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Retroflexion of rhotic-plus-sibilant sequences at word junctions in Northern Norwegian dialects

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Master's thesis in Theoretical Linguistic [LIN-3990] [September, 2021]

Acknowledgements

First of all, I would like to thank my supervisors, Bjørn Lundquist and Martin Krämer. When I came to linguistics from literature, they taught me everything I know about phonology and much of the syntax. I am eternally grateful for their understanding, constant support, boundless patience, confidence in my abilities and willingness to help at any time of the day or night, no matter whether it is summer or Christmas. I have never regretted my choice, and many times thanked fate for bringing me together with these incredible people and truly enthusiastic scientists. I would like to thank Bjørn for countless hours of discussion about retroflexion, his incredible dedication to research, enormous help with statistical analysis, numerous checks, and motivation to move forward. And I would like to thank Martin for all the phonological conversations, the chances that expanded my linguistic experience, the detailed answers to my many questions, and the "great progress" with which he accompanied his mails and gave me the strength to check and rewrite the next new draft. This work (my very first official paper in English!) would never have been written without them.

I would also like very much to thank my friend, Øystein Solvang, who, while not a linguist, nevertheless did not leave me alone to wade through the jungle of statistical analysis. And although now he has probably developed an addiction to capsule coffee, I hope that knowledge about retroflexion at the word boundaries in Northern Norwegian dialects will be useful to him in life.

Billion thanks to my beloved husband, Bendik, who supported me at all stages of writing this work, patiently proofread the parts of the study, listened to my theories about retroflexes, repeated the same thing hundreds of times as a native speaker of the Tromsø dialect and helped me hear what I could not hear myself. I would never have ended up in the North, if not for him, would never have dared to study linguistics and, most likely, never learned about Tromsø. I know how much he dislikes long sentences, but I can't help myself.

Thank also to my mother-in-law, Kjellaug, who always gave me silent support, listened to me when I wanted to give up everything, and became my closest friend and real family on the North.

Many thanks to my parents, whom I have seen only once in the last two years due to the pandemic, but with whom I communicate on the Internet every day. They always supported my every decision, praised and motivated me even when everything was bad, and believed in me more than I believed in myself. They are exactly what ideal loving parents can be.

And, of course, thanks to all those who helped me with advice, checked databases, participated in surveys and in every possible way expanded my knowledge of the topic. Thanks to Dash Stevens for proofreading the final version of my work, and thanks to all those who selflessly 加油 side by side with me for the past two years. It was an incredible adventure, amazing experience, and wonderful years of my life.

Abstract

Retroflexion at the junction of words is an optional process. Numerous previous works devoted to this topic analysed the process of retroflexion based on researcher’s intuition or examining the behaviour of retroflexes in an artificially created environment in laboratory conditions. In this work, the retroflexion of rhotic-plus-sibilant sequences at word junctions is observed in the natural spontaneous speech of speakers of Northern Norwegian dialects. It investigates how the speaker's age, place, dialectal area, lexical element, syllabic structure, syntactic category, lexical and phrasal stress, and speech planning affect the application of retroflexion. A database containing excerpts from the speech of speakers of Northern Norwegian dialects was compiled specifically for this study. Selected phrases contain words with rhotic-plus-sibilant sequences at the junction. Statistical analysis in R and comparative analyzes were used to study the triggering environment for retroflexion at the word boundaries.

The results showed the influence of the speaker's age, place, county, the chosen lexical unit in the second position, frequency of collocations, speech planning and the number of syllables in the second word on the application of retroflexion. While the influence of the dialect area turned out to be small, and the influence of stress and syntactic category was not confirmed. The significance of the performance was also found. Results suggest that older speakers, who take more pauses in speech and speak more slowly, do not plan sets of words in tandem, and often violate the phonological distance, which causes failing retroflexion at the word boundaries. Younger speakers in general use retroflexes in speech more actively.

Key words: *retroflexion, retroflex, phonology, phonological process, speech planning.*

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Introduction

The goal of this work is to observe and analyze patterns of retroflexion in Northern Norwegian dialects. In these dialects, retroflexion occurs as the result of rhotic-plus-sibilant sequences, and this work focuses on one specific environment: where retroflexion occurs across word boundaries. Further, the Northern Norwegian dialects are rarely reported on, which this work attempts to address, and the environment wherein it occurs was selected due to the availability and salience of phonological data in working corpora.

Retroflexion is one of the central topics for phonological research on the Norwegian language, and while these consonants are found in many Norwegian dialects, they are also found in large parts of Sweden and can therefore be considered a common feature of continental Scandinavian languages rather than a trait unique to the Norwegian language. Within a word, retroflexion can be mandatory or optional; in compound words and at the junction of words, this process becomes exclusively optional. Multiple previous works have tried to determine the place of retroflexes in the language system (e.g., Brekke, 1881; Rinnan, 1969; Steblin-Kamenskij, 1965), to characterize the patterns of their behavior and conditions in which they arise. Additionally, these works attempt to consider them within the word or compound word, and to a lesser degree at word boundaries.

Because this work focuses on word boundaries, the phonetic information necessary for retroflexion is exhibited by phonemes found across words. The basic phonological process assumed here is that the rhotic segment /r/ spreads the [apical] feature on the following segment which in turn receives this [apical] feature and undergoes retroflexion. In addition to phonetic factors, the influence of which on retroflexes has been proven in other works, other factors appear at the phrasal level, influenced by phonology, syntax, and lexicon.

The rhotic segment /r/, followed by the sibilant fricative /s/ can result in the phonetically contrasted retroflex phoneme /ʃ/, which is quite easily identified by ear even by native speakers of a language in which there are no retroflexes:

(1) Kurs [kʉʃ:] – ‘course’
stor sko [stu: ʃku:]~[stu:r sku:] – ‘big shoe’
vintersol [ˈvin:tə˧ʃul:]~[ˈvin:tər˧sul:] – ‘winter sun’
etter skole [æ:tte: # skule]/[æ:tte: ʃkule:] – ‘after school’

A database was compiled for the present study, consisting of examples drawn from the Nordic Dialect Corpus v. 3.0. This extensive and detailed corpus was chosen due to the open

access to the material, clear filtering capabilities of the search engine, and access to informant information. The database of corpus entries compiled for the present study feature word combinations with rhotic-plus-sibilant sequences at the word boundary, which as explained above would conceivably result in retroflexion. All speakers are native speakers of Northern Norwegian dialects. The data was explored using statistical and comparative analysis, and the present study seeks to explore these principal research questions:

- To what extent do independent factors, such as age, specific regional dialect, and dialect area trigger retroflexion across word boundaries in spontaneous production?
- Do phonological factors, such as lexical or phrasal stress, trigger retroflexion across word boundaries as they do with /rd/-clusters?
- Do syntactic categories and lexical choices influence the triggering of retroflexion?
- Can the length of the second word predict applying or failing of the retroflexion process?
- What role, if any, does speech planning play in the triggering of the retroflexion process and how does it influence the retroflexion process?
- What are the overall predictive factors for the triggering of retroflexion in Northern Norwegian dialects?

The first question arose from the observation that the process of retroflexion is realized differently by speakers of different dialects. This led to the idea that, perhaps, the dialect itself is an influencing factor and can predict retroflexion patterns for a given speaker. If a dialect can determine the appearance or absence of retroflexes in speech, it is therefore possible that dialect groups might pattern similarly. A speaker's age has a direct impact on performance, and retroflexion, as a phonological process, is sensitive to the peculiarities of speech. All three factors are natural, independent, and uncontrollable. However, these factors are potentially significant as they are inescapable facets of being a person who speaks a language.

The second question includes from phonological and prosodic factors for consideration, such as stress patterns. The influence of lexical stress has been explored by prior works studying this phenomenon, which concentrated on theoretical knowledge about the process of retroflexion. For example, lexical stress has been shown to affect retroflexion of /rd/-clusters within words and compound words. Because the present study focuses on rhotic-plus-sibilant

clusters at word boundaries, it is possible to assume that stress patterns, whether at the lexical or phrasal level, can be a predictive factor.

The third question focuses on factors such as lexical units and syntactic categories because of the varied distribution of retroflexion. In the case of multi-word phrases, lexical meanings become more significant due to the rules binding morphosyntactic operations. The spectrum of lexical meanings is quite wide and diverse; it could therefore be assumed that, perhaps, the triggering quality is possessed not by the word itself, but by the syntactic category to which it belongs.

In the process of collecting the database, initial observations seemed to indicate that shorter words starting with a sibilant undergo retroflexion more frequently than longer words, thus giving rise to the fourth question. Due to the apparent imbalance in the occurrence of long and short words in Norwegian, it is possible that longer words are resistant to retroflexion or that, conversely, shorter words are potentially more susceptible to it.

The fifth question touches on the concept of speech planning. The retroflexion process has not been analyzed from this perspective before, but this factor is potentially significant. Speech planning is directly connected to predictability, which can be further associated with many different variations in speech (such as variations in speech duration and the selective omission of segments). Because of this, pronunciation of a given word or words can differ vastly from the cited form. Segmental sequences, such as those found at word boundaries, can obviously require phonetic or phonological corrections (Kaisse, 1985 via Kilbourn-Ceron et al., 2020). Due to these factors, predictability of the spoken word also influences its phonetic realization (Aylett and Turk, 2004; Bell et al., 2003; Ernestus, Lahey, Verhees and Baayen, 2006; Fosler-Lussier and Morgan. 1999; Lieberman, 1963; Torreira and Ernestus, 2009 via Kilbourn-Ceron et al., 2020).

Planned speech production thus creates constraints for cross-word interactions. The specific pronunciation of the initial segment in a sequence relies on phonological information from the previous word, and its realization can vary as a result of that additional information (Kilbourn-Ceron et al., 2020). This point is of undoubted importance in the case of retroflexion at word boundaries because the application of retroflexion presupposes the availability of phonological information found in the triggering environment. The absence or inaccessibility of the rhotic segment will prevent the [apical] feature from spreading to the following sibilant segment. Similarly, if the following segment is not a sibilant it will not receive the [apical] feature and therefore not undergo retroflexion. Thus, speech planning and related word predictability are potentially important factors in creating a triggering environment.

Finally, the sixth question asks what factors contribute to the emergence of retroflexion in summation, such that the process can be understood as a result of predictive factors and reliable processes.

The significance of this work lies in the fact that a detailed analysis of retroflexion across word boundaries, as well as retroflex segments in the speech of speakers of Northern Norwegian dialects, have not yet been the subject of such a detailed study. Previous studies have discussed this phenomenon in laboratory or otherwise experimental environments, relying on speaker and researcher intuition – not the analysis of spontaneous speech production – offering little insight into natural speech production and daily speech patterns. This is what the present study compensates for, as it examines the natural speech of speakers of Northern Norwegian dialects.

The results obtained in this work will expand and deepen the knowledge of multilectal variations in this region, as well as supplement the available body of knowledge on this rare and intriguing phonological process.

Initially, the planned scope of the present study was to explore four possible cases of retroflexion, where each case corresponds to a rhotic-plus-dental combination of segments. However, only the rhotic-plus-sibilant combination was sufficiently salient for the chosen process of acoustic analysis; as a result, the scope of the study was limited to one possible environment where retroflexion occurs. A more comprehensive discussion on this is outlined Chapter 3.

Going forward, it would be relevant to consider all possible environments where retroflexion occurs. Comparing the results obtained in this work with an analysis of other instances of retroflexion occurring in the same environment (e.g., between word boundaries) would enable a deeper understanding of the phenomenon – not only as it occurs in Northern Norwegian, but of the retroflexion process in general.

The work consists of several chapters, each of which describes, analyzes, and discusses different aspects of the retroflexion process. A brief overview of the chapters is given here:

- Chapter 1: "**The phonetics and phonology of retroflexes**". This chapter introduces the phonemic inventory of Norwegian, describes phonetic and phonological features of retroflex segments, and discusses whether retroflex segments are phonemic in Norwegian.
- Chapter 2: "**Previous approaches to retroflexes in Norwegian**". Here, I provide a historical overview of retroflexion and discuss the theoretical background of retroflexion patterns in Norwegian rhotic-plus-sibilant sequences.

- Chapter 3: "**Methodology**". This chapter describes the methodology of the present study and compilation of the corpus subset used for analysis. This chapter additionally discusses the focus on rhotic-plus-sibilant sequences over rhotic+/n t d/ sequences.
- Chapter 4: "**Statistical analysis of the data base**". This chapter includes an overview of the retroflexion of rhotic-plus-sibilant sequences based on the examples collected in the database for this study and introduces the statistical analysis of phonological and syntactic features of the observed retroflex segments. This chapter confirms the influence of age, region, dialect area, county, and syllabic structure on the realization of retroflexes in daily speech among the selected informants and demonstrates the insignificance of the influence of lexical stress. It also examines the influence of the second word and syntactic category of the words on the retroflexion process.
- Chapter 5: "**Analysis of the results obtained**". This chapter contains a detailed analysis of observed retroflexes based on the results discussed in the previous chapter. Some features, as discussed earlier, are checked with the help of the comparative analysis between the examples with and without retroflexes.
- Chapter 6: "**Discussion**". summarize all the previous results obtained and gives the full overview of the retroflexion of rhotic-plus-sibilant sequences at word boundaries in Northern Norwegian dialects.

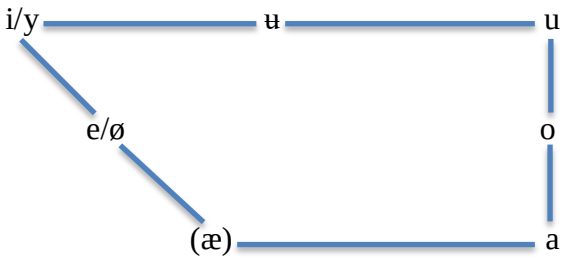
Following the conclusion is the list of references and appendices, which include example of the database for the study, some statistical tables and R code for the statistical analysis.

1. The phonetics and phonology of retroflexes.

1.1 The place of retroflexes in the Norwegian sound inventory.

There are 18 vowels (not including diphthongs) and 22 consonants in the Norwegian language. Orthographically, there are nine vowels <a e i o u y æ ø å> which express the 18 phonologically contrastive phonemes, all of which can be long or short. The vowel /æ/ is considered a marginal phoneme (Kristoffersen, 2000), and its phonemic status is not clear because in most cases it is expressed as an allophone of /e/. Kristoffersen (2000) describes it as being in near-complimentary distribution: [æ] appears before /r/ or /ɽ/, and [e~ɛ] in all another positions, though there are some exceptions to this complimentary distribution.

(1) Norwegian vowels (Solhaug, 2010)



Front and back vowels are marked on the left and right dimensions respectively. Openness of a vowel is shown in the vertical dimension. Vowels separated by a slash indicate pairs, where the right vowel is the rounded counterpart of the left segment. This represents a general version of the vowel inventory because, in practice, phonological structure in Norwegian is rather contradictory and prompts many questions. As a result, it is not very clear how to effectively organize phonemic segments. In addition, different dialects of Norwegian have different phonological processes, which in turn leads to the formation of different phonological structures (Kristoffersen, 2000; Solhaug, 2010).

The number of consonants in Norwegian also varies from dialect to dialect. Kristoffersen (2000) describes a traditional Urban East Norwegian (UEN) system, which is taken as a basis in most cases. Solhaug (2010) modifies this system, as shown below:

(2) Consonant inventory (Kristoffersen, 2000; modifications from Solhaug, 2010):

	Coronal				
Manner/place of articulation	Labial	Dental/alveolar	Retroflex	Dorsal	Laryngeal

Plosives	p, b	t, d	ʈ, ɖ	k, g	
Nasals	m	n	ɳ	ŋ	
Fricatives	f	s	ʃ	ç	h
Liquids		ɾ	ɽ, ɭ		
Approximants	ʋ, (w)			j	

Like many others, Kristoffersen (2000) assumes that retroflex sound has a counterpart, thus there is a contrast between dental/alveolar and retroflex. Solhaug (2010), though, states that /l/ is a retroflex in all cases. However, this retroflex does not have any connection with the retroflexion of coronals preceded with the rhotic /r/.

Although the above table is UEN, most of the Norwegian dialects can be described with this system. Nevertheless, there are some issues in terms of retroflexes that are worth mentioning.

Originally, it was believed that the Norwegian language has /ʃ/ and /ʂ/ sibilants. The first one appeared as the consequence of palatalisation, and the second one appeared based on retroflexion. However, the difference between them is so insignificant, that even native Norwegian speakers cannot define it by ear. Uffman (2007) states that the difference between these two sounds is usually neutralized in favour of /ʃ/, but also allows for the possibility of variation, for example in the Narvik dialect (Uffmann, 2007) or Oslo dialect (Papazian, 1977, Jahr, 1981). The rhotic segment itself is not a retroflex and not a result of retroflexion, although it contains a retroflexion triggering feature, which will be described below.

1.2 Phonetic properties of retroflexes.

The retroflex sound is created when the rhotic segment /r/ or /ɽ/ is followed by coronal segment /t/, /d/, /n/, or /s/. This assimilation process leads to the conclusion that /r/ or /ɽ/ spreads some feature which changes the coronal segment into a retroflex (Solhaug, 2010).

The process of retroflexion is not completely clear from an articulatory perspective. Sounds produced by curling the tip of the tongue backwards are retroflex, but there is no concrete place of articulation. Curling the tip of the tongue backwards, it is possible to reach the alveolar, post-alveolar and palatal areas. All coronal types, marked as dental/alveolar or retroflex, can be articulatorily alveolar, so the passive articulator is not the instrument that can clearly distinguish them. The coronal place feature remains the same (Solhaug, 2010). Following Endersen (1985), it is believed that the tongue blade is the main factor for sound producing, and not the tip of the tongue. Vanvik (1972, in Solhaug, 2010) claims that any

curling the tongue blade upwards and pushing it against the roof of the mouth will lead to retroflex articulation.

Thus, it can be argued that the place of retroflex articulation is somewhere between the alveolar ridge and the hard palatal. Or, following Endersen (1985), retroflexes are acceptable if the speaker uses the blade of the tongue, instead of the tip of the tongue, to press some area between the alveolar ridge and the hard palate. However, it seems that for Norwegian retroflexes the main role is played by the tip of the tongue, even though the place of articulation place is still anywhere between the alveolar ridge and the hard palate.

What about an active articulator as a distinguishing instrument?

The phonemes /ʈ ɖ ɳ ɭ ʃ/ are apical and /t d n l s/ are laminal. Endersen (1985) concluded that retroflexes articulated closer to the alveolar ridge receive a "higher" status and are considered as "preferred", while other types are considered as "vulgar". By the IPA standards, retroflexes are produced when the curled tip of the tongue touches the area behind the alveolar ridge (e.g., they are post-alveolar); but for Norwegian retroflexes, they can be alveolar without curling the tongue so far back as to produce a "true" retroflex.

Hamann (2003) proposes four proto-typical characteristics for evaluating retroflexes: apicality, posteriority, sublingual cavity and retraction. Retroflex segments do not need to have all of these characteristics, though some are mandatory, and the more qualities that are available the more obviously retroflex the segment. All four of them will be described in more details below.

- Apicality – the active articulator is the tip of the tongue. Norwegian retroflexes are apical so this very characteristic is necessary to accept the sound as a retroflex.
- Posteriority – unlike coronals, retroflexes tend to articulate farther back in the oral cavity. This characteristic is not necessary for Norwegian retroflexes.
- Sublingual cavity – the tongue curls backwards and creates a cavity under. The size of the cavity depends on how far backwards the tongue curls.
- Retraction – withdrawal of the tongue body to the pharynx or velum. This displacement makes retroflexes pharyngealized or velarized to an extent.

Each of these four characteristics exhibits different rates of influence on the acoustic properties of the retroflexes.

1.3 Phonological properties of retroflexes.

The rhotic segments /r/ and /ɽ/ can spread apicality to following coronals, and this spreading should be marked in phonological configuration. Thus, the rhotic segments should have a feature which coronals do not have. Kristoffersen (2000) states that the [apical] feature is assumed to depend on the place feature [coronal].

(3) Coronal segments (Kristoffersen, 2000:38)

	Laminals				Retroflex				
	t	d	n	s	ʈ	ɖ	ɳ	ɭ	ʃ
coronal	∨	∨	∨	∨	∨	∨	∨	∨	∨
apical					∨	∨	∨	∨	∨

/r/ and /ɽ/ also share the same featural "power". To solve this problem, Kristoffersen (2000) proposes the privative feature [posterior], referring to the degree of articulatory backness. Retroflexes which are derived from the rhotic segment /ɽ/ will have the feature [+posterior] due to their articulation further back in the mouth.

1.4 Underlying or derived retroflexes.

The phonological status of retroflexes is also debated. In cases without any alternations, the segment is considered underlying (Rinnan 1969, Kristoffersen 2000, Molde 2005). For example, in the word *gardin* [gɑˈɖiːn] 'curtain', the retroflex is considered underlying because it never alternates. But in the word *gardist* [gɑˈɖɪst] 'guardian', the non-assimilated /rd/-cluster is underlying, though the retroflex surfaces if there is a suitable phonological environment – in this case, its post-stress position (Solhaug, 2010). The conclusion is, therefore, that some segments are underlying while some others are the result of assimilation between the rhotic segment and the following coronal segment. It also can mean that retroflexes and laminals are contrastive, as shown in the examples below.

(4) Examples from Solhaug (2010:41):

katt [kɑtː] – cat

kart [kɑʈː] – map

Another possible scenario is that retroflex segments are never underlying and always derived. Thus, they are never true retroflex segments, and they just represent a phenomenon that reflects the underlying abilities of rhotic segments followed by coronals. The main argument which supports this theory is that /rt/, /rd/, /rn/, /rl/ and /rs/ clusters are usually absent from the surface forms in the Norwegian language. However, the process is obviously

productive, since even borrowed words (for example, the names of countries or cities, and so on) can be pronounced with a retroflex (Solhaug, 2010).

If we assume that retroflex segments are always derived, the Norwegian sound inventory is smaller than previously assumed because there are no retroflex segments – though there is a feature that can contradict this statement. Firstly, there is an obvious difference between laminals and retroflexes, as in example (4) above. Secondly, /rd/-clusters surface as rhotic-plus-coronal sequences quite regularly in Eastern Norwegian and, taking stress assignment into account, this behaviour become predictable (Solhaug, 2010).

The idea that retroflexes in a non-derived environment are underlying results in a loss of generalization. *Gardin* [gɑˈɖi:n] 'curtain' would have an underlying form /gɑɖin/, while gardist [gɑˈɖɪst] 'guardian' would be an underlying /gɑɾd-ist/. These two words feature the same stress patterns, which leads to the result where both surface with a retroflex. Generalization of non-retroflexion, dependent on the stress assignment, would fail if it would be possible to assume underlying retroflex for one of these words but not for the other (Solhaug, 2010).

However, there are significant problems with the idea that retroflexes are always derived from underlying clusters. Following the concept of Lexicon Optimization (Prince and Smolensky, 1993), input retroflexes in L1 acquisition would lead to the identicality of the underlying and the surface forms. Speakers of a Norwegian like L1 will have heard a lot of retroflexes since childhood and, accordingly, would naturally consider them as underlying phonemes. But words like *garde* and *gardist* behave differently and, assuming /gɑɖ/ as an underlying form, would lead to the failure of predictions about *garde* [ˈgɑɾdə]. Having /gɑɾd/ as the underlying form would lead to the same problem, but regarding *gardist* [gɑˈɖɪst] (Solhaug, 2010).

Stress patterns in words with similar phonological configurations can help in determining the underlying form. The underlying form would consist of a retroflex in cases where there are never any alternations and, consequently, there is no reason to assume it as a possible option. If we assume that language acquisition occurs in the same way, just retroflexes without alternations will be considered underlying, while all another retroflex clusters cannot be such.

Solhaug (2010) claims that this approach is more acceptable. In accordance with McCarthy (2005) and his free ride learning, he applies this idea to the Norwegian dialects. McCarthy (2005) analyses the Sanskrit vowel system and how children acquire Sanskrit, where surface mid-long vowels [e:] and [o:] were the diphthongs /ai/ and /au/ underlyingly. When children realize that /a + i/ across morpheme boundaries surface as [e:], they change the underlying form of surface [e:] in tautomorphemic environments (taking a free ride). In the case

of Norwegian retroflexes, the speaker uses alternating forms to understand the real underlying form of retroflexes (Solhaug, 2010). Thus, [ʈ ɖ ɳ ʃ] surface from underlying clusters of /rt/, /rd/, /rn/ or /rs/. However, the segment /ʃ/ usually has an independent status due to the phonetic contrast with /s/ (Solhaug, 2010).

2. Previous approaches to the retroflexes in Norwegian.

2.1 Historical overview: different approaches to retroflexion.

The appearance of retroflexes in Norwegian coincided with the period when these sounds disappeared from other Germanic languages (Solhaug, 2010). This is evidenced by the presence of retroflexes in only one closely related language - Swedish. However, due to the lack of access to the spoken language of that period, it is impossible to say exactly when retroflexes became part of the language. The written examples that are available are useless in this matter, since the retroflexes are not displayed in the orthography.

Steblin-Kaminsky (1965) raises the question of why the /r/ segment in Norwegian has alveolarizing (retroflecting) power, while in other languages the process of retroflexion is not present at all. Since Steblin-Kaminsky was an adherent of the structuralist tradition, his method is to seek an explanation within the sound system itself. In the case of Norwegian, the process began in 1100 CE when there were two liquids, /r/ and /l/, in the sound system. It is assumed that the difference between the two sounds was not in the place of articulation, but in the manner. Thus, /r/ was defined as a trill (while /l/ was non-trill) or /l/ was defined as lateral (whereas /r/ is not). At some point, the /rð/ cluster became the retroflex flap /ɽ/ (Seip 1955:177). The emergence of the third liquid, /ɽ/, changed the relationship between the /r/ and /l/, as their opposition was now useless. The third liquid /ɽ/ began to assimilate with the following coronals and form retroflexes: the place of articulation was due to the retroflex flap, not the coronal.

2.1.1 Kristoffersen's approach.

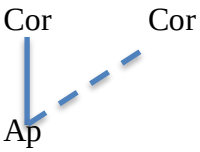
Kristoffersen (2000) supports the opinion that retroflexes are underlying, but in non-derived contexts only. This refinement was made on the basis that /rd/-clusters after an unstressed syllable morpheme internally do not become retroflexes.

The second point in Kristoffersen's analysis: retroflexion is not one, but two separate processes. The first process is the spread of the [apical] quality from the rhotic to the following coronal, and the second is the deletion of the rhotic segment afterwards. Beside apical articulation, retroflexes are different from other coronals in the way that they are more posterior. Kristoffersen (2000) assumes that there is a third process which inserts a [posterior] feature on all apical coronals and this feature gives the passive place of articulation to the retroflexes. The

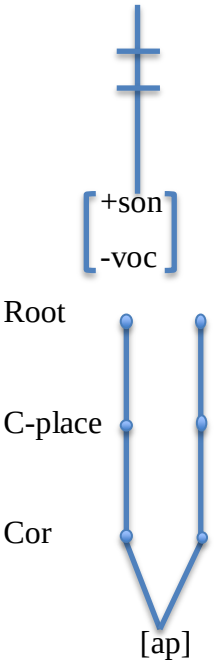
last rule does not apply to the underlying /r/, which means that only derived apicals can get the [posterior] feature.

