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# The phonemic status of the sequence *ts* in Lower Luga Ingrian: Affricate or consonant cluster?

Master's Thesis

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**Author's Affirmation**

I confirm that I have written this thesis independently and have correctly cited all sources. The thesis complies with the requirements of the Institute of Estonian and General Linguistics and with good academic practice.

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**Abstract**

This study investigates the phonemic status of the sequence *ts* in Lower Luga Ingrian, an endangered and underresearched Finnic variety. In order to determine whether it should be analyzed as an affricate or a consonant cluster in this language, *ts* is evaluated against phonetic, phonological, and morphological criteria. These criteria are based on cross-linguistic characteristics of affricates and how they differ from clusters, and build off studies which have previously investigated the phonemic status of affricates in Finnic languages. Using field data elicited from 5 speakers of Lower Luga Ingrian, durational measurements from 764 tokens of *ts* are analyzed via linear mixed-effects models. It is found that *ts* does not show the expected properties of an affricate and instead behaves like a CC sequence like *ps* or *ks*, leading to the conclusion that *ts* in Lower Luga Ingrian should be considered a consonant cluster.

**Keywords:** affricates, consonant clusters, Lower Luga Ingrian, language contact

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# 1. Introduction

"It is not always easy to distinguish between a single phoneme and a combination of phonemes. The sound flow of the concrete speech event is an uninterrupted movement. From a purely phonetic point of view, that is, ignoring the linguistic function of sound, it is not possible to say whether a particular segment of this sound continuum is to be considered "monophonematic," that is, a single phoneme, or "polyphonematic," that is, a combination of phonemes." (Trubetzkoy 1969: 55)

What Trubetzkoy describes above is the crux of the problem on the phonological interpretation of affricates. Should a sequence of a stop plus fricative be regarded as a single unit, that is, an affricate, or should it be regarded as a sequence of two units, that is, a consonant cluster? This thesis will explore this question in the Lower Luga Ingrian language.

In this chapter, a background on Lower Luga Ingrian, its evolution, and a comparison to mixed languages are given. The motivations and research questions for this thesis are outlined at the end of the chapter.

## 1.1. Lower Luga Ingrian

### 1.1.1. Demographical and Historical Context

Lower Luga Ingrian is a Finnic language spoken in the Kingisepp region (Leningrad Oblast, Russia) in villages along the lower course of the Luga River (Kuznetsova, Markus & Muslimov 2015: 131; Markus & Rozhanskiy 2022: 308). In 2019, Rozhanskiy and Markus (2019: 306) reported less than 20 fluent speakers for all varieties of Ingrian; as of 2025, they reduced their estimate to a maximum of 10 speakers (Rozhanskiy & Markus 2025: 449–450). Most of these speakers are elderly (the average age exceeding 80 years), with the youngest fluent Lower Luga Ingrian speaker having been born in 1935 (Kuznetsova, Markus & Muslimov 2015: 141; Rozhanskiy & Markus 2019: 306).

In Lower Luga villages, where there may be around two to four Ingrian speakers each, Russian is generally preferred as the day-to-day medium of communication (Kuznetsova, Markus & Muslimov 2015: 139). This is a result of the historic Russification of the Finnic peoples of Ingria throughout the 20th century (Kuznetsova, Markus & Muslimov 2015: 153–159). Despite work to standardize the Ingrian language during a brief period of cultural autonomy in the 1920s, a series of deportations throughout the 1930s and during World War II decreased the Finnic population in Ingria (Kuznetsova, Markus & Muslimov 2015: 155–157).

At the end of the war, Ingrians returning to the Soviet Union were met with hostility and were persecuted for speaking their language, and as a result, intergenerational transmission of the Ingrian language and culture was effectively cut off (Kuznetsova, Markus & Muslimov 2015: 159). Kuznetsova, Markus, and Muslimov (2015: 160) indicate that efforts to teach Ingrian in schools today have not received support from the Ingrian population.

### 1.1.2. Relationship to Other Finnic Languages

The name "Lower Luga Ingrian" might suggest that this language is just another dialect of Ingrian, but it is actually best considered a mixed language or convergent variety between Votic and Soikkola Ingrian (Kuznetsova, Markus & Muslimov 2015: 131; Rozhanskiy & Markus 2019: 306). The emergence of Lower Luga Ingrian can be explained by a language shift from Votic to Ingrian (Kuznetsova in press). With Ingrians relocating to the Lower Luga area, a region inhabited by Votes, Lower Luga Ingrian evolved as a means of communication between the two groups (Rozhanskiy & Markus manuscript). The Ingrians adapted their speech to accommodate the Votes, and the Votes learned this streamlined version of Ingrian; future generations learned this variety as their first language (Rozhanskiy & Markus manuscript).

This direction of shift, i.e., Votes switching to Ingrian rather than Ingrians switching to Votic, can be explained by the relatively low prestige of the Votic language when compared to other languages spoken in Ingria (Kuznetsova, Markus & Muslimov 2015: 137). Thus, it was typical for Votes to switch to Russian, Finnish, or Ingrian as necessary when in the presence of a non-Votic guest (Kuznetsova, Markus & Muslimov 2015: 137). For instance, Tsvetkov (1925: 43) notes that when a Votic man introduces his Ingrian wife to his family, it is customary for his entire family to switch to Ingrian. There is some evidence supporting this language shift in the Votic population. For one, many villages along the Lower Luga river that are described as Ingrian villages today used to be Votic villages, as documented in the late 1700s (Trefurt 1785: 115). Second, genetic evidence shows that Votes and Soikkola Ingrians differ in their leading Y-chromosome haplogroup; Lower Luga Ingrians, however, show a mixed proportion of the haplogroups characteristic of Votes and Soikkola Ingrians (Kuznetsova et al. 2022).

### 1.1.3. Phonology

A phonological description of contemporary Lower Luga Ingrian can be found in Kuznetsova (2009: 170, in press). The consonant inventory is given in Table 1 below.

**Table 1.** Consonant inventory of Lower Luga Ingrian, adapted from Kuznetsova (in press)[1].

| | | Labial | Dental | Palatal(ized) | Postalveolar | Velar |
|---|---|---|---|---|---|---|
| Stop | Voiceless | p | t | tʲ | | k |
| | Voiced | b | d | dʲ | | g |
| Fricative | Voiceless | f | s | sʲ | ʃ | h |
| | Voiced | | z | | ʒ | |
| Affricate | | | | t͡sʲ | t͡ʃ | |
| Glide | | v | | j | | |
| Nasal | | m | n | nʲ | | |
| Lateral | | | l | lʲ | | |
| Rhotic | | | r | rʲ | | |

Kuznetsova (2009: 170, in press) notes that overall the phonology of Lower Luga Ingrian is more structurally similar to Lower Luga Votic than any variety of Ingrian, the one major difference being the system of affricates. She attributes this to the direction of language shift, i.e., Votic speakers switching to Ingrian (Kuznetsova in press). Like Votic, consonants in Lower Luga Ingrian feature a binary length contrast instead of the ternary contrast found in Soikkola Ingrian; voicing, even if limited, is also phonemic in Lower Luga Ingrian, unlike in Soikkola Ingrian (Kuznetsova in press). Of note to this thesis, she lists the affricates /t͡sʲ t͡ʃ/[2] as part of the Lower Luga Ingrian consonant inventory. Regarding /t͡sʲ/, however, Kuznetsova (in press) admits that the justification for considering it a phonemic affricate is based on preliminary data, highlighting the need for more phonetic studies on this topic in Lower Luga Ingrian. (Kuznetsova 2009 and her paper in press will be explored in more detail in Section 2.2.6.)

