle Vietnamese			Northern Vietnamese
Onset	Tone	Coda	Tonal reflex
Voiceless	A		> <i>ngang</i>
Voiced	A		> <i>huyền</i>
Voiceless	B		> <i>sắc</i>
Voiced	B		> <i>nặng</i>
Voiceless	C		> <i>hỏi</i>
Voiced	C		> <i>ngã</i>
Voiceless		<i>p, t, k</i>	> <i>sắc</i>
Voiced		<i>p, t, k</i>	> <i>nặng</i>

Table 30: The six tones of present-day Northern Vietnamese (Michaud & Sands 2020: p. 3).

name	description	IPA	tone numbers	example
ngang ‘level’	mid level	˥	44	<i>ma</i> ‘ghost’
sắc ‘sharp’	high rising	˨˩˦	24	<i>má</i> ‘cheek, mother (southern)’
huyền ‘hanging’	low falling (often breathy)	˨˩˦˨˩˦	32	<i>mà</i> ‘but’
hỏi ‘asking’	mid dipping	˨˩˦˨˩˦˨˩˦	312	<i>mả</i> ‘tomb, grave’
ngã ‘broken’	medial glottal constriction, ends on high pitch	˨˩˦˨˩˦˨˩˦˨˩˦	325	<i>mã</i> ‘code’
nặng ‘heavy’	glottal constriction cuts short the syllable	˨˩˦˨˩˦˨˩˦˨˩˦˨˩˦	22	<i>mạ</i> ‘rice seedling’

Like in Latvian and Samogitian Lithuanian, some tones in Vietnamese are associated glottal constriction. It is worth noting as a parallel discussed issue that this constriction is sometimes explained as an innovation rather than a retained reflex of the glottalization reconstructed in Proto-Viet-Muong (Michaud & Sands 2020: p. 9).

6.1.2 Happy to be spread: the Mainland Southeast Asia area

Tonogenesis is well-known for being an areal phenomenon, in the sense that even unrelated languages in close contact end up showing remarkably parallel tonal developments. This is especially apparent in the Mainland Southeast Asia area, where phonation types seem to

have conditioned tonal contrasts exactly as in Vietnamese in completely unrelated language families. The approximate time period in which these geographically close languages underwent the acquisition of tones appears to align, making it more likely for the tone systems of these languages to have influenced each other areally than for them to have developed in parallel independently .

In White Hmong (part of the Hmong-Mien family), the process looks very similar to what happened in Vietnamese, where coda glottalization conditioned a rising tone, while a glottal spirant conditioned a falling tone:

Table 31: Tonogenesis in White Hmong (Ratliff 2015: p. 249)

Atonal stage	CV	CV?	CVh	CVC _{vl}
Tonogenesis	CV ^{level}	CV ^{rising}	CV ^{falling}	CVC _{vl} ^{atonal}

In addition, Middle Chinese, a Sino-Tibetan language, is also theorized to have developed tones from an atonal Old Chinese stage. Here, a coda glottal stop is reconstructed to be reflected as a rising tone as well, with a spirant coda *-s* behaving like final *-h*¹⁸ in the history of Vietnamese and White Hmong tonogenesis:

Table 32: Tonogenesis in Chinese (Sagart 1999)

Atonal stage	-Ø, -N	-ʔ	-s	-p, -t, -k
Tonogenesis	平 <i>píng</i> (level)	上 <i>shǎng</i> (rising)	去 <i>qù</i> (departing)	入 <i>rù</i> (entering)

In fact, Sagart (1999: p. 11) proposes that the tonal developments in Vietnamese were very likely transmitted from Chinese as it was acquiring tone due to the Chinese occupation of Vietnam.

The general observation that languages without tone in unrelated families can influence each other to develop them in similar ways is strong evidence for Haudricourt's assertion that tone systems are not unchanging properties of language systems, but rather are easily innovated and borrowed or lost, exactly as other types of sound changes. In fact, tonogenesis seems to be relatively eager in being triggered areally due to contact. This observation has led many (see Svensson 2023: p. 114) to therefore suggest that the innovative tonal systems in Balto-Slavic and Scandinavia may have also influenced each other in their development due to their close areal proximity. However, such theories are made more or less likely depending on the exact time period the tonal or prosodic developments are supposed to have taken place.

6.1.3 Go high or go low?: Dene (Athabaskan)

This section presents the case of tonogenesis in Athabaskan to show that coda glottalization does not necessarily always get reflected as a higher ending pitch in the syllable as it did in Vietnamese and presents possible explanations for this fact. The idea that related languages can reflect very different tonal values from the same non-tonal source also manifests itself in the Balto-Slavic languages and Scandinavian languages, which sometimes show completely

¹⁸An intermediate sound change *s* > *h* is very likely in this case and also typologically expected.

opposite tonal values in corresponding forms, so a better typological understanding of how these differences can arise is important.

Table 33 illustrates that glottalization and different tone values correspond among the Athabaskan languages. The tonal languages general distinguish between high and low tone, while the atonal situation with a contrast between glottalization and no glottalization as still reflected in Hupa is presumed to be original. The glottal constriction is more precisely present in the ejective stop *t'*. This glottalization became high tone in most Athabaskan languages such as Chipewyan (like in Vietnamese), but was also reflected in some languages as low tone, as in Gwich'in.

Table 33: Tone contrast and glottalization in Athabaskan (Michaud & Sands 2020: p. 9)

Proto-Dene	Chipewyan	Gwich'in	Hupa	
*łəd	łər	łád	łid	'smoke'
*wət'	bér	vàd	mət'	'belly'

What are the possible explanations for the differing tonal reflexes? In general, there are two ways to explain why glottalization would produce a pitch rise in some languages but a pitch drop in others:

1. The exact phonetic realization of the glottalization was different between divergent varieties at the time they conditioned tone. Indeed, glottalization is only a cover term for being somewhere on the continuum of glottal constriction, and we would expect anticipating tenser glottal constriction (such as in ejectives or full glottal stops) to condition higher pitch in the syllable than we would expect with anticipating laxer glottal constriction (such as in creaky voice).

As further argued in (Michaud & Sands 2020: p. 9), the state of the phonological system influences the threshold of what part of the glottal stricture spectrum ends up being ultimately interpreted as high or low tone. It is often observed in sound change that there is pressure to preserve phonological contrast on a systematic level, though of course merger happens often as well. For example, as Proto-Viet-Muong already had a breathier type of glottal stricture, namely in *-h*, which naturally would condition a lower ending pitch on the syllable, rhyme glottalization in *-ʔ* had to condition a higher ending pitch on the syllable in order to preserve the contrast, since the rhyme glottalization was still more tense in terms of glottal stricture than the laryngeal spirant.