These first two rules are illustrated by featural geometrical representations below (Kristoffersen, 2000:98):

(5) The Retroflex Rule a: [ap]-spreading

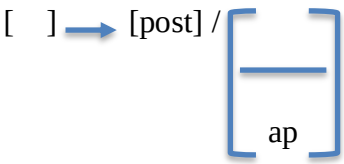


(6) The Retroflex Rule b: Rhotic delinking



The diagrams presented above clearly demonstrate the implementation of the first two rules. (5) shows the spreading of [apical] to the next coronal segment, and (6) illustrates the deletion of the rhotic segment, resulting in the situation where the [apical] feature remains the only visible sign. The third rule should ensure that the apicals have a passive place of articulation (Kristoffersen, 2000:99):

(7) The Retroflex Rule c: [post]-insertion



The diagram above shows that the [posterior] feature is inserted on all apicals.

Later Kristoffersen (2000) distinguishes between two types of derived context: the word level, where free morphemes are combined with bound morphemes resulting in affixed words, and the post-lexical level, consisting of clauses and phrases.

(8) Stratal application of the Retroflex Rule (Kristoffersen 2000:99)

Stratum	*Mode of application*
Cyclic level	Subject to the Strict Cycle Condition (retroflexion only applies to "old" environments).
Word level	Applies to underlying /rd/-clusters when /r/ belongs to an unstressed syllable.
Postlexical level	Applies in derived environments only.

Solhaug (2010) notes that an important point in Kristoffersen's approach (2000) is the specific order of the rules. If this order is changed, the output will be decidedly incorrect. Another important aspect of this theory is the assumption that this phonological process applies at different levels. Thus, the theory develops within the framework of Lexical Phonology, where the basic idea is that a given computation can move freely between syntactic and phonological components, where each of the components functions as a "sponsor" for the other.

Solhaug (2010:75) notes several weaknesses in the presented theory of retroflexion analysis, and he considers the very first doubtful fact to be the assumption of the underlying status of retroflexes in cases where they do not alternate with unassimilated clusters. He makes the following arguments in support of the inconsistency of this provision:

a. there is no relationship between the influence of stress and retroflexion.
b. no contrast between /rt/~/ʈ/.
c. e-lowering in front of retroflexes need special explanations.

The second problematic point is the specific order of application of the rules. There are no external reasons confirming the need for a specific order for applying these rules, except, in fact, the correct phonological result. Due to the lack of extrinsic motivation, these rules become a description of the process rather than its explanation (Solhaug, 2010).

The next point derives from the preceding two. Spreading and delinking are very often used to describe a wide range of phonological processes, and their motivation lies in statistics. The last rule is mostly purely descriptive, and without certain restrictions, it is necessary to explain everything (Solhaug, 2010).

The last point also relies on language and phonology in general, since all the rules mentioned above are constructed exclusively within the Norwegian language and can only be applied to retroflexes in Norwegian (and possibly also the closely related Swedish). Generative grammar claims that children learn their native language so quickly because abstract linguistic representations are universal, and some linguistic knowledge exists in the human brain from birth. While supporting this idea in linguistic theory, grammatical models must also remain

universal and represent languages in general. Thus, there should be no language specific rules (Solhaug, 2010).

2.1.2 Bradley's approach.

In this approach, the author adheres to the idea that /r/ in modern language is implemented as tap [ɾ]. Articulatory overlap between segments on the same tier leads to retroflexion, and weak perceptual cues of taps make them capable of mixing with other segments. Bradley (2002) combines the process of retroflexion with the more general process of r-deletion before consonants of any type. This process before coronal consonants results in retroflexion, and before non-coronal consonants it simply ends with the loss of the rhotic segment. This happens due to the specific phonetic features of the tap [ɾ]. Bradley (2002) notes that to enhance perceptibility and maintain sonority, taps tend to prefer an intervocalic position while avoiding word-edge positions (Bradley, 2002:46).

The idea is that the difference in gestural timing gives different phonetic realizations of this cluster. If the oral gesture of the first segment is temporarily detached from the next segment, a short vowel will be inserted between them to keep the rhotic segment in its original (tap) quality, but in the presence of gestural overlap in a given cluster, two potential results appear. Segments with the same place of articulation will result in confusion of phonetic characteristics. Gestural overlap across tiers, on the other hand, will lead to the deletion of one of the segments since one oral gesture can absorb the other. And here Bradley (2002) combines the process of retroflexion with the general rule that /r/ disappears if it is in front of other consonants. These are the two general tendencies in connected speech. Although retroflexes only target coronal segments in Norwegian, Kristoffersen (2000:180) notes cases where /r/ in the morpheme-final position is periodically deleted in front of non-coronal segments. The same tendency is observed in the derived environment, in compound words, and at word boundaries, but if the tap can be resyllabified as the onset of the next syllable, deletion will not occur. This is supported by the observation that this segment generally prefers an intervocalic position.

However, there are exceptions to this statement when all requirements are satisfied, but the tap is not deleted even optionally. Bradley (2002) attributes such exceptions to morphology. The non-derived environment does not undergo tap deletion, while the derived environment (compound words and words with affixes) does. In his work, the author tries to figure out how a derived environment differs from a non-derived environment in terms of tap loss. The timing of gestures, in his opinion, is the main difference. Simply put, all the necessary information about the segments of which it consists, the length of the segments, and the stress and tone (if

any) are considered. It also contains information about the timing of the oral gestures of the segments with respect to each other. All this information about timing specification protects /r/ from deletion in the non-derived environments. But in derived environments, there is no lexically specified timing relation, and therefore there is nothing that could ensure the presence of the tap.

The idea presented in this author's work has significant drawbacks, and Solhaug (2010) notes some problems with Bradley's analysis. The first problem is the same as in Kristoffersen's (2000) work, where it is assumed that underlying and surface forms are identical in non-alternating clusters (Bradley 2002:46). Solhaug (2010) claims that there are good reasons to believe that all retroflexes (except /ɭ/) are rhotic-coronal clusters underlyingly. The second problem is connected to the complexity of the words which Bradley (2002) uses to support proposed idea. They are undoubtedly complex from a morphological point of view, but they are not complex in a synchronic grammar of modern Norwegian. For example, the word *erklære* ('to declare') (example from Solhaug, 2010) consists of the affix *er-* and the root *klære*, which cannot be used and does not make sense separately. Thus, it is questionable if an idea that can be supported only by examples of derived environments, which contain elements which do not work alone, can be accepted as trustworthy. Such words as *erklære* in modern Norwegian could be analysed as simplex words.

2.2 Retroflexion patterns in Norwegian.

Different patterns of retroflex behavior have been observed in Norwegian. As mentioned previously, a retroflex can appear in a rhotic context when /r/ or /ɽ/ triggers a change of the following coronal /s t d n/ into the corresponding retroflex /ʃ ʈ ɖ ɳ/. The rhotic element of the combination is deleted, and the retroflex segment appears in the surface form. The same process occurs when the rhotic segment /r/ precedes /ɭ/. The described process is considered basic and occurs in the root context, between morphemes, and at word boundaries (Solhaug, 2010).

(9) Kurs [kʉʃ:] – course
Garn [ga:ɳ] – yarn
Stort [stu:ʈ] – big.NEUTR
År siden [o: ʃi:a] – years ago

The created environment is different in these three cases. The root context is not the derived environment, and the boundaries of morphemes or words are derived environments. However, in all three cases the rhotic segment is removed, and only the changing of the quality

of the subsequent coronal consonant remains of the presence of the other element in the past. Historically, this can be applied to root contexts (Solhaug, 2010).

Despite the generality of the basic rule, there are also special cases, for example a root-locked /rd/ cluster in Eastern Norwegian dialects, which nevertheless occurs across morpheme boundaries (Solhaug, 2010), like in the examples below:

(10) Ord [uɾd] – word

Datter di [dat:e: ɖi:] – your daughter

This oddity is not the only one. The seemingly obvious asymmetry between derived and non-derived contexts demonstrates other features as well, which can be illustrated in these examples.

(11) (from Solhaug, 2010:31):

garde [ˈgɑɾdə] – guard

gardist [gɑˈɖɪst] – guardsman

In example (11), retroflexion applies only in the case of the second word, while in the first word it fails to apply even though context is non-derived and it is predicted that the cluster will undergo retroflexion. The second word is morphologically complex and behaves according to expectations. The asymmetry can be explained with Kristoffersens (2000) suggestion about the stress governing the split in /rd/ cluster pronunciation, as mentioned previously. /rd/ undergoes retroflexion when the cluster precedes the stressed syllable and does not undergo this process if it follows a stressed syllable. *Garde* and *gardist* have the same root but differ in stress assignment. The stress falls on the first syllable in the first word and on the second syllable in the second word. Thus, in the first word stress is assigned to the syllable preceding the /rd/ cluster and retroflexion fails, while in the second word with stress assigned to the second syllable retroflexion applies according to predictions (Solhaug, 2010).

The situation when the process affects not one coronal, but clusters of coronal segments, and leads to the whole cluster becoming retroflex, is called *multiple retroflexion*. The cluster is pronounced apically, and the rhotic segment is deleted according to the basic rule. This pattern is common at word boundaries, but also sometimes occurs in root contexts (Solhaug, 2010).

(12) Først [føʃʈ] – first

Stort nok [stu:ʈ ɳɔk:] – big.NEUTER enough

Retroflexion can affect not only the nearest coronal, but also spread to the entire cluster. Potentially, the distance of the effect of retroflexion is unlimited, but the phonotactics of the Norwegian language is a natural constraint for any process (Solhaug, 2010). An intervening vowel can also be an obstacle to the process.

The complication in the process of retroflexion was observed by Julien (2002). Retroflexion can be obligatory or optional depending on the context. For example, retroflexion is obligatory in simple root words or in words with bounded morphemes, but this process becomes optional across morpheme boundaries and in compound words.

(13) (Examples from Solhaug, 2010:33):

barn [bɑ:ɳ] *[barn] – ‘child’

stor skog [stu: ʃku:g]~[stu:r sku:g] – ‘big forest’

vinternatt [ˈvin:təˌɳɑt:]~[ˈvin:tərˌnɑt:] – ‘winter night’

Solhaug (2010) explains this retroflex asymmetry by phonological distance. This distance is present even though the elements are adjacent and can affect the retroflexion process. Any hitch or pause between the rhotic and coronal segments cancels the retroflexion. However, retroflexion still can occur in similar cases without an intervening pause.

(14) Har sett [har # sett]/[ha: ʃet:] – see.PST

Thus, it can be assumed that phonological structure is sensitive to more aspects than just stress and segmental features. The syntactic structure also plays a big role. In some cases, it is the syntax that determines the phonology and creates the rules according to which retroflexion can be obligatory or optional. This idea also suggests that there is a higher phonological structure than words and word strings (Solhaug, 2010).

Selkirk (1978) proposed an example of possible structure:

(15) The Prosodic Hierarchy:

υ Utterance

ι Intonation Phrase

Φ Phonological Phrase

ω Prosodic Word

Ft Foot

σ Syllable

The syllable (σ) is the smallest unit and the lowest level in this hierarchy.

The foot (Ft) is composed of multiple syllables.

A prosodic word (ω) is any ordinary word other than a functional word.

A phonological phrase (Φ) more or less coincides with a syntactic phrase.

The intonation phrase (ι) roughly matches the syntactic clause (CPs).

And, finally, an utterance (υ) can consist of one or more syntactic clauses.

According to Solhaug (2010), retroflexion is obligatory up to the level of the prosodic word, and optional at all levels above that. However, the status of compound words is still unclear. Compound words behave like phonological phrases since retroflexion is optional here, though their stress pattern does not match the syntactic phrase.

Kristoffersen (2000) and Rice (2006) note that the prosodic word (with rare exceptions) has predictable penultimate stress. When it comes to combinations of words, stress from a lower prosodic level is inherited by higher prosodic levels: thus, two ω-words makes a Φ-phrase, and the stress on the Φ-level will go to the right. This tendency is observed at all hierarchically higher prosodic levels. However, different behavior can be observed in compound words when the stress moves to the left and makes this type of words a hybrid type. Solhaug (2010) proposes a solution to this problem in the spirit of Itô and Mester (2007); that is, to split the prosodic hierarchy.

(16) (from Solhaug, 2010:35)

Φ Phonological Phrase

|

ω-maximal (Prosodic Word)

|

ω-minimal (Prosodic Word)

|

Ft Foot

Compounds are not phonological phrases, but they save their phonological properties such as, for example, optional retroflexion. Retroflexion would be obligatory at the minimal prosodic word level (ω-minimal), but optional at the maximal prosodic word level (ω-maximal) and, accordingly, above that.

(17) Sladder [ʃlad:ər] – gossip

Oslo [ˈuʃlu] – Oslo

In these examples /s/ followed by /l/ is changed into [ʃ]. Such retroflexion is clearly different from retroflexion in a rhotic context. Such changes of /s/ appear at the root if both elements are within the same syllable, or within the root when the two elements are in different syllables or across boundaries, but it does not happen across word boundaries (Solhaug, 2010). The question, then, is: why is /s/ changing under such unusual circumstances and not

categorized as an independently existing phenomenon? This is because this change is triggered by the same principles as retroflexion.

In a rhotic context: retroflexion is progressive and rightwards spreading.

/s/ + /l/ context: like retroflexion except leftwards spreading of /ʃ/ to coronals preceding it.

(18) Examples from Solhaug (2010:39):

lunsj [lønʃ] – lunch

kanskje [ˈkɑnːʃə] – perhaps

lunsj som [lønʃ ʃɔmː] – lunch which

The first two examples show regressive leftwards spreading, while the last example shows progressive rightwards spreading from /ʃ/.

In Norwegian adjectives, certain segments are omitted and retroflexion is proliferated. This feature seems to be observed in relation to non-coronal elements.

(19) Examples from Solhaug (2010:40)

sterk~sterkt [stæɾk]~[stæʈ] – strong

skarp~skarpt [skɑɾp]~[skɑʈ] – sharp

Usually, a direct boundary between the rhotic element and the coronal target is required in rhotic contexts, but in some cases non-coronal segments are ignored, like in the examples above which illustrate the adjustment to the word suffix, marking neutral gender. However, skipping is not possible across the other types of boundaries and happens only on the prosodic word level.

2.3 What triggers retroflexion.

Sverre Stausland Johnsen (2011, 2012) tried to explain the various patterns of behavior of retroflexes in his dissertation “The origin of variation in Norwegian retroflexion” (2011) and several articles (e.g., in Stausland Johnsen, 2012) based on it. He claims that underlying alveolars /t d n s/ in Norwegian change into [ʈ ɖ ɳ ʂ] after /ɾ/ but the likelihood of such a change depends on phonological context. For /t d n/ this process is obligatory, but optional for /s/; the following segment has influence on the undergoing retroflexion from /s/ to [ʂ].

In his works, he concentrates on retroflexes within nominative compound words, but this provides a solid enough basis for considering retroflex patterns in other contexts.

The process of retroflexion has been described in the previous literature as an obligatory process, absent only in those cases when there is a significant intonational or pausal boundary between morphemes (Eliasson, 1986:282 via Stausland, 2012; Kristoffersen 2000:316f; Torp

2007:70). Kristoffersen states that retroflexion ‘seems to be beyond speakers’ active control’ (2000:317). Stausland Johnsen (2011, 2012) says that the description is generally correct. Retroflexion seems to be mandatory in cases where a morpheme ending with a tap /ɾ/ precedes the morpheme starting with alveolar /t d n/ sounds, but the process is completely optional in the case of words beginning with the alveolar sibilant /s/. However, some words do undergo retroflexion processes more often than others, and Stausland Johnsen (2012) names the following segment as one of the influential factors. Specifically, retroflexion is generally preferred if a consonant appears as the following segment after the alveolar sibilant /s-/, and if a vowel is the following segment, then retroflexion is, accordingly, less likely.

(20) Examples from Stausland Johnsen (2012:199):

/ʊintɐɾ-sku:/ → √[ʊintəʂku:]~[ʊintəsku:]

/ʊintɐɾ-su:ɽ/ → [ʊinteʂu:ɽ]~√[ʊintesu:ɽ]

This pattern can be characterized differently. Retroflexion is more common in complex onsets (/sC-/) than in simple onsets (/s-/) (Stausland Johnsen, 2011; 2012).

The proposed pattern above was tested in a laboratory experiment in which 10 Norwegian speakers pronounced the most frequent monosyllabic nouns with /st-/ and /sV-/, placed in a nominal compound preceded by the nonce element <bemmer> ending in a tap /ɾ/. The experimental results showed that retroflexion was variably applied to each stimulus word in /s-/. Retroflexion was not present anywhere in 100% of cases, and no example escaped retroflexion in 100% of cases. Thus, the optionality of retroflexion in the case of alveolar sibilant /s/ can be considered confirmed. The results of Stausland Johnsen’s (2011; 2012) experiment also showed that retroflexion is more frequent in the case of words with /st-/ than in the case of words with a simple onset /sV-/, and a mixed effects logistic regression model proves that the difference is significant.

The second part of the laboratory experiment by Stausland Johnsen (2011; 2012) tested phonological productivity. This part is intended to confirm that the results obtained are not related to the fact that these words were inherited along with the processes occurring at earlier linguistic stages. That is, it is not always possible to assert with confidence whether the process is active and productive, or whether the inherited qualities of words are manifested.

In this experiment, the stimuli were three monosyllabic words starting in /sV/, three monosyllabic words in /st-/, and three monosyllabic words in /sk-/. All words were artificial but used the phonotactics of the Norwegian language and were chosen based on the most frequent complex onsets (Stausland Johnsen, 2011; 2012). All nominal compounds were created with the first element <sommer> /sɔmər/ ‘summer’. The results showed that

retroflexion was optionally applied to each stimulus, with individual word variability ranging from 35% to 72%. All the results of the previous experiment were confirmed, and it was also found that retroflexion is less frequent with words beginning with a complex onset /st-/ than with words beginning with a complex onset /sk-/. Mixed effect logistic regression models confirmed the significance of all observed differences.

In contrast to the examples starting with alveolar sibilant /s-/, retroflexion undergoes in close to 100% cases if the morphemes beginning in alveolar stops or nasals. Thus, the likelihood of retroflexion can be arranged in the following hierarchical manner (Stausland Johnsen, 2011; 2012):

(21) /t/, /d/, /n/ > /sk/ > /st/ > /sV/

Another retroflexion trigger, perceptual distance, was described in the article "From perception to phonology: The emergence of perceptually motivated constraint rankings" (Stausland Johnsen, 2012). According to the author, articulatory modification is not a very promising direction for considering the causes of the retroflexion process. This is because the shift from the laminal alveolar contact for [t d n s] to the apical postalveolar contact for [ʈ ɖ ɳ ʃ] is the same for all alveolars. Thus, there is no explanation as to why the shift is applied less frequently to any element, or why the following element might affect the likelihood of retroflexion for some of the alveolars.

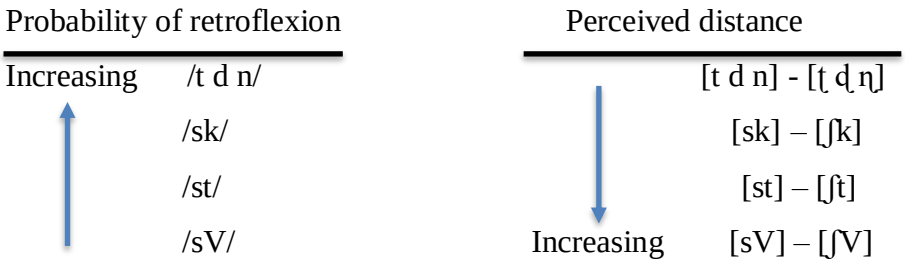
Although the articulatory shift is the same for all elements, the resulting perceptual shift does not have to be the same. The perceived distance between [t] and [ʈ] is not necessary coincide with the perceived distance between [s] and [ʃ]. Stausland Johnsen claims that the perceived distance, and difference overall, is the ultimate trigger for Norwegian retroflexion patterns. He citates Kohler (1990:86ff) who, based on data from the German language, explains that the perceived distance between [tp] and [pp], or between [nm] and [mm] is smaller than the perceived distance between [sf] and [ff]. Following Kohler, Steriade (2001:222 via Stausland Johnsen) states that "the likelihood of an underlying representation *x* surfacing as a modified *x'* is a function of the perceived similarity between *x* and *x"*" (Steriade, 2001 via Stausland Johnsen, 2012:129). Applying this principle to the obtained results for retroflexion, morphemes starting with alveolar /s/ are less likely to surface as [ʃ], while the chance of retroflexion for alveolar /t d n/ is relatively high.

Stausland Johnsen formulates the following principle, applied to the Norwegian retroflexion:

(22) The greater the perceived distance between an alveolar and a retroflex, the less likely it is that the alveolar undergoes retroflexion (Stausland Johnsen, 2012:129).

The above hypothesis suggests that the distance between [s] and [ʃ] is greater than the distance between [t d n] and [ʈ ɖ ɳ]. In addition, the distance between [s] and [ʃ] is bigger before the vowel than before the consonant, and bigger before the consonant /t/ than before /k/.

(23) A pictorial representation from the work of Stausland Johnsen (2012:129):



The distance between segments can most easily be determined by assessing how clearly and well the speakers can separate the segments. The experiments that Stausland Johnson (2012) describe in his work are aimed precisely at determining how well speakers separate alveolar and retroflex segments in Norwegian from each other.

Only native speakers of Norwegian were selected for the experiments, as only their answers can be considered sufficiently accurate and relevant. Previous literature (Polka, 1991; Golestani and Zatorre, 2004) has found that native speakers of languages that do not have contrasting retroflexes in their own language sometimes perform at chance level and resort to guessing when it is required to distinguish the retroflex coronals from non-retroflex coronals. This aspect also presented certain difficulties in this work, since the database was compiled by a non-native speaker of Norwegian and the accuracy of determining retroflexes by ear in each individual case required additional checks.

Thus, [s] and [ʃ] are considered as optional allophones because retroflexion for /s/ was stated as “optional”.

The results of the first experiment confirmed the hypothesis that the distance between [s] and [ʃ] is greater than between [t d n] and [ʈ ɖ ɳ], and that the distance between [s] and [ʃ] is greater before a vowel than before a consonant. Moreover, the distance is greater yet before the consonant /t/ than the consonant /k/ (Stausland Johnsen, 2012). The only difference from the proposed hypothesis was the insignificant difference in the distance between [s] and [ʃ] before a vowel than before the consonant /t/.

The second experiment involved the same procedure as the first, but with a significant reduction in time. The objectives of the experiment remained the same. A significant difference between the segment before a vowel and before the consonant /t/ was proved in this experiment and the main hypothesis was supported once again.

The confirmed perceived distance between /t-/, /d-/ and /n-/ categories and /ʈ-/, /ɖ-/, /ɳ/ categories shows that retroflexion is always applied if the similarity between the alveolar segments and retroflexes reaches a certain level. Stausland Johnsen (2012) states that it is difficult to distinguish between alveolar and retroflexes of these categories in such conditions, because their perceived distances are too similar. However, this perceived distance is not so small for leading to complete neutralization between these segments in Norwegian.

Stausland Johnsen (2012) concludes that there is a clear correlation between identified perceptual properties and the likelihood of retroflexion. And the following question arises: why this correlation exists? He suggests that the retroflex version of the word will not be categorized as a variant of that word if a retroflex token is too perceptually distant from the alveolar base form (Stausland Johnsen, 2012:135).

2.4 Speech planning and its potential influence on application of retroflexion.

Speech planning consists of several steps. Speaking requires formulation of the message on the conceptual level, from which linguistic processing starts and then becomes an articulatory plan which results in externalization. Lexical selection and form encoding are two identified stages of linguistic processing (using terminology used by Levelt, 2001).

Lexical selection is the process where a speaker selects necessary linguistic representations to express the intendent information in the message. If the result of production is a single word, the selection result is a unique lemma. Lemmas store the syntactic and semantic qualities of the word, and this stage precedes all other information, occurring during form encoding (Kilbourn-Ceron et al., 2020).

Form encoding starts with retrieval of the phonological code, storing in the lemma. Metrical structure of at least syllabic and prosodic levels, appearing then, guides to the more detailed phonetic code, which can move further to the articulatory execution (Kilbourn-Ceron et al., 2020).

In fast speech the processes of selection and encoding occur repetitively multiply times and participate in an additional process of integrating of these resulting items into the prosodic and syntactic context. It is broadly accepted that speech is planned from the beginning of the utterance and the speaker can initiate articulation once there is complete motor plan for the first word (Kawamoto, Liu and Kello, 2015). Linguistic planning processes in parallel with articulation, and planning occurs just before the resulting utterance.

Things like prosodic phrasing or intonational contours are completed before the articulation (Keating and Shattuck-Hufnagel, 2002). However, before the coding is completed, they can be fixed. For example, final slot in a prosodic phrase always has the fixed duration regardless of the word length (Ferreira, 1993 via Kilbourn-Ceron et al., 2020). This means that variables at the utterance level can be set early and phonetic details of the sub-programs are retrieved while utterance is pronouncing (Kilbourn-Ceron et al., 2020).

Wheeldon and Lahiri (1997, 2002) prove that initiation time of utterance depends on the number of prosodic words. And since segmental interactions across prosodic words are quite common, it is possible to suggest that multiply words form can be encoded in tandem.

It is not easy to say how early the planning window occurs, but it seems that the window size can vary and depend on several factors. One of the factors is that initiation time of the utterance can be driven more by the upcoming prosodic words number or by the internal complexity of the upcoming first word (Wheeldon and Lahiri, 1997; 2002). So, the planning ahead is very task dependent. Syntactic constituency, semantic coherence and lexical frequency of the words have also influence on the planning window size (Wheeldon, 2013; Konopka, 2012). Increased cognitive load decreases speech speed and depends on the planning scope (Ferreira and Swets, 2002; Wagner, Jescheniak and Schrieders, 2010; Mitchell, Hoit and Watson, 1996). Planning scope is also depending on individual differences in working memory (Swets, Jacovina, and Gerrig, 2014). Speakers who is faster in initiating speech show less sensitivity to the phonological details (Lange and Laganaro, 2014). Kilbourn-Ceron et al. (2020) mark that “planning window” term is not ideal because planning itself is a continuous process with several levels of activation (Pluymaekers, Ernestus and Baayen, 2005a). Thus, instead of extending planning window, it is more reasonable to talk about activation of the upcoming material to that degree, where it affects planning of the current word.

Lexical frequency is a known factor with significant effects on the linguistic processing. In case of multi-word utterances, sentences which start with high-frequency words are initiated faster that those starting with low-frequency words (Konopka, 2012). Konopka (2012) also suggests that the higher frequency of the first word give a greater chance that first and following word are planned together, while Miozzo and Caramazza (2003) states opposite, that a high-frequency first word is less likely planned together with the next word. And though it remains unclear what happens exactly in the case of the frequency of the first word, Kilbourn-Ceron et al. (2020) states that second word with the higher frequency would for sure make it more likely that two words were planned together.

Language users are sensitive to the predictability of the words in context. In spontaneous speech hesitation is more likely precedes the words which are less predictable from the context (Beattie and Butterworth, 1979). Phonetic realization is also affected by measures of predictability, like, for example, the highest frequency monosyllabic d/t final words in English are 22% shorter than the lowest frequency words (Gregory, Raymond, Bell, Fosler-Lussier, and Jurafsky, 1999 via Kilbourn-Ceron et al., 2020). Verb final d/t are more likely to be deleted when the verb appears with its usual syntactic complement.