## 1.2. Mixed Languages and Language Contact

Since Lower Luga Ingrian has been described as a mixed language, we should first look at how language mixing happens, what it means for the development of a language's phonology, and if "mixed language" is even the best term for a case like Lower Luga Ingrian.

[1] Consonants whose phonemic status is labeled as unclear in Kuznetsova's original table have been omitted. Length is contrastive for all consonants with the exception of /g t͡sʲ rʲ/, according to Kuznetsova (in press). In the case of /g/, this is because she has found no occurrences of long /gː/ in her data.

[2] Kuznetsova (2009, in press) was not able to determine whether the palatalization in /t͡sʲ/ is phonemic, since it only occurs before front vowels in her data.

Mixed languages have been described as languages which combine features of two parent languages such that it is difficult to describe them as a daughter of exclusively one language or the other (van Gijn 2009: 93). They are distinct from pidgins and creoles in that they usually emerge in areas where the inhabitants exhibit a high degree of bilingualism between the parent languages (van Gijn 2009: 108). Bakker and Muysken (1994: 42) identify the process by which mixed languages arise as "language intertwining", which, according to their definition, takes and combines "lexical morphemes from one language and grammatical morphemes from another". Two well-known mixed languages, Media Lengua and Michif, are discussed below.

Media Lengua is a good example of the principle of language intertwining, since it takes its grammatical structure from Quechua and lexicon from Spanish (Bakker & Muysken 1994: 43–44, van Gijn 2009: 94). Muysken (2012: 206–207) discusses how at lower levels of the phonological domain, such as at the segmental level, both the grammar language, Quechua, and lexifier language, Spanish, may contribute to the phonology of Media Lengua. However, at higher levels of the phonological domain, such as at the level of the intonational phrase, Media Lengua takes after Quechua (Muysken 2012: 206–207). Van Gijn (2009: 96, 108) maintains that the phonology of Media Lengua is overall more similar to that of Quechua; all features unique to Quechua are retained in Media Lengua, while on the other hand Spanish features absent from Quechua are often (but not always) forced to adapt.

Michif is typically described as a mixed language where the verb system is inherited from Cree and the noun system from French (Bakker & Muysken 1994: 45; van Gijn 2009: 104–105). Bakker and Muysken (1994: 45), however, argue that Michif still behaves like other intertwined languages, taking its grammar from one language, Cree, and its lexicon from the other language, French. They reason that the polysynthetic nature of Cree and the fact that Cree verbs are bound morphemes are responsible for verb roots in Michif coming from Cree and not French (Bakker & Muysken 1994: 45). What is interesting about Michif's phonology is that it consists of two parallel systems, one belonging to the Cree part and one belonging to the French part, creating a sort of cophonology (van Gijn, 2009: 105, 108). Each part has their own phonotactics and allophonic processes that do not affect the other part. This contrasts with Media Lengua, where both parent languages have contributed in different measures to the phonology, but the result is one phonological system (van Gijn 2009: 98–99).

These two cases demonstrate some variability in how language mixing happens. For some mixed languages, like Media Lengua, it is easy to determine which parent language is the grammatical language and which is the lexifier. For others, like Michif, it is not necessarily as clear-cut since there is some overlap in the contributions of the parents. Despite the differences

in how mixing manifests in these languages, Bakker and Muysken (1994: 49) assert that they both fundamentally show language intertwining, where the grammar is derived from language and the lexicon from the other. They attribute any differences in the outcome of language intertwining to typological differences between parent languages (Bakker & Muysken 1994: 49). Crucially, they point out that the grammar of a mixed language, which includes the phonology, "is often derived from the language known best by the first generation of speakers, and from the language which it resembles most in its pronunciation" (Bakker & Muysken 1994: 50).

However, these generalizations are all based on studies on language mixing between unrelated or distantly related languages. In fact, the majority of language contact research has focused on either unrelated or distantly related languages: "Most of the theoretical works on language contact pay little attention to genetically related languages, and seem to imply that the situation there is no different than when contact occurs among unrelated languages" (Epps, Huehnergard & Pat-El 2013: 211). This means that we cannot assume that these generalizations hold for Lower Luga Ingrian, which evolved through the contact of closely related languages. Instead, we may compare Lower Luga Ingrian to Kukkuzi, a Finnic variety that also emerged through contact between Votic and Ingrian.

The development of Kukkuzi resembles the process of language intertwining: Kukkuzi has the grammatical structure of Votic combined with an Ingrian lexicon (Markus & Rozhanskiy 2012: 92). Lower Luga Ingrian, on the other hand, incorporates Votic features at the phonological, morphological, and lexical levels such that it is difficult to describe it simply developing through language intertwining (Rozhanskiy & Markus manuscript).

What we do know about the development of Lower Luga Ingrian is that it began as a lingua franca between the Ingrians and Votes occupying the same region and then became the native language of later generations (Rozhanskiy & Markus manuscript), mirroring the evolution of a pidgin to a creole. Owing to Soikkola Ingrian and Votic being closely related, speakers were able to incorporate features from their idiolects when speaking Lower Luga Ingrian and still maintain mutual intelligibility. This gave rise to the considerable subdialectal and idiolectal variation observed in Lower Luga Ingrian today. While the development of Kukkuzi and Lower Luga Ingrian both demonstrate the convergence of two closely related languages into a new variety, Lower Luga Ingrian does not fit the definition of a typically mixed language the way Kukkuzi does. It may therefore be useful to refer to Lower Luga Ingrian not as a mixed language but instead by a different term, such as "convergent language". Regardless of what

we call it, though, we cannot consider Lower Luga Ingrian as just another variety of Ingrian which acquired its Votic features over time through sustained contact.

In summary, the lack of research on contact and mixing between related languages limits our ability to speculate on the contributions of Soikkola Ingrian and Votic toward the Lower Luga Ingrian phonology beyond what has already been reported by Kuznetsova (in press), i.e., that the consonant inventory of Lower Luga Ingrian closely resembles that of Lower Luga Votic, with the exception of affricates.