2. At the time that glottalization conditioned tonal contrasts in certain varieties, the tonal outcome was the same, but later sound change caused the tone values in one variety to change or, in the most extreme case, for tonal reversal to happen (see e.g. (Langston 2011) for tonal reversal in dialects of Croatian and (Ternes 2006) for Franconian).

In order to distinguish between the possibilities, careful work needs to be done to tease out the exact diachrony and intermediate stages by examining data among all relevant varieties.

6.1.4 How common is coda/glottalization-triggered tonogenesis?

The survey in (Hyslop 2022) offers a way to quantitatively evaluate how commonly coda position and/or glottalization end up conditioning tonogenesis. Out of her 73 recorded tonogenetic event, 13 were triggered by elements in coda position, in languages as geographically distinct as Vietnamese, Upriver Halkomelem, Tsat, Tibetan, Panjabi, Lahu, Dâw, Mandarin, Burmese, Balsas Nahuatl and Athabaskan. Furthermore, glottalization appeared to be a main trigger in 8 out of the surveyed language.

Coda position and glottalization as the manner of trigger do not always coincide when considering tonogenesis. In the Tibeto-Burman language Lahu, glottalized versus aspirated versus plain *onsets* conditioned tonal contrasts (Matisoff 1970), while voiced aspirate codas conditioned tonal contrasts in the preceding vowel in Panjabi (Bhatia 1975: p. 15).

Overall, proposing the genesis of new tonal contrasts as being caused or conditioned by rhyme glottalization in the history of a language would not raise any eyebrows when considering the ubiquity of this kind of sound change cross-linguistically.

6.2 Balto-Slavic: Nature of acuteness

As demonstrated in section 4.6, the Proto-Balto-Slavic phonological system is now typically reconstructed with some kind of acuteness feature that acted independently of a mobile lexical pitch accent. The exact phonetic nature of the acuteness feature in Proto-Balto-Slavic is contested, even though the presence of the feature on a given syllable is more or less securely reconstructable, with the result that the synchronic distribution of the feature is understood. What we do know for sure on the phonetic side is that the acuteness feature as reconstructed for Proto-Balto-Slavic is associated with the acute accent in accented syllables in Lithuanian and also with additional creaky-voice-like phonation features as in the broken tones of Latvian and Samogitian. This section examines the theories for the possible phonetic realization of acuteness from the perspective of the typology of tone and accent systems and from the diachronic perspective of tonogenesis.

The three main approaches of interpretation for the phonetic value of acuteness in Proto-Balto-Slavic are (based on the labels given in Svensson 2023: p. 97):

1. **Acuteness-as-tone:** The presence and absence of the acuteness feature was realized phonetically as a tonal contrast between rising and falling.
2. **Acuteness-as-glottalization:** The acuteness feature was realized phonetically as some sort of ‘glottalization’ feature – ‘glottalization’ as a cover term for the following three interpretations:
 - (a) a coda-final glottal stop
 - (b) true rhyme glottalization or laryngealization (creaky voice) as in Scandinavian *stød*
 - (c) some combination of phonation and tone as in the Latvian broken tone
3. **Acuteness as length:** The acuteness feature is just vowel length: long vowels are acute and short vowels are non-acute.

Hypothesis 1 is the traditional theory, on account of the fact that Lithuanian, south Slavic languages, and the other ancient Indo-European languages (namely Vedic Sanskrit and Ancient Greek) which preserved the mobile accent in some way all used tonal contrasts to distinguish accented syllables as part of a pitch accent system. In addition, the relationship between tonal contrasts and phonation were barely understood in Neogrammarian times, so that the interpretations under hypothesis 2 had not been considered.

Hypothesis 2 (as extensively advocated for by e.g. Kortlandt in publications such as Kortlandt 1998) has gained enough currency to become the dominant theory ¹⁹. There is variation in the exact phonetic interpretation of ‘glottalization’, but the main idea is that the acuteness feature was not originally primarily realized via a tonal contrast. Although some authors such as Svensson (2023) consider it important to distinguish the different types of glottalization approaches, with ‘glottalization’ being too underspecified, we have seen already that in the case of Latvian, the phonation type part of the broken tone can in fact be realized as either a final glottal stop or as true rhyme laryngealization. Therefore, grouping together the precise phonetic interpretations under glottalization is still useful when considering the feature abstractly in a phonological way. Even in Southeast Asian tonogenesis, there is usually degrees of freedom left for the precise phonetics of the coda phonation types, with the abstract phonological contrasts themselves sometimes playing a role for predicting the exact reflex of an erstwhile glottalization feature as explained in section 6.1.3.

Hypothesis 3 is based on the observation that acuteness is typically associated with length. However, there are syllables which are reconstructed to be long which should not carry acuteness (see Jasanoff 2017: p. 74 for examples), so this hypothesis is not satisfactory by itself to explain the comparative data. We will see that there are good explanations for why exactly acuteness is associated with long syllables without necessarily making acuteness exactly equal to length.

As mentioned before, Proto-Balto-Slavic already had a pre-existing mobile accent system where word-prominence was implemented via a higher pitch as in Vedic. When a syllable with the acuteness feature (and these syllables were indeed typically long syllables) was then accented, this created a new system of tonal oppositions on long syllables contrasting with those which did not carry the acuteness feature. This could be classified as a form of broad tonogenesis in the terminology of (Hyslop 2022), as there was already a basic form of pitch contrast in Proto-Indo-European to mark word prominence without further tonal contrasts.

The next sections will present arguments for hypothesis 2 both by examining how acuteness functions phonologically and by considering arguments from diachronic typology against the backdrop of the cross-linguistic tonogenetic events described earlier in this chapter.

6.2.1 Synchronic behavior of acuteness

This section describes key properties for how the reconstructed acuteness feature operated in the Proto-Balto-Slavic phonological system as a whole and evaluates its properties typolog-

¹⁹However, see chapter 3 (Svensson 2023) for arguments in support of the traditional theory

ically, in order to assess the likelihood of acuteness-as-tone vs. acuteness-as-glottalization, where I will argue that acuteness-as-glottalization is less problematic from a synchronic point of view.

The application of the comparative method shows two key properties of acuteness:

- Acuteness was **autonomous**: the presence of acuteness on a given syllable is independent of the location of the stress.
- The presence of acuteness was a property of all long syllables.