Kilbourn-Ceron et al. (2020) propose the Production Planning Hypothesis. Their approach includes following key points: a) there are some external to the phonological grammar factors, which can influence on variability of the phonological patterns and b) modelling variability is the most important things for understanding phonological patterns. They claim that predictability affects the size of the form encoding window, which, in turn, limits the input size to the phonological input-output mapping. Information outside this window cannot affect variable element even if the information is in the very next word. It means that if the trigger of the process it not planned fast enough, the process cannot apply. That is co-presence failure (Tamminga, 2018).

Production Planning Hypothesis predicts that factors affecting speech planning, also affect phonological interactions on the word boundaries. Even more, it predicts that phonological alternations which depend on phonological information from the following word must be variable, because phonological processes are not applicable without retrieved conditioning phonological environment of the following word. And it is known that speakers do not reliably extract phonological details from more than one word ahead (Kilbourn-Ceron et al., 2020).

And how can all the above affect the success of the retroflexion process at the word boundaries?

Both words must be planned simultaneously for the appearance of a retroflex at the word boundaries, since both words contain certain phonological information that affects the effectiveness of the process. As mentioned above, phonological information is gained from the previous word, that is, a word with rhotic element /r/, must be available during the planning of the next word. If the phonological information of the preceding word is not available, as, for example, in the case of too big phonological distance between words, the process cannot take place.

In fast speech, both stages of linguistic processing, lexical selection and form encoding, are repeated multiply times, and the resulting elements are embedded in higher prosodic and

syntactic structures. Intonational contours and prosodic phrasing are decided prior to the articulation process, but phonetic details can be adjusted in the process. This means that the appearance or absence of a retroflex at the word boundaries is not decided in advance and may vary during the speech process. In many ways, the appearance of a retroflex depends on whether the words, at the boundaries of which a retroflex appears, are planned in tandem. And since planning is highly dependent on the situation and the purpose of speech, it is influenced by various factors, such as the number of prosodic words or the internal complexity of a word. Syntactic constituency, semantic coherence, and lexical frequency, as well as the individual characteristics of the speaker's memory - all these factors can influence the planning process (Kilbourn-Ceron et al., 2020). And thus, all these factors can also influence the effectiveness of the retroflexion process.

As also noted above, if the second word has a high frequency, the planning of this word occurs in tandem with the previous word. That is, if the word with the initial alveolar sibilant /s/ has a statistically high frequency, then it is planned simultaneously with the previous word containing the rhotic element. In this case, all the conditions necessary for a successful retroflexion process are met and the necessary phonological information is available. Speakers are also highly sensitive to contextual predictability, which can contribute to the emergence of retroflex (Kilbourn-Ceron et al., 2020). If the trigger for the process is not planned quickly enough and is not available at the time the variable phonetic form is selected, the process cannot be applied. Thus, if the word with a rhotic element is already not available during the planning process of the following word or the word with /s/ is not planned simultaneously with the previous word, retroflexion theoretically cannot apply. Then the so-called *co-presence failure* happens (Tamminga, 2018).

3. Methodology.

The Northern Norwegian dialects that are the subject of this study are quite numerous and widespread in the two northern regions of Norway, Nordland and Troms-Finnmark. An extensive electronic database with open access (using university information) was used to collect audio materials for analysis. Nordic Dialect Corpus v. 3.0 was chosen among several possible options. This database contains audio materials from earlier years, making it more extensive than the updated version 4.0. The quality of the audio recordings is quite variable, but in most cases good enough to be used as the material for analysis. This database was chosen due to the availability of audio recordings and relatively extensive information regarding the speakers, as well as due to the presence of a convenient search engine. The search for the required audio recordings was carried out based on the required sound elements and their location in the word and in relation to each other, with help of database filters by location and presence of potentially necessary speech elements. Built-in database filters allow to distribute examples according to informant code, recording year, birth year, gender, age, age group, place, area, region, country, and genre. Nordic Dialect Corpus v. 3.0 also has a search bar where it is possible to search for specific words or segments, and in an "extended" search it is possible to determine the position of segments in a word and search for several segments in coordination with each other. The database contains not only audio recordings from Norway, but also Denmark, Faroe, Iceland, and Sweden (a total of 874 speakers (3113388 tokens) selected from 237 places in 5 countries). To complete the database for the study, the following filters were used: country (Norway), region (Northern Norway), area (Finnmark, Troms, or Nordland, respectively) and place (all places in turn). In the "extended" search line, *r* and *s* were entered, where *r* was marked as "end" (meaning this segment should appear in the end of the word) and *s* was marked as "start" (meaning this segment should follow the *r* segment but appear at the beginning of the next word).

The database for this research, which contains only the data required for the planned retroflexion study, was created based on the Nordic Dialect Corpus v. 3.0 database. It is worth noting that Nordic Dialect Corpus v. 3.0 was finished before Troms and Finnmark merged into one county, which means that the speakers were divided among themselves into respective groups both in the main database and in the database.

The choice of the analysed villages and cities was based on the locations available in the main database but provided sufficient territory coverage for the results to be considered

exhaustive. Audio recordings from 14 places in Nordland, 19 places in Troms, and 7 places in Finnmark were selected for analysis. The table below shows the specific coverage of the area based on the following main points: dialect area, place, and number of examples for rhotic segment /r/ and following coronal segments s/d/t/n on the word boundaries respectively.

(24) Overview of the entire data base:

County	Place	n	r#s	r#d	r#n	r#t
Nordland	Andøya	187	68	68	32	19
	Ballangen	86	33	21	13	19
	Beiarn	101	36	18	20	27
	Bodø	115	43	25	17	30
	Hattfjelldal	103	40	26	8	29
	Herøy N	96	33	20	19	24
	Mo i Rana	103	36	22	23	22
	Myre	167	102	22	13	30
	Narvik	80	17	22	17	24
	Rana	43	13	24	3	3
	Sømna	106	31	17	25	33
	Stamsund	103	36	21	17	29
	Steigen	62	0	20	14	28
	Storsandnes	56	15	22	16	3
	Bardu	96	32	21	13	30
Troms	Botnhamn	71	24	20	15	12
	Kåfjord	103	37	28	17	21
	Karlsøy	95	32	27	19	17
	Kirkesdalen	118	45	27	19	27
	Kvæfjord	81	19	19	15	28
	Kvænangen	131	46	29	28	28
	Lavangen	91	33	19	18	21
	Målselv	84	22	29	12	21
	Medby	65	26	23	11	5
	Mefjordvær	81	29	25	20	7
	Signaldalen	83	29	26	13	15
	Sørdalen	84	22	25	18	19
	Sørreisa	60	21	21	8	10
	Stonglandseidet	69	15	26	20	8
	Torsken	36	14	15	4	3
	Tranøy	11	2	6	0	3
	Tromsø	120	52	25	16	27
	Tromsøysund	60	21	23	13	3
Finnmark	Hammerfest	108	29	26	29	24
	Kautokeino	101	28	30	19	24
	Kirkenes	117	45	25	19	28
	Kjøllefjord	110	45	19	17	29
	Lakselv	141	56	25	28	32
	Tana	121	48	25	20	28
	Vardø	99	48	12	18	21
Sum		3744	1323	944	666	811

According to the information on the Northern Norwegian Dialects website, the collected audio recordings can be divided not only according to place and region, but also according to dialect areas. This division would be more appropriate, since belonging to the same dialect area implies a certain similarity of dialectal features. Namely, dialectal features are of primary interest for this work. In total, thirteen dialect areas are distinguished, and all of them are presented below, with a corresponding distribution of places collected in a miniature database.

Dialect Area	**Place**
Austfinnmarksmål	Vardø
Indre tromsmål	Bardu, Kirkesdalen, Målselv, Signaldalen, Sørdalen
Saltenmål	Beiarn, Bodø
Midttromsmål	Botnhamn, Medfjordvær, Sørreisa, Tromsø, Tromsøysund
Vestfinnmarksmål	Hammerfest, Kirkenes, Kjøllefjord
Vefsnmål	Hattfjelldal, Herøy N
Nordtromsmål	Kåfjord, Karlsøy,Kvænangen
Indre finnmarksmål	Kautokeino, Lakselv, Tana
Senjamål	Lavangen, Medby, Stonglandseidet, Torsken, Tranøy
Ranamål	Mo i Rana, Rana
Brønnøymål	Sømna
Lofotmål	Stamsund
Målet i Sør-Troms, Vesterålen og Ofoten	Andøya, Ballangen, Kvæfjord, Myre, Narvik, Storsandnes

Some of the places were not marked on the map provided on the site, but since the map illustrates dialectal coverage, the distribution of the rest of the collected places was done manually. The dialectal distribution does not always coincide with the official regional distribution. Places can be located within the same county but belong to different dialect areas.

A total of 1323 examples of the /*r#s*/ combination was collected from all three regions. 535 examples were collected from Nordland, 489 examples were collected from Troms, and 299 examples were collected from Finnmark.

The database also includes 666 examples of the /*r#n*/ combination (250 examples from Nordland, 266 from Troms, and 150 examples from Finnmark), 811 examples of /*r#t*/ (350

examples from Nordland, 275 examples from Troms, and 186 examples from Finnmark), and 944 examples of /*r#d/ (*369 examples from Nordland, 413 examples from Troms, and 162 examples from Finnmark).

To summarize, the entire miniature database includes 3744 examples of four combinations (*r#s, r#d, r#t* and *r#n*), creating potentially suitable environment for retroflexion.

The database for this study was compiled by hand in Excel, with a structured registration of information required for the research. An example of the data base can be seen in the Appendix of this work.

The database sections themselves are worth explaining in more detail. Their names are sometimes replaced with an abbreviation to facilitate the use of the database in R. It includes the following information:

• **Fylke** - name of the region (Nordland, Troms or Finnmark). The need for this section is obvious. As was mentioned above, Troms and Finnmark in this work are still observed as two different counties because the main data base which was used for the collection of retroflex data used the old distribution and was created when Troms and Finnmark still were separated.

• **Place** - name of the place (village or city) speaker is from. This category is necessary for distinguishing dialects and defining dialect boundaries and characteristics.

• **SpeakerAge** - the age of the speaker in the audio recording. This information in some cases turned out to be unknown and was marked as "NA". In all other cases, this information could be found from the description in the main database. This category is necessary in order to have an idea of the age groups of speakers and to carry out a comparative analysis, observing the influence of the age on the level of the retroflex use in the spontaneous speech.

• **Combination** – checked word boundary. The first word ends with the rhotic segment /r/ and the second word starts with the following /s/, /t/, /d/, or /n/, respectively. This category demonstrates the different environments in which the retroflexion process can take place.

• **Retroflex** - retroflexion state. Only two designations appeared in this category: "yes" or "no". "Yes" indicated the presence of a retroflex, "no" indicated its absence. This category was filled in manually after the sound was assessed by ear. This is one of the most important, but also the most controversial sections in the entire database. During the checkout, part of the table was sent to the independent listener, and only this column was left empty, providing an opportunity to enter own answer.

• **Confidence** - scored with numbers from "1" to "5", where "1" means "absolutely not sure" and "5" means "completely sure". In this column, the listener marked their own confidence in annotating the retroflex sound. This column was necessary to identify the most

obvious and expressive cases of retroflexion, which would allow to provide the most accurate analysis and to obtain reliable results.

• **Context** - literary (bokmål) spelling of a phrase or sentence where the suitable environment for retroflexion is created. This information was obtained from the main database and, accordingly, it is a script made by the fillers of the main database. A few small mistakes found while collecting a miniature database have been manually corrected. This column is necessary for understanding the content of the text, as well as for the evaluating the conditions of retroflexion in terms of phonology and syntax.

• **Transcription** - phonetic presentation of the phrase uttered by the speaker, without the designation of retroflex. This column was also copied from the information provided by the fillers of the main database in the transcript of the audio material. This section is necessary to determine whether it is possible to create conditions for the process of retroflexion within a particular dialect, as well as to assess the specific characteristics inherent in the speakers of a particular place.

• **PS1** - part of speech 1. Syntactic category which refers to the first word, ending in the rhotic segment /r/. This column is necessary to examine the process of retroflexion from a syntactic point of view.

• **PS2** - part of speech 2. Syntactic category which refers to the second word, starting with potentially retroflex element. Fixation of this information will make it possible to make a more complete syntactic analysis of retroflexion.

• **FW** - the first word in a combination, which corresponds to PS1.

• **SW** - second word in a combination, which corresponds to PS2.

• **SyllablesFW** - the number of syllables in the first word.

• **SyllablesSW** - the number of syllables in the second word.

• **StressFW** - marks the stress that appears in the first word. This column contains the following marks: one (monosyllabic word), ante-penultimate (the stress falls on the third syllable from the end), noWord (the word is incomplete, interrupted, and, accordingly, there is no stress), penultimate (the stress falls on the second syllable from the end), initial (the word consists of more than three syllables and the stress falls on the first syllable in the word), second (the word consists of five or more syllables and the stress falls on the second syllable), third (the word consists of six or more syllables and the stress falls on the third syllable).

• **StressSW** - marks the stress that appears in the second word. The markings are the same and for “StressFW”.

• **Quality** - the type of the connection between the rhotic segment and the next sibilant. In the process of compiling and listening to the database, it became clear that different dialects, different speakers, and different environments give a different connection between the rhotic /r/ and the next segment. All these connections deserve special attention since their analysis provides new information regarding retroflexion. "*There is r*" – means that the rhotic element remains in place, and the next segment is also pronounced. And although all the conditions for retroflexion are met, the process of retroflexion itself does not occur. "*No r*" - means that the rhotic element is not pronounced, but the segment following it is pronounced unchanged. Thus, the rhotic element disappears, as in the process of retroflexion, but the retroflexion itself does not occur and stop does not change. "*No s/d/t/n*" means that r-segment remains in place and is pronounced, but the next segment disappears. No retroflexion occurs. In cases where retroflexion still takes place, the nature of the connection between the elements is not specified.

• **Notes** - random notes. In this column, all oddities and peculiarities that could be of any interest in research or serve as a basis for assumptions were noted without a specific system. Many notes appeared during the collection of the database and then served as the basis for the emergence of some potential factors triggering the retroflexion process.

This system in this database was formed by trial and error. Initially, the "Confidence" and "Quality" columns were missing. In the process of listening to sound recordings, it became clear that not all of them are of the same good quality, and it is not always possible to determine the retroflex by ear for sure. An additional column for "Confidence" has been added to make the assessment of each case fairer and more precise. The difference in connection between the rhotic segment /r/ and the next segment became more and more obvious when almost the entire database was already collected. The column "Quality" has been added to provide a clear statistical representation of the nature of this relationship. The number of syllables and the type of stress in the first and second words were added manually after the database was fully completed to collect statistics on the effects of word length and lexical stress.

Several test auditions were carried out by native Norwegian speakers with linguistic experience to achieve the most fair and accurate result on the identification of retroflexes in different combinations. The first check was carried out at the beginning of the collection of the database. The first listening test consisted of 18 examples of */r#d/*, */r#t/* and */r#n/* combinations with varying degrees of clarity and confidence.

The second control check was carried out already when the collection of the database was completed, and all own judgments were made. The purpose of the second test was to determine the accuracy and percentage of agreement of opinions of different listeners, since the entire

study is conducted by a non-native Norwegian speaker in whose native language there are no retroflex sounds. The final check was more extensive and included 50 randomly selected examples of the four considered combinations. 12 examples of the /*r#s/* combination, 12 examples of the /*r#t/* combination, 12 examples of the /*r#n/* combination and 14 examples of the /*r#d/* combination were shown in the test example. Two native Norwegian speakers from different parts of Norway, both with linguistics backgrounds, listened to these examples independently from each other, noted retroflexes, and rated their confidence in each given answer.

This test turned out to be very useful and somewhat changed the course of the study. The compiled comparative diagram showed that, despite some differences in individual and overlapping examples, most of the answers were the same for all three listeners (the main one and two testers). However, the number of matching and not matching responses was different for each individual combination. The largest number of matching answers was predictably found in the examples with the rhotic-plus-sibilant sequences. In this case, all listeners matched in 10 examples out of 12. The number of matching responses in the /*r#t/* and /*r#n/* combinations was the same: 8 responses out of 12. And 9 out of 14 answers coincided for all listeners in the /*r#d*/ combination.

8 out of 12 and 9 out of 14, while showing a 66,67% coincidence, nevertheless, is not much higher than a coincidence. This result is positive, but based on it, it is impossible to draw specific and reliable conclusions. That is why, despite the number of examples that the database for the study includes, it was decided to focus on studying the patterns that the rhotic-plus-sibilant sequence demonstrates. In this case, the results obtained in this study can be considered reliable and reasonably accurate.

4. Statistical analysis of the database

The first step in working with the database compiled for this study is statistical analysis. The statistical analysis was carried out in the R program. Since the collected database includes a wide and varied range of information, which makes it possible to consider the process of retroflexion from different angles and to carry out a different comparative analysis, the statistical part of the work required careful study and division into certain stages.

This chapter has several subchapters.

The first subchapter "4.1 Overview of the rhotic-plus-sibilant sequences at the word junctions in Northern Norwegian dialects" describes the details of the database assembled for a given combination. Clarifications are given for age, gender, and location of speakers. And all the collected data is distributed in accordance with the thirteen dialect areas, taken as a basis.

The second subchapter “4.2 Phonological overview of the retroflexion of the rhotic-plus-sibilant sequences on the word junctions” is an overview of the *r#s* combination at the word boundaries from a phonological point of view. This subchapter provides an overview of all collected audio recordings, categorized by location, and the locations are grouped into dialect areas based on a similar distribution on the site “Northern Norwegian Dialects”, made by Øystein Vangsnes and Pavel Iosad. Working with statistics in this sub-chapter helped to obtain results on the percentage of environment suitable for retroflexion, applied retroflexion, and failed retroflexion process for which all conditions were potentially present. Testing the influence of age on the retroflexion process was one of the goals in this sub-chapter, as well as testing the hypothesis that came up during the collection of the data base: young speakers of Northern Norwegian dialects tend to use retroflexes more often than old speakers. In addition to determining the potential impact, the question was if the potential difference in this ratio is significant and noteworthy.

The third subchapter "4.3 Syntactic and lexical overview of the retroflexion of the rhotic-plus-sibilant sequences on the word junctions" examines the success of the retroflexion process and its features from the syntactic point of view. This subchapter focuses on the statistical analysis of lexical elements and syntactic categories, which represent words in combination, at the boundaries of which the process of retroflexion can potentially occur. The objectives of this analysis were to identify the percentage distribution and frequency of unique words in a combination, as well as the percentage of syntactic categories (parts of speech) found in combinations. Information about how the retroflexion process applies for certain words or parts

of speech could provide new insights into what exactly triggers retroflexion at the word boundaries.

Further analysis was based on the results obtained in this chapter.

4.1 Overview of the retroflexion on the rhotic-plus-sibilant sequences on the word junctions.

A database compiled for this study includes 1323 audio examples using a combination of the rhotic segment /r/ and the following sibilant /s/ at the word boundaries. 535 examples are distributed between places in Nordland, 489 examples were collected from locations in Troms, and 299 examples were collected from places in Finnmark. The number of places taken for consideration in each region was limited as follows: 13 places in Nordland, 19 in Troms and 7 in Finnmark. This limitation was made in accordance with the data available for each location in the main database (Nordic Dialect Corpus v. 3.0). The exact distribution of examples by region and location is shown in the table below.

(25) Data distribution for counties, places, and number of examples:

County	Place	n
Nordland	Andøya	68
	Ballangen	33
	Beiarn	36
	Bodø	43
	Hattfjelldal	40
	Herøy N	33
	Mo i Rana	36
	Myre	102
	Narvik	17
	Rana	13
	Sømna	31
	Stamsund	36
	Storsandnes	15
Troms	Bardu	32
	Botnhamn	24
	Kåfjord	37
	Karlsøy	32
	Kirkesdalen	45
	Kvæfjord	19
	Kvænangen	46
	Lavangen	33
	Målselv	22
	Medby	26
	Mefjordvær	29
	Signaldalen	29
	Sørdalen	22
	Sørreisa	21
	Stonglandseidet	15
	Torsken	14
	Tranøy	2
	Tromsø	52
	Tromsøysund	21
Finnmark	Hammerfest	29
	Kautokeino	28
	Kirkenes	45
	Kjøllefjord	45
	Lakselv	56
	Tana	48
	Vardø	48
Sum		1323

In most places, there were presented audio recordings of four speakers: two old and two young. One speaker in each category was male and one was female. In some cases, there were only two speakers, or even one, taken from the same category. Only audio recordings of old speakers were collected in Bardu, Botnhamn, Mefjordvær, Signaldalen, Sørdalen, Stonglandseidet, Storsandnes and Tromsøysund. Only audio recordings of young speakers have been collected in Kvæfjord, Medby and Stamsund. In Andøya there were two speakers from the "old" category, and one speaker of no specific age (presumably young, but without any definite specifications in the description). Målselv had two speakers: one old and one of undetermined age. In Rana, Sørreisa, Torsken and Tranøy, all the speakers were without a specific age category.

Thus, in 17 out of 39 places collected in three regions of Northern Norway, we cannot draw any specific conclusions about the age distribution and the characteristics of the use of retroflexes in colloquial speech, depending on age.

In total, the database for the study contains data on 122 speakers of different Northern Norwegian dialects. They were conditionally divided into the categories "young" and "old", where all speakers under 50 years old were considered "young" speakers, and all speakers from 50 (inclusive) years old and above were considered “old”.

The influence of age on the process of retroflexion will be discussed below.

The places under consideration were distributed not only to counties, but also to dialect areas. Dialect areas used for this study are abbreviated in the tables.

Explanations for all abbreviations are presented in the table below.

(26) Explanation of abbreviations for dialect areas:

	Abbreviation	Name
1	STVL	Målet i Sør-Troms, Vesterålen og Ofoten
2	IT	Indre tromsmål
3	SAL	Saltenmål
4	MT	Midttromsmål
5	VES	Vestfinnmarksmål
6	VEF	Vefsnmål
7	NT	Nordtromsmål
8	IF	Indre finnmarksmål
9	SEN	Senjamål
10	RM	Ranamål
11	BM	Brønnøymål
12	LM	Lofotmål
13	AF	Austfinnmarksmål

The statistical table with detailed retroflexion distribution according to dialect areas, which can be found in the Appendix of the present work, shows that the retroflexion process takes place in one hundred percent of cases only in Tranøy. However, this result is not in any way significant, since only two examples were collected in this place, uttered by one speaker. What it actually illustrates is that the process is optional and is unevenly distributed depending on the location and dialect area. The disappearance of the potential [apical] segment is observed in isolated cases in Tromsø, Hattfjelldal and Kjøllefjord. An example of -es insertion is observed in only one case in Kirkenes.

In further statistical analysis, which was carried out to determine the level of retroflexion in the speech of speakers of different dialects, examples with the absence of a rhotic element present in the database were not considered. The absence of a rhotic segment will scold the triggering environment and obviously cannot lead to the appearance of a retroflex.

4.2 Phonological overview of the retroflexion of the rhotic-plus-sibilant sequences on the word junctions.

In this section, we will continue to consider the distribution of retroflexion results depending on dialect area. And to begin with, as mentioned above, we will remove from consideration all examples where there is no suitable environment for retroflexion. Without a suitable environment (the presence of both necessary segments), this process simply will not happen, therefore, there is no need to consider it influencing the result of retroflexion.

(27) Distribution of retroflex condition by Dialect Area and Age:

	DialectArea	Place	Old	total_nor	pis_r	pis_r_no_s	pis_r_es	pis_retroflex
1	AF	Vardø	0	23	13.043	0	0	86.957
2	AF	Vardø	1	12	8.333	0	0	91.667
3	BM	Sømna	0	11	18.182	0	0	81.818
4	BM	Sømna	1	19	10.526	0	0	89.474
5	IF	Kautokeino	0	13	61.538	0	0	38.462
6	IF	Kautokeino	1	13	76.923	0	0	23.077
7	IF	Lakselv	0	31	32.258	0	0	67.742
8	IF	Lakselv	1	23	21.739	0	0	73.913
9	IF	Tana	0	23	21.739	0	0	78.261
10	IF	Tana	1	21	33.333	0	0	66.667
11	IT	Bardu	1	24	50	0	0	50
12	IT	Kirkesdalen	0	23	8.696	0	0	91.304
13	IT	Kirkesdalen	1	17	29.412	0	0	70.588
14	IT	Målselv	1	17	17.647	0	0	82.353
15	IT	Målselv		3	66.667	0	0	33.333
16	IT	Signaldalen	1	28	21.429	0	0	78.571
17	IT	Sørdalen	1	18	27.778	0	0	72.222
18	LM	Stamsund	0	33	12.121	0	0	87.879
19	MT	Botnhamn	0	11	9.091	0	0	90.909
20	MT	Botnhamn	1	10	10	0	0	90
21	MT	Mefjordvær	1	24	16.667	0	0	83.333
22	MT	Sørreisa		19	47.368	0	0	52.632
23	MT	Tromsø	0	24	29.167	4.167	0	66.667
24	MT	Tromsø	1	14	28.571	0	0	71.429
25	MT	Tromsøysund	1	19	52.632	0	0	47.368
26	NT	Kåfjord	0	16	31.250	0	0	68.750
27	NT	Kåfjord	1	12	41.667	0	0	58.333
28	NT	Karlsøy	0	21	47.619	0	0	52.381
29	NT	Karlsøy	1	4	0	0	0	100
30	NT	Kvænangen	0	24	29.167	0	0	70.833
31	NT	Kvænangen	1	16	18.750	0	0	81.250
32	RM	Mo i Rana	0	18	16.667	0	0	83.333
33	RM	Mo i Rana	1	16	18.750	0	0	81.250
34	RM	Rana		10	20	0	0	80
35	SAL	Beiarn	0	15	0	0	0	100
36	SAL	Beiarn	1	19	31.579	0	0	68.421
37	SAL	Bodø	0	22	9.091	0	0	90.909
38	SAL	Bodø	1	17	29.412	0	0	70.588
39	SEN	Lavangen	0	16	31.250	0	0	68.750
40	SEN	Lavangen	1	12	16.667	0	0	83.333
41	SEN	Medby	0	25	16	0	0	84
42	SEN	Stonglandseidet	1	13	30.769	0	0	69.231
43	SEN	Torsken		14	42.857	0	0	57.143
44	SEN	Tranøy		2	0	0	0	100
45	STVL	Andøya	1	24	50	0	0	50
46	STVL	Andøya		8	0	0	0	100
47	STVL	Ballangen	0	14	14.286	0	0	85.714
48	STVL	Ballangen	1	14	28.571	0	0	71.429
49	STVL	Kvæfjord	0	10	40	0	0	60
50	STVL	Myre	0	40	7.500	0	0	92.500
51	STVL	Myre	1	13	0	0	0	100
52	STVL	Narvik	0	7	14.286	0	0	85.714
53	STVL	Narvik	1	8	0	0	0	100
54	STVL	Storsandnes	1	13	38.462	0	0	61.538
55	VEF	Hattfjelldal	0	23	4.348	0	0	95.652
56	VEF	Hattfjelldal	1	15	20	6.667	0	73.333
57	VEF	Herøy N	0	15	20	0	0	80
58	VEF	Herøy N	1	16	6.250	0	0	93.750
59	VES	Hammerfest	0	16	12.500	0	0	87.500
60	VES	Hammerfest	1	8	25	0	0	75
61	VES	Kirkenes	0	25	24	0	0	76
62	VES	Kirkenes	1	17	17.647	0	5.882	76.471
63	VES	Kjøllefjord	0	19	31.579	5.263	0	63.158
64	VES	Kjøllefjord	1	14	42.857	0	0	57.143

Dialect Area – dialect area, abbreviation of which can be seen above.