## 1.3. Motivation and Research Questions

Sections 1.1 and 1.2 have highlighted some research gaps. Firstly, there is a need for more phonetic studies on *ts* in Lower Luga Ingrian to determine whether it can be considered an affricate. Secondly, language contact between closely related languages remains an understudied aspect in linguistics. Finally, not only is Ingrian as a whole endangered, it is possibly the least researched Finnic language (Rozhanskiy & Markus 2019: 307). Given this, investigation into Lower Luga Ingrian *ts* is merited.

This thesis aims to answer the following questions:

1) Is the sequence *ts* an affricate or a consonant cluster in Lower Luga Ingrian?
2) How does the phonemic status of *ts* in Lower Luga Ingrian compare to that of *ts* in Votic and Soikkola Ingrian, the two primary languages that have shaped Lower Luga Ingrian?

## 2. Affricates

In order to answer these questions, it is first necessary to understand the characteristics of affricates in comparison to clusters. This chapter will cover the phonological and phonetic characteristics of affricates cross-linguistically, which will be drawn upon to develop a set of "litmus tests". These litmus tests will then be applied to *ts* in Lower Luga Ingrian to see whether its behavior is more akin to that of a typical affricate or cluster.

### 2.1. Typology of Affricates in the World's Languages

Firstly, how are affricates different from stops? Stops can be defined as speech sounds consisting of a complete closure in the vocal tract followed by a short acoustic burst (in the case of released stops, but not in the case of unreleased stops) (Berns 2016: 142; Ladefoged & Maddieson 1996: 49). Affricates are similar as they also begin with a complete vocal tract occlusion, but unlike stops, they transition into a fricative release which is longer and more pronounced than the burst following a stop (Ladefoged & Maddieson 1996: 90). Affricates are also similar in that, as explained by Ladefoged and Maddieson (1996: 91) and Maddieson (1984: 26), they may distinguish many of the features stops can distinguish, and they are generally analyzed as part of a language's series of stops. Crucially, an affricate is treated phonologically as a single unit, or one timing slot (Ladefoged & Maddieson 1996: 90).

However, the question arises: Can any sequence of a stop plus fricative be considered an affricate? If not, how can we decide whether a stop-fricative sequence in a given language should be considered an affricate as opposed to a consonant cluster?

Firstly, Tarnóczy (1987: 257–258) differentiates "real affricates" from "pseudo-affricates" (i.e., non-affricates) based on the place of articulation of the stop component and the place of articulation of the fricative component. That is, according to Tarnóczy, a real affricate is a junction between a homorganic stop and fricative, although he concedes that even in "real affricates" like /t͡s/ and /t͡ʃ/, the stop component /t/ is not perfectly homorganic with the fricative components /s/ or /ʃ/ (Tarnóczy 1987: 256). However, with sequences like /ps/ or /ks/, the stop and fricative components are not adjacent in terms of place of articulation, making them clearly heterorganic and thus, according to his criterion, "pseudo-affricates". Figure 1 below shows what Tarnóczy considers to be real, semi-, and pseudo-affricates.

| | | |
|---|---|---|
| o [pφ], [bβ] | x [tf], [dv] | x [ks], [gz] |
| Δ [pf], [bv] | o [tθ], [dð] | x [kʃ], [gʒ] |
| x [pθ], [bð] | o [ts], [dz] | Δ [kʟ̝], gɹ] |
| x [ps], [bz] | o [tʃ], [dʒ] | Δ [kç], [gj] |
| x [pʃ], [bʒ] | o [tʟ̝], [dɹ] | o [kχ], [gʏ] |
| | o [c], [ɟ] | |

**Figure 1.** Real affricates (o), semi-affricates (△), and pseudo-affricates (x) according to Tarnóczy (1987: 257).

Tarnóczy's (1987) criteria help to rule out heterorganic stop-fricative sequences as affricates, but they do not say anything about differentiating affricates from homorganic stop-fricative clusters. We can clearly see from languages like English that not every homorganic stop-fricative sequence is an affricate: e.g., /ts/ in *cats* /kæts/ is a cluster, but /t͡ʃ/ in *catch* /kæt͡ʃ/ is an affricate.

Some researchers have looked at duration as a plausible criterion for differentiating between affricates and clusters. According to Trubetzkoy (1969: 58), affricates should be no longer in duration than singleton consonants, and certainly never as long as a stop-fricative cluster such as *ks*. This is echoed by Fujimura and Erickson (1999: 77), who state that the total duration of an affricate is more similar to a singleton stop or singleton fricative than the combination of the two. Berns (2016: 144) says that the total duration of an affricate should actually be expected to be a bit longer than a stop due to the relatively more complex articulatory gesture of the former, but it should still be substantially shorter than a stop-fricative cluster.

Geminate affricates have also been documented in the world's languages (Berns 2013: 92–94). It has been noted cross-linguistically that when an affricate geminates, it is the stop component that tends to lengthen rather than the fricative component (Ladefoged & Maddieson 1996: 92; Laver 1994: 439). Laver (1994: 439) comments that it is not impossible for geminate affricates to be formed primarily through the lengthening of the fricative component, but this is "extremely rare", and Berns (2014: 388–389) adds that if this is the case, it seems to co-occur with some lengthening of the stop component too. Geminate affricates are also distinct from series of two of the same affricate in a row (Ladefoged & Maddieson 1996: 92).

Other differences between affricates and clusters have been discussed in Trubetzkoy (1969). According to Trubetzkoy (1969: 58), if the stop-fricative sequence in question occurs in a position in which consonant clusters are forbidden, then that is a strong reason to consider it an affricate over a cluster. Also, if one of the components of a stop-fricative sequence cannot occur

on its own, then this supports its status as an affricate (Trubetzkoy 1969: 59). For example, individual /ʃ/ does not occur in Castilian Spanish outside of /t͡ʃ/ (Hualde 2005: 43, 53), so this supports the analysis that Castilian Spanish has the affricate /t͡ʃ/.

On the other hand, if the stop-fricative sequence is split across multiple syllables, i.e., a syllable boundary occurs between the stop component and fricative component, Trubetzkoy (1969: 56) takes this as evidence in favor of analyzing it as a cluster. This notion is restated more generally by Tzakosta and Vis (2009: 379), who maintain that if the two components of a stop-fricative sequence are split by a "linguistic boundary", such as a syllable or morphological boundary, then it should be considered a cluster. For instance, English *cats* is morphologically composed of *cat* and the plural marker *-s*; this intervening morphological boundary thus rules out the interpretation of English *ts* as an affricate according to Tzakosta and Vis (2009).

It has also been reported by Fourakis, Botinis, and Nirgianaki (2005) that word-initially, affricates and clusters consisting of an obstruent and /s/ may be phonetically differentiated through the duration of the fricative component. When comparing word-initial *ts* with *ps* and *ks* in Greek, they found the fricative component /s/ to be shorter in duration when part of *ts* than when part of *ps* or *ks*. Tzakosta and Vis (2009) highlight the difference in /s/ duration between *ts* on one hand and *ps* and *ks* on the other as one piece of evidence for considering *ts* an affricate in Greek.