This behavior of acuteness in the phonological system of reconstructed Balto-Slavic allows us to typologically evaluate the likelihood of the tonal hypothesis or the glottalization hypothesis for the phonetic interpretation of acuteness from a synchronic perspective. We note that the reconstructed distribution of acuteness, namely that it can appear on multiple long nuclei syllables per word independent from the position of the stress, matches how laryngealized vowels behave in some languages²⁰ more than how pitch accent in Lithuanian, Ancient Greek, Vedic Sanskrit, Japanese, or the pitch accent varieties of Scandinavia behaves. Additionally, in pitch accent languages with tonal contrasts in heavy syllables such as in Ancient Greek and the Balto-Slavic languages outside of Latvian, the additional tonal contrasts are restricted to stressed positions. Recall from 4.6 that Proto-Balto-Slavic is already reconstructed to have a accentual system (most likely *also* pitch based), alongside acuteness. Hence, the two properties listed for acuteness as reconstructed in Proto-Balto-Slavic then imply that acuteness cannot have just been a descriptor for a rising and falling tonal opposition in prominent syllables in a pitch accent system as attested in these languages.

However, it is conceivable still for the tonal hypothesis that Proto-Balto-Slavic was a more fully tonal language, with acuteness behaving as a pitch feature (or tone) that functioned autonomously and could be carried by multiple syllables per prosodic word. However, this setup is also problematic when considering the phonological system as a whole typologically. Referring back to the definition of tone in section 3.2, if acuteness were indeed realized primarily via pitch, and since acuteness is indeed a property of morphemes, and not restricted to the position of the accent, we would be dealing with a system that has *both* an independent true tone feature (= acuteness) in the sense of Mandarin or Bantu, where many morphemes are lexically marked with an indication of pitch, *and* word-level metrical structure marked by a pitch accent. Such a system would be rarely attested (though see Svensson 2023: pp. 118–119 for a discussion of potential counterexamples) and does not fit nicely into the typological continuum observed between stress and tone languages.

On the other hand, supposing that Proto-Balto-Slavic realized acuteness as a suprasegmental feature such as creaky voice is less problematic when considering the phonological system as a whole. Typologically, it is no problem for a mobile pitch accent to coexist with a creaky voice feature. In Jalapa Mazatec, an independent creaky voice feature on vowels coexists with a low-mid-high tonal system (Silverman et al. 1995: p. 115). Even though

²⁰See e.g. (Davletshin 2019: p. 183) for examples of words with multiple laryngealized vowels in the Totocan languages. However, note that Scandinavian *stød* is constrained to the stressed syllables in simple words (see section 5.1), though it can surface multiply on the same prosodic word in compounds.

glottalization does typically have pitch as a phonetic correlate, the main phonetic cue (i.e. the difference in phonation) does not clash with the existing main phonetic cue for word prominence in the pitch accent system, which would be the main oddity in having a system with both independent tone and pitch accent. Therefore, purely from the perspective of the reconstructed phonological system of Proto-Balto-Slavic, evidence from the synchronic typology of stress and tone systems points towards a glottalization realization of acuteness alongside the inherited pitch accent system from Proto-Indo-European, over a purely tonal realization of acuteness independently coexisting alongside a pitch accent system.

6.2.2 Diachronic development of acuteness

Not only should we look at the synchronic behavior and distribution of acuteness in the phonemic system of Proto-Balto-Slavic at a fixed stage, we should also look at the concrete phonetic reflexes the feature takes on in the descendant languages. In this section, we apply the diachronic typology built up in this chapter about how glottalization conditions pitch contours to evaluate both theories on how the diachrony of both glottalization and pitch contour types relate to each other and to acuteness in Proto-Balto-Slavic.

Table 34: Phonetic reflexes/traces of Proto-Balto-Slavic acuteness

	acuteness reflex
Lithuanian	falling pitch
Latvian	rising pitch, glottalization
Samogitian	rising pitch, glottalization
Old Prussian	(likely) rising pitch
Proto-Slavic	rising pitch

Table 34 summarizes the different phonetic features associated with the outcome of acuteness in the Balto-Slavic languages. Note that although most authors agree that Latvian glottalization in the broken tone is most likely old, for Samogitian, some authors such as Svensson (2023) suppose that glottalization is a more recent innovation. Let's now consider the plausibility of both the acuteness-as-tone and acuteness-as-glottalization theories typologically from a diachronic perspective, given these outcomes.

Assuming the hypothesis that Proto-Balto-Slavic acuteness was tone, the most logical choice for the contour would be a rising pitch contour given that acuteness was reflected as a rising pitch contour in most varieties outside of standard Lithuanian. We can then safely assume that a tonal reversal process took place in Lithuanian, as the closely related Samogitian dialects still show rising pitch. What remains to be explained under an acuteness-as-tone hypothesis is the presence of glottalization in both Latvian and Samogitian. As discussed in section 6.1.1 for Vietnamese, it is indeed possible for erstwhile pure pitch contours to develop coarticulated register phonation diachronically. The fact that glottalization in Latvian and Samogitian are both accompanied by pitch contour distinctions as well thus makes it typologically plausible²¹ that the register phonation developed from an original Proto-Balto-

²¹What is less well-attested, however, is when tonal contrasts with no pre-existing coarticulated glottalization later develops into glottalization without tone, i.e. *tonoexodus* which leaves the glottalization in place. This is a more relevant argument for the Scandinavian case described in section 6.3.

Slavic system where acuteness was purely realized as tone.

On the other hand, assuming the hypothesis that Proto-Balto-Slavic acuteness was originally some kind of glottalization feature, it becomes even more straightforward to explain the glottalization reflexes in Latvian and Samogitian. In turn, we now have to explain the development of the pitch contrast reflexes associated with the presence of acuteness. This is also easy to explain, as section 6.1 has laid the groundwork describing how register phonation or the loss of a code-final glottal stop to conditions tonal contrasts, and how this process is quite common cross-linguistically from the perspective of diachronic typology. In fact, even the rising pitch contour reflex is well-supported by the tonogenetic accounts of most cases of coda-loss laryngealization becoming tonal contrasts. The falling pitch in Lithuanian is then the result of an innovated tone reversal as in the other scenario.