Place – place where examples were collected.

Old – age of the speakers, where 1 means "old speaker" (50 or more) and 0 means "young speaker" (less than 50 years old).

Total_nor – number of examples with suitable retroflexion envirinment, including cases without retroflex itself.

Pis_r – percentage of cases without retroflex in suitable retroflexion environment.

Pis_r_no_s – percentage of cases with pronounced rhotic segment, but absent following /s/ - segment.

Pis_r_es – percentage of cases with pronounced rhotic segment, which is separated from following /s/-segment by insertion of -es.

Pis_retroflex – percentage of cases with applied retroflexion process in suitable retroflexion environment.

The comparative table above illustrates the distribution and percentage of retroflex conditions depending on the dialect area, place, and age. All examples where the rhotic element /r/ is obviously absent are excluded from consideration, therefore the total number of examples by place is different from that one was shown in the previous tables.

In the "old" column, the age designations are replaced by "0" and "1", where "0" stands for "young" and "1" - for "old". Empty spaces between "0" and "1" mark speakers whose age is undefined. And the next four columns show the percentage of different types of connection between the segments under consideration.

There is a difference between speakers of different age categories in places where there are representatives of both categories. Speakers from the "young" category use retroflexes more often than speakers from the "old" category. The difference is especially noticeable in Kautokeino (38,46% VS 23,07%), Tana (78,26% VS 66,66%), Kirkesdalen (91,30% VS 70,58%), Botnhamn (90,90% VS 90%), Kåfjord (68,57% VS 58,33%), Mo i Rana (83,33% VS 81,25%), Beiarn (100% VS 68,42%), Bodø (90,90% VS 70,58%), Ballangen (85,71% VS 71,42%), Hattfjelldal (95,65% VS 73,33%), Hammerfest (87,50% VS 75%) and (63,15% VS 57,14%).

Excluding examples where there is no suitable setting for retroflexion, 1079 observations remain under consideration. 563 examples from the speech of old speakers and 516 examples from the speech of young speakers, that is, almost equally many observations for both groups.

Based on these observations, the following table shows the mean of using retroflexes in speech (the R-code used to obtain the statistics can be found in the Appendix of this work):

Age	Mean

Old	0.7193606
Young	0.7926357

Overall, the old group have 71.9% retroflexes, and the young group have 79.3%. Below the significance of this difference is tested using a logistic mixed effects model (using the lme4 package in R and including a random intercept for participant (there is no "Participant" column in the database, but this information is easily extracted from the combination Place + Age)):

```
modAge <- glmer(Ret ~   AgeGroup  + (1|Part), data=Han, family=binomial)
summary(modAge)

Fixed effects:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)     1.1213     0.1575   7.120 1.08e-12 ***
AgeGroupYoung   0.3265     0.2314   1.411    0.158
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr)
AgeGroupYng -0.657
```

The result shows that there is a difference between the groups, but it is not significant ($p>0.05$, more exactly, $p=0.15$). Thus, we can conclude that young speakers use retroflexes in speech more actively than older speakers, but this difference is insignificant.

The following table shows statistical data on the quantitative distribution of retroflexion according to dialect areas.

(28) Distribution retroflex and non-retroflex in suitable retroflex environment by dialect areas:

	DialectArea	Total	RF	RC
1	AF	35	88.57	11.43
2	BM	30	86.67	13.33
3	IF	124	62.9	36.29
4	IT	130	73.08	26.92
5	LM	33	87.88	12.12
6	MT	121	69.42	30.58
7	NT	93	67.74	32.26
8	RM	44	81.82	18.18
9	SAL	73	82.19	17.81
10	SEN	82	74.39	25.61
11	STVL	151	79.47	20.53
12	VEF	69	86.96	13.04
13	VES	99	72.73	27.27

Total – number of examples under consideration.

RF – retroflex

RC – retroflex conditions, but no retroflex

The table shows that in most cases the process is applying if the conditions for retroflexion are suitable. Austfinnmarksmål, Brønnøymål and Vefsnmål are dialect areas with the highest percent of retroflexion, while Indre Finnmarksmål and Nordtromsmål shows the lowest percent of applied retroflexion in suitable conditions. In other dialectal areas, the level of retroflexion cannot be called either very high or too low. More detailed table illustrating the distribution of rhotic-plus-sibilant sequences including the detailed description of connection quality between segments with distribution by dialect areas can be found in the appendix of this word.

The most interesting for observation and analysis are those dialect areas where a high level of retroflexion coexists with an extremely low percentage of failed retroflexion in suitable environment. Analysis of such examples potentially can help to achieve the objectives of this study and answer the research questions. Thus, the most relevant for consideration and analysis are following dialect areas: Austfinnmarksmål with 11,43% of failed retroflexion in suitable environmern, Brønnøymål with 13,33% of failed retroflexion, Lofotmål with 12,12% and Vefsnmål with 11,59% of failed retroflexion. Special cases, where the rhotic segment /r/ is followed by sibilant /s/, but retroflex process does not happen even though phonological distance allows it, will be observed further in the next chapter.

Next table shows percentage of successful retroflexion process and failed retroflexion in retroflex suitable condition, based on the speakers age and dialect areas. The data in the table are distributed in such a way that it shows the percentage of applied and failed retroflexion processes in suitable environment within the same age group of a particular dialect area, but not the percentage of retroflexion between different age groups within the same dialect area. Thus, the percentage of applied retroflexion and failed retroflexion on suitable environment within one age group will give 100%. This approach makes it possible to assess the level of retroflexion within the same age group. The data in the table provides an overview of the applied retroflexion process among all examples with suitable retroflexion conditions. That is, examples where the rhotic segment /r/ is initially absent are excluded from the overview, since the retroflexion process cannot occur there.

(29) Percentage distribution of retroflexion by dialect areas, considering speaker's age category:

	Area	Old RF	Old RC	Young RF	Young RC
1	AF	91.67	8.33	86.96	13.04
2	BM	89.47	10.53	81.82	18.18
3	IF	59.65	40.35	65.67	34.33
4	IT	70.19	29.81	91.30	8.70
5	LM	0	0	87.88	12.12
6	MT	71.64	28.36	74.29	25.71
7	NT	75	25	63.93	36.07
8	RM	80.77	19.23	83.33	16.67
9	SAL	69.44	30.56	94.59	5.41
10	SEN	76	24	78.05	21.95
11	STVL	70.83	29.17	85.92	14.08
12	VEF	83.87	16.13	89.47	10.53
13	VES	69.23	30.77	75	25

Area – dialect area.

Old RF – percentage of the examples with the retroflex within the "old" category.

Old RC – percentage for the examples with suitable conditions for retroflexion (not always satisfied) within the old speaker group.

Young RF – percentage of the examples with the retroflex within the "young" category.

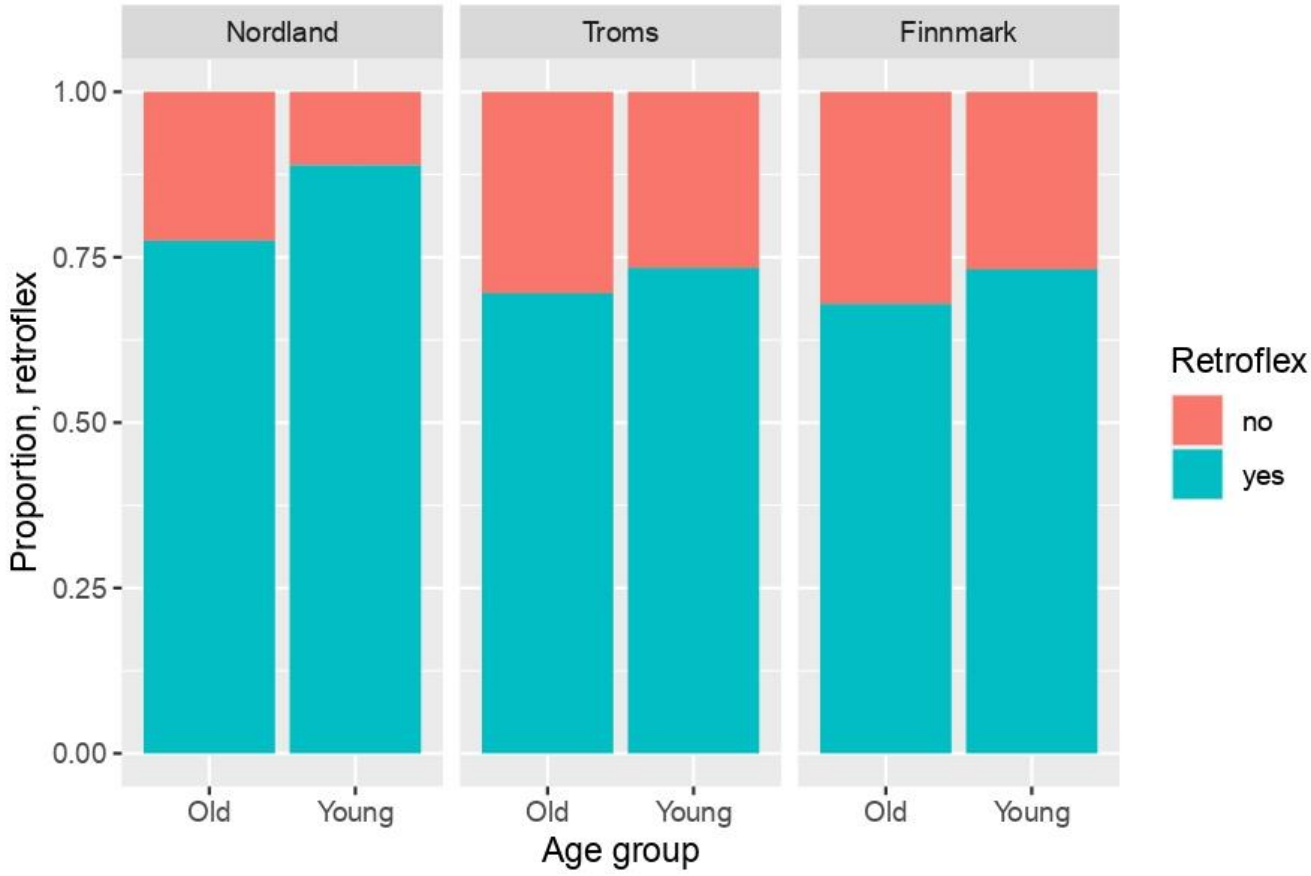
Young RC – percentage for the examples with suitable conditions for retroflexion (not always satisfied) within the young speaker group.

The table shows that in all dialect areas the percentage level of retroflexion withing the old speakers age group is higher than the level of no retroflexion in conditions satisfying the process. Sometimes this difference is very large, as is the case with Austfinnmarksmål (91,67% of retroflexion vs. 8,33% of non-retroflex), Brønnøymål (89,47% of retroflexion vs. 10,53% of non-retroflex), Vefsnmål (83,87% of retroflexion vs. 16,13% of non-retroflex) or Ranamål (80,77% of retroflexion vs. 19.23% on non-retroflex). In the group of young speakers, the situation is somewhat different and other dialect areas are marked by a high level of retroflexion: Saltenmål (94,59% of retroflexion vs. 5,41% of non-retroflex), Indretromsmål (91,30% of retroflexion vs. 8,70% of non-retroflex) Vefsnmål (89,47% of retroflexion vs. 10,53% of non-retroflex), Lofotmål (87,88% of retroflexion vs. 12,12% of non-retroflex), Austfinnmarksmål (86,96% of retroflexion vs. 13,04% of non-retroflex), Målet i Sør-Troms, Vesterålen og Ofoten (85,92% of retroflexion vs. 14,08% of non-retroflex), Ranamål (83,33% of retroflexion vs. 16,67% of non-retroflex) and Brønnøymål (81,82% of retroflexion vs. 18,18% of non-retroflex).

Some dialect areas show little difference between applied and failed retroflexion in the suitable environment. For the old group of speakers, these are such dialect areas as Indre

finnmarksmål (59,65% of retroflexion vs. 40,35% of non-retroflex), Vestfinnmarksmål (69,23% of retroflexion vs. 30,77% of non-retroflex) and Saltenmål (69,44% of retroflexion vs. 30,56% of non-retroflex). For the young group of speakers, mostly all dialect areas show the high level of applied retroflexion, and among the most noticeable dialect areas with noticeably low level of retroflexion are Indre finnmarksmål (65,67% of retroflexion vs. 34.33% of non-retroflex) and Nordtromsmål (63,93% of retroflexion vs. 36,07% of non-retroflex).

It also seems important to assess the influence of the county, combined with age, on the level of retroflexion in the speech of speakers of dialects. The R code can be found in the Appendix, and below is a plot that clearly illustrates the results obtained:



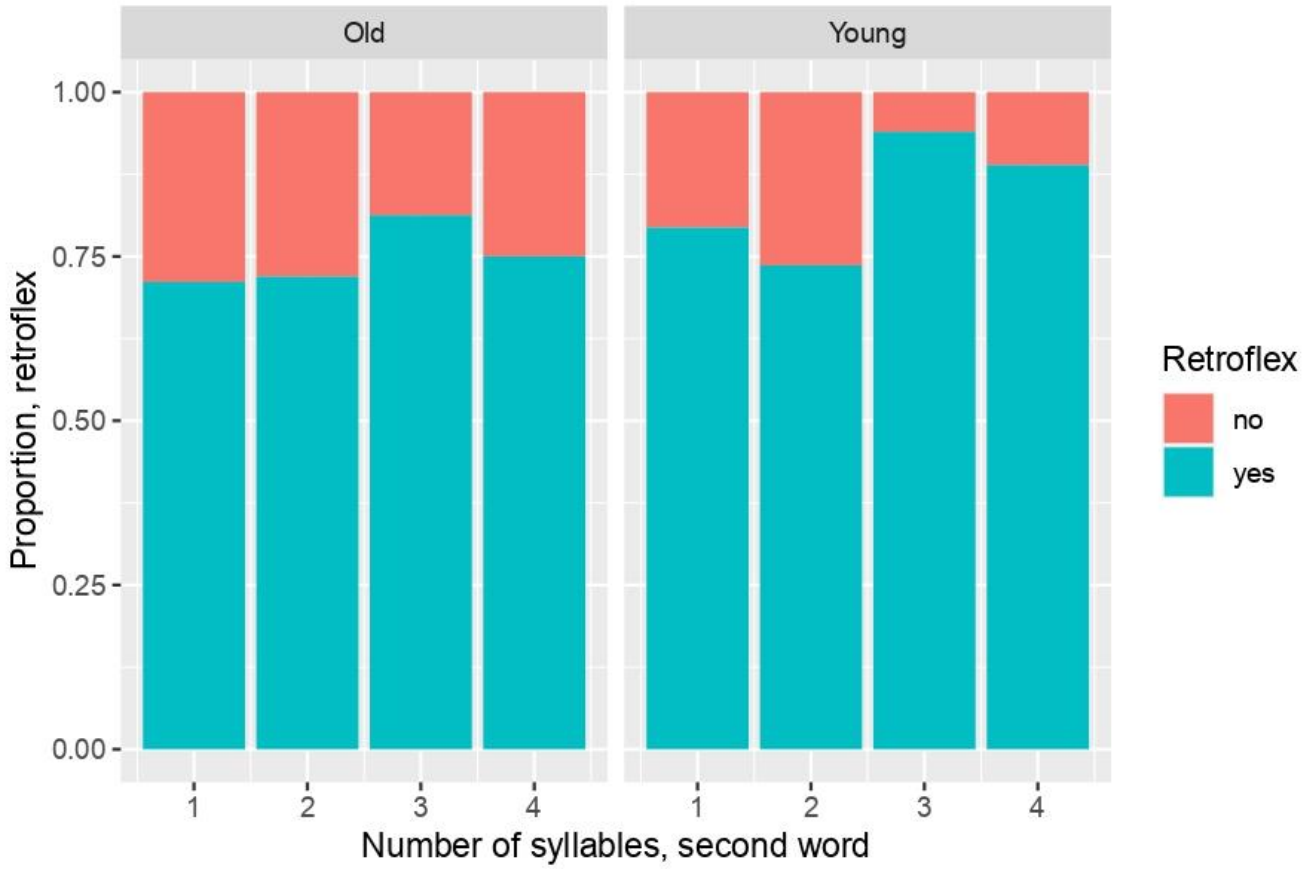
The shown effect of the county is quite big. The level of retroflexion decreases as you move north, from Nordland to Finnmark. There is no obvious interaction with the age group, but in general it can be seen that young speakers are more actively using retroflexes in speech. The effect is numerically higher in Nordland.

	Nordland	Troms	Finnmark
Old	0.7748691	0.6954887	0.6792453
Young	0.8888889	0.7337278	0.7315436

The influence of age at this stage is no longer in doubt. One of another potentially influencing factors, thought about which arose during the compiling of the database for the study, concerned the influence of word length, i.e., the number of syllables, on the appearance of retroflex. However, it remained unclear whether short words are more frequent in Norwegian in general and therefore more often subject to the process of retroflexion, or whether the length of the word really affects the application of the process.

The plot below demonstrates the effect of the age and length of the first word with a rhotic segment on the application of the process (detailed R code can be found in Appendix of this work).

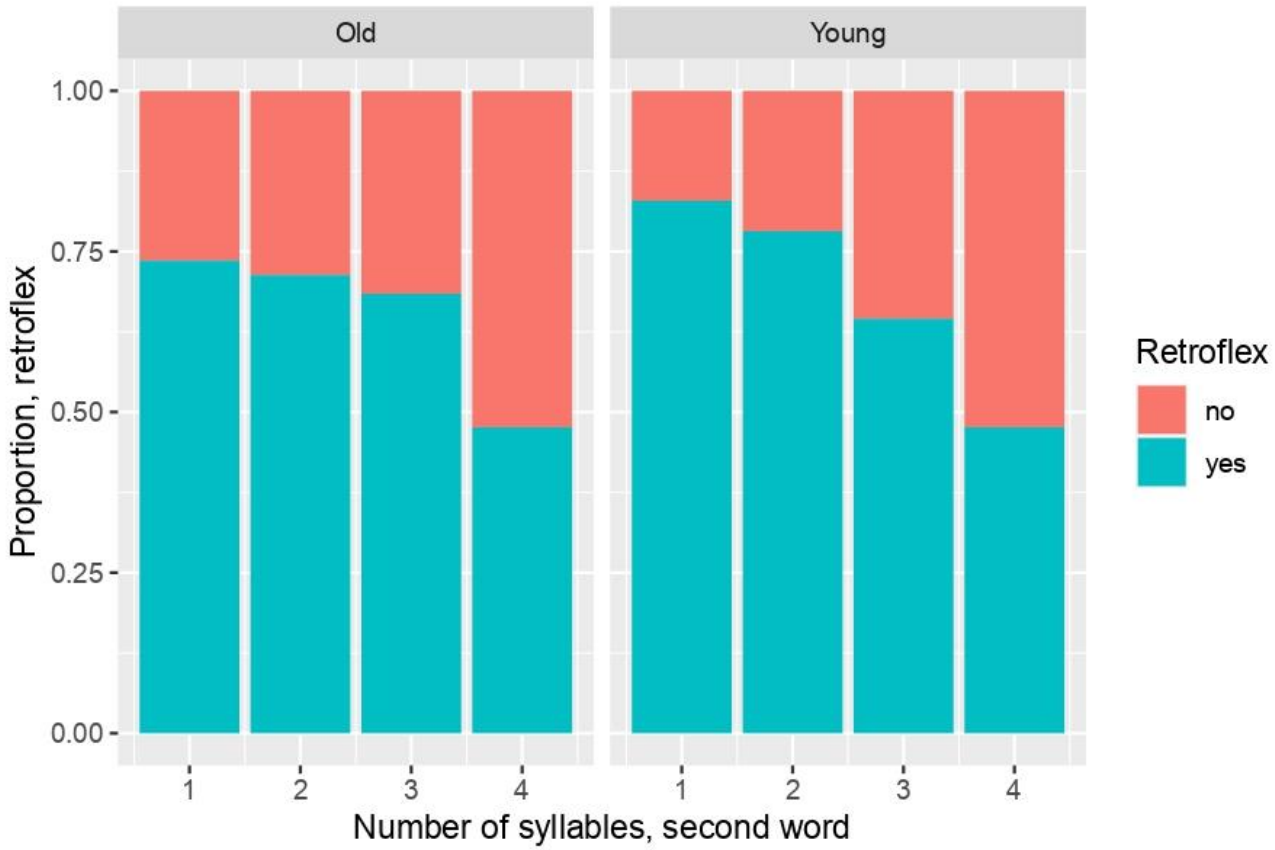
(30) Influence of age and the first word length on retroflexion:



The plot shows that the level of retroflexion, as mentioned earlier, is slightly higher in the group of young speakers, however, no systemic relationship between the number of syllables and the level of use of retroflexes is observed. Thus, we can conclude that the length of the first word does not in any way affect the application of retroflexion.

As for the length of the second word, this effect is clearly illustrated in the plot below:

(31) Influence of age and the second word length on the retroflexion:



The plot shows that the influence of the length (i.e., number of syllables) of the second word is undoubted and depends on the age group. For short words young speakers are more likely to use retroflexes. It is also shown that the young group is affected by second word length in a different way than the old group, more specifically, for the young speakers: the shorter the word is, the higher chance for a retroflex realization.

Thus, the retroflexion triggering feature of the second word, starting with the sibilant segment, becomes apparent. It is the second word that determines whether the retroflexion process will apply.

Stress affects the retroflexion of the /rd/-clusters within the word and compound word, as mentioned in the theoretical chapters. The influence of stress on the process of retroflexion may also be relevant in the case of a rhotic-sibilant sequences at the junction of words. An appropriate statistical analysis (see the Appendix to this paper for details) was carried out to determine this possible impact. Below are tables summarizing the results obtained. The first table illustrates the quantitative distribution of the first and second words depending on the type of stress.

(32) Stress and its distribution in first and second words:

Stress in the first word	**Stress in the second word**

One	767	One	745
Initial	5	Initial	18
Second	1	Second	-
Third	1	Third	-
Ante-penultimate	40	Ante-penultimate	55
Penultimate	253	Penultimate	253
Ultimate	12	Ultimate	7

One - monosyllabic.

Initial - the word consists of more than three syllables and the stress falls on the first one.

Second - the word consists of more than four syllables and the stress falls on the second one.

Third – the word consists of more than five syllables and the stress falls on the third one.

Ante-penultimate – the stress falls on the third from the end syllable.

Penultimate – the stress falls on the second last syllable.

Ultimate – the stress falls on the last syllable of the word.

The table shows that the most numerous are monosyllabic words. The second most frequent stress is the penultimate. The second table shows the retroflexion mean for each type of stress in the first and second words.

(33) Retroflexion mean of stress distribution:

StressFW	Mean	StressSW	Mean
One	0.7522816	One	0.7798658
Initial	0.8000000	Initial	0.5555556
Second	1.0000000	Second	-
Third	0.0000000	Third	-
Ante-penultimate	0.9000000	Ante-penultimate	0.6545455
Penultimate	0.7430830	Penultimate	0.7233202
Ultimate	0.6666667	Ultimate	0.5714286

The results obtained do not provide any additional information regarding the triggering environment for retroflexes. Monosyllabic words and words with penultimate stress show the highest level of retroflexion. However, the randomness of the distribution of high and low

percentages proves that lexical stress is not an influential factor for the application of retroflexion.

4.3 Syntactic and lexical overview of rhotic-plus-sibilant sequences at the word junctions.

This section will explore syntactic and lexical influences on the retroflexion process. It is initially unknown whether the syntax of a language, syntactic categories, or lexical elements created the tiggering environment or influences the application of the retroflexion process. Nevertheless, each of these categories can be partly decisive. To determine the level of influence of each category on the result, it was decided to conduct a statistical analysis from a syntactic and lexical points of view. This is necessary also due to the concentration of this work on retroflexes that appear at the word boundaries. In this case elements containing the rhotic segment /r/ and the subsequent segment /s/ appear in different conditions and sometimes are components of different constituencies. Thus, there is every reason to believe that their syntactic and lexical characteristics are to some extend decisive for the application of process of retroflexion.

The first table in this section shows the distribution of the first word (containing a rhotic segment /r/) and the second word (starting with an alveolar sibilant /s/) by frequency of occurrence in the collected database. The table shows the number of unique words that appeared in the position of the first or second element, the number of repetitions of the 15 most frequent words, and their percentage of the total number of words in the database.

(34) The most frequent unique words of the combination with numbers and percentages:

	First Word	Frequency	Percentage	Second Word	Frequency.1	Percentage.1
1	der	193	14.590	så	349	26.380
2	har	123	9.300	som	166	12.550
3	her	95	7.180	sånn	116	8.770
4	eller	84	6.350	siden	50	3.780
5	år	70	5.290	seg	48	3.630
6	for	68	5.140	skal	37	2.800
7	var	49	3.700	sett	28	2.120
8	blir	32	2.420	sikkert	21	1.590
9	mer	32	2.420	sin	13	0.980
10	får	29	2.190	skulle	11	0.830
11	før	24	1.810	sagt	10	0.760
12	er	20	1.510	ser	10	0.760
13	etter	17	1.280	står	10	0.760
14	over	17	1.280	sto	10	0.760
15	går	15	1.130	sånne	9	0.680
	Unique first words: 225			Unique second words: 286		

First word – word with the rhotic segment /r/.

Second word – word with the following alveolar sibilant /s/.

Frequency – number of appearances in the database for the study.

Percentage – frequency of the word within the entire database compiled for the study.

The most frequent first words in the database were *der* (193 appearances), *har* (123), *her* (95), *eller* (84), etc. The most frequent at the position of the second word in the database were the words: *så* (349 examples), *som* (166), *sånn* (116), *seg* (48), etc. Nevertheless, the frequency of these words, although it provides some information about the language (such as the fact that a quarter of all words in second position in the spontaneous speech is the word *så*), does not give any idea about the influence of this frequency on the process of retroflexion. And this will be corrected with the following tables giving a more specific and accurate overview.

(35) Retroflex distribution of the first word in percentage and frequency:

	FW	Freq. w/RF	% of RF	Freq. w/RF-cond.	% of FW w/RF
1	der	124	15.21	171	72.51
2	har	68	8.34	97	70.10
3	år	61	7.48	70	87.14
4	for	56	6.87	65	86.15
5	her	56	6.87	86	65.12
6	eller	38	4.66	56	67.86
7	får	25	3.07	28	89.29
8	blir	20	2.45	27	74.07
9	mer	19	2.33	27	70.37
10	før	16	1.96	23	69.57
11	går	13	1.60	15	86.67
12	over	12	1.47	16	75.00
13	hver	11	1.35	14	78.57
14	stor	11	1.35	14	78.57
15	etter	9	1.10	11	81.82

FW – first word of the combination (word which ends on the pronouncing rhotic segment /r/).