Additionally, some languages may contrast affricates with stop-fricative clusters at the same place of articulation. According to Brooks (1964: 207, 209–210), Polish distinguishes the affricate /t͡ʂ/ from the cluster /tʂ/: *czy* /t͡ʂɨ/ 'polar question particle' vs. *trzy* /tʂɨ/ 'three'. Brooks (1964: 209–210) found that the difference between /t͡ʂ/ and /tʂ/ in Polish manifests in the relative duration of the /ʂ/ component, which is consistent with Fourakis, Botinis, and Nirgianaki (2005). This kind of contrast has also been investigated in English with the following word pairs: *white shoes* /waɪt.ʃuz/, where there is a /t/ and /ʃ/ which form a cluster across the lexical boundary, and *why choose* /waɪ.t͡ʃuz/, where the second word begins with the affricate /t͡ʃ/. Laver (1994: 365) partially attributes the difference between the two to the duration of the fricative component: the /ʃ/ component in *white shoes* is longer relative to the /ʃ/ component in *why choose*. In Lehiste's (1959: 38) investigation, she found that the average duration of /ʃ/ in *white shoes* was 150 ms, whereas for *why choose* it was 100 ms. Thus, we should generally expect the fricative in a stop-fricative cluster to be longer in duration than the fricative component of an affricate.

Based on the cross-linguistic studies above, we can start creating a list of properties that we should expect a typical affricate to have.

1) Affricates should be homorganic or nearly homorganic (Tarnóczy 1987: 257–258).
2) Affricates should be around the same duration as a singleton consonant and never as long as a stop-fricative cluster (Berns 2016: 144; Fujimura & Erickson 1999: 77; Trubetzkoy 1969: 58).
3) When an affricate geminates, it is expected that the stop component of the affricate lengthens while the fricative component remains roughly the same in duration (Ladefoged & Maddieson 1996: 92; Laver 1994: 439).
4) It is more favorable to consider a stop-fricative sequence an affricate if it occurs in positions where consonant clusters are forbidden (Trubetzkoy 1969: 58).
5) It is more favorable to consider a stop-fricative sequence an affricate if one (or both) of the components cannot be found as independent phonemes in the language (Trubetzkoy 1969: 59).
6) A linguistic boundary (e.g., syllable or morpheme boundaries) should not fall in between the components of an affricate (Trubetzkoy 1969: 56; Tzakosta & Vis 2009: 379).
7) The fricative component of an affricate should be shorter than the fricative component of stop-fricative clusters in the same language (Brooks 1964; Fourakis, Botinis & Nirgianaki 2005; Laver 1994: 365; Lehiste 1959: 38).

These criteria are not without issues, however. Regarding (3), clusters, like affricates, can also show length distinctions, as shown in Estonian in Lippus (2005: 33). As will be discussed in Section 2.2.4, Rozhanskiy and Markus (2017: 369–370) have found that in the Votic language, contrary to (4), geminated affricates are formed primarily by lengthening the fricative component, not the stop component.

Another consideration is that some of these criteria will contribute very little to understanding *ts* in Lower Luga Ingrian. Concerning (1), *ts* certainly qualifies as being homorganic, but this criterion simply exists to rule out clusters like *ks* as potential affricates. Furthermore, both /t/ and /s/ exist in Lower Luga Ingrian, so we cannot conclude anything by applying (6).

In order to find criteria which are a better fit for the Lower Luga Ingrian language, the next section will examine how researchers have previously investigated the phonemic status of affricates in languages more closely related to Lower Luga Ingrian.

## 2.2. Typology of Affricates in Finnic Languages

This section will discuss previous research on the nature of affricates in Finnic languages. By looking at closely related languages, we may build an understanding of what kind of properties one may expect *ts* to have in Lower Luga Ingrian. Proto-Finnic is reconstructed as having both short and long affricates: {**č*, **ć*, **čč*, **ćć*} in Early-Proto Finnic, which reduced to just {**c*, **cc*} by Late Proto-Finnic (Kallio 2007: 230). As will be shown, however, not all modern Finnic languages retain these affricates. Conversely, some Finnic languages have seen the development of new affricates.

### 2.2.1. Livonian

Tuisk (2018: 211) determined that Livonian possesses phonemic affricates, distinguishing at the very least /t͡s/, /t͡ʃ/, /d͡z/, and /d͡ʒ/. This conclusion is based on the following criteria.

Tuisk (2018: 199-200) found that the total duration of word-initial affricates was similar to or shorter than that of word-initial sibilants. For example, the total duration of *ts* in *Tsälmõtõ* 'Tsälmõt River' was 61 ms (/t/ duration) + 74 ms (/s/ duration) = 135 ms (total), whereas the duration of the initial *s* in *seitskimdõ* 'seventy' was 191 ms. As discussed earlier, we should expect a typical affricate to be around the same duration as a singleton consonant (Fujimura & Erickson 1999: 77; Trubetzkoy 1969: 58). Therefore, the fact that *ts* is even shorter than *s* provides evidence against considering it a cluster in Livonian.

Word-medially, Tuisk (2008: 201) observed that *ts* and *tš* each contrasted long and short forms: *mõtsā* 'forest.NOM.SG' (where *ts* is short) : *mõtsõ* 'forest.PART/ILL.SG' (where *ts* is long). Crucially, she noticed that when comparing short *ts* in *mõtsā* with long *ts* in *mõtsõ*, the duration of the fricative component only changed slightly, whereas the stop component was significantly longer in long *ts* (shown in Table 2) (Tuisk 2018: 202). This observation of a length opposition in which the stop component lengthens and the fricative component remains relatively unchanged in duration is what we would expect from an affricate according to Ladefoged and Maddieson (1996: 92) and Laver (1994: 439).

**Table 2.** Comparison of the durations (ms) of the individual components of *ts* and total duration of *ts* between *mõtsā* 'forest.NOM.SG' and *mõtsõ* 'forest.PART/ILL.SG', adapted from Tuisk (2018: 202).

| | /t/ Duration | /s/ Duration | Total Duration |
|---|---|---|---|
| *mõtsā* | 68 | 125 | 193 |
| *mõtsõ* | 216 | 100 | 316 |

Tuisk uses these criteria, listed as (2) and (3) in the last section, to argue in support of phonemic affricates in Livonian. This provides us with an example of these criteria being applied to a Finnic language.

### 2.2.2. Veps

Viitso (2008: 214–215), who briefly discusses the status of affricates in Veps, presents evidence for both affricate and cluster interpretations of the sequences *ts* and *tš*, but leans toward treating them as affricates.

The following morphological evidence supports a cluster interpretation. In a word like *veitš* 'knife' the partitive case is formed similarly to words ending in consonant clusters. Shown in Table 3, *ps*, *ks*, and *tš* all lose the stop component when adding the partitive suffix *-t* (Viitso 2008: 214). We find in these examples a morphophonological process which ensures that clusters of three consonants are avoided by deleting the initial stop. We can reason that if the suffix *-t* were applied to an affricate, no deletion would happen since a sequence of only two consonants would be created.