Therefore, both hypotheses have plausible explanations for the diachronic outcomes of acuteness which we see in the later Balto-Slavic languages, with the glottalization hypothesis being perhaps slightly more typologically attested. However, the arguments presented in section 6.2.1 can also be applied in a time-slice fashion to give a system-level picture of how the entire phonological system surrounding pitch contrast, accent, and glottalization may have evolved: Note that Latvian, which has glottalization as part of its tonal system, also shows autonomous tone and initial stress. This is likely not a coincidence. In section 6.2.1, we argued that having both a mobile pitch accent as well as a pure autonomous tone system is not a stable setup synchronically, so it would make sense that, as tonogenesis was occurring, the loss of glottalization was cocomitant with the absorption into a pure pitch accent system via neutralization of acuteness in unaccented syllables to “resolve” the clash of having a pitch-based word-accent system and tone system existing independently. In Latvian, the loss of glottalization and independent tones was not complete, with an innovated initial stress system replacing the mobile pitch-accent system resolving the clash instead.

In summary, we can combine the arguments presented from both the synchronic and diachronic perspectives systematically to propose the following situation as most likely for the phonetic nature of the acuteness feature: At the stage of Proto-Balto-Slavic, acuteness was realized phonetically primarily as glottalization alongside a mobile pitch accent system. This glottalization later conditioned a tonal opposition between rising and falling, where syllables with acuteness had a rising pitch contour. In the later stages of the Balto-Slavic varieties, depending on how prominent the glottalization remained in the phonological system and the exact nature of the stress system, the acuteness-conditioned tonal oppositions either became fully incorporated into the existing mobile pitch accent system with the full loss of the glottalization phonetic cue (as in Lithuanian or Proto-Slavic) or, in the case of Latvian, kept the glottalization as a phonetic cue, while reducing the role of pitch prominence and mobility of the accent to allow the tones to stay autonomous, both in order to avoid the synchronically awkward situation of having an autonomous tone system alongside a mobile pitch accent system. For the case of Samogitian, it works just as well to assume that its register phonation was later innovated once the former acuteness tonal oppositions were already incorporated into the mobile pitch accent system, as to assume that the register phonation was simply inherited as in the case of Latvian.

6.3 Scandinavian: Which came first, *stød* or pitch accent?

Like in the case of Balto-Slavic, the primacy of *stød* or pitch accent is also controversial in Scandinavian, with the traditionally dominant view of tonal contrasts appearing in Scandinavian first before *stød* came into being. This section gives a brief overview of the main suggestions and argues for a less popular model in line with the typology on tonogenesis we have presented so far based on recent work presented in (Wetterlin & Lahiri 2015).

Proto-Germanic is commonly assumed to have a basic fixed root stress system with neither *stød* or tonal contrasts. Even Old Norse, an attested languages in Runic inscriptions from the 8th century on, is typically interpreted as having neither feature as well. On account of the comparative data, there are three possible scenarios for the origin of *stød* and tonal contrasts in the continental Scandinavian languages:

1. *stød* arose first, then *stød* conditioned the tonal oppositions in the pitch accent languages (Liberman 1982, Wetterlin & Lahiri 2015)
2. Pitch accent arose first, then the tonal oppositions became *stød* (d'Alquen & Brown 1992, Gårding 1977, Kock 1901, Oftedal 1952, Riad 1998, etc.)
3. *stød* and pitch accent arose independently (Fischer-Jørgensen 1989, Rischel 2001)

Hypothesis 2 is the most commonly assumed hypothesis for geographic reasons: *stød* appears to be a more innovative feature in Denmark, having the tendency in recent times to spread at the expense of sub-standard pitch accent varieties (Riad 2003). Tonal contrasts are frequently explained to have arisen by means of syncope and stress class resolution (Riad 1998) before becoming *stød*. The actual mechanism for tone contrasts becoming *stød* is usually explained as a type of tone compression phenomenon (Lorentz 2002, Riad 2003, Rischel 2001, Kiparsky 2002) creating the phonetic conditions for creaky voice to emerge. However, this is problematic from a typological point of view, since it is hardly attested in the rest of the world, if at all, for tonal contrasts to arise from stress clash.²² In addition, the initial stress in Proto-Germanic is securely reconstructed as not being primarily pitch-based based on widespread syncope of unstressed syllables, so an explanation of how pitch instead of loudness became more important for prominence at the word-level is also needed, i.e. a mechanism for strict tonogenesis. As noted in (Hyslop 2022: p. 289), out of the 73 languages surveyed in, there are only two languages which seem to show tonogenesis via stress interaction (where the other, Southerneastern Mongour, had already realized stress primarily via pitch), and there is no exact parallel to the stages proposed by (Riad 1998), as summarized in table 35.

Furthermore, while the mechanism for tone compression is well-described, and the development from tone to phonation is not unattested cross-linguistically (see Quiaviní Zapotec: Uchihara 2016), it is also much more common for glottalization to transmute into tone than the other way around.

²²It is, however, attested for pitch contour oppositions in accented syllables to develop from a pre-existing pitch-based accent system via contraction, as had happened in final syllables in Ancient Greek. See (Jasanoff 2017: p. 12).

Table 35: Swedish tonogenesis via stress-clash theory (Hyslop 2022: p. 289)

Stage A	Early Proto-Nordic	pitch contours are lexically entirely redundant
Stage B	Late Proto-Nordic	stress clash, synchronic destressing, pitch may carry function
Stage C	Old Swedish	loss of secondary stress, secondary split, tonal information becomes lexical

On the other hand, hypothesis 1 is well-supported typologically, as already described in detail in this chapter. Additionally, the fact that Balto-Slavic likely shows a similar development is not irrelevant in light of its geographic proximity and the fact that tonogenesis is well-known as an areal phenomenon. In order to address the geographic facts commonly used in support of hypothesis 2, Wetterlin & Lahiri (2015) propose that *stød* first developed in Denmark and the socio-political domination of the Danes in Scandinavia during the Middle Ages is what caused other varieties (originally without any type of phonation or tonal oppositions) to reinterpret the *stød* ~ no *stød* contrast as a tonal contrast. By extension, it could be argued that the pitch accent varieties remaining in Denmark are receding due again to influence from Standard Danish.