Freq. w/RF – frequency with the retroflex. Number of examples with the concrete first word, which end up with retroflex.

% of RF – percentage of retroflexes with specific first word from total amount of examples in data base observed.

Freq. w/RF-cond. – frequency of the first word appearing in the suitable retroflexion conditions, which can be applied or not in the end.

% of FW w/RF – percentage of the concrete first word with applied retroflexion from the total amount of the examples with this first word (Freq. w/RF / Freq. w/RF-cond.).

All the results are taken from that part of the database, which has all the suitable conditions for an applied retroflexion process. And the situation is changing significantly, since some words, despite their frequency in the full database, lose positions and move down.

The word *år* becomes the third most frequent word, while *her* and *eller* move down in the list.

All the most frequent first words that appear in suitable environment for the retroflexion process in most cases successfully lead to retroflexes. Even the most frequent word *der* leads to successful application of the retroflexion process in 72.51% of the time. Although such frequent words as *her* and *eller* appear in the examples with applied retroflexion process in a small percentage of cases: 65,12% and 67,86%. *Får* becomes the most frequent first word with the greatest chance of performing the retroflexion process among all others with 89,29% of the possibility.

The following table shows a similar percentage distribution for the most frequent words in second position starting with the alveolar sibilant /s/, which can potentially receive the [apical] feature and turn into retroflex.

(36) Retroflex distribution of the second word in percentage and frequency:

	SW	Freq. w/RF	% of RF	Freq. w/RF-cond.	% of SW w/RF
1	så	220	26.99	275	80
2	som	113	13.87	143	79.02
3	sånn	76	9.33	96	79.17
4	siden	44	5.40	48	91.67
5	seg	32	3.93	39	82.05
6	skal	17	2.09	32	53.12
7	sikkert	16	1.96	19	84.21
8	sto	10	1.23	10	100
9	seint	9	1.10	9	100
10	sett	9	1.10	12	75
11	se	8	0.98	9	88.89
12	sin	8	0.98	12	66.67
13	sagt	7	0.86	10	70
14	ser	6	0.74	8	75
15	sida	6	0.74	8	75

In this table, there are more matches of the most frequent words with suitable conditions for the retroflexion process and the most frequent words throughout the database.

Among the most frequent words in the second position in suitable environment for the retroflexion process there are the words *sto* and *seint* which undergo retroflexion in 100% of the cases. The alveolar sibilant /s/ in the word *siden* became a retroflex in 91,67% of examples.

In general, the table shows that in the case of words in the second position, the chance of an applied retroflexion process is very unevenly distributed. Some words practically guarantee the appearance of a retroflex, and some do not even give a rough guess, since a retroflex appears only about 50% of the time. This heterogeneity may again indicate that it is word with the alveolar sibilant /s/ in the second word that is decisive for the application of the retroflexion process. That is, the lexical affiliation of the second word is more important for the appearance of the retroflex than the first word. So, for example, no matter which word precedes the verb *sto*, the alveolar sibilant will still undergo retroflexion.

As for the most frequent word combinations found in the database collected for research, they are presented below:

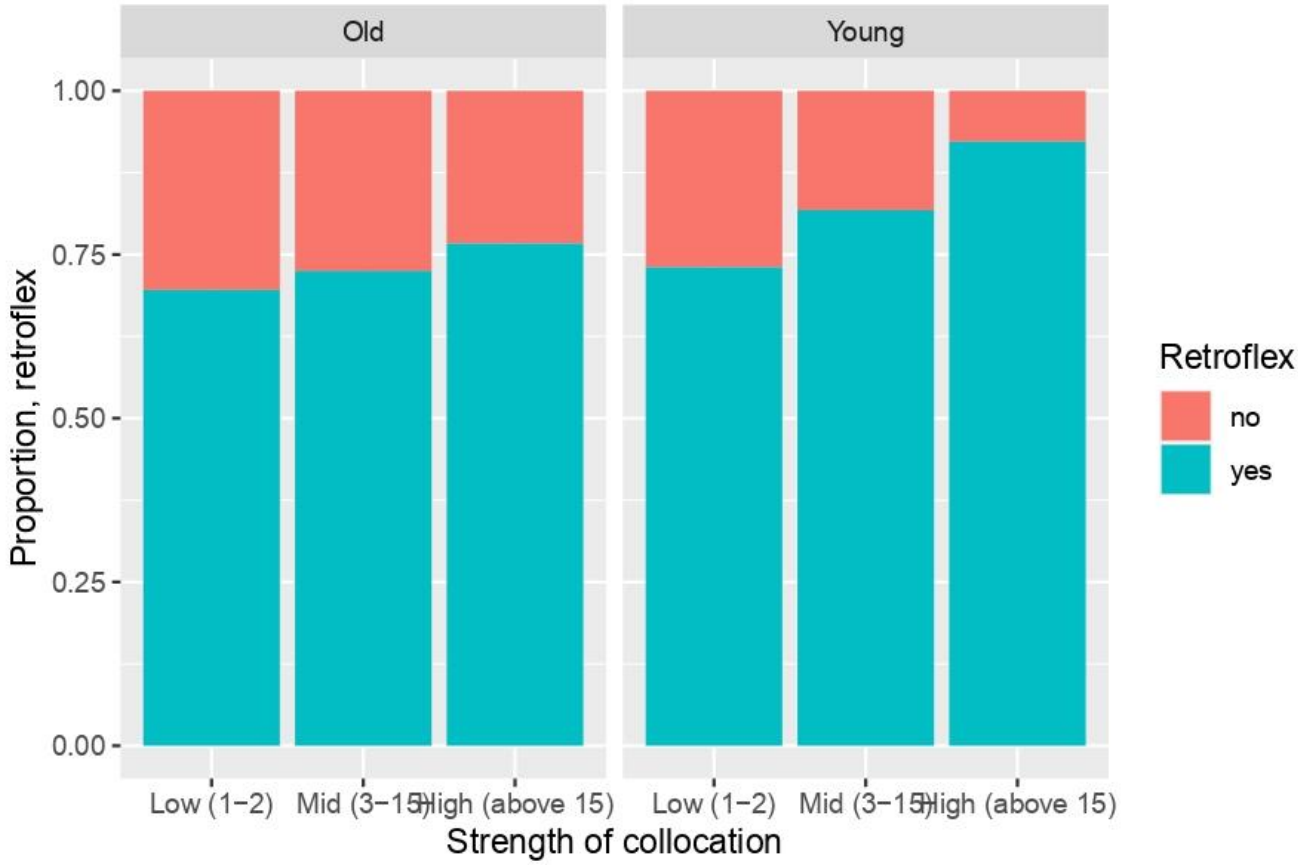
First Word	**Second Word**	**Number of examples**
Der (1st the most frequent)	Så (1st the most frequent)	51
Der (1st the most frequent)	Som (2nd the most frequent)	44
År (3d the most frequent)	Siden (4th the most frquent)	44
Eller (6th the most frequent)	Sånn (3d the most frequent)	26
Her (5th the most frequent)	Så (1st the most frequent)	26
Har (2nd the most frequent)	Sett (10th the most frequent)	20
Har (2nd the most frequent)	Sånn (3d the most frequent)	19
Var (not very frequent)	Så (1st the most frequent)	19
Eller (6th the most frequent)	Så (1st the most frequent)	19
Her (5th the most frequent)	Som (2nd the most frequent)	14
År (3d the most frequent)	Så (1st the most frequent)	14
Får (7th the most frequent)	Så (1st the most frequent)	13

This table shows that the most numerous combinations consist of the most frequent words in the collected database, apart from the verb *var* ('be.PAST'). However, the second words, despite the greater variety of unique words at this position in the database, are more often repeated in the most frequent combinations. For example, the word *så* ('so') occurs in 6 of the most frequent combinations and gives 80% of applied retroflexion. The rest of the words on the second position in the most frequent combinations also give at least 75% of retroflexion. And in the case of the word *siden* ('since'), the level of retroflexion reaches 91.67%. Thus, the

predictability of the second word in the combination plays a significant role and gives a high probability of the appearance of a retroflex. As for the first words in the most frequent combinations, the maximum level of retroflexion is achieved with the word *får* ('get.PRES') (89.29%) which appears just in one and the last frequent combination in the table, and the minimum - with the word *her* ('here') (65.12%) which appears in two the most frequent combinations.

The plot below illustrates the influence of collocation frequency on the retroflex use within two age groups.

(37) Influence of age and collocation frequency on the level of retroflexion:



There is some noticeable difference between young and old speakers when it comes to collocations frequency. Frequent collocations are more likely to undergo retroflexion, and this tendency is more obvious in the group of young speakers. Both groups, old and young, demonstrate a dependency of retroflexion from the collocation's frequency. However, this dependency is more prominent within the group of young speakers.

Thus, it can be concluded that more frequent collocations are more likely to undergo retroflexion, and the connection between the frequency of collocations and the level of

retroflexion is more obvious in the speech of young speakers. However, the difference between groups decreases significantly along with a decrease in the frequency of collocations.

The following table shows the number and percentage of syntactic categories that correspond to the first and second words. The percentage distribution is determined in relation to each other of all syntactic categories in the first and second positions in the complete database.

(38) Retroflex distribution of the syntactic categories corelated with the first and second words of the combination in percentage and frequency:

	Word class	PS1freq	% of PS1	PS2freq	% of PS2
1	VERB	390	29.48	198	14.98
2	NOUN	270	20.41	224	16.94
3	ADV	252	19.05	217	16.41
4	PREP	221	16.70	73	5.52
5	CONJ	100	7.56	184	13.92
6	ADJ	64	4.84	119	9
7	DET	24	1.81	155	11.72
8	SUBJUNC	2	0.15	97	7.34
9	NUM			7	0.53
10	PRON			48	3.63

Word class – syntactic category to which the word belongs.

PS1freq – the number of corresponding words on the first position, which are belongs to each syntactic category.

% of PS1 – the percentage of examples with a given syntax category at the position of the first word.

PS2freq - the number of corresponding words on the second position, which are belongs to each syntactic category.

% of PS2 - the percentage of examples with a given syntax category at the position of the second word.

A verb is most often found in the position of the first word, and a noun is most often found in the position of the second word. At the same time, the verb in the first position occurs in about a third of all examples, and the noun in the second position is found only in 16.94% of cases.

It should be noted that these data provide more information about the structure of the language than about the behavior of retroflexes, ever though it is correlated with the words on the boundaries of which retroflex can appear. It gives an overview of the percentage distribution of a particular syntactic category in spontaneous speech. Therefore, below will be given two more detailed tables with the concentration on retroflexes and their behavior.

(39) PS1 frequency and percent distribution:

	PS1	Freq. PS1 (RC)	Freq. PS1 (RF)	% PS1 (RC)	% PS1 (RF)	% PS1 w/RF in RC
1	ADJ	59	44	5.44	5.40	74.58
2	ADV	224	160	20.66	19.63	71.43
3	CONJ	71	52	6.55	6.38	73.24
4	DET	20	13	1.85	1.60	65
5	NOUN	237	191	21.86	23.44	80.59
6	PREP	201	148	18.54	18.16	73.63
7	SUBJUNC	2	1	0.18	0.12	50
8	VERB	270	206	24.91	25.28	76.30

PS1 - syntactic category of the first word,

Freq.PS1 (RC) - frequency of a word in conditions suitable for retroflexion,

Freq. PS1 (RF) - frequency of a word with an applied retroflexion,

% PS1 (RC) - percentage of occurrence of a particular syntactic category in relation to other syntactic categories in suitable conditions for retroflexion,

% PS1 (RF) - the percentage of occurrence of a syntactic category with an applied retroflexion,

% PS1 w/RF in RC - the percentage of applied retroflexion among the entire database with suitable conditions for the process.

The table shows that the noun in the first position ending with the rhotic element /r/ gives the greatest chance of an applied retroflexion process (80,59%). While subjunction undergoes retroflexion only in 50% of cases. However, the number of examples with this syntactic category is too small to make any definite conclusions. The only thing that can be said is that if a noun, verb, adjective or conjunction is the first word of the combination on the boundary of which retroflex can potentially appear, the chance of an applied retroflexion process is much higher than in the case of a determiner or subjunction.

A similar table is presented below for analysing the situation with syntactic categories in the second position:

(40) PS2 frequency and percent distribution:

	PS2	Freq. PS2 (RC)	Freq. PS2 (RF)	% PS2 (RC)	% PS2 (RF)	% PS2 w/RF in RC
1	ADJ	100	72	9.23	8.83	72.00
2	ADV	169	135	15.60	16.56	79.88
3	CONJ	149	125	13.76	15.34	83.89
4	DET	132	102	12.19	12.52	77.27
5	NOUN	189	133	17.45	16.32	70.37
6	NUM	4	2	0.37	0.25	50.00
7	PREP	60	47	5.54	5.77	78.33
8	PRON	39	32	3.60	3.93	82.05
9	SUBJUNC	86	68	7.94	8.34	79.07
10	VERB	155	99	14.31	12.15	63.87

In the case of the second position, none of the syntactic categories gives a 100% guarantee of an applied retroflexion. However, there are reasons to expect that conjunction, pronoun, adverb, or subjunction, appearing on the second position in the combination, would lead to the applied retroflexion process with a greater chance of possibility.

Even though certain results have been achieved and a certain probability of the appearance of a retroflex depending on the syntactic category has been determined, the result cannot be called satisfactory. There are not enough examples for some categories, while other categories are more frequent in the language themselves and have nothing to do with the process of retroflexion. Therefore, the influence of syntactic categories on the success of the retroflexion process cannot be confidently called significant.

5. Analysis of the results obtained.

One of the main assumptions has been that older speakers use retroflexes in speech less actively than younger speakers. The difference in the use of retroflexes in speech between old and young speakers was noticeable even from frequency analysis. Logistic mixed effects model showed that young speakers use retroflexes in the speech more actively than old ones but the difference in retroflex use between age groups in insignificant. However, it still can be assumed that the age of the speakers is a certain factor influencing the application of the retroflexion process.

One of the suggestions for why age affects the frequency of using retroflexes is the speed of pronunciation. For the retroflexion process to apply, a sufficiently short phonological distance between the elements is needed. Older speakers have a much lower rate of speech, often stop between words, and thus increase the phonological distance between elements. If this distance becomes too long, retroflexion does not apply, even if other factors potentially triggering the application of this process are present. Young speakers, on the other hand, have a too high rate of speech, so the distance between words is always very short. In their case, retroflexes can appear even where they were not supposed to be otherwise. Younger speakers are also less attentive to phonological details due to their high speed of pronunciation.

Therefore, we can say that the rate of speech affects the effectiveness of the retroflexion process. And age determines the chances of a high or low speech rate.

The performed statistical analysis provided some overview and understanding of what can potentially influence the application of the retroflexion process. Based on the results obtained, now there is an opportunity to delve directly into the comparative analysis and try to find some specific patterns.

5.1 Phonological analysis of the retroflexion process of rhotic-plus-sibilant sequences at the word boundaries.

Excluding age groups, the highest level of use of retroflexes was found in Austfinnmarksmål (88,57%), Brønnøymål (86,67%), and Vefsnmål (86,96%) dialect areas. Dialect areas with a high use of retroflexes in this work are those where the level of retroflexion exceeds 80%. Dialect areas with a low level of use of retroflexes are those where the level of retroflexion is below 70%. These dialect areas include Indre Finnmarksmål (62,9%) and Nordtromsmål (67,74%).

Those dialectal areas where the difference between the level of applied and failed retroflexion process in suitable environments differs significantly, are of greatest interest for research and potential for the study. That is, dialect areas, where a very high level of applied retroflexion coexist with an extremely low percentage of cases with failed retroflexion under suitable conditions, can provide the most reliable information about what exactly triggers the retroflex appearance at the word boundaries.

In the case of old speakers, a high level of retroflexion and a low level of failed retroflexion in suitable conditions is observed in the following dialect areas:

Austfinnmarksmål: 91,67% VS. 8,33%.

Brønnøymål: 89,47% VS. 10,53%.

Vefsnmål: 83,86% VS. 16,13%.

Ranamål: 80,77% VS. 19,23%.

Below are examples, excerpts from speaker interviews, which contain words at the boundaries of which retroflex can potentially appear. From the variety of examples, only a few have been selected. The selected examples in most cases illustrate the most similar retroflex environment, but in some cases the retroflexion process is applied, and in the other it is not. Thus, it becomes possible to analyze and try to understand the difference between the results shown.

(41) **Austfinnmarksmål**:

Non-retroflex: **a**) ja fisken *har*.VERB *stått*.VERB [ha stådd] så djupt _clears-throat_ (Vardø, Finnmark).

Retroflex: **b**) men e # jeg har jo # jeg har jo tegna et e mer positivt bilde av av e det enn enn mange av de her andre som *har*.VERB *skrevet*.VERB [ha: ʃkrevve] om # om e internatlivet (Vardø, Finnmark).

c) e vi som er fritidsfiskere vi *får*.VERN *selge*.VERB [få: ʃælle] # (Vardø, Finnmark).

Examples above illustrate the phrases from the interviews of old speakers from Vardø, Finnmark. The underlining of some words next to the combination in question mark the phrasal stress. Lexical stress, as was confirmed before, cannot influence the appearance of retroflexes. However, there are reasons to suggest that the appearance of retroflexes at the word boundaries can be influenced by the phrasal stress. The hypothesis will be checked during the comparative analysis performed in this chapter. In square brackets next to a combination of words, at the junction of which a retroflex may appear, a transcription of dialect pronunciation is given, although the example of speech itself is given in Bokmål.

Example (41) a) demonstrates a combination of two verbs *har* and *stått* (‘have stood’) that together form the past tense. The retroflex does not appear, because, as can be seen in the transcription of the speaker's pronunciation, the rhotic element is omitted in the first verb *har* (‘to have’). The omission of rhotic final element in present tense verbs is common in Norwegian and occurs in many dialects. However, this violates the conditions for the occurrence of retroflex, therefore, in this case, process cannot apply.

Examples (41) b) and c) also show a combination of two verbs, but at the boundaries of which there are all the necessary conditions for the appearance of a retroflex. Example b) shows the combination of the verb *har* with the verb *skrevet* (‘has written’), but at the same time the verb *har* (‘to have’), which in this case is auxiliary for the formation of the past tense, retains the final rhotic element. Example c) shows a combination of the verb *får* and the verb *selge* (‘get to sell’), where the first verb also acts as an auxiliary and does not omit the final rhotic element in the given dialect. According to Stausland (2011, 2012), the example (41) b) has a high chance to receive retroflexion, while the example (41) c) is the least possible to consist a retroflex because a sibilant /s/ is followed by vowel. It might be logical to assume that phrasal stress, which tends to progressively spread to the right (Solhaug, 2012), has a certain influence, but phrasal stress also appears in the example (41) a) without retroflex. Thus, phrasal stress does not seem to play a role in these examples.

(42) **Brønnøymål**:

Non-retroflex: **a**) hvem du *trur*.VERB *som*.SUBJUNC [trur så] s- tar seriegull? (Sømna, Nordland).

b) kalte det # n- noen greier det *der*.ADV *som*.SUBJUNC [der så] var # som vi kalte skotet da for e for der hadde de da e ved og torv og sånne ting (Sømna, Nordland).

Retroflex: **c**) ja for når vi begynte så var jo et lite småbruk det var jo ikke store biten # og s- og det var jo de # de rundtom *der*.ADV *som*.SUBJUNC [de: ʃå] # la ned (Sømna, Nordland).

d) men e der er mange òg som kjøper e jeg var utpå campingplassen der en gang og m da var der en *tysker*.NOUN *som*.SUBJUNC [tysske: ʃå] kom inn åt han som driver det og # (Sømna, Nordland).

Examples in (42) present phrases from interviews with older speakers from the Brønnøymål dialect area. All four of them were collected at the same place, Sømna, in Nordland. Examples a) and b) have all the conditions for applied retroflexion, but retroflex does not appear. Examples c) and d) contain combinations of words at the boundaries of which a retroflex appears. All examples have the word *som* (‘which’) as the second word in a

combination where the initial element can get [apical] feature. In examples b), c) and d), the phrasal stress falls on a word with a rhotic element, however, option b) still does not receive retroflex. The only unifying quality, which occurs in examples a) and b), but not in examples c) and d), is the phrasal stress on the word appearing immediately after *som*. Progressive rightwards spreading of the stress again does not seem to work in the case with retroflexes on the word boundaries. According to Stausland (2011, 2012) the word *som* initially has the least likelihood of getting a retroflex. However, in the two examples shown above, this does happen.

(43) **Vefsnmål**:

Non-retroflex: a) med sånn indu- industrivasker *der*.ADV *som*.SUBJUNC [dær se] det heter og ## (Hattfjelldal, Nordland).

b) vi kom oss så langt at vi var *der*.ADV *selvfølgelig*.ADJ [dær seføgle] var det nå ikke bordkledd og e alle # skilleveggene satt og (Hattfjelldal, Nordland).

c) det var en kjempetur altså en *tur*.NOUN *smekka*.ADJ [tur smækkæ] med kultur (Herøy N, Nordland).

Retroflex: d) # det er da vel sånn e gjenvinningsgreier *der*.ADV *som*.SUBJUNC [dæ: ʃå] de kjører e inn til Bo- Boden (Hattfjelldal, Nordland).

e) hvor mange år jeg har det har ikke jeg regna etter men jeg *har*.VERB *sikkert*.ADJ [ha: ʃekkert] # noe sånt jeg òg (Herøy N, Nordland)

f) # det ligger akkurat i utkanten imellom # det blir jo Granmoen som blir # så imellom oss og veien *der*.ADV *som*.PREP [dæ: ʃå] veien nå går # (Hattfjelldal, Nordland).

The examples given in (43) are selected based on phrases from interviews with old speakers of the Vefsnmål dialect area. All examples were collected at two locations, Hattfjelldal and Herøy N, in Nordland. Three examples have suitable conditions for the retroflexion process, but retroflex does not appear at the word boundaries. The following three examples have the right conditions for retroflexes to occur, and the retroflexion process is applied.

Example a) and d) are the most comparable. Both examples are collected in Hattfjelldal, Nordland, in both examples considering combination is a combination of the adverb *der* and the subjunctive *som*, and the phrasal stress falls on the word preceding the adverb. There are no obvious differences in the retroflex and non-retroflex examples, and the phrase stress in this case does not affect the effectiveness of the retroflexion process. The segment following the alveolar sibilant is also not a decisive factor in the appearance of the retroflex. Therefore, retroflexion can be assumed definitely optional.

(44) **Ranamål:**

Non-retroflex: a) det blir ikke gagn i nei e når det er *vinter*.NOUN *så*.CONJ [vinnter så] skal det være vinter da skal det være # snø og så skal det være kaldt (Mo i Rana, Nordland).

b) ja det var ett eller anna med den der katten der jeg trur han hadde e jeg trur han hadde nå e han fikk jo noe anfall og noe *greier*.NOUN *så*.ADV [greier så] (Mo i Rana, Nordland). (small pause before så).

c) luggene det er bare et *par*.NOUN *strømper*.NOUN [par strømmpa] som du tar på deg altså # med en med med en såle (Mo i Rana, Nordland).

Retroflex: d) og det var jo for e et hopprenn det kan jo vare i bra mange timer # sjøl om det var i *februar*.NOUN *så*.CONJ [februa: ʃå] var ikke sola kommet dit ennå (Mo i Rana, Nordland).

e) og det var jo e hun # tova jo # ull # sånn plate med ull og så # hadde hun laga seg et *mønster*.NOUN *som*.SUBJUNC [mønnste: ʃå] hun klipte etter og (Mo i Rana, Nordland).

Examples (44) represent the Ranamål dialect area and consist of phrases of old speakers from Mo i Rana, Nordland. Examples a), b) and c) are without retroflexes, although all the conditions for the process are present, examples d) and e) consist retroflexes. Examples d) and e) are different from a), b) and c) because the phrasal stress in them falls on the first word in the combinations under consideration, that is, on a word with a rhotic element. A similar situation was observed in some examples with applied retroflexion above, which may indicate that phrasal stress can, to some extent, act as a trigger for this process, and progressive rightwards spreading of the stress can work in some cases with the retroflexes on the word boundaries. However, the segment following the alveolar sibilant does not appear to be significant factor in these examples.

In the case of young speakers, high level of applied retroflexion and significantly low level of failed retroflexion are observed in the following dialect areas:

Saltenmål: 94,59% VS. 5,41%.

Indretromsmål: 91,30% VS. 8,70%.

Vefsnmål: 89,47% VS. 10,53%.

Loformål: 87,88% VS. 12,12%.

Austfinnmarksmål: 86,96% VS. 13,04%.

Målet i Sør-Troms, Vesterålen og Ofoten: 85,92% VS. 14,03%.

Ranamål: 83,33% VS. 16,67%.

Brønnøymål: 81,82% VS. 18,18%.

Below will be given and described examples taken from interviews of young speakers from those dialect areas where the percentage of using retroflexes in speech exceeds 85%.

(45) **Saltenmål:**

Non-retroflex: a) ja # de fle- de fleste kjenner *nordlendinger*.NOUN *så*.CONJ [nolænninge så] (Beiarn, Nordland).

Retroflex: b) jeg har ikke noen organiserte # i øyeblikket jeg går nå litt på tur å # er med venner # synes det er morsomt å lese # utrulig nok e # em nå som det er *sommer*.NOUN *så*.CONJ [såmme: ʃå] har tar jeg ut seilbrettet mitt # (Bodø, Nordland).

Saltenmål, examples of which are presented in (45), is a dialectal area in which young speakers use retroflexes in 94.59% of examples, which is an extremely high result. And only in 5.41% of cases, the retroflex does not appear, although all the conditions for its appearance are met. And since there was only one example of non-retroflex, this is exactly what is given above. Example a) is contrasted with example b), which consists of a combination of similar elements, a noun and a conjunction *så*. The non-retroflex example is compiled from a speaker in Beiarn, Nordland, and the opposite example, with a retroflex, is compiled in Bodø, Nordland. Besides the difference in place, there is a difference in the position of the combination in the phrase. *Nordlendinger så*, which is pronounced without retroflex, completes the phrase, while *sommer så* appears in the middle of the phrase. The difference in the word length, as already was stated above, does not play a role even though in these examples it is an obvious difference. Phrasal stress does not show any of the characteristics of a possible trigger in these examples.

(46) **Indretromsmål:**

Non-retroflex: a) ja føler med litt ja ## hvem du *trur*.VERB *så*.CONJ [trur så] vinner Tippeligaen neste år da? (Kirkesdalen, Troms).

Retroflex: a) så i *år*.NOUN *så*.ADV [å: ʃå] gikk med i joggeskoene # så det er litt forskjell (Kirkesdalen, Troms).

b) *Før*.ADV *så*.CONJ [fø: ʃå] hadde vi # melkekyr ## (Kirkesdalen, Troms).

Indretromsmål also demonstrates a high (over 90%) level of use of retroflexes in young speaker's speech. All shown examples have *så* as the second word, but in non-retroflex case this word acts as a conjunction, and in the retroflex ones it acts as an adverb and a conjunction. The main visible difference is in the phrasal stress, which, in the case of retroflex examples, falls on the first word with rhotic element in the combination and can provide progressive rightwards spreading potentially causing the application of the retroflexion process.