**Table 3.** Declension of nouns ending in clusters *ps* and *ks* compared to a noun ending with *tš*, adapted from Viitso (2008: 214)[3].

| NOM.SG | GEN.SG | PART.SG | Gloss |
|---|---|---|---|
| *veitš* | *veitšen* | *vešt* | 'knife' |
| *laps* | *lapsen* | *last* | 'child' |
| *uks* | *uksen* | *ust* | 'door' |

Furthermore, some instances of *tš* in the language arose from vowel elision between stops and sibilants (Viitso 2008: 215), as seen in Table 4. This is illustrated by the form *entšen* 'former.GEN', where the sequence *tš* is the result of the *i* in **endizen* 'former.GEN' eliding. Viitso thus treats these as clusters. This is another plausible criterion that could be added to the

[3] The transcription used in Tables 3 and 4 has been simplified from Viitso's, keeping only what is pertinent to the discussion of affricates and clusters.

list, although as there is a lack of examples in Lower Luga Ingrian where *ts* arose from the elision of an intervening segment, nothing would be gained by including this criterion.

**Table 4.** Modern Veps forms of the word *enzne* 'former' compared with the proto-forms they evolved from.

| | Modern Veps Form | Proto-Form |
|---|---|---|
| NOM.SG | *enzne* | **endinen* |
| GEN.SG | *entšen* | **endizen* |
| PART.SG | *endišt* | **endistä* |

As for evidence for considering *ts* and *tš* affricates, Viitso (2008: 215) indicates that *ts* participates in a length alternation between 1SG and 3SG verb forms: *katson* 'watch.PRS.1SG' : *kat̀sob* 'watch.PRS.3SG', where ⟨◌̀⟩ represents prolongation. The fact that the stop component carries the length difference between morphological forms aligns with Ladefoged and Maddieson's (1996: 92) and Laver's (1994: 439) expectations for affricates. This length alternation for *ts* in Veps is similar to what Tuisk (2018) observed in Livonian.

Viitso (2008: 215) also argues that native speaker intuition should not be ignored, and the fact that *ts* and *tš* are written in Northern Veps Cyrillic as ⟨ц⟩ and ⟨ч⟩ instead of digraphs ⟨тс⟩ and ⟨тш⟩ suggests that these sounds are thought of as single units. This last argument is not convincing since it is entirely possible for languages to use single graphemes to represent consonant clusters, e.g., ⟨ψ⟩ and ⟨ξ⟩ for /ps/ and /ks/, respectively, in Greek, or ⟨x⟩ for /ks/ in Latin. Furthermore, this criterion cannot be applied to Lower Luga Ingrian due to lack of a standardized orthography.

Out of the new criteria Viitso has presented, there is one that is potentially applicable to Lower Luga Ingrian:

- We should expect affricates not to participate in cluster reduction when the partitive suffix *-t* is added.

### 2.2.3. Võro

Standard Estonian, like Standard Finnish, lacks affricates (Asu & Teras 2009: 367–368; Hint 1998: 136; Suomi, Toivanen & Ylitalo 2008: 38). However, affricates have been described in South Estonian varieties like Rõuge (Hint 1965) and Hargla (Nigol 1957; Nigol & Pajusalu 1994). The phonemic status of *ts* in one such variety, Võro, has been studied more thoroughly

by Lippus (2005), who compared it with *ts* in Standard Estonian (henceforth referred to simply as Estonian). Using criterion (3) from Section 2.1 as well as a new criterion not seen in any of the above-described studies, the ratio of vowel durations between the first and second syllable, Lippus concluded that unlike Estonian, Võro has a phonemic affricate /t͡s/.

Lippus examined *ts* in two groups of Võro speakers, one younger (born from 1930–1952) and one older (born from 1914–1929), conducting two experiments. In one experiment, he investigated the duration of *ts* itself. In Võro (like in Estonian), vowels and consonants distinguish three degrees of length, which are referred to as Q1 (short), Q2 (long), and Q3 (overlong). For the older group, he found that, intervocalically in disyllabic words, the fricative component of *ts* remains relatively the same in duration between Q1, Q2, and Q3, and it is the duration of the stop component that plays the biggest role in differentiating quantities (Lippus 2005: 19–20, 23–24). This is consistent with the literature in that when affricates geminate, it is the stop component that is expected to lengthen instead of the fricative component (Laver 1994: 439; Ladefoged & Maddieson 1996: 92).

In another experiment on Võro, Lippus looked at second syllable vowel lengthening. In many Finnic languages, it is typical that in a word of the structure (C)VCV(C), where the intervocalic C is a singleton, phonetical lengthening is observed in the second vowel (Kuznetsova 2016: 4–5; Kuznetsova, Tiburcio & Uchihara in press: 13). In words of other foot types, such as (C)VCCV(C), where CC is a cluster or a geminate, phonetic reduction is observed in the second vowel (Kuznetsova 2016: 4–5). Therefore, when looking at a word of the structure (C)V*ts*V(C), one would expect the second vowel to lengthen if Võro *ts* patterns like an affricate, but to reduce if it patterns like a cluster. Lippus (2005: 31) found that in (C)V*ts*V(C) words, the second vowel is indeed lengthened, thus behaving like the structure (C)VCV(C). This supports the analysis of Võro having a phonemic Q1 affricate /t͡s/.

This finding contrasts with Estonian. In Estonian, *ts* cannot occur in Q1, which is evidence that it is a cluster since no clusters in Estonian can be Q1 (Lippus 2005: 33). This comparison shows how two closely related languages can differ with regard to the treatment of affricates, reminding us that we cannot assume that a stop-fricative sequence is an affricate in one language purely on the basis that it is an affricate in a closely related language.

Since second vowel lengthening in (C)VCV(C) structures (henceforth simply VCV) has been documented in many Finnic languages, including Estonian, West Votic, Ingrian, and most dialects of Finnish (summarized in Kuznetsova, Tiburcio & Uchihara in press: 13), we can create a new criterion:

- For languages that exhibit second vowel lengthening in words of the structure VCV, we should expect the second vowel to lengthen if C is an affricate.

### 2.2.4. Votic

Votic has been described in Paul Ariste's Votic grammar (1968: 7–10) as possessing the affricates /t͡ʃ/, /d͡ʒ/, and /t͡s/. For example, /t͡ʃ/ ⟨tš⟩ commonly occurs in Votic as a reflex of **k* before front vowels (Markus & Rozhanskiy 2017: 373; Pajusalu 2012: 212): *tšülä* 'village' (cf. Finnish *kylä* and Estonian *küla*), *tšeeli* 'tongue' (cf. Finnish *kieli* and Estonian *keel*), and *tšäsi* 'hand' (cf. Finnish and Estonian *käsi*). Examples with /d͡ʒ/ ⟨dž⟩ include *redžeD* 'sled' and *audžiD* 'pikes' (Ariste 1968: 7–10). The presence of phonemic affricates is supported by observations on consonant gradation and second syllable vowel lengthening.