As explained in section 5.2, accent 1 and accent 2 are realized differently across the pitch accent varieties, so it is hard to tell whether *stød* transmuted into a low or high tone. One possible scenario under the *stød*-first hypothesis proposes that *stød* was reinterpreted as a low tone, while the absence of tone led to a neutral high tone. This is reflected directly in the correspondence set between Standard Danish and South Jutlandic in table 27. As for explaining the disyllabic tonal melodies found in Standard Swedish and many Norwegian dialects, these languages use a post-lexical H focus tone at the end of prosodic phrases for information structural purposes, such as to signal narrow or contrastive focus. Under this theory, a pitch contour contrast in the word domain is created based on whether the low tone reinterpreted from *stød* is present in the context of a general high focus tone, as illustrated in table 36. The high-low-high contour for Accent 2 results from the high tone in the stressed syllable clashing with the high focus tone, resulting in a low tone being inserted between them. This repair strategy is common cross-linguistically: such clashes are more formally instances of violations of the **obligatory contour principle** (or OCP), which is a phonological principle stating that identical features (in this case, high tones) should not occur in succession in underlying representations (McCarthy 1986: p. 208), and phonological systems tend to repair OCP violations either through epenthesis of other elements (in this case, a low tone) or by deletion or merging of features. The resulting pitch contours for Accent 1 and Accent 2 are the tonal melodies still found in Central Swedish and Eastern Norwegian, while the other tonal melodies found in the region can be either explained as tone reversal phenomenon or directly as a different phonetic reinterpretation of the *stød* element.

The proposed Scandinavian analysis with its varied tonal outcomes actually parallels the reconstructed situation in Athabaskan quite closely. In table 33, we see that Proto-Dene is reconstructed with a glottalization contrast, where Chipewyan and Gwich'in show *different* tonal contrast reflexes (as do the pitch-accent Scandinavian varieties), while Hupa keeps the

Table 36: Possible development of accent 1 and accent 2 contrast (Wetterlin & Lahiri 2015: p. 64)

Accent 1		LH _F	Accent 2		H ^L H _F
arm [?]	>	arm ₁	sommer	>	sommer ₂
finger [?]	>	finger ₁	tal-e	>	tal-e ₂

glottalization contrast (like Danish). Indeed, even in the case of Balto-Slavic, we already saw in section 6.2.2 that the same glottalization feature can condition different or even opposite pitch contour reflexes between different languages.

Hypothesis 3 has the benefit of allowing more freedom to account for the exceptions to the *stød* ~ accent 1 correspondences. However, it requires the same theory as in hypothesis 2 that tonal contrasts developed due to syncope, and requires two independent and highly parallel genesis events to occur in a time frame when no other Germanic language developed either feature. Hence, it is even less attractive purely on account of Occam's razor than the other two hypotheses.

Therefore, a *stød*-first theory remains the most typologically likely out of the three, even if hypothesis 2 and 3 are not impossible. Furthermore, the geographical argument in favor of hypothesis 2 can also be addressed to some degree. The main remaining issue to deal with actually lies in the comparative data, that is, how in a *stød*-first theory, the presence of *stød* or pitch accent in a given Scandinavian word can be accounted for directly from the Old Norse etyma. Section 7.2 addresses the appearance and systematization of glottalization in Scandinavia in a way that also explains the inflectional and lexical distribution of *stød* and pitch accent in the lexicon of the Scandinavian varieties.

6.4 Typological takeaway

This chapter has briefly surveyed the typology of tonogenesis cross-linguistically as it pertains to the likely development of tone and glottalization in the Baltic sea area, taking a detour to look at similar phenomena on other sides of the world in Southeast Asia and North America. By evaluating the systems and features reconstructed by the comparative method from this typological perspective, we have seen that a glottalization-first approach is not only typologically well-supported, but also that it is possible to propose plausible scenarios of development to explain the attested data from this basis.

7 Origin of glottalization in the Baltic sea area

This chapter discusses the diachronic origin of the glottalization features responsible for conditioning the tonal contrasts later seen in the Balto-Slavic and Scandinavian languages. Neither Proto-Indo-European, the ancestor of both the Balto-Slavic and Scandinavian languages, nor even Proto-Germanic, the intermediate proto-languages between Proto-Indo-European and the North Germanic languages, are usually reconstructed with a suprasegmental glottalization feature, making it desirable to provide an adequate explanation for how such features entered the phonological systems of these languages. In investigating the origin of glottalization we will see parallels between the two languages groups in how glottalization arose, and further ground a theory of origin for glottalization in other cross-linguistically attested developments.

7.1 Origin of Balto-Slavic acuteness

Taking the view advocated for in section 6.2 that the acuteness feature at the Proto-Balto-Slavic stage had as its primary phonetic correlate some sort of glottalization or phonation-type distinction, we now turn to various suggestions for where the feature came from. The problem has long been studied in the context of deriving accentual reflexes in Balto-Slavic languages from reconstructed Proto-Indo-European, and there is a large amount of literature on the topic of the origin of acuteness in this context (for recent contributions to the topic, see Svensson 2023 and Jasanoff 2017). In this section, I will try to describe the key points of consensus regarding the origin of acuteness, before briefly summarizing and evaluating the details that differ between major accounts.

A natural starting point is the comparison of Balto-Slavic forms with cognates in other Indo-European languages. Doing this reveals two contexts that have usually been treated separately: word-internal positions and word-final position.

Recall from section 6.2 that acuteness has been observed to strongly correlate with length in the comparative data, even leading some to equate acuteness with Indo-European length. Table 37 (adapted from the examples in Svensson 2023: p. 129) shows how long vowels in Vedic Sanskrit in word-internal syllables correspond to acute syllables in Balto-Slavic cognate forms.

Table 37: Association between Indo-European length and Balto-Slavic acuteness

Lithuanian	Serbo-Croatian	Vedic Sanskrit	
<i>vīl̃kas</i>	<i>vûk</i>	<i>vṛ̥ka-</i>	‘wolf’
<i>peñkios</i>		<i>pañca-</i>	‘five’
<i>laũkas</i>		<i>loka-</i>	‘field’
<i>mótē</i>	<i>māti</i>	<i>mātár-</i>	‘mother’
<i>véjas</i>	<i>vjètar</i>	<i>vātá-</i>	‘wind’
<i>pīlnas</i>	<i>pūn</i>	<i>pūrṇá-</i>	‘full’

This correspondence most clearly falls apart in word-final positions (i.e. inflectional endings): final long vowels can either be acute or non-acute in Balto-Slavic. Interestingly, the contrast between acute and non-acute endings in Balto-Slavic appears to partially pattern

with contrasts involving marked vowel features in other Indo-European languages: a contrast in Greek between acute and circumflex accent, a contrast in Germanic between two different types of final long vowels (bimoric and trimoric), and a contrast in Indo-Iranian between long vowels which are supposed to be scanned normally vs. disyllabically in the *Rigveda* and the *Gathas* (Svensson 2023: pp. 124–125), implying the presence of vowel hiatus in the latter case. Current reconstructions of the relevant inflectional endings assuming the laryngeal theory²³ provides an explanation without assuming the need for special types of vowels in final syllables in Proto-Indo-European. In particular, the loss of intervocalic laryngeals in a nominal ending such as the PIE nominative plural ending $*-ah_2-as > *-aas$ created vowel hiatus, as observable in the earliest Indo-Iranian texts. Subsequent vowel contraction created circumflex accent in Greek, resp. trimoric vowels in Germanic. These marked long vowels contrasted with plain long vowels (frequently arising from loss of coda laryngeals) as seen in the PIE accusative plural ending $*-ah_2s > *\bar{a}s$ (Svensson 2023: p. 127). As for Balto-Slavic, it appears that PIE long vowels created by vowel contraction across a laryngeal hiatus always end up *without* acuteness (which is actually the *unmarked* member of the opposition). Table 38 summarizes the outcome of PIE intervocalic laryngeal loss in Balto-Slavic, Greek, Germanic, and Indo-Iranian.