(47) **Vefsnmål:**

Non-retroflex: a) det er det er jo det eneste det er *der*.ADV *spurten*.NOUN [dær spurrt'n] som er artig # ellers så er det ikke noe (Herøy N, Nordland).

b) ja men det er nå neste er nå klar og hvem *tar*.VERB *seriegull*.NOUN [tar seriegull] # skråstrek cupen (Herøy N, Nordland).

c) meg trygg på fem mål i håndball det kan jo # enkelt bli tatt inn jeg har.VERB sett.VERB [har sett] det før (Herøy N, Nordland).

Retroflex: d) nei men det var vel folk var vel litt usikre òg for de trudde det var mer som et sånn *der*.ADV *slekts*.NOUN [dæ: ʃlækkts] (Hattfjelldal, Nordland).

e) ja du får bare komme på besøk # hun F3 hun *har*.VERB *skapene*.NOUN [ha: ʃkapan] fulle av (Hattfjelldal, Nordland).

f) ja en *får*.VERB *se*.VERB [få: ʃå] kanskje man må ta å s- # ta seg en tur i nå i år (Hattfjelldal, Nordland).

The examples in (47) are examples from the Vefsnmål dialect area, where young speakers use retroflexes at the word boundaries in 89.47% of cases and do not use retroflexes even in suitable environment in 10.53% of cases. However, in this dialect area, the percentage of retroflexion among young speakers is still very high. The above six phrases from interviews with young speakers from this dialect area were collected in Herøy N and Hattfjelldal, Nordland. Examples a), b) and c) are examples with suitable conditions for the appearance of retroflexes, but failed retroflexion. Examples d), e), and f) are examples with suitable conditions and an applied retroflexion process. Three examples without retroflexes are collected in Herøy N, and three examples with retroflexes are collected in Hattfjelldal. All six examples are suitable for comparison and are selected based on similarities: the adverb *der* and a noun, a present tense verb and a noun, two verbs where the first verb is auxiliary. Phrasal stress falls on the second word in a combination where the first element can obtain [apical] feature, in five out of six examples. In this case, the only obvious distinguishing aspect between the examples with and without retroflexion is the place from which dialects are collected.

(48) **Lofotmål:**

Non-retroflex: a) det er greie folk *der*.ADV *så*.CONJ [dær så] (Stamsund, Nordland).

b) jeg *har*.VERB *sittet*.VERB [har sott] på noen ganger # (Stamsund, Nordland).

Retroflex: c) men det er jo bra med med fisk så står uti hvis du dorger utfor *der*.ADV *så*.CONJ [dæ: ʃå] kan du få stor fisk (Stamsund, Nordland).

d) det er ikke noen som har noen interesse utav det så # _front-click_ men vi *har*.VERB *snakka*.VERB [ha: ʃnakka] om å ta det og så ta en gjeng og så en # (Stamsund, Nordland).

Young speakers from Loformål dialect area also show high (87,88%) use of retroflexes in speech. All examples presented in (48) are collected in Stamsund, Nordland. Examples a) and b) do not contain retroflexes, although all the conditions for the process are met. Examples

c) and d) are examples with retroflexes. The examples are selected according to the principle of similarity. a) (retroflex) and c) (non-retroflex) with a combination of the adverb *der* and the conjunction *så*. b) (retroflex) and d) (non-retroflex) with two verbs at the boundaries of which a retroflex may appear. The difference between a) and c) lies in the fact that considering combination in example a) takes the final position in the sentence. And in d), unlike b), the phrasal stress falls on the first word in the combination, the one that contains the rhotic element and spreads the [apical] feature on the following element.

(49) **Austfinnmarksmål:**

Non-retroflex: a) og jeg fortsatte å se dem # jeg har sett jeg trur jeg *har*.VERB *sett*.VERB [ha sedd] den der Date movie og så har jeg sett e # (Vardø, Finnmark).

Retroflex: b) men e # jeg har jo # jeg har jo tegna et e mer positivt bilde av av e det enn enn mange av de her andre som *har*.VERB *skrevet*.VERB [ha: ʃkrevve] om # (Vardø, Finnmark).

Young speakers from Austfinnmarksmål dialect area are using retroflexes in speech in 86,96% of cases and do not use it in 13,04% of cases. Examples in (49) shows one phrase from the interview with a young speaker from Vardø, Finnmark which contains retroflex and one phrase which does not. Both examples potentially could have retroflex sound on the word boundaries between two verbs where the first verb is an auxiliary. *Har sett* ('have seen') is pronounced without retroflex, while *har skrevet* ('has written') is pronounced with retroflex. The most noticeable difference in these examples is the phrasal stress that falls on the second verb in combination in the non-retroflex case, which contradicts the idea that retroflexion is triggered by progressive rightwards spreading of stress. Retroflexion at the word boundaries again seems to be absolutely optional.

(50) **Målet i Sør-Troms, Vesterålen og Ofoten:**

Non-retroflex: a) *eller*.CONJ *snøstorm*.NOUN [eller snystårrm] nesten (Kvæfjord, Troms).

b) ok *her*.PREP *står*.VERB [hær står] det skole # vannkjøler eller brutaus- brusautomat på skolen # (Ballangen, Nordland).

Retroflex: c) nei jeg husker i fjor # *eller*.CONJ *så*.ADV [elle: ʃå] var det forfjor # (Kvæfjord, Troms).

d) når det står fremme *her*.PREP *så*.CONJ [hæ: ʃå] blir det spist for si det sånn (Narvik, Nordland).

Målet i Sør-Troms, Vesterålen og Ofoten is the last dialect area where the retroflexion level is higher than 85%. Four examples are collected from Kvæfjord in Troms, Ballangen and

Narvik in Nordland. Two non-retroflex examples contain combinations of conjunction with following noun and preposition with following verb, two retroflex examples contain conjunction followed by adverb and preposition followed by conjunction. Phrasal stress appears before the word with the rhotic segment /r/ in both examples with retroflex.

Based on the observations obtained in a comparative analysis of similar phrases from interviews with different speakers from different age groups and dialect areas, it can be concluded that phrasal stress has no specific effect on the application of the retroflexion process, does not have progressive rightwards spreading in majority of cases and therefore cannot be considered a significant trigger. Phrasal stress can fall on any word in a sentence that needs to be emphasized by meaning. But especially often it falls on nouns, verbs, and adjectives, which are also the most frequent syntactic categories observed in the data base. Therefore, if the retroflex appears at the word boundaries, where one of the words is a noun, verb or adjective, the probability of phrasal stress is quite high. However, this has nothing to do with the process of retroflexion itself. Stausland's (2011, 2012) suggestion about the distribution of the following segments according to their retroflex probability did not give any significant result here since in majority of examples an alveolar sibilant /s/ was followed by vowel, which, according to Stausland (2011, 2012) gives the lowest chance for applied retroflexion. However, there were not enough examples with /k/ or /t/ following /s/ and because of this it is impossible to give a specific conclusion on this matter.

In some dialect areas retroflex distribution is so random that retroflexion process can be safely considered optional even without additional analysis. These dialect areas include the following (for old speakers):

Indre finnmarksmål: 59,65% VS. 40,35%.

Vestfinnmarksmål: 69,23% VS. 30,77%.

Saltenmål: 69,44% VS. 30,56%.

And for the young speakers, the dialect areas with a relatively small percentage difference between applied and failed retroflexion process in suitable conditions are following:

Indre finnmarksmål: 63,93% VS. 34,33%.

Nordtromsmål: 63,93% VS. 36,07%.

5.2 Syntactic analysis of the retroflexion process of rhotic-plus-sibilant sequences at the word boundaries.

The previous chapter with statistical analysis provided statistics on the lexical distribution of the first and second unique words in the desired combination, based on examples contained in a research database. The influence of the second word on the application of retroflexion has been proven, but it does not directly correlate with the frequency of the unique second word. However, it was also shown that there is the obvious connection between the collocation frequency and the retroflexion level within age groups.

The word *så* occupies 26,38% of all words in the second position available in the database, and the word *som* – 12,55%. However, the frequency of occurrence of any unique word in the speech of dialect speakers does not affect the application of the retroflexion process. In percentage terms, the words that are the most frequent differ from the words that most often change the quality of the alveolar sibilant to retroflex.

Some lexical units give a high enough chance of the appearance of retroflexes, which makes them quite predictable. In the case of unique words in the first position, there is not a single word that would give a chance higher than 87%, but at the same time, most of the words give approximately the same chance of retroflexion in 60-70%.

The most influential for the application of for retroflexion process lexical units with a rhotic element are the following:

År – 87,14% (61/70).

Går – 86,67% (13/15).

Får – 86,29% (25/28).

Etter – 81,82% (9/11).

(51) **År:** 87,14% of applied retroflexion (61 examples with retroflex out of 70).

Non-retroflex: Nei, men han er bare 12 *år*.NOUN *så*.CONJ [år så] du kjenner han sikkert ikke (Mo i Rana, Nordland).

Retroflex: For meg som ikke hadde vært der på mange mange *år*.NOUN *så*.CONJ [å: ʃå] syns jeg det (Narvik, Nordland).

The examples presented in (51) were selected based on their similarity, so that possible differences are most clear. In addition to the difference in place and dialect area, there is a noticeable difference in phrasal stress, which in the case of the example containing the retroflex falls on the word *år*.

The word *år* appears in many different combinations, but the most common combination is *år siden* (‘year ago’). If we look at all collected examples with this combination that can be

assumed to be stored in the speaker's mental vocabulary, and therefore most likely planned at the same time, only 2 out of 46 examples are pronounced without retroflex. These examples are shown below:

(52) **a)** er faktisk niogtjue *år*.NOUN *siden*.ADV [år sia] # siden e # så det har vært så tørt og vatnet det var så lite at # det var e (old, Ballangen, Nordland, Målet i Sør-Troms, Vesterålen og Ofoten).

b) nei # jeg begynte jo ikke # hva tid jeg begynte # e begynner vel å bli par år sia et par *år*.NOUN *siden*.ADV [år sia] jeg # jeg begynte (old, Kåfjord, Troms, Nordtromsmål).

Both examples are taken from the speech of older speakers, which gives a high degree of probability that the speech was not delivered quickly. This, as well as the speaker's doubts about the choice of words, is indicated by the context in which this combination of words appears. Speakers pause and repeat, which means that the planning process is likely to involve no more than one element at a time. In all other cases, the combination *år siden* contains a retroflex at the word boundaries.

(53) **Går:** 86,67% of applied retroflexion (13 examples out of 15):

Non-retroflex: a) Sånn som du når du *går*.VERB *studiespesialisering*.NOUN [går studiespesialisering] du har jo tre skoleår bare der å tenke ut # ikke sant (Lakselv, Finnmark).

b) Vi veit alle ## hvilken tragedie det er når småbarn # *går*.VERB *seg*.PRON [går se] bort # i skog og mark (Sørreisa, Troms).

Retroflex: c) Men # på alle postene greier han å gå # _laughter_ # han *går*.VERB *seg*.PRON [gå: ʃe] helt forderva (Stamsund, Nordland).

d) nei jeg trur ikke jeg skal ha sånn s- jeg trur ikke jeg skal bare ha sånn her på armen # men e # vi får nå se hvordan det *går*.VERB *seg*.PRON [gå: ʃe] til (Vardø, Finnmark).

In example (53) all examples with the word *går* (‘go’) on the second position where the retroflexion process does not occur are marked. These examples are contrasted with similar examples from the speech of other speakers, where retroflexion occurs. The available combinations with *går* are not very diverse: *går sikkert*, *går så*, *går sakte*, *går studiespesialisering*, *går skole*, *går seg* and *går sin*. According to the Production Planning Hypothesis, a second word with a high frequency is usually planned in tandem with the previous word, which means that a word with the alveolar sibilant /s/ with a high frequency is more likely to undergo retroflexion. Therefore, it is necessary to consider the frequency of the words

following the verb *går* in the available combinations to determine the significance of the frequency and its effect on the process.

Word	**Frequency (considered 10000 the most frequent Norwegian words)**	**Number (per approx.150 million words)**
Seg	26	720787
Så	34	429457
Sin	56	248382
Sikkert	612	22935
Skole	665	21513
Sakte	5481	2408
Studiespesialisering	Not within 10000 the most frequent words	Not frequent

The table above shows that word in the example (53) a) that does not go through the retroflexion process is not high frequent for the Norwegian language. This means that the probability of planning this word in tandem with the previous word containing the rhotic segment required for applied retroflexion is low. This may explain the failure of the process, despite the external presence of all the necessary elements. However, in context, it can be seen that the speaker made many pauses in speech, some of which were quite long, which emphasizes uncertainty and reflection in the choice of words. In this case, when speech is slow and contains a lot of pauses, there is a high probability of planning only one element in one period of time. This can affect the application of the retroflexion process, since during the planning of the second word, the necessary phonological information of the first word containing the rhotic element is no longer available.

(54) **Får:** 86,29% of applied retroflexion (25 examples out of 28):

Non-retroflex: a) sykt det du ser jo på Deadliest catch det er jo flere ganger du *får*.VERB *se*.VERB [får se] holdt på å si de er med i # (Vardø, Finnmark).

b) ja kanskje dere *får*.VERB *sove*.VERB [får såve] på hans rom (Kjøllefjord, Finnmark).

c) ikke sant så e # det er jo ingen som *får*.VERB *sett*.VERB [får sedd] de store filmene på kino # det er synd (Kvænangen, Troms).

Retrfolex: d) men e men det har ikke vært helt vellykka enda de er ikke helt ferdig da så e # så vi får.VERB *se*.VERB [få: ʃe] (Vardø, Finnmark).

e) ja jeg får.VERB sove.VERB [få: ʃåve] da _laughter_ jeg får ikke til å sove uten bølger (Medby, Troms).

f) ja # jeg trur ikke du rekker alt eller kommer jo an på hva som er på lista di da selvfølgelig # men e # det er mye du ikke får.VERB sett.VERB [få: ʃett] (Bodø, Nordland).

The verb *får* ('get.PRES') occurs in many combinations with an applied retroflexion process. The percent of combinations with applied retroflexion is 86.29% of cases. The verb itself is in 72nd place in terms of frequency of use (205162 repetitions per about 10 million words). In the database for this study, the verb *får* occurs in a fairly limited number of combinations, such as: *får sånn, får se, får seg, får sett, får selge, får si, får sikkert, får slutte, får sove, får starte, får steinen, får stor* and *får strømbrudd*. *Får se* ('get to see') is the most frequent combination in the research database. Only in three cases the retroflex does not appear, although all the conditions for the process are present. These examples include such combinations as *får se* ('get to see'), *får sett* ('get seen') and *får sove* ("get to sleep"). Example (54) a) demonstrates *får se* word combination on the boundaries of which retroflex does not appear even though the word *se* has a high frequency (145th in the list of the 10000 the most frequent Norwegian words with 99451 appearances per approximately 10 million words) and all other examples with this combination undergo retroflexion. The reason became obvious when listening the speaker. Transcription of the phrase is shown above.

(55) [Sykt de du se jo på Deddliest kættsj de e jo flere ganng du få ʃ- # se håll på å si dæmm e me]

The speaker began to pronounce retroflex [ʃ] but stopped without finishing the word. And after pause speech started again with the word se which obviously did not have any connection with the preceding rhotic segment anymore. The rest of the compared examples differ not only in the presence or absence of retroflexion, but also in the place in which the speaker speaks, as well as in age, since in example (54) b) the phrase is pronounced by an old speaker from Kjøllefjord, Finnmark, and (54) f) - young speaker from Medby, Tromsø. Also, in examples with retroflexes, the phrase stress falls on the second word in the combination. The frequency of the use of verbs *sett* and *sove* is not high. The first verb ranks 207th in terms of frequency of use, and the second – 5491th. Therefore, by themselves, they cannot guarantee that the planning of these words occurred in tandem with the preceding word.

(56) **Etter:** 81,82% of applied retroflexion (9 out of 11 examples):

Non-retroflex: a) og dagen *etter*.PREP *så*.ADV [ætter så] så skulle han M8 så skulle jeg og han M8 gå til_fjells (Tromsøysund, Troms).

b) ja og # jeg trur kanskje jobbe også *etter*.PREP *studeringa*.NOUN (Kautokeino, Finnmark).

Retroflex: c) men du kommer jo en dag før og reiser en dag *etter*.PREP *så*.ADV [ætte: ʃå] du slepper å e # komme midt i konserten og e dra klokka to på natta (Kirkenes, Finnmark).

d) ja kanskje ikke nå ja # det er godt å komme hjem # rett *etter*.PREP *skolen*.NOUN [ette: ʃkola] og så får man middag på fatet med en gang # (Narvik, Nordland).

The examples in (56) are collected from Tromsøysund in Troms, Kautokeino and Kirkenes in Finnmark, and Narvik in Nordland. Examples a) and c) are very similar in environment, which is suitable for retroflexion, however, retroflexion applies just in the c) example. Phrasal stress is the same in both cases, and only difference between examples is in places where it was collected. Examples b) and d) consist of preposition followed by noun, both words have not high frequency in Norwegian. Noticeable differences between examples are in places where they were collected, and in phrasal stress, which appears on the second word in the example d). According to Stausland (2011, 2012), an alveolar sibilant /s/ followed by /k/ has a higher chance to undergo retroflexion than if it is followed by /t/. And comparing examples b) and d) supports this rule.

The lexical units in the second position are much more variable. Some of them give 100% applied retroflexion, no matter which lexical unit precedes. At the same time, other lexical units in the second position demonstrate a very low level of applied retroflexion. This makes it possible to assume that the first lexical unit and, accordingly, the rhotic segment do not have a function that triggers retroflexion. The second element, the alveolar sibilant /s/, has a triggering quality for the retroflexion process and obtains an [apical] feature.

Some of the lexical elements with the highest and lowest chance of applied retroflexion are presented below:

Sto – 100% (10/10).

Seint – 100% (9/9).

Sia – 92,86% (26/28).

Siden – 90% (18/20).

Se – 88,89% (8/9).

Sikkert – 84,21% (16/19).

Seg – 82,05% (32/39).

Sin – 66,67% (8/12).

Skal – 53,12% (17/32).

(57) **Sto** is one of the two second words in the miniature database that gives 100% retroflexion (10 examples of 10), regardless of age, place, frequency, or any other factors. It is combined with the preceding word “der” in all examples, some of them are shown below:

a) # på kongens vold på Bø *der*.ADV *sto*.VERB [dæ: ʃto] slaget (Botnhamn, Troms, Midttromsmål, 65yo).

b) og da e når jeg kom inn med han i gangen der da så jeg *der*.ADV *sto*.VERB [dæ: ʃto] det jo en til pakke som var akkurat like stor (Hattfjelldal, Nordland, Vefsnmål, 27yo).

c) ja # kom jeg der ikke sant røyka i bilen der og f- musikken på full peising og # *der*.ADV *sto*.VERB [dæ: ʃto] de på skolekrysset # (Kvænangen, Troms, Nordtromsmål, 23yo).

d) nei *der*.ADV *sto*.VERB [de: ʃto] jo en sånn en i # i huset der borti Sunnan (Myre, Nordland, Målet i Sør-Troms, Vesterålen og Ofoten, 59yo).

Stå der is also an established syntactic construct, which is stored in this form in the speaker's mental lexicon. The verb itself ranks 491st in the list of the most frequent words in the Norwegian language, which makes it not a very common word.

(58) **Seint** is another example of the second word which gives 100% of retroflexion with 9 examples out of 9. It also combines with the same preceding word for in all the examples. This combination of preposition + adjective is a standard syntactic construct and is therefore stored as such in the speaker's mental lexicon. Some examples with this combination are shown below:

a) et hadde vært litt artig og så meldt seg på Trondheim Oslo men jeg trur ikke det blir # i # år # ja ja det er ikke *for*.PREP *seint*.ADJ [fø: ʃeint] ennå (Hattfjelldal, Nordland, Vefsnmål, 28yo).

b) lyst til å gjøre noe anna så er det jo ikke det *for*.ADV *seint*.ADJ [få: ʃeint] (Lakselv, Finnmark, Indre finnmarksmål, 16yo).

c) så går jeg kanskje en time for å komme meg ditt # og da er det jo *for*.ADV *seint*.ADJ [få: ʃeint] (Medby, Troms, Senjamål, 15yo).

Seint ranks 5048th in the list of the most frequent words in the Norwegian language, which makes it not a common word.

(59) **Siden** gets retroflex 91,67% of the time, which is 44 out of 48 collected examples in the miniature database. In most cases, this word appears preceded by the noun

år “year”. *År siden* is a persistent expression that is stored in the mental vocabulary of native speakers. However, this combination does not successfully go through the retroflexion process in the example below:

a) nei # jeg begynte jo ikke # hva tid jeg begynte # e begynner vel å bli par år sia et par *år*.NOUN *sia*.ADV [år sia] jeg # (Kåfjord, Troms, Nordtromsmål, 70yo).

b) uninterpretable_ er faktisk niogtjue *år*.NOUN *siden*.ADV [år sia] # siden e # så det har vært så tørt og vatnet det var så lite at # det var e (Ballangen, Nordland, Målet i Sør-Troms, Vesterålen og Ofoten, 68yo)

The example (59) a) is an excerpt from an interview with an old speaker from Kåfjord, Troms, and the example (59) b) is an excerpt from the speech of an old speaker from Ballangen, Nordland. As the context shows, there are many repetitions and pauses, indicating doubts and uncertainty about the choice of words in these examples. In this case, it is highly likely that the speakers process information of only one element during one period of time, and not all phonetic information necessary for an applied retroflexion process is available during the planning of the variable segment.

Other examples with failed retroflexion and *siden* as a second word are listed below:

c) for en *menneskealder*.NOUN *sia*.ADV # omtrent (Torsken, Troms, Senjamål, NA).

d) og hva du *trur*.VERB *siden*.NOUN [trur sid'n] han bodde hos oss den gangen ## da skjeppa vi oss isammen (Tromsøysund, Troms, Midttromsmål, 86 yo).

Siden is ranked 83rd on the list of the most frequently used words in the Norwegian language which makes it frequent and presumably gives a high probability of planning in tandem with preceding word. The reasons why the retroflex does not appear in the above examples may be the same as previously mentioned and related to the speaker's age or the place where the example was recorded.

(60) **Se** gives 88.89% of cases with applied retroflexion, when it is the second word in a combination, at the boundaries of which a retroflex can potentially occur. All of the examples with the verb *se* that were collected in the research database for this study were preceded by the verb *får*. Only one example did not undergo retroflexion successfully, and this example is below:

a) sykt det du ser jo på Deadliest catch det er jo flere ganger du *får*.VERB *se*.VERB [får se] holdt på å si de er med i # med og assisterer i redning (Vardø, Finnmark, Austfinnmarksmål, 22yo).

The reason becomes obvious when listening to this phrase, and in this work, transcription is given.

(61) [sykt de du se jo på Deddliest kættsj de e jo flere ganng du får ʃ- # se håll på å si dæmm e me i # me å asistere i reddning å]

Speaker started to pronounce [ʃ], but did not finish the word and started after the pause with pronouncing the verb *se*. Phonological information of the verb *får* was not available anymore.

(62) **Sikkert** appears in several different combinations: *år sikkert, blir sikkert, der sikkert, får sikkert, går sikkert, har sikkert, ser sikkert* and *står sikkert*. In 16 out of 19 examples *sikkert* successfully undergoes the process of retroflexion. *Har sikkert* is the most frequent combination in the research database. The word itself ranks 1033 in the list of the most used words in the Norwegian language, which makes it not too frequent. For example, the word *år* takes 36th place in the same list, *blir* takes 40th place, and *der* takes 75th place. In fact, all words preceding *sikkert* in collected examples are more frequent.

Non-retroflex: a) du *har*.VERB *sikkert*.ADJ [har sikkert] læ- lest (Kvænangen, Troms, Nordtromsmål, 23yo). (not sure it is not a retroflex)

b) du har sikke- _laughter_ ja men du *har*.VERB *sikkert*.ADJ [har sikkert] rett til å gjøre det (Karlsøy, Troms, Nordtromsmål, 28yo)

c) nei vi bruker jo å gå # fast området og fiske vi har vært *der*.ADV *sikkert*.ADJ [dær sikkert] i tjue fem og tjue år # (Tana, Finnmark, Indre finnmarksmål, 61yo).

Retroflex: a) sånn at det # det *har*.VERB *sikkert*.ADJ [ha: ʃekkert] noe med det å gjøre men jeg trur også dette vi hadde jo en sånn # (Bodø, Nordland, Saltenmål, 64yo).

b) akkurat # ja # det er nå sikkert du er du er det stor jord *der*.PREP *sikkert*.ADJ [dæ: ʃikkert] til å (Tana, Finnmark, Indre finnmarksmål, 60yo).

In the examples (62), it can be seen that the word *sikkert* often receives phrasal stress, but this fact does not in any way affect the appearance of the retroflex.

(63) **Seg** successfully undergoes the retroflexion process in 82,05% of cases, that is 32 examples out of 39. It appears in various combinations such as: *bryr seg, får seg, for seg, forandrer seg, går seg, gjør seg, kommer seg, over seg, skar seg, skiller seg, sparer seg* and *tar seg*. The most frequent combination in collected examples is *for seg*. The pronoun itself ranks 26th in terms of frequency of use among all words in the Norwegian language, which makes it very frequent.

According to the Production Planning Hypothesis, words with such a high frequency have a high chance of planning in tandem with the preceding word, which means that all the necessary phonetic information is available and the retroflexion process should be applied. However, the presence of examples without retroflex shows that the frequency of a lexical unit is not always a guarantee. Some non-retroflex and retroflex examples are given below:

Non-retroflex:

b) og skille nord # budskapen *for*.PREP *seg*.PRON [førr sæ] og sørbudskapen for seg (Tromsøysund, Troms, Midttromsmål, 86yo).

c) er du nå der ditt stygge svin sa hun ## og skreik aldeles *over*.PREP *seg*.PRON [åver se] og rop- (Sørreisa, Troms, Midttromsmål, NA).

d) vi veit alle ## hvilken tragedie det er når småbarn # *går*.VERB *seg*.PRON bort # i skog og mark (Sørreisa, Troms, Midttromsmål, 86).

Retroflex: a) ja e i og *for*.PREP *seg*.PRON [få ʃæ] så er det det men (Myre, Nordland, Målet i Sør-Troms, Vesterålen og Ofoten, 26yo).

b) og da hadde han lagt seg under dyna det var akkurat som han hadde trukket dyna *over*.PREP *seg*.PRON [åver sæ] på senga vår som vi bruker å ligge (Myre, Nordland, Målet i Sør-Troms, Vesterålen og Ofoten, 26yo).

Many of the examples given without retroflex are collected in the Midttromsmål dialect area. 5 out of 7 examples of combinations with *seg* without retroflex in a research database are collected from the speech of speakers of this dialect area. At the same time, there is not a single example where the combination with this word in the Midttromsmål dialect area successfully underwent the process of retroflexion. The two remaining examples without retroflexes are collected in Indre finnmarksmål and Indre tromsmål dialect areas:

(64) nei det er jo hovedstaden # det er jo det j- *skiller*.VERB *seg*.PRON [sjiller sei] ut bare der # (Lakselv, Finnmark, Indre finnmarksmål, 28yo).

(65) jeg ser de som e bruker den gamle metoden at de e # e *tar*.VERB *seg*.PRON [tar se] mat e nyss før de går og legger seg # for_eksempel (Signaldalen, Troms, Indre tromsmål, 85yo).