Like stops, affricates in Votic participate in consonant gradation (Ariste 1968: 10, 12; Markus & Rozhanskiy 2017: 381–383). This is illustrated below in Table 5.

**Table 5.** Examples of affricates in weak grade versus strong grade environments, adapted from Markus & Rozhanskiy (2017: 381).

| Alternation | Weak Grade | Strong Grade |
|---|---|---|
| *tš* : *ttš* | *lütšin* 'thread.PRS.1SG' | *lüttšimä* 'thread.SUP' |
| *ts* : *tts* | *kutsun* 'invite.PRS.1SG' | *kuttsuma* 'invite.SUP' |
| | *tantsin* 'dance.PRS.1SG' | *tanttsima* 'dance.SUP' |

Consonant gradation is a phenomenon present in all Finnic languages with the exception of Veps and Livonian (Laakso 2001: 184). Historically, Finnic gradation was predictable based on phonetic environment: Stops in the onset of closed syllables lenited, creating an alternation between a strong grade (in open syllables) and a weak grade (in closed syllables) (Laakso 2001: 184). This gradation targeted geminate stops, intervocalic singleton stops, and singleton stops which followed a sonorant (Saar 2014: 259). In Votic, gradation can target singleton and geminate stops and sonorant-stop clusters like in other Finnic languages, but also clusters with two stops (e.g., *tk*), clusters made up of a fricative plus stop (e.g., *sk*), sibilants (e.g., *ss*, *šš*), and affricates (Ariste 1968: 12–14). However, clusters made up of a stop plus fricative like *ps* and *ks* do not participate in gradation. Therefore, *ts* and *tš*, which do participate in gradation, do not behave like clusters. From this, we have one piece of evidence toward building a new criterion:

- If stops participate in consonant gradation, we can expect affricates to do so as well.

It must be mentioned that, conversely to other studies, Markus & Rozhanskiy (2017: 369–370) found that when an affricate geminates in Votic, it is the fricative component that lengthens, while the stop component remains relatively the same. As discussed earlier, it is generally expected that when an affricate is geminated, it is the stop component that increases. Note, however, the amount of data the authors used to calculate this is not clear.

Another piece of evidence in favor of phonemic affricates can be found in forms like *pitšā* 'long.GEN.SG' and *ẹtsā* 'end.GEN.SG' (Ariste 1968: 12). Given that Votic has second vowel lengthening in VCV structures (Rozhanskiy 2015: 102), the fact we observe this lengthening in V*ts*V and V*tš*V structures shows that that they are underlying VCV, indicating that *tš* and *ts* behave like singleton consonants in this language.

Ultimately, the case of Votic shows us another instance of second vowel lengthening occurring in V*ts*V structures and introduces a new criterion, which is that we may expect *ts* in Lower Luga Ingrian to participate in gradation if it is an affricate.

### 2.2.5. Soikkola Ingrian

In 2020, Rozhanskiy and Markus studied the phonemic status of *ts* in Soikkola Ingrian. In order to determine whether Soikkola *ts* patterns more like an affricate or a cluster, they looked at seven criteria (Rozhanskiy & Markus 2020: 444–445). Some criteria they used have been discussed earlier, like second vowel lengthening, occurrence in positions where clusters are forbidden, total duration compared to singletons, and relative duration of components compared to stop-fricative clusters. They also used participation or lack of participation of *ts* in consonant gradation as a criterion. The remaining criteria we have not seen in any of the previously discussed studies:

- Has the *s* in *ts* participated in the historic shift of **s* to *š*?
- What does the structure of the stop component in an affricate look like in a spectrogram compared to a cluster?

The first of these new criteria relates to the historic sound change that took place in Soikkola Ingrian, where **s* shifted to *š* [ʃ] in all positions, including clusters: e.g., *ks* is realized as [kʃ] (though some speakers maintain a contrast between /s/ and /ʃ/ in Russian loanwords) (Markus & Rozhanskiy 2022: 311; Rozhanskiy & Markus 2020: 446). Therefore, the authors investigated if this same shift occurred in *ts*, i.e., is *ts* realized as [tʃ]? Ultimately, they found that *ts* remained as [ts] and did not shift to [tʃ] (Rozhanskiy & Markus 2020: 447). This suggests that *ts* behaves as a single unit, i.e., an affricate, and not as a cluster. While this is a strong

criterion for Soikkola Ingrian, we unfortunately cannot use it to help us evaluate *ts* in Lower Luga Ingrian since the **s* > *š* sound change did not occur in this variety.

Regarding the second new criterion, Rozhanskiy and Markus (2020: 447–448) observed some spectral differences between the realization of *kš* and *ts* in that instances of *kš* tended to show a clear separation between the stop and fricative components in spectrograms, whereas this was not the case for *ts*. However, they acknowledged that this was a weaker criterion since these observations were not consistent for every token and were more of a tendency, and the differences that were observed can be attributed to the fact that the /k/ and /ʃ/ in *kš* are not homorganic while the /t/ and /s/ in *ts* are (Rozhanskiy & Markus 2020: 448). For these reasons, this criterion will not be used for Lower Luga Ingrian.

The results from all criteria used by Rozhanskiy and Markus (2020) are summarized in Table 6.

**Table 6.** The behavior of *ts* according to each criterion, adapted from Rozhanskiy and Markus (2020: 468).

| Criterion | Supports affricate interpretation | Supports cluster interpretation |
|---|---|---|
| Participation in the shift from **s* to *š* | ✓ | |
| Spectral boundary between stop and fricative components | ✓ | |
| Occurrence word-initially | | ✓ |
| Participation in gradation | | ✓ |
| Relative duration of stop and fricative components | ✓ | |
| Total duration of *ts* | | ✓ |
| Second vowel lengthening | | ✓ |

As seen above, *ts* does not behave strongly like a consonant cluster nor an affricate in Soikkola Ingrian. What is especially difficult is that the strongest criteria, which are the first and last criteria in Table 6, point to different conclusions regarding its status as an affricate (Rozhanskiy & Markus 2020: 469–470).

Though does not allow us to add any new criteria to our list, this study is important to this thesis since it shows how *ts* behaves in Soikkola Ingrian, a parent language of Lower Luga

Ingrian. The results of this thesis will be compared to *ts* in Soikkola Ingrian and *ts* in Votic (Section 2.2.4).

### 2.2.6. Lower Luga Ingrian

The phonemic status of Lower Luga Ingrian *ts* has been only partially investigated, namely by Kuznetsova (2009) who described the phonological systems of both Soikkola and Lower Luga Ingrian. She restates her findings in Kuznetsova (in press), where she describes Lower Luga Ingrian as having the affricates /t͡ʃ/ and /t͡sʲ/, the former distinguishing length. She characterizes /t͡sʲ/ as phonetically palatalized, i.e., she could not find evidence that palatalization was contrastive for this affricate, so henceforth I will refer to it simply as /t͡s/ (Kuznetsova 2009: 273–274, 276–277, in press).