Table 38: Result of PIE intervocalic laryngeal loss in final syllables

PIE		Balto-Slavic	Greek	Germanic	Indo-Iranian
intervocalic laryngeal loss	>	no acute	circumflex	trimoric vowels	vowel hiatus

Laryngeal theory also allows us to treat word-internal and word-final contexts uniformly and refine the first-order ‘length = acuteness’ approximation in word-internal positions. Long vowels in Balto-Slavic appear to have the following origins, according to (Jasanoff 2017: p. 74):

1. long vowels and diphthongs by post-IE coda laryngeal loss and compensatory lengthening (e.g., $*b^h\acute{u}- < *b^h uH-$). These are uncontroversially acute in Balto-Slavic, as in Lith. *bŭti*, PSl. **bŷti* ‘to be’ < PIE $*b^h uH-t(e)i$, or Lith. *gėrti* ‘to drink’ < PIE $*g^{\#} erh_3-t(e)i$. The acute examples listed in table 37 are also ultimately derived from reconstructed PIE forms with root coda laryngeals.
2. long vowels by post-IE contraction across a laryngeal hiatus (e.g., $\bar{a}$ -stem nom. pl. $*-\bar{a}s < *-ah_2as$). These are uncontroversially non-acute in Balto-Slavic (as summarized in table 38), as in Lith. gen. sg., nom. pl. *anõs* < $*-\bar{a}s < *-ah_2as$ ‘those’_{FEM}.
3. inherent long vowels from other sources, for example from the Indo-European lengthened grade. Whether these long vowels yielded acuteness or not is controversial when

²³The **laryngeal theory** is a now universally accepted theory in Indo-European linguistics which posits three consonantal segments (notated $*h_1$, $*h_2$, $*h_3$, with $*H$ denoting any of these) in the phonological system of Proto-Indo-European. Directly attested solely in the Anatolian languages, they are well-known for inducing vowel coloring and causing aspiration in Indo-Iranian. The loss of laryngeals in coda position is also notable for being a major source of long vowels in Indo-European languages. See (Fortson 2010: pp. 62–64) for an introduction to the Indo-European laryngeal theory.

looking at the comparative data, and has direct consequences for how acuteness actually originated phonetically. See Chapter 5 of (Svensson 2023) for a full discussion.

4. long vowels by Winter's law, i.e. a PIE short vowel before a voiced consonant lengthens in Balto-Slavic. These are also acute, as seen in Lith. *núogas* 'naked' (compare Vedic Sanskrit *nagná-*).

In light of the comparative evidence associating acuteness with various types of length or laryngeal segments in Proto-Indo-European, there are two major competing approaches for how glottalization developed in Balto-Slavic from Proto-Indo-European.

Table 39: Development of phonemic glottalization from long vowel distinctions

PIE		Post-IE laryngeal loss			Proto-Balto-Slavic	
*-ah ₂ as	>	*-aas	>	*-aas	>	*-ās NOM.PL
*-ah ₂ s	>	*-ās	>	*-āʰs	>	*-āʰs ACC.PL

1. **Glottalization-from-vowel-length:** Advocated by e.g. Jasanoff (2017), this theory connects the rise of glottalization to a contrast in the two types of long vowels also seen in the other Indo-European languages as already discussed with table 38. Under this theory, Balto-Slavic developed two types of long vowels similar to the bimoric/trimoric or no-hiatus/hiatus contrast in Germanic or Vedic, whereby the distinction was reinforced phonetically by adding glottalization to the plain long vowels to emphasize the length distinction. Later, the length distinction was lost, producing a new contrast between long glottalized vowels and plain long vowels. Table 39 illustrates how glottalization entered the phonemic system of Balto-Slavic under this rephonologization scenario.

Not only was this distinction present in endings, the contrast between *-VH and *-VHV sequences was also inherited into Balto-Slavic in non-final syllables in a few situations as well (Jasanoff 2017: p. 78). This made the resulting glottalization contrast in long vowels even more salient, facilitating the rise of glottalization becoming a full feature of the lexicon as subsequent sound changes and analogical derivation created further minimal pairs.

In terms of the comparative data, this theory predicts that inherent long vowels inherited from PIE should always have received glottalization in Balto-Slavic, as did all other long vowels not having arisen from intervocalic laryngeal loss. Only long vowels arising from intervocalic laryngeal loss escaped the insertion of glottalization.

2. **Glottalization-from-glottalic-contact:** Advocated principally by Kortlandt (1976), this theory supposes that glottalization in Balto-Slavic arose phonetically as a direct reflex in the presence of a Proto-Indo-European laryngeal segment (*h*₁, *h*₂, or *h*₃) in coda position. While the exact phonetic interpretation of the Proto-Indo-European laryngeals is unclear, their general characteristics of having caused vowel coloring and vowel lengthening after coda loss in all Indo-European languages, consonant aspiration

in Indo-Iranian, and vowel hiatus after intervocalic loss in Indo-Iranian, all suggest phonetics compatible with having caused rhyme glottalization after coda loss in Balto-Slavic. For example, one approach is to assume the laryngeal segments simply merged into a glottal stop element in Pre-Balto-Slavic.

In terms of the comparative data, this approach then also straightforwardly explains the glottalization contrast between the two types of long vowels arising from coda laryngeal loss and intervocalic laryngeal loss. However, in contrast with the vowel length approach, the glottalic contact theory predicts that inherent long vowels inherited from PIE should not end up with glottalization in Balto-Slavic, which is still controversial from data. But what is uncontroversial from the data is the fact that long vowels due to Winter's law show glottalization in Balto-Slavic, yet there is no laryngeal segment in this case to explain it. Kortlandt (2011: p. 7) resolves this issue by assuming that PIE unvoiced stops were (pre)glottalized which dissolved into a laryngeal and buccal part, where the laryngeal part behaved like the laryngeal segments in causing rhyme glottalization on the preceding vowel.