Skille seg ut ("to be different") is a stable expression and should theoretically be stored in the speakers' mental lexicon. *Tar seg* are also part of several set expressions, but not in this context. In the second example, there are signs of slow and hesitant speech, which is also influenced by the age of the speaker. The likelihood of repetitions, pauses and short planning is greatly increased. In the first example, it can be seen that the speaker also had some doubts

about the planning of the speech, and initially began to say something different. Such confused speech can be the reason for the violation of the necessary connections, phonological information is not available and the retroflex does not appear.

A similar statistical survey was done for syntactic categories or parts of speech to determine the position and role of each lexical element containing a segment from a combination from a syntactic point of view. And although certain results have been obtained, it cannot be said that they play any decisive role in the success of the retroflexion process or provide an opportunity to determine what triggers this process.

The most frequent syntactic categories defining the first and second words, at the junction of which a retroflex can potentially appear, are the verb, the noun and the adverb. The position of the first word is most often taken by a verb (29.48% of all examples collected in the database), a noun (20.41%) or an adverb (19.05%). In the position of the second word, the most common are the noun (16.94% of all examples collected in the database), the adverb (16.41%) or the verb (14.98%). This distribution is quite logical, since after the verb, according to the language structure, there are most often nouns or adverbs, and Norwegian verbs in present tense end in the rhotic segment /r/, which is not omitted in many dialects.

Considering the percentage of syntactic categories in terms of the application of the retroflexion process, none of the categories either in the position of the first word or in the position of the second word will give a chance higher than 83.89%.

The syntactic categories that give the highest percentage of retroflexion at the position of the first word are presented below:

Noun – 80,59% (191/237).

Verb – 76,30% (206/270).

Adjective – 74,58% (160/224).

Preposition – 73,63% (148/201).

The syntactic categories that give the highest percentage of retroflexion at the position of the second word differ from those at the position of the first word, and are presented below:

Conjunction – 83,89% (125/149).

Pronoun – 82,05% (32/39).

Adverb – 79,88% (135/169).

Subjunction – 79,07% (68/86).

Consequently, the frequency of the use of words in speech does not depend in any way on which words are most successful for the appearance of retroflexes. This once again underlines the fact that the process of retroflexion is to some extent predictable and must have

certain triggers. However, the syntactic category is not such a trigger, since almost none of the categories has a higher than 80% chance of applied retroflexion. Anything below 80% is not much different from a random chance.

6. Discussion

The main question posed in this work was: what creates the triggering environment for the process of retroflexion of the rhotic-plus-sibilant sequences at the word boundaries in Northern Norwegian dialects? And based on the above analysis, it can be argued that the speaker's age, place, dialect area, county, length of the second word, frequency of the collocations, the choice of the lexical unit with the sibilant segment and speech planning have a certain impact on the application of this process, while syntactic category, stress, and the word with the rhotic segment gave no particularly impressive results.

Nevertheless, the results obtained can be considered successful and significant, since certain factors creating the triggering environment for the process have been identified.

Speaker's age. 1323 examples with a combination of words, on the boundaries of which there are rhotic segment /r/ and alveolar sibilant /s/ were collected for this study. The examples were collected from interviews with 122 speakers of different Northern Norwegian dialects, divided into two groups: young (under 50) and old (50 and over). Just examples from the speech of old speakers were collected in Bardu, Botnhamn, Mefjordvær, Signaldalen, Sørdalen, Stonglandseidet, Storsandnes and Tromsøysund. While just examples of speech of the young speakers were collected from Kvøfjord, Medby and Stamsund. Some of the places contained the speakers with unknown age: Andøya (2 old speakers and one without specific age), Målselv (1 old speaker and 1 speaker with unknown age), Rana, Sørreisa, Torsken and Tranøy (all of them have just speakers with unknown age). Thus, in 17 places out of 39, it is not possible to make any specific conclusions about the age influence. Retroflexion rates higher than 80% among young speakers were registered in Vardø, Sømna, Målselv, Medby, Stamsund, Botnhamn, Kvænangen, Mo i Rana, Beiarn, Bodø, Ballangen, Myre, Narvik, Hattfjelldal and Herøy N. For the old speakers the same high retroflexion level in spontaneous speech was registered in Vardø, Sømna, Botnhamn, Kvænangen, Mo i Rana, Målselv, Medfjordvær, Lavangen, Myre, Narvik and Herøy N.

It has been hypothesized that young speakers use retroflexes in speech more often than old speakers. Statistical analysis showed high rates of retroflexion among young speakers in Bodø, Botnhamn, Hammerfest, Hattfjelldal, Herøy N, Karlsøy, Kirkenes, Kirkesdalen, Kvænangen, Lakselv, Medby, Mo i Rana, Myre, Stamsund and Vardø. However, the difference in the use of retroflexes between the age groups, even though it was different, did not show significance. Age can also greatly affect the speed of speech, which disrupts and increases the

phonological distance between words. Thus, the phonological information of individual words becomes inaccessible, and the process cannot apply.

Dialect Area. The North Norwegian dialects, which are the subject of this study, are conditionally divided into thirteen dialect areas. The division into areas was supposed to help generalize the patterns of behavior of retroflexes in speech, as well as provide a more general overview over the retroflexion process. The statistical analysis showed that Austfinnmarksmål, Brønnøymål and Vefsnmål dialectal areas has a high level of retroflexion, while Indre finnmarksmål and Nordtromsmål demonstrated the lowest retroflexion level among all dialect areas. Dividing speakers into the age groups withing the dialect areas shower that the highest level of retroflexion within the old speakers' group is observed in Austfinnmarksmål (91,67%), Brønnøymål (89,47%), Vefsnmål (83,87%) and Ranamål (80,77%) dialect areas. Young speakers have a high level of retroflexion in spontaneous speech in Saltenmål (94,59%), Indre tromsmål (91,30%), Vefsnmål (89,47%), Lofotmål (87,88%), Austfinnmarksmål (86,96%), Målet i Sør-Troms, Vesterålen og Ofoten (85,92%), Ranamål (83,33%) and Brønnøymål (81,82%) dialect areas. A high level of retroflexion is considered to be over 80%.

In some dialect areas, an almost equal distribution was found between cases with and without retroflexes, making the use of retroflexes in speech quite random. Such dialect areas are, for example, Indre finnmarksmål (59,65%), Vestfinnmarksmål (69,23%) and Saltenmål for old speakers, and Indre finnmarksmål (65,67%) and Nordtromsmål (63,93%) for young speakers.

County. The downward trend in the use of retroflexes in speech is observed within the counties. The more southern region, Nordland, shows a higher level of use of retroflexes.

Lexical items. 225 unique words were recorded at the position of the first word and 286 unique words at the position of the second word. The words in the second position are not only more diverse, but also give the most unequal distribution of high and low levels of retroflexion, which may have been a sign that the first segment of the second word has a triggering quality for the process. The most frequent words in the first position in most cases successfully undergo retroflexion. The most frequent first word in the database, *der*, appears with retroflex in a suitable environment 72.51% of the time. Nevertheless, such frequent lexical units as *her* and *eller* successfully undergo retroflexion in a significantly smaller percentage of cases: 65,12% and 67,86%. The lexical unit that occupies the position of the first word and appears in examples with applied retroflexion most often is the verb *får* (89.12%).

Lexical units in the second position in some cases give 100% retroflexion. Examples are the verb *sto* and the adverb *seint*. Both words appear in different combinations with different

preceding words, and therefore are themselves triggers for the process. The words *siden* and *se* appear in second position in a slightly lower percentage of cases, but still impressively high: 91.67% and 88,89%. The first word also appears in combination with the preceding word *år* in all cases. Several examples, where /s/ in *siden* did not receive the apical quality, are explained by the peculiarities of the speaker's pronunciation (confused speech, repetitions, pauses). In contrast to frequent lexical units on the second position with a high level of retroflexion, there are also frequent lexical units that demonstrate a surprisingly low rate of applied retroflexion. The word *skal* becomes retroflex in 53,12% of cases, *sin* - in 66,67%, *sagt* - 70%, *ser* and *sett* - 75%. That is, no matter how often these words are used in spontaneous speech, the level of their retroflexion still remains not much higher than a random chance. Thus, in the case of many lexical units, the retroflexion process is surely optional.

Word length. The number of syllables in the first word in the combination showed no effect on retroflexion. However, the number of syllables in the second word shows significant influence. Shorter words in second position give a higher chance of retroflexion, and this chance decreases with an increase in the number of syllables in the second word. This once again confirms the idea that it is the second word that contains the triggering feature for the retroflexion process.

Speech planning. The Production Planning Hypothesis was taken as the basis for the speech planning theory. The main idea taken from this hypothesis was that the two words should be planned in tandem, and the phonological information of both words should be available during the planning of the variable segment. The high frequency of the second word, according to the Production Planning Hypothesis, gives a high chance of planning in tandem with the preceding word. Another influential factor is stable syntactic constructions that coexist in the speaker's mental lexicon. This factor reveals its influence in comparative analysis, as well as in the obvious connection between the frequency of collocations and the level of retroflexion. Frequent collocations give a high chance of predictability, which means they are planned in tandem, even if they are not stored in the speaker's mental vocabulary. And the frequency of collocations is directly proportional to the level of retroflexion, that is, a high frequency of collocations gives a high level of retroflexion.

Syntactic category and phrasal stress. These are potentially influential factors which were not confirmed during the study. Analysis of syntactic categories did not produce any particularly impressive results. It became known that the word in the first position in the combination is a verb, and the word in the second position is a noun. However, the first word in a combination, at the boundaries of which a retroflex appears, is most often a noun. It can be

assumed that there is a slightly higher chance of retroflexion occurring in a combination where the first word is a noun, verb, adjective or conjunction, and the second word is a conjunction, pronoun, adverb, or subjunction. However, the most successful combinations remain unknown.

In the process of listening and collecting examples for the database, one of the potential triggers was phrasal stress. In previous works devoted to retroflexion in words, the influence of lexical stress on the application of the process for /rd/-clusters was proved, as well as the influence of the progressive rightwards spreading of the stress. In this work lexical and phrasal stresses were both taken into account. Statistical analysis refuted the possible influence of lexical stress on the retroflexion process, and comparative analysis showed the inconsistency of the hypothesis about the influence of phrasal stress. Phrasal stress most often falls on nouns, verbs, and adjectives. The same syntactic categories are the most frequent in the combinations under consideration, so the phrasal stress falling on them in some cases is most likely a coincidence.

The results proposed in Stausland's (2011, 2012) works were neither confirmed nor refuted during the analysis in this study. Since the subject of consideration was spontaneous speech, the environment for retroflexes was not controlled, so the most frequent element following the alveolar sibilant /s/ in all examples was the vowel, which, according to Stausland, gives the least likelihood of retroflex occurrence.

The main limitation of this work was described in the "Methodology". Initially, the database was broader, but it was forced to narrow down from four combinations to one, the level of confidence in the correctness of the estimation of which is the highest. It would also be a good idea to expand the database to get more varied results for the assessment. However, considering one combination instead of four allowed more potentially influential factors to be included in the analysis, which made the analysis more versatile.

This study undoubtedly has great potential for further development. The consideration can include the remaining four combinations of segments, which can appear at the word boundaries in Norwegian and give retroflexes. It would be interesting to expand and deepen this research, to understand whether there are any specific patterns in other retroflexes, whether they are affected by any other triggers, and what they have in common.

Conclusion

The main purpose of this work was an attempt to analyze and determine which factors create the triggering environment for the appearance of a retroflex [ʃ] (*r#s*) at the junction of words in Northern Norwegian dialects. This goal was chosen because retroflexes in the Norwegian language and in the language system in general are controversial. Retroflexion process is optional and the factors controlling optionality are mostly remain unknown. It was originally planned that the study will contain four combinations (*r#s, r#n, r#d, r#t*), potentially capable of undergoing to retroflexion. A research database was compiled for all combinations, but a control test showed that the ability to detect retroflex by ear in three combinations out of four was below 80%. This result is insufficient to carry out the analysis and count on reliable results. Therefore, it was decided to leave only one combination, where the definition of retroflex is sufficiently accurate and has a high degree of probability.

Retroflexes were the subject of consideration in previous works (Kristoffersen, 2000; Solhaug, 2010; Stausland, 2012, 2012, 2012, 2011; Steblin-Kaminski, 1981; Endersen, 1985; Molde, 2005; Torp, 2002; etc). Stausland's works (2011, 2012) examined the combination of */r#s/* and obtained concrete phonological results of specific patterns. The data for research in his works were collected in laboratory conditions, included strictly selected environments for potential retroflex and context manipulation to test specific assumptions. His results were not very applicable in the case of spontaneous speech, although some coincidences were found.

Basically, all previous research has concentrated on examining the process of retroflection from a phonological point of view. In this work, an attempt was made to consider the process of retroflexion at the word boundaries, and to include in the list of possible triggers not only phonological, but also syntactic and lexical factors. In previous works, for the most part dialects from the western part of Norway became the central object of consideration, while in this study all attention was focused on the Northern Norwegian dialects. In addition, spontaneous daily speech is considered in this study, rather than specially selected combinations or random examples as was common before.

The age of the speaker, the place where the dialect comes from, dialect area, lexical elements, word length, syntactic categories, lexical and phrasal stress, and speech planning were considered as factors potentially creating the triggering environment. Hypothetically, each of these factors could act as a trigger for the retroflexion process and influence on phonological variability. The results of statistical and comparative analysis showed that the age of the

speaker, the place where the dialect was taken from, the dialect area, the county, the selected lexical element and word collocations, the length of the word and speech planning really affect the application of the retroflexion process and to different extend create the triggering environment. Younger speakers showed a higher level of use of retroflexes in speech. Austfinnmarksmål, Brønnøymål and Vefsnmål dialect areas demonstrate a high level of use of retroflexes among speakers of both age groups, while Indre finnmarksmål and Nordtromsmål register the level of use of retroflexes in the speech of speakers not much higher than a random chance. Vardø, Sømna, Kirkesdalen, Målselv, Stamsund, Botnhamn, Medfjorvær, Karlsøy, Kvænangen, Mo i Rana, Rana, Beiarn, Bodø, Lavangen, Tranøy, Andøya, Ballangen, Myre, Narvik, Hattfjelldal, Herøy N and Hammerfest are places with a retroflex use level higher than 80%. In some cases, only one of the age groups registered such a high result of using retroflexes in speech.

The choice of the lexical unit is also a decisive factor for the appearance of the retroflex. The most influential factor for application of the retroflexion process is the choice of the lexical unit in the second position, because this choice can trigger the application of the process up to 100%. The frequency of the use of the word does not play any role and even the frequency words in the second position in some cases give only about 53% of cases with a retroflex. The frequency of the collocation, however, directly proportional to the level of retroflexion in speech. This also supports the hypothesis of the impact of speech planning since the frequent collocations are predictable and most likely to be planned in tandem. Therefore, all the phonological information required for the process is available simultaneously. More frequent collocations give a higher chance of retroflexes appearing. This tendency is more evident among young speakers.

Counties closer to the Southern part of Norway give a higher level of retroflexion. Thus, in Nordland the level of retroflexion is higher than in Troms, and in Troms it is higher than in Finnmark. In Nordland, the level of retroflexion among young speakers is numerically higher than among old ones, in other regions such a noticeable difference is not observed.

Shorter words in the second position give a higher level of retroflexion, while the number of syllables in the first word does not matter.

With regard to lexical categories and stress, these factors have not shown any consistent or significant impact on the success of the retroflexion process at the word boundaries. Thus, none of these factors can be considered a trigger for the retroflexion process.

For the next stage of research, it would make sense to include more combinations which can potentially undergo retroflexion in the consideration to determine their patterns of behavior

and triggering environment, and to find out whether they are the same or different from each other. Acoustic analysis of the speech of the speakers would help raise the level of accuracy in identifying retroflexes to 100%.

Nevertheless, the methodology chosen for this study can be considered quite successful and gave sufficiently indicative results that can serve as a basis for more detailed studies in the future. These results also bring a certain novelty and expand the knowledge base about retroflexes and the process of retroflexion, as well as shed light on the speech processes occurring in spontaneous speech of the speakers of the little-studied Northern Norwegian dialects.

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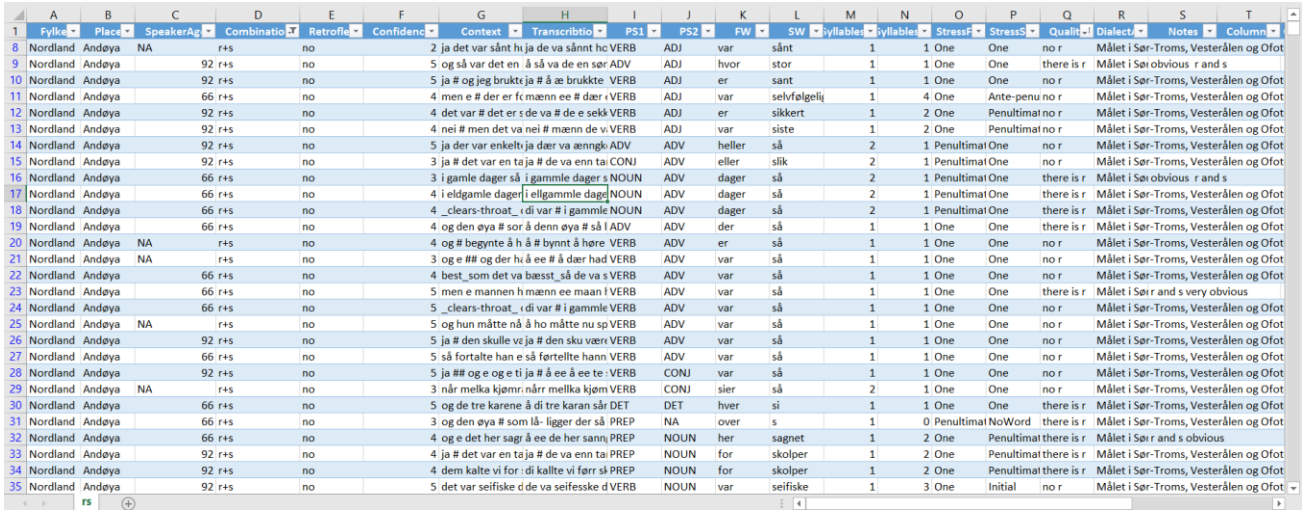
Appendix

A.1 The example of the database:



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Fylke	Place	SpeakerAg	Combinatio	Retrofle	Confidenc	Context	Transcribtio	PS1	PS2	FW	SW	yllables	yllables	StressF	StressS	Qualit	Dialect	Notes	Column
8	Nordland	Andøya	NA	r+s	no	2	ja det var sånt hi	ja de va sånnt hc	VERB	ADJ	var	sånt	1	1	One	One	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
9	Nordland	Andøya	92	r+s	no	5	og så var det en	å så va de en sør	ADV	ADJ	hvor	stor	1	1	One	One	there is r	Målet i	Sør obvious r and s	
10	Nordland	Andøya	92	r+s	no	5	ja # og jeg brukte	ja # å æ brukkte	VERB	ADJ	er	sant	1	1	One	One	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
11	Nordland	Andøya	66	r+s	no	4	men e # der er fc	mænn ee # dær v	VERB	ADJ	var	selvfølgeli	1	4	One	Ante-penu	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
12	Nordland	Andøya	92	r+s	no	4	det var # det er s	de va # de e sekk	VERB	ADJ	er	sikkert	1	2	One	Penultimat	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
13	Nordland	Andøya	92	r+s	no	4	nei # men det va	nei # mænn de vi	VERB	ADJ	var	siste	1	2	One	Penultimat	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
14	Nordland	Andøya	92	r+s	no	5	ja der var enkelt	ja dær va ænngk	ADV	ADV	heller	så	2	1	Penultimat	One	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
15	Nordland	Andøya	92	r+s	no	3	ja # det var en ta	ja # de va enn tai	CONJ	ADV	eller	slik	2	1	Penultimat	One	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
16	Nordland	Andøya	66	r+s	no	3	i gamle dager så	i gammle dager s	NOUN	ADV	dager	så	2	1	Penultimat	One	there is r	Målet i	Sør obvious r and s	
17	Nordland	Andøya	66	r+s	no	4	i eldgamle dager	i ellgammle dage	NOUN	ADV	dager	så	2	1	Penultimat	One	there is r	Målet i	Sør-Troms, Vesterålen og Ofot	
18	Nordland	Andøya	66	r+s	no	4	_clears-throat_	di var # i gammle	NOUN	ADV	dager	så	2	1	Penultimat	One	there is r	Målet i	Sør-Troms, Vesterålen og Ofot	
19	Nordland	Andøya	66	r+s	no	4	og den øya # sor	å denn øya # så l	ADV	ADV	der	så	1	1	One	One	there is r	Målet i	Sør-Troms, Vesterålen og Ofot	
20	Nordland	Andøya	NA	r+s	no	4	og # begynte å h	å # bynnt å høre	VERB	ADV	er	så	1	1	One	One	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
21	Nordland	Andøya	NA	r+s	no	3	og e ## og der hi	å ee # å dær had	VERB	ADV	var	så	1	1	One	One	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
22	Nordland	Andøya	66	r+s	no	4	best_som det va	bæsst_så de va s	VERB	ADV	var	så	1	1	One	One	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
23	Nordland	Andøya	66	r+s	no	5	men e mannen h	mænn ee maan l	VERB	ADV	var	så	1	1	One	One	there is r	Målet i	Sør r and s very obvious	
24	Nordland	Andøya	66	r+s	no	5	_clears-throat_	di var # i gammle	VERB	ADV	var	så	1	1	One	One	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
25	Nordland	Andøya	NA	r+s	no	5	og hun måtte nå	å ho måtte nu sp	VERB	ADV	var	så	1	1	One	One	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
26	Nordland	Andøya	92	r+s	no	5	ja # den skulle v	ja # den sku vær	VERB	ADV	var	så	1	1	One	One	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
27	Nordland	Andøya	66	r+s	no	5	så fortalte han e	så førtellte hann	VERB	ADV	var	så	1	1	One	One	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
28	Nordland	Andøya	92	r+s	no	5	ja ## og e og e ti	ja # å ee å ee te	VERB	CONJ	var	så	1	1	One	One	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
29	Nordland	Andøya	NA	r+s	no	3	når melka kjømr	når mellka kjøm	VERB	CONJ	sier	så	2	1	One	One	no r	Målet i	Sør-Troms, Vesterålen og Ofot	
30	Nordland	Andøya	66	r+s	no	5	og de tre karene å	di tre karan sår	DET	DET	hver	si	1	1	One	One	there is r	Målet i	Sør-Troms, Vesterålen og Ofot	
31	Nordland	Andøya	66	r+s	no	3	og den øya # som	lå- ligger der så	PREP	NA	over	s	1	0	Penultimat	NoWord	there is r	Målet i	Sør-Troms, Vesterålen og Ofot	
32	Nordland	Andøya	66	r+s	no	4	og e det her sagr	å ee de her sann	PREP	NOUN	her	sagnet	1	2	One	Penultimat	there is r	Målet i	Sør r and s obvious	
33	Nordland	Andøya	92	r+s	no	4	ja # det var en ta	ja # de va enn tai	PREP	NOUN	for	skolper	1	2	One	Penultimat	there is r	Målet i	Sør-Troms, Vesterålen og Ofot	
34	Nordland	Andøya	92	r+s	no	4	dem kalte vi for	di kallte vi førr sk	PREP	NOUN	for	skolper	1	2	One	Penultimat	there is r	Målet i	Sør-Troms, Vesterålen og Ofot	
35	Nordland	Andøya	92	r+s	no	5	det var seifiske d	de va seifesske d	VERB	NOUN	var	seifiske	1	3	One	Initial	no r	Målet i	Sør-Troms, Vesterålen og Ofot	

rs

A.2 Distribution of examples by dialect areas (table):

	DialectArea	Place	total	retroflex	no_r	is_r	is_r_no_s	is_r_es
1	AF	Vardø	48	31	13	4	0	0
2	BM	Sømna	31	26	1	4	0	0
3	IF	Kautokeino	28	8	2	18	0	0
4	IF	Lakselv	56	38	2	15	0	0
5	IF	Tana	48	32	4	12	0	0
6	IT	Bardu	32	12	8	12	0	0
7	IT	Kirkesdalen	45	33	5	7	0	0
8	IT	Målselv	22	15	2	5	0	0
9	IT	Signaldalen	29	22	1	6	0	0
10	IT	Sørdalen	22	13	4	5	0	0
11	LM	Stamsund	36	29	3	4	0	0
12	MT	Botnhamn	24	19	3	2	0	0
13	MT	Mefjordvær	29	20	5	4	0	0
14	MT	Sørreisa	21	10	2	9	0	0
15	MT	Tromsø	52	26	14	11	1	0
16	MT	Tromsøysund	21	9	2	10	0	0
17	NT	Kåfjord	37	18	9	10	0	0
18	NT	Karlsøy	32	15	7	10	0	0
19	NT	Kvænangen	46	30	6	10	0	0
20	RM	Mo i Rana	36	28	2	6	0	0
21	RM	Rana	13	8	3	2	0	0
22	SAL	Beiarn	36	28	2	6	0	0
23	SAL	Bodø	43	32	4	7	0	0
24	SEN	Lavangen	33	21	5	7	0	0
25	SEN	Medby	26	21	1	4	0	0
26	SEN	Stonglandseidet	15	9	2	4	0	0
27	SEN	Torsken	14	8	0	6	0	0
28	SEN	Tranøy	2	2	0	0	0	0
29	STVL	Andøya	68	20	36	12	0	0
30	STVL	Ballangen	33	22	5	6	0	0
31	STVL	Kvæfjord	19	6	9	4	0	0
32	STVL	Myre	102	50	49	3	0	0
33	STVL	Narvik	17	14	2	1	0	0
34	STVL	Storsandnes	15	8	2	5	0	0
35	VEF	Hattfjelldal	40	33	2	4	1	0
36	VEF	Herøy N	33	27	2	4	0	0
37	VES	Hammerfest	29	20	5	4	0	0
38	VES	Kirkenes	45	32	3	9	0	1
39	VES	Kjøllefjord	45	20	12	12	1	0

The "*total*" column indicates the number of examples collected at each location. The next five columns show the number of examples with a specific connection quality of the rhotic element /r/ and the alveolar sibilant /s/ following it, according to place and dialect area. "*No_r*", "*is_r*", "*is_r_no_s*", "*is_r_es*" and "*retroflex*" combined give a "*total*" result.

"*Retroflex*" means that the rhotic segment disappears, and the following segment gets the [apical] feature and become retroflex.

"*No_r*" means that the rhotic segment /r/, which is necessary for the successful retroflexion process, was deleted in advance. In this case there are no conditions for retroflexion at all. The disappearance of the final rhotic segment /r/ is common in many Norwegian dialects. For example, in the case of verbs in the present tense. However, only those examples were included in the database where the disappearance of the final /r/ was not predictable and common. That is why these examples, which in fact do not have any conditions for retroflexion, were included in the general table and taken into account.

"*Is_r*" means that both segments necessary for a successful retroflexion process are present and pronounced. The environment is there, but the process still does not happen. This category of examples seems to be the most interesting for this study, since it opens opportunities for searching for possible reasons for blocking the process, even when the phonetic distance is close enough.