Of interest to this thesis is /t͡s/, which Kuznetsova recorded in at least one native lexeme and one Russian loanword: *man**ts**ikka* ‘strawberry’ and ***ts**epa* ‘chain’, respectively (Kuznetsova in press). She reported that *ts* was on average 40 ms shorter in *mantsikka* and *tsepa* than in all other words with *ts*, e.g., *veitsi* ‘knife’, *tantsima* ‘dance.SUP’, after accounting for differences in structure and word length (Kuznetsova in press). She argues that the brevity of *ts* in *mantsikka* and *tsepa* is due to it being an affricate in these lexemes. On the other hand, the *ts* in all other lexemes (found to be 40 ms longer than in *mantsikka* and *tsepa*) could be either a long affricate /t͡sː/ or a cluster /ts/ according to her; she asserts that there is no phonological contrast between the two, and idiolectal and subdialectal variation was a factor conditioning their realization (Kuznetsova 2009: 277–278, in press). Importantly, Kuznetsova (in press) found no grade alternation between /t͡s/ and /t͡sː ~ ts/ unlike what we witnessed earlier in Votic (Table 5).

Though based on preliminary data, Kuznetsova’s (2009, in press) work has revealed several important considerations. Firstly, the phonetic realization of *ts* may differ depending on the idiolect/subdialect, meaning that it may be an affricate for some speakers and a cluster for others (Kuznetsova 2009: 277–278). Secondly, special attention must be paid to the lexemes *mantsikka* ‘strawberry’ and *tsepa* ‘chain’; her data has shown that *ts* is shorter here than in other words.

## 2.3. Summary

As seen throughout Chapter 2, even closely related languages like Estonian, Võro, Soikkola Ingrian, and Votic may differ significantly in how affricates and clusters behave phonologically

and manifest phonetically. Moreover, we have seen in studies on Veps and Soikkola Ingrian that, within the same language, sequences like *ts* and *tš* may show properties of both affricates and clusters. In cases like Soikkola Ingrian where there is strong evidence for both affricate and cluster interpretations of *ts*, Rozhanskiy and Markus (2020: 473–474) conclude that the interpretation may lie ultimately in the discretion of the researcher. This reemphasizes the need to use concrete, objective criteria to determine the status of *ts* in Lower Luga Ingrian. We can finally add the Finnic-specific criteria from Section 2.2 to the broader cross-linguistic criteria discussed in Section 2.1 to create a more Lower Luga Ingrian-specific list of criteria. In order to classify *ts* as an affricate, it would have to meet the following criteria:

- The duration of *ts* should be approximately similar to that of a singleton consonant and never as long as a stop-fricative cluster.
- Assuming *ts* can be geminated, we should expect the stop component to lengthen and the fricative component to remain roughly the same in duration.
- It is more favorable to consider *ts* an affricate if it occurs in positions where consonant clusters are forbidden.
- The fricative component of *ts* should be shorter than the fricative component of stop-fricative clusters in Lower Luga Ingrian.
- Assuming Lower Luga Ingrian has second vowel lengthening in a word of the structure VCV, we should expect the second vowel to lengthen in a V*ts*V word.
- Since stops in Lower Luga Ingrian participate in consonant gradation, we should expect *ts* to do so as well[4].
- We should expect noun stems ending in *ts* not to participate in cluster reduction when the partitive suffix -*t* is added.

[4] Since consonant gradation does not target stop-fricative clusters like *ps* and *ks* in Soikkola Ingrian (Saar 2014: 260) and Votic (Ariste 1968: 12–14), we can expect the same for Lower Luga Ingrian. Following this logic, if *ts* in Lower Luga Ingrian is found to participate in gradation, this would mean it does not behave like a cluster.

# 3. Materials and Method

In Chapter 2, we formed a list of criteria for differentiating between affricates and clusters so that we may determine the phonological status of *ts* in Lower Luga Ingrian. In order to answer many of these criteria, specifically those concerning the phonetic behavior of *ts*, this thesis will use unpublished speech data collected by Elena Markus and Fedor Rozhanskiy in 2015. This data was recorded in a fieldwork setting with a digital recorder and an external microphone. There were instances of background noise, e.g., from refrigerators, vehicles, etc., so tokens with bad audio quality or background noise were excluded from analysis.

Informed consent was obtained from all speakers. The ethics of how much metadata to disclose while also protecting their privacy were considered. Ultimately, it was decided that referring to speakers by their real initials presented a low risk of harm while being clearly beneficial for researchers who have worked with or are familiar with these speakers (see Table 7).

## 3.1. Speakers and Data Structure

The data was recorded from five speakers of Lower Luga Ingrian, four female and one male, initialized as AU, ND, NP, PF, and ZP. Years of birth ranged from 1924–1933. Two speakers (AU, ND) represent the southern dialect zone, two speakers (NP, PF) represent the western dialect zone, and one speaker (ZP) represents the northern dialect zone. Table 7 summarizes background information on speakers' year of birth, dialect zone, current place of residence, place of birth, parents' place of birth, and exposure to the Estonian language. Figure 2 shows the regions where Lower Luga Ingrian is spoken.

**Table 7.** Metadata on Lower Luga Ingrian speakers.

| Speaker | Sex | Year of Birth | Dialect Zone | Place of Residence | Place of Birth | Mother's Place of Birth | Father's Place of Birth | Estonian Influence |
|---|---|---|---|---|---|---|---|---|
| AU | f | 1932 | Southern | Polana | Polana | Tiensuu | Tiensuu | Possible |
| ND | m | 1924 | Southern | Vanakülä | Vanakülä | Haaviko | Vanakülä | Possible |
| NP | f | 1927 | Western | Narusi | Narusi | Narusi | Narusi | Possible |
| PF | f | 1927 | Western | Narusi | Ropsu | Joenperä (Votic) | Ropsu | |
| ZP | f | 1933 | Northern | Tiensuu | Jaama | Pärspää | (Russian) | |