In summary, the two approaches explain the origin of glottalization from a phonetic point of view in different ways, while also making different predictions for whether inherent long vowels in PIE should have gained glottalization in Balto-Slavic. Many authors have also attempted to advocate for hybrid approaches where certain contexts or derivations favor one approach over the other (Svensson 2023: p. 145) in order to best account for the comparative data. From the perspective of sound change, we see that the main proposed mechanisms for the rise of glottalization phonetically involve either the insertion of glottalization motivated by phonotactic structure, and/or the presence of segments phonetically compatible with glottalization causing vowels to gain acuteness, depending on the approach taken. It is probable that both played a role to some extent; section 7.2 describes a similar proposed development in the Scandinavian languages where the loss of a glottal consonant induced a glottalization contrast precisely depending on the phonotactic context.

7.2 Origin of Scandinavian *stød*

Assuming the typologically more likely possibility that Scandinavian *stød* originally conditioned tonal contrasts in the pitch accent varieties, the question remains of where *stød* came from in the first place, as neither tonal contrasts nor glottal phonation existed in Proto-Norse. Answering this question requires examining the distribution of pitch accents and *stød* in the lexicon with respect to Old Scandinavian etymologies, many of which are directly attested or have reconstructable Proto-Germanic forms.

Irrespective of the more controversial question of whether *stød* or pitch accent arose first, these features are uncontroversially distributed according to the syllable count of forms as they were around the 12th century (Iosad 2024: p. 18). Monosyllabic words generally received accent 1 or *stød*, while polysyllables received accent 2 or no *stød*. There are two key sound changes involving change of syllable count from Old Norse into Old Scandinavian of the 12th century which appear to be responsible for phonologizing this contrast:

1. Prosodic incorporation of postposed definite articles.
2. Epenthesis in word-final consonant clusters.

For the proponents of a pitch-accent first theory, the changes of syllable count caused previously predictable differences in pitch contours between monosyllables and disyllables to become unpredictable. Under the assumption that the metrical structure changed while the contours remained stable, it is plausible that pitch contour contrasts arose due to a general mechanism called **peak delay**, where more segmental material before a prosodic boundary is associated with a later peak in pitch. This could have caused original disyllables to have a later peak in pitch than newly created disyllables which used to be monosyllables. As reviewed in (Iosad 2024: p. 19), this type of theory involving phonetic peak delay does have a strong basis cross-linguistically. Once the tonal contrasts became phonologized, *stød* is then created in Danish following the arguments already described in section 6.3.

However, such a theory does not straightforwardly adapt to a *stød*-first view of tonogenesis in Scandinavia. In fact, an entirely different phonetic mechanism is proposed in the work of Wetterlin & Lahiri (2015) for the arisal of *stød*, based on the development of encliticized definite articles in Northern Germanic. Originally, these articles were independent words *hinn*, *hitt*. Then the following stages occurred:

1. The initial *h* of the article became a stop in monosyllables but otherwise got lost entirely when the articles became encliticized. This is explained as the *h* becoming a glottal stop in monosyllables to reinforce the prosodic word boundary and to prevent refooting between the noun and article. In polysyllables, no such reinforcement was necessary. The stop could then be interpreted as *stød*. Hence, monosyllabic **armr* + **hinn* > **armr=ʔinn* > *armʔen* ‘arm=the’ contrasts with polysyllabic **himinn* + **hinn* > **himmelen* ‘sky=the’.
2. Learners began to reanalyze *stød* from the article onto the noun itself, so that monosyllabic nouns were treated as carrying *stød* intrinsically.²⁴ At the same time, monosyllabic verb forms also began to carry *stød* as syllable count becomes the primary criteria for its presence regardless of word class.
3. Sound change such as epenthesis changed the syllable count of some nouns such as **foeʔtr* > **foeʔter* > Danish *føddʔer* ‘feet’ and verb forms such as ON. **finnʔr* > Danish *finnʔer* ‘find’ such that the presence of *stød* is no longer predictable based on syllable count.
4. Analogy created morphological paradigms where *stød* becomes an important factor in determining morphological class membership.
5. *stød* becomes a full feature of the lexicon, after enough sound change and analogy has occurred to make its presence unpredictable.

²⁴Compare here the early Modern English reanalysis of *a napron* to *an apron*.

In summary, under this proposal *stød* appeared due to the loss of an encliticized glottal *h* consonant disappearing in certain phonotactic contexts in order to reinforce certain syllable structures. Then, the feature further solidified its contrastive presence in the lexicon through sound change and analogy. This created the conditions for tonal contrasts to arise in some varieties to fulfill the same lexically contrasting role. Again, the benefit of this scenario is to bring the North Germanic origin of tonal contrasts in line with tonogenesis in other languages where glottalization was the primary trigger. There is also additional areal and typological support to this scenario for the appearance of glottalization in that there are parallels to how glottalization appeared in Balto-Slavic and other language families, as discussed in section 7.3.

7.3 Typological takeaway

In the theories of origin for glottalization proposed for Balto-Slavic and Scandinavian so far, we seem to have the loss of a consonant with phonetics compatible with glottalization lead to rhyme glottalization becoming lexicalized in certain syllable structures.

Typologically speaking, rhyme glottalization arising from the loss of a final glottal stop has also been observed in other language families such as in the history of Sino-Tibetan (Michaud 2004). This is supporting typological evidence for the coda loss of laryngeals in PIE yielding glottalization on the rhyme in Balto-Slavic, so that we would get the sequence of changes PIE **b^huH-* ‘be’ > **b^húʔ-* > **b^húʔ-*, as proposed by Kortlandt’s glottalic contact theory. In the Scandinavian languages, the observation also can be applied to the origin of *stød* in monosyllabic nouns, where the loss of a glottal consonant created a hiatus, which was then resolved by a glottal stop only in monosyllabic structures, before the glottal stop conditioned rhyme glottalization and finally disappeared.

8 Linguistic reconstruction: a meta-overview

This chapter reviews and summarizes the meta-linguistic themes and their relationships to each other seen throughout the thesis in service of the main goal of linguistic reconstruction applied specifically to the history of tone and glottalization in the Baltic sea area. Specifically, we hope now to be able to answer the following question with reference to concrete phenomena: What are the relative roles of the comparative method, internal reconstruction, typology, and areal linguistics when attempting to reconstruct the history of linguistic systems and particular features thereof?