"*Is_r_no_s*" is an incredibly rare instance where the rhotic segment remains in place and is pronounced, but the following segment is missing.

"*Is_r_es*" marks the situation when the rhotic segment /r/ stays on the place and the following consonant is pronounced, but they are separated by inserted -es sequence.

A.3 Distribution of *rhotic+sibilant sequences* quality by dialect areas (table):

	DialectArea	Total	Retroflex	is_r	is_r_no_s	is_r_es
1	AF	35	88.570	11.430	0	0
2	BM	30	86.670	13.330	0	0
3	IF	124	62.900	36.290	0	0
4	IT	130	73.080	26.920	0	0
5	LM	33	87.880	12.120	0	0
6	MT	121	69.420	29.750	0.830	0
7	NT	93	67.740	32.260	0	0
8	RM	44	81.820	18.180	0	0
9	SAL	73	82.190	17.810	0	0
10	SEN	82	74.390	25.610	0	0
11	STVL	151	79.470	20.530	0	0
12	VEF	69	86.960	11.590	1.450	0
13	VES	99	72.730	25.250	1.010	1.010

DialectArea – abbreviation of the dialect area.

Total – percentage r of examples collected in the dialect area.

Retroflex – percentage of examples with applied retroflexion.

Is_r – percentage of examples where both segments are pronounced, environment is suitable for the retroflexion process but retroflexion fails.

Ir_r_no_s – percentage of examples with perceived rhotic segment /r/ and absent sibilant /s/.

Is_r_es – percentage of examples with insertion of /-es/ appearing after the rhotic segment /r/.

A.4 Retroflex distribution by dialect areas, considering the age categories (table):

	Area	Old total	Old RF	Young total	Young RF	Combined total	Old RC	Young RC
1	AF	12	11	23	20	35	1	3
2	BM	19	17	11	9	30	2	2
3	IF	57	34	67	44	124	23	23
4	IT	104	73	23	21	127	31	2
5	LM	0	0	33	29	33	0	4
6	MT	67	48	35	26	102	19	9
7	NT	32	24	61	39	93	8	22
8	RM	26	21	18	15	44	5	3
9	SAL	36	25	37	35	73	11	2
10	SEN	25	19	41	32	66	6	9
11	STVL	72	51	71	61	143	21	10
12	VEF	31	26	38	34	69	5	4
13	VES	39	27	60	45	99	12	15

Old total – total amount of examples from old speakers in the dialect area.

Old RF – the number of examples with retroflexes in the speech of old speakers.

Young total – total amount of examples from young speakers in the dialect area.

Young RF – the number of examples with retroflex in the speech of young speakers.

Combined total – total amount of examples from young and old speakers in the dialect area.

Old RC – suitable retroflex conditions which did not lead to the successful retroflexion in the speech of old speakers.

Young RC – suitable retroflex conditions which did not lead to the successful retroflexion in the speech of young speakers.

A.5 R-code (main + tables):

```
rm(list=ls())
options(scipen=999)
# Libraries
library(tidyverse)
library(broom)
library(stargazer)
library(stringr)
library(tidyr)
library(lme4)

getwd() # Working directory
df <- read.csv("Rs final.csv",fileEncoding="UTF-8") # Import data
df <- df %>%
  filter_all(all_vars(!is.na(Confidence))) # remove empty obs.
df <- df[,-c(16:26),] # remove empty columns
df$Quality <- as.character(df$Quality) # mark retroflex obs.
df$Quality <- ifelse(df$Quality=="", "retroflex", df$Quality) # Input
'retroflex' for retroflex cases
df$Quality <- factor(df$Quality) # Coerce to factor
df$Retroflex <- ifelse(df$Retroflex=="no ", "no",
                       ifelse(df$Retroflex=="yes ",
"yes",df$Retroflex)) # Fix spelling mistake
df$FW <- str_trim(df$FW) # Fix typo
df$SW <- str_trim(df$SW) # Fix typo
df$PS1 <- ifelse(df$PS1=="RPEP","PREP",df$PS1) # Fix typo
```

```
     # Supplementary data
     rn <- read.csv("rn.csv",fileEncoding = "UTF-8")
     rd <- read.csv("rd.csv",fileEncoding = "UTF-8")
     rt <- read.csv("rt.csv",fileEncoding = "UTF-8")
     colnames(rt) <- colnames(rn)
     sup.df <- rbind(rn,rd,rt)
     sup.df <- sup.df[,1:15]

     sup.df <- sup.df %>%
       filter_all(all_vars(!is.na(Confidence))) # remove empty obs.

     sup.df$Quality <- as.character(sup.df$Quality) # mark retroflex obs.
     sup.df$Quality <- ifelse(sup.df$Quality=="", "retroflex",
sup.df$Quality) # Input 'retroflex' for retroflex cases
     sup.df$Quality <- factor(sup.df$Quality) # Coerce to factor
     sup.df$Retroflex <- ifelse(sup.df$Retroflex=="no ", "no",
                                ifelse(sup.df$Retroflex=="yes ",
"yes",sup.df$Retroflex)) # Fix spelling mistake
     sup.df <- rbind(sup.df,df)


     ## Abbreviations ##
     abb.df <- as.data.frame(
       rbind(cbind("STVL","Målet i Sør-Troms, Vesterålen og Ofoten"),
           cbind("IT","Indre tromsmål"),
           cbind("SAL","Saltenmål"),
           cbind("MT","Midttromsmål"),
           cbind("VES","Vestfinnmarksmål"),
           cbind("VEF","Vefsnmål"),
           cbind("NT","Nordtromsmål"),
           cbind("IF","Indre finnmarksmål"),
           cbind("SEN","Senjamål"),
           cbind("RM","Ranamål"),
           cbind("BM","Brønnøymål"),
           cbind("LM","Lofotmål"),
           cbind("AF","Austfinnmarksmål")),
     ) # List of abbreviations
     colnames(abb.df) <- c("Abbreviation","Name")
     stargazer(abb.df,summary=FALSE,type="latex") # Export table
     df$DialectArea <-
abb.df$Abbreviation[match(df$DialectArea,abb.df$Name)] # Use abbreviations
for dialect area in df


     ## Overview table ##
     table1 <- df %>%
       select(Place, DialectArea,Quality) %>%
       group_by(DialectArea, Place) %>%
       summarise(total=n(), # Summaries frequency for each group, and total
                 retroflex=sum(Quality=="retroflex"),
                 no_r=sum(Quality=="no r"),
                 is_r=sum(Quality=="there is r"),
                 is_r_no_s=sum(Quality=="there is r, no s"),
                 is_r_es=sum(Quality=="there is r, insertion of -es")
       )
     table1 <- as.data.frame(table1) # transform table
     stargazer(table1,summary=FALSE,type="latex") # export table


     ## Percentage of retroflex enivornment without retroflexation table ##
     table2 <- as.data.frame(table1) # copy to new object
```

```
    table2$total_nor <- table2$total - table2$no_r # create total without
no retroflex environment
    table2$pis_r <- table2$is_r / table2$total_nor *100 # Percent
    table2$pis_r_no_s <- table2$is_r_no_s / table2$total_nor *100 #
Percent
    table2$pis_r_es <- table2$is_r_es / table2$total_nor *100 # Percent
    table2$pis_retroflex <- table2$retroflex / table2$total_nor *100 #
Percent

    table2 <- table2[,c(1,2,10:13)] # remove unwanted variables
    stargazer(table2,summary=FALSE, type="latex") # export table


    ## Age comparison table ##
    table3 <- df
    table3$SpeakerAge <- as.numeric(table3$SpeakerAge)
    table3$Old <- ifelse(table3$SpeakerAge>=50,1,
                         ifelse(table3$SpeakerAge<50,0,NA)) # Dichotomised
age variable

    # Grouped fractions
    table3 <- table3 %>%
      select(Place, DialectArea,Quality,Old) %>%
      group_by(DialectArea, Place, Old) %>%
      summarise(total=n(),  # Summarise frequencies for each group and
total
                retroflex=sum(Quality=="retroflex"),
                no_r=sum(Quality=="no r"),
                is_r=sum(Quality=="there is r"),
                is_r_no_s=sum(Quality=="there is r, no s"),
                is_r_es=sum(Quality=="there is r, insertion of -es")
      )

    # Percentages
    table3 <- as.data.frame(table3)
    table3$total_nor <- table3$total - table3$no_r # create total without
no retroflex environment
    table3$pis_r <- table3$is_r / table3$total_nor *100
    table3$pis_r_no_s <- table3$is_r_no_s / table3$total_nor *100
    table3$pis_r_es <- table3$is_r_es / table3$total_nor *100
    table3$pis_retroflex <- table3$retroflex / table3$total_nor *100

    table3 <- table3[,-c(4:9)] # Remove unneccesary columns
    stargazer(table3,summary=FALSE, type="latex") # export table


    ## Age groups ##
    test.df <- df %>%
      select(Quality,SpeakerAge,Place,Retroflex) %>%
      filter(Quality != "no r") # Filter out obs. with "no r"
    test.df$Retroflex <- ifelse(test.df$Retroflex == "yes",1,0) #
Dichotomize Retroflex
    test.df$Old <- ifelse(test.df$SpeakerAge>=50,1,
                         ifelse(test.df$SpeakerAge<50,0,NA)) # Dichotomize
age variable
    test.df <- na.omit(test.df) # Remove NAs


    ## Number of observations##
    d <- df %>%
      select(Fylke,Place) %>%
```

```
  group_by(Fylke, Place) %>%
  summarise(total=n())
d <- as.data.frame(d)
colnames(d) <- c("County","Place","n")
stargazer(d,summary=FALSE) # Table 5a
sum(d$n)

## Number of observations, with all ##
d <- sup.df %>%
  select(Fylke,Place,Combination) %>%
  group_by(Fylke, Place) %>%
  summarise(total=n(),
            rs=sum(Combination=="r+s"),
            rd=sum(Combination=="r+d"),
            rn=sum(Combination=="r+n"),
            rt=sum(Combination=="r+t")
)

d <- as.data.frame(d)
colnames(d) <- c("County","Place","n")
stargazer(d,summary=FALSE) # Table 5b
colnames(d)[4:7] <- c("r#s","r#d","r#n","r#t")
sum(d$n)
sum(d$'r#s')
sum(d$'r#d')
sum(d$'r#n')
sum(d$'r#t')

#sup.df[sup.df$Fylke=="Troms ",]

## Word combinations ##

table6.1 <- as.data.frame(table(df$FW)) # Create frequency table
table6.1 <- table6.1[order(-table6.1$Freq),] # Order table
table6.1 <- table6.1[1:15,] # Keep only 15 first obs.
table6.1$Share <- round(table6.1$Freq/nrow(df)*100,2) # Percentages

table6.2 <- as.data.frame(table(df$SW)) # Create frequency table
table6.2 <- table6.2[order(-table6.2$Freq),] # Order table
table6.2 <- table6.2[1:15,] # Keep only 15 first obs.
table6.2$Share <- round(table6.2$Freq/nrow(df)*100,2) # Percentages

table6 <- cbind(table6.1, table6.2) # Combine
rownames(table6) <- NULL # Number
colnames(table6) <- c("First Word", "Frequency","Percentage", "Second
Word", "Frequency","Percentage") # Column name
stargazer(table6,summary=FALSE) # Export
length(unique(df$FW)) # Number of unique FW
length(unique(df$SW)) # Number of unique SW


## Word combinations retroflex ##

d <- df %>%
  filter(Quality != "no r")# Remove 'no r'
table7.F <- as.data.frame(table(d$FW)) # Frequency table, FW
table7.S <- as.data.frame(table(d$SW)) # Frequency table, SW
table7 <- d %>%
  filter(Quality == "retroflex") # Keep only 'retroflex'

# First Word
```

```
     table7.1 <- as.data.frame(table(table7$FW)) # Create frequency table
     table7.1 <- table7.1[order(-table7.1$Freq),] # Order table
     table7.1 <- table7.1[1:15,] # Keep only 15 first obs.
     table7.1$Share <- round(table7.1$Freq/nrow(table7)*100,2) #
Percentages

     table7.1$Freq_total <-
table7.F$Freq[match(table7.1$Var1,table7.F$Var1)] # Frequency of retroflex
condition
     table7.1$Share_retroflex <-
round(table7.1$Freq/table7.1$Freq_total*100,2) # Percentage of retroflected
FW as share of FW with retroflex condition
     colnames(table7.1) <- c("FW","Freq. w/RF","% of RF","Freq. w/RF-
cond.","% of FW RF")
     rownames(table7.1) <- NULL
     stargazer(table7.1,summary=FALSE)

     # Second Word
     table7.2 <- as.data.frame(table(table7$SW)) # Create frequency table
     table7.2 <- table7.2[order(-table7.2$Freq),] # Order table
     table7.2 <- table7.2[1:15,] # Keep only 15 first obs.
     table7.2$Share <- round(table7.2$Freq/nrow(table7)*100,2) #
Percentages

     table7.2$Freq_total <-
table7.S$Freq[match(table7.2$Var1,table7.S$Var1)] # Frequency of retroflex
condition
     table7.2$Share_retroflex <-
round(table7.2$Freq/table7.2$Freq_total*100,2) # Percentage of retroflected
FW as share of FW with retroflex condition
     colnames(table7.2) <- c("SW","Freq. w/RF","% of RF","Freq. w/RF-
cond.","% of SW w/RF")
     rownames(table7.2) <- NULL
     stargazer(table7.2,summary=FALSE,digits=2)


     ## Frequency of PS1 and PS2 ##

     table8.1 <- as.data.frame(table(df$PS1)) # Create frequency table
     table8.1 <- table8.1[order(-table8.1$Freq),] # Order table
     table8.1$Share <- round(table8.1$Freq/sum(table8.1$Freq)*100,2) #
Percentage
     colnames(table8.1) <- c("PS1","PS1freq","% of PS1") # Variable names

     table8.2 <- as.data.frame(table(df$PS2)) # Create frequency table
     table8.2 <- table8.2[order(-table8.2$Freq),] # Order table
     table8.2$Share <- round(table8.2$Freq/sum(table8.2$Freq)*100,2) #
Percentage
     colnames(table8.2) <- c("PS2","PS2freq","% of PS2") # Variable names

     table8 <-
merge(table8.1,table8.2,by.x="PS1",by.y="PS2",all.x=TRUE,all.y=TRUE) #
Merge tables
     table8 <- table8[order(-table8$PS1freq),] # Order table
     rownames(table8) <- NULL
     table8
     stargazer(table8,summary=FALSE,digits=2) # Export


     ## Table ##
     d1 <- df %>%
```

```
      filter(Quality != "no r") # Retroflex condition obs.
    d2 <- df %>%
      filter(Quality == "retroflex") # Retroflex obs.

    # PS1
    table9.1 <- as.data.frame(table(d1$PS1)) # Frequency w/ RC
    colnames(table9.1) <- c("ps1","v1")

    table9.0 <- as.data.frame(table(d2$PS1)) # Frequency w/RF
    colnames(table9.0) <- c("ps1","v2")
    table9.1 <- merge(table9.1,table9.0,by="ps1") # Merge

    table9.1$v3 <- round(table9.1$v1/sum(table9.1$v1)*100,2) # % of verb,
RC
    table9.1$v4 <- round(table9.1$v2/sum(table9.1$v2)*100,2) # % of verb,
RF
    table9.1$v5 <- round(table9.1$v2/table9.1$v1 * 100, 2) # % of verb w/
RF of verb w/ RC

    colnames(table9.1) <- c("PS1","Freq. PS1 (RC)","Freq. PS1 (RF)","% PS1
(RC)","% PS1 (RF)","% PS1 w/RF in RC")
    stargazer(table9.1,summary=FALSE,digits=2) # Export

    # PS2
    table9.2 <- as.data.frame(table(d1$PS2)) # Frequency w/ RC
    colnames(table9.2) <- c("ps2","v1")

    table9.0 <- as.data.frame(table(d2$PS2)) # Frequency w/RF
    colnames(table9.0) <- c("ps2","v2")
    table9.2 <- merge(table9.2,table9.0,by="ps2") # Merge

    table9.2$v3 <- round(table9.2$v1/sum(table9.2$v1)*100,2) # % of verb,
RC
    table9.2$v4 <- round(table9.2$v2/sum(table9.2$v2)*100,2) # % of verb,
RF
    table9.2$v5 <- round(table9.2$v2/table9.2$v1 * 100, 2) # % of verb w/
RF of verb w/ RC

    colnames(table9.2) <- c("PS2","Freq. PS2 (RC)","Freq. PS2 (RF)","% PS2
(RC)","% PS2 (RF)","% PS2 w/RF in RC")
    stargazer(table9.2,summary=FALSE,digits=2) # Export


    ## Distribution of RF within dialect area ##
    # Table 10a
    d <- d1 %>%
      select(DialectArea,Quality) %>%
      group_by(DialectArea) %>%
      summarise(total=n(),
                retroflex=sum(Quality=="retroflex"))
    d <- as.data.frame(d)
    d$NoRetroflex <- d$total - d$retroflex
    d$retroflex <- round(d$retroflex/d$total * 100 ,2)
    d$NoRetroflex <- round(d$NoRetroflex/d$total * 100, 2)
    stargazer(d,summary=FALSE,digits=2)

    # Dialect area and type of connection
    d <- d1 %>%
      select(DialectArea,Quality) %>%
      group_by(DialectArea) %>%
      summarise(total=n(),
```

```
                retroflex=sum(Quality=="retroflex"),
                r=sum(Quality=="there is r"),
                r_no_s=sum(Quality=="there is r, no s"),
                r_es=sum(Quality=="there is r, insertion of -es"))
    d <- as.data.frame(d)
    d$retroflex <- round(d$retroflex/d$total * 100 ,2)
    d$r <- round(d$r/d$total * 100, 2)
    d$r_no_s <- round(d$r_no_s/d$total * 100, 2)
    d$r_es <- round(d$r_es/d$total * 100, 2)
    stargazer(d,summary=FALSE,digits=2)


    ## Table ##
    d1$Old <- ifelse(d1$SpeakerAge>=50,1,
                     ifelse(d1$SpeakerAge<50,0,NA)) # Dichotomize age
variable

    dold <- d1 %>%
      select(DialectArea,Quality,Old) %>%
      group_by(DialectArea) %>%
      filter(Old==1) %>%
      summarise(total=n(),
                retroflex=sum(Quality=="retroflex"))
    dold <- as.data.frame(dold)
    colnames(dold) <- c("Area","o_total","o_retroflex")

    dyoung <- d1 %>%
      select(DialectArea,Quality,Old) %>%
      group_by(DialectArea) %>%
      filter(Old==0) %>%
      summarise(total=n(),
                retroflex=sum(Quality=="retroflex"))
    dyoung <- as.data.frame(dyoung)
    colnames(dyoung) <- c("Area","y_total","y_retroflex")

    # Combine tables
    d <- merge(dold,dyoung,by="Area", all.x=TRUE,all.y=TRUE)
    d$total <- d$o_total+d$y_total
    d$o_rc <- d$o_total - d$o_retroflex
    d$y_rc <- d$y_total - d$y_retroflex
    table11 <- d
    colnames(table11) <- c("Area","Old total","Old RF", "Young
total","Young RF","Combined total","Old RC","Young RC")
    stargazer(table11,summary=FALSE,digits=2) # Export


    ## Dialect area distribution for age and applied or failed
retroflexion ##
    table12 <- d
    table12$o_retroflex <- round(table12$o_retroflex/table12$o_total *100,
2)
    table12$o_rc <- round(table12$o_rc/table12$o_total *100, 2)
    table12$y_retroflex <- round(table12$y_retroflex/table12$y_total *
100, 2)
    table12$y_rc <- round(table12$y_rc / table12$y_total * 100, 2)
    table12 <- table12 %>%
      select(Area,o_retroflex,o_rc,y_retroflex,y_rc)
    colnames(table12) <- c("Area","Old RF","Old RC", "Young RF", "Young
RC")
    stargazer(table12,summary=FALSE,digits=2)
```

```
     ## Table ##

     table14 <- df %>%
       filter(Quality != "no r") %>%
       select(DialectArea,Quality) %>%
       group_by(DialectArea) %>%
       summarise(total=n(), # Summaries frequency for each group, and total
                 RF=sum(Quality=="retroflex"),
                 RC=sum(Quality=="no r" | Quality == "there is r" | Quality
== "there is r, no s" | Quality == "there is r, insertion of -es")
     )

     table14$RF <- round(table14$RF/table14$total * 100,2)
     table14$RC <- round(table14$RC/table14$total * 100,2)
     colnames(table14)[2] <- "Total"
     stargazer(table14,summary=FALSE)


     ## Table ##
     table15 <- df %>%
       filter(Quality != "no r") %>%
       select(DialectArea,Quality) %>%
       group_by(DialectArea) %>%
       summarise(Total=n(), # Summaries frequency for each group, and total
                 Retroflex=sum(Quality=="retroflex"),
                 is_r=sum(Quality=="there is r"),
                 is_r_no_s=sum(Quality=="there is r, no s"),
                 is_r_es=sum(Quality=="there is r, insertion of -es")
       )
     table15 <- as.data.frame(table15) # transform table
     table15$Retroflex <- round(table15$Retroflex/table15$Total * 100, 2)
     table15$is_r <- round(table15$is_r/table15$Total * 100, 2)
     table15$is_r_no_s <- round(table15$is_r_no_s/table15$Total * 100, 2)
     table15$is_r_es <- round(table15$is_r_es/table15$Total * 100, 2)
     stargazer(table15,summary=FALSE,type="latex") # export table
```

A.6 Logistic mixed effects model:

(Only includes 1079 observations, i.e., only "retroflex" and "R present". This dataset is called "Han").

```
xtabs(~ Han$AgeGroup)
Han$AgeGroup
  Old Young
  563   516

tapply(Han$Ret, Han$AgeGroup, mean)
      Old     Young
0.7193606 0.7926357

modAge <- glmer(Ret ~   AgeGroup  + (1|Part), data=Han, family=binomial)
summary(modAge)

Fixed effects:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)     1.1213     0.1575   7.120 1.08e-12 ***
AgeGroupYoung   0.3265     0.2314   1.411    0.158
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr)
```

```
AgeGroupYng -0.657
```

A.7 Effect of the collocation:

```
modColl <- glmer(Ret ~   NrColl  + (1|Part), data=Han, family=binomial)
> summary(modColl)

Random effects:
 Groups Name        Variance Std.Dev.
 Part   (Intercept) 0.6991   0.8361
Number of obs: 1033, groups:  Part, 103

Fixed effects:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) 1.118886   0.130509   8.573  < 2e-16 ***
NrColl      0.016440   0.005842   2.814  0.00489 **

summary(glmer(Ret ~   NrColl * AgeGroup  + (1|Part), data=Han,
family=binomial))


Random effects:
 Groups Name        Variance Std.Dev.
 Part   (Intercept) 0.6547   0.8091
Number of obs: 1033, groups:  Part, 103

Fixed effects:
                    Estimate Std. Error z value Pr(>|z|)
(Intercept)          1.041878   0.173560   6.003 1.94e-09 ***
NrColl               0.007247   0.006938   1.045   0.2962
AgeGroupYoung        0.120834   0.253219   0.477   0.6332
NrColl:AgeGroupYoung 0.031338   0.013876   2.258   0.0239 *

Han$Collocation <- "Low (1-2)"
Han$Collocation[Han$CollGroup == "2"] <- "Mid (3-15)"
Han$Collocation[Han$CollGroup == "3"] <- "High (above 15)"

tapply(Han$Ret, list(Han$CollGroup, Han$AgeGroup), mean)


CollGroup

 pdf(file = "RetroflexbyAgeCollGroup.pdf", height = 4, width = 6)

ggplot(data=Han, aes(x=Collocation,, fill=Retroflex)) +
  facet_grid( ~ AgeGroup) +
  geom_bar(position = "fill")+
  xlab("Strength of collocation")+
  ylab("Proportion, retroflex")+
  guides(fill=guide_legend(title="Retroflex"))

dev.off()
```

A.8 Effect of the county:

```
modDia <- glmer(Ret ~   DialectArea  + (1|Part), data=Han, family=binomial)
modNull <- glmer(Ret ~   1  + (1|Part), data=Han, family=binomial)
anova(modDia, modNull)
Data: Han
Models:
modNull: Ret ~ 1 + (1 | Part)
```

```
modDia: Ret ~ DialectArea + (1 | Part)
        npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
modNull    2 1108.3 1118.2 -552.17   1104.3
modDia    14 1113.5 1182.6 -542.73   1085.5 18.889 12    0.09125 .

modDia <- glmer(Ret ~   Fylke  + (1|Part), data=Han, family=binomial)
anova(modDia, modNull)
Data: Han
Models:
modNull: Ret ~ 1 + (1 | Part)
modDia: Ret ~ Fylke + (1 | Part)
        npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
modNull    2 1108.3 1118.2 -552.17   1104.3
modDia     4 1101.1 1120.8 -546.53   1093.1 11.285  2   0.003544 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

tapply(Han$Ret, list(Han$AgeGroup, Han$Fylke), mean)
       Finnmark  Nordland     Troms
Old   0.6792453 0.7748691 0.6954887
Young 0.7315436 0.8888889 0.7337278

pdf(file = "RetroflexbyAgeFylke.pdf", height = 4, width = 6)

ggplot(data=Han, aes(x=AgeGroup, fill=Retroflex)) +
  facet_grid( ~ Fylke) +
  geom_bar(position = "fill")+
  xlab("Strength of collocation")+
  ylab("Proportion, retroflex")+
  guides(fill=guide_legend(title="Retroflex"))

dev.off()
```

A.9 Effect of the word length:

```
modSyllAge <- glmer(Ret ~   SW_Syllables  + (1|Part), data=Han,
family=binomial)
>  summary(modSyllAge)
Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) ['glmerMod']
 Family: binomial  ( logit )
Formula: Ret ~ SW_Syllables + (1 | Part)
   Data: Han

     AIC      BIC   logLik deviance df.resid
  1091.2   1106.0   -542.6   1085.2     1030

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.8803  0.2971  0.4082  0.5467  1.5309

Random effects:
 Groups Name        Variance Std.Dev.
 Part   (Intercept) 0.7205   0.8488
Number of obs: 1033, groups:  Part, 103

Fixed effects:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)    1.9179     0.1936   9.905  < 2e-16 ***
```

```
SW_Syllables  -0.4338     0.0976  -4.444 8.82e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr)
SW_Syllabls -0.777
```

A.10 Effect of the lexical stress:

```
tapply(Han$Ret, list(Han$StressFW), mean)
Ante-
penultimate          Initial              One      Penultimate
    Second
       0.9000000        0.8000000        0.7522816        0.7430830
       1.0000000
           Third         Ultimate
       0.0000000        0.6666667
> tapply(Han$Ret, list(Han$StressSW), mean)
Ante-
penultimate          Initial           NoWord              One
Penultimate
       0.6545455        0.5555556        0.0000000        0.7798658
       0.7233202
        Ultimate
       0.5714286
> tapply(Han$Ret, list(Han$StressSW), length)
Ante-
penultimate          Initial           NoWord              One
Penultimate
             55               18                1              745
            253
        Ultimate
              7
> tapply(Han$Ret, list(Han$StressFW), length)
Ante-
penultimate          Initial              One      Penultimate
    Second
             40                5             767              253
              1
          Third         Ultimate
              1               12
```