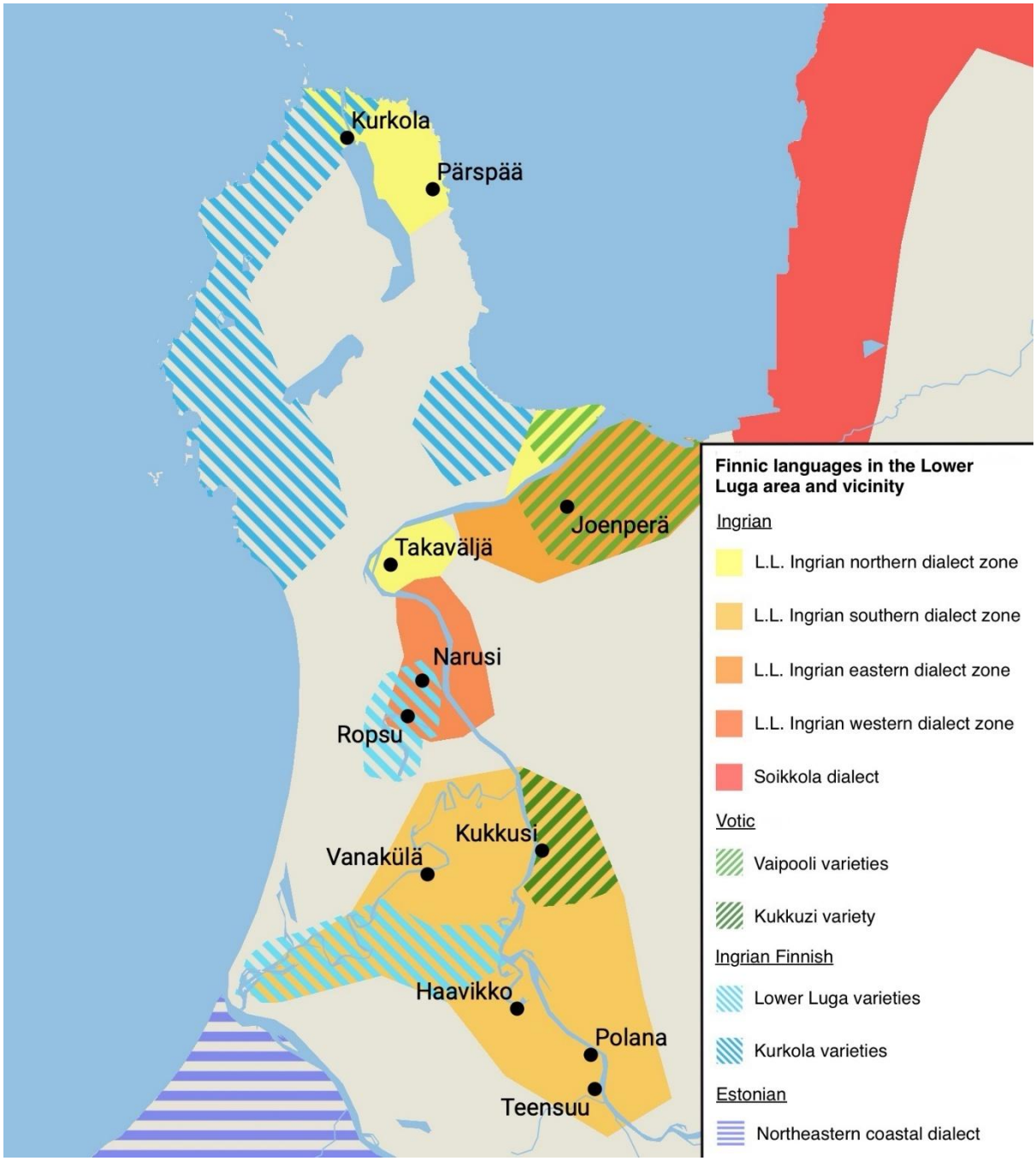


**Figure 2.** Map of Ingrian dialect zones, created by Rando Lukk[5]. Of interest is the northern dialect zone (light yellow), where speaker ZP is from; the western dialect zone (dark orange), where NP and PF are from; and the southern dialect zone (dark yellow), where AU and ND are from.

Since Lower Luga Ingrian lacks a standardized orthography and the speakers do not have experience reading Ingrian, it was not possible to have them read a prepared text in the target language as, for instance, was done by Lippus (2005). Instead, elicitation of wordforms was

[5] This map has been included with the permission of Rando Lukk. I have translated the legend, originally in Estonian, into English.

done through oral Russian-to-Ingrian translation tasks. Speakers were given Russian sentences to translate such that the expected Ingrian translations would elicit words containing *ts*. For example, Russian sentences containing *лес* 'forest' were used to elicit Ingrian *metsä* 'forest', which contains *ts*. Words were selected so that there were examples of *ts* in a variety of environments: word-initially, word-medially (intervocalically and after /n/), and word-finally (after a vowel and after /n/). Figure 3 below gives an overview of the structure of every word containing *ts* in the data. Additionally, words containing *ts* appeared in different phrase positions, clause-initially, clause-medially, and clause-finally, and were also pronounced in isolation.

| | *Ending With* ↓ | **$C_2$** | | | **$C_3$** |
|---|---|---|---|---|---|
| Beginning With → | | (C)V**ts**... | (C)VV**ts**... | (C)VN**ts**... | (C)VCV**ts**... |
| **Monosyllabic** | ... | ets, mets | liits | tants | |
| **Disyllabic** | ... | | | | madits |
| | ... *V* | etsi, metsä | liitsa | tantsi | |
| | ... *VV* | etsiä, metsää | liitsaa | tantsia | |
| | ... *VC* | etsin, metsän | liitsan | tantsin | |
| | ... *VVC* | kutsuin | | | |
| | ... *VCC* | etsimm | liitsass | tantsimm, mantsikk | |
| **Trisyllabic** | ... *V* | | | | maditsa |
| | ... *VV* | | | | maditsaa |
| | ... *VC* | | | | maditsad |
| | ... *VCC* | | | | maditsass |
| | ...*VC V* | etsimä | | tantsima | |
| | ...*VC VC* | etsisin | | tantsisin, mantsikad | |
| | ...*VC VCC* | | | mantsikast | |
| | ...*VCC V* | itselle | | mantsikka | |
| | ...*VCC VV* | | | mantsikkaa | |
| **Tetrasyllabic** | ... *VCV* | | | | maditsoja |
| | ... *VCCV* | | | mantsikanka | maditsanka |

**Figure 3.** Matrix of word structures for words containing *ts*[6].

Any wordforms that occurred in the data fewer than 5 times were omitted. The final dataset comprised a total of 764 words containing *ts*. Word-initial position was the least represented position in the data, there being only 10 words where *ts* occurred word-initially, and therefore was left out of the analysis for criteria involving duration. Of the remaining 754 words, there

[6] Words of the structure CV*ts*V can optionally be realized with the final vowel dropped, e.g., *etsi* 'search.CNG' [etsi ~ ets] and *metsä* 'forest.NOM' [metsæ ~ mets]. This is reflected in Figure 3, where the monsyllabic structures are actually free phonetic variants of the disyllabic structures ending in a short vowel. (This is also the case for *maditsa* [maditsa ~ madits] 'beam, joist'.) This is an important finding relating to second vowel lengthening/reduction and is thus discussed more in Section 4.2.5.

were 666 where *ts* occurred word-medially and 88 where *ts* occurred word-finally. Of the 666 words where *ts* occurred word-medially, 237 were of the structure V*ts*V, from which vowel durations were measured. The number of words containing *ts* sorted by speaker per word position is given in Table 8.

**Table 8.** Number of *ts* tokens per word-position per speaker.

| | Word-Initial | Word-Medial | Word