Clearly, each of these themes factor into any potential reconstruction. In my view, the comparative method is the primary tool used for restricting the space of possible reconstructed systems for any given set of related language varieties based on attested data, for which features the features of a possible reconstructed system must have direct correspondences to. In the context of the present study, the comparative method is used to posit the existence of some abstract feature operating in a reconstructed system which is able to explain correspondences between attested glottalization and tonal features in attested language varieties. Internal reconstruction augments comparison by inferring from the structure of a single system the likely prehistory of that system, in many cases corroborating information deduced via the comparative method. For example, morphological alternations in languages such as Lithuanian showing an underlying type of accent on multiple syllables reveals implicit information about how acuteness may have functioned more autonomously in the prehistory of Lithuanian, agreeing with the conclusions from comparison with other Balto-Slavic varieties.

One of the key meta-linguistic topics this thesis is framed around is that of the role that typology, both diachronic and synchronic, should play in augmenting the information obtained from the comparative method and internal reconstruction. As outlined above, the comparative method and internal reconstruction can be classified as internal-evidence based methods which are grounded in fieldwork or philological data. Diachronic and synchronic typology are, on the other hand, methods based on ‘external’ evidence which are usually quantitatively evaluated into trends and patterns. Such trends are almost never absolute, yet nevertheless yield valuable information about how linguistic systems are expected to operate, both synchronically and diachronically. Hence, typology from the perspective of reconstruction can be seen as a set of heuristics to evaluate the ‘naturalness’ of reconstructed systems or trends with evidential weight dependent on the strength of the relevant cross-linguistics observations. Concretely, for the primary research question investigated in this thesis, synchronic typology has been used as a strong heuristic for positing the concrete phonetics of what the reconstructed feature corresponding to glottalization and tonal accent in the daughter languages should look like, by positioning the feature in the phonological system of the reconstructed language as a whole and leveraging the well-developed typology of pitch accent to conclude that glottalization is more compatible candidate in terms of how the feature is reconstructed to behave synchronically. This use of typology to fill in details about a reconstructed system complements the use of the comparative method to reconstruct the overall shape and behavior of the reconstructed system.

Likewise, the use of diachronic typology serves a similar role, this time from the perspective of observed diachronic trends, where directionality plays a central role in evaluating what kind of feature led to the rise of tonal contrasts and glottalization in the language varieties spoken around the Baltic sea. The body of evidence showing glottalization as the originator of tonal contrasts in a wide variety of languages cross-linguistically, with significantly less evidence for the other direction, is a strong heuristic arguing for a glottalization-first hypothesis, in the same way that the directionality observed for palatalization being more likely than depalatalization is a strong typological heuristic for evaluating the concrete phonetics for a reconstructed phoneme yielding a correspondence set such as $k, k, k, \widehat{tj}, \widehat{tj}$ as $*k$ instead of $*\widehat{tj}$. Of course, being heuristics, these typological trends cannot be taken as absolute rules of reconstruction, but the art of reconstruction consists of finding the space of most likely explanations for the attested linguistic data.

Orthogonally, we have also seen how areal linguistics and contact phenomena complement internally motivated sound changes. While this thesis does not investigate the concrete contact relationships between the language varieties in the Baltic sea area, the structural similarities and parallel trends in the development of glottalization and tone cannot be ignored. The areal linguistic perspective is particularly relevant for reconstruction as a proposed development in one variety may be heuristically used as evidence for a similar development in another variety where contact is possible or even probable. This holds true especially in the context of suprasegmental systems and tonogenesis where there is strong cross-linguistic evidence for contact-induced transfer. In this sense, areal linguistics can be used to augment internal motivated sound changes based on comparative evidence as a type of typological heuristic for areas of convergence of features which are observed to locally cluster.

9 Conclusion

To answer the question of the origin of tone and glottalization in the Baltic sea area, this thesis has surveyed the prosodic systems of the languages spoken in the area as well as similar cross-linguistic situations involving the diachrony of these features. I have attempted to build up an internally consistent and typologically plausible story to explain the appearance of new tonal oppositions/pitch-accent types and phonemic glottalization via a glottalization-first approach in both the Balto-Slavic and Scandinavian language families.

By accounting for how tonal oppositions and glottalization appear in the Baltic sea area in this way, this thesis has also contributed to the broader understanding of how tonogenesis and glottalization arise in general. For example, the traditional accounts of how pitch accent contrasts arose in Scandinavian are often cited as a unique example of how stress clash and syllable elision can create new tonal contours. This thesis has argued that there is a coherent and typologically grounded trajectory for the development of glottalization and innovated pitch contour contrasts in both Scandinavian and Balto-Slavic akin to processes observed in Southeast Asia or other parts of the world that show tonogenesis triggered by coda glottalization. The main hypothesis presented is that glottalization is likely the source of new tonal contrasts in both language areas, and it is possible that the respective processes influenced each other. Indeed, the distribution of acuteness in the phonological system of Balto-Slavic as a whole behaves more in line with how glottalization behaves rather than tone. In addition, the glottalization features responsible for conditioning new tonal contrasts likely had their origin in both language families in phonotactically compensatory strategies associated with the loss of consonants articulated in the back of the vocal tract.

Hence, this thesis has argued that by applying synchronic and diachronic typology to the systems constructed by the comparative method, we find certain advantages in a glottalization-first reconstruction of events over a tone-first sequence of events. The development of tones and glottalization around the Baltic sea does not have to differ substantially from trends observed in the rest of the world.

9.1 Future work

The typological parallels between the Balto-Slavic and Scandinavian languages are at times striking in terms of how these features developed, assuming the theories presented here. While this thesis has not investigated the areal linguistic aspect of this connection deeply, it remains for future work to investigate how much of the parallels are indeed contact-induced or rather simply based on happenstance, and relatedly, to more accurately date the precise rise of glottalization and new pitch contour contrasts, perhaps through deeper fieldwork on Baltic or Scandinavian dialects showing transitional systems. The suprasegmental systems of the Baltic Sea region, far from being isolated curiosities, offer a window into the universal dynamics of how glottal articulation shapes the evolution of tone.

In addition, while segmental sound change in conditioned contexts is well-studied from a computational modeling point of view using string rewriting systems and transducers, modeling suprasegmental sound change in general adds layers of complexity. In future work, it

would be desirable to formulate a general framework of conditioned sound changes involving suprasegmental segments, in order to add formal soundness to the types of suprasegmental sound changes investigated in this thesis. Such a model could be used to e.g. evaluate quantitatively how many cognate sets a particular hypothesized reconstruction would predict.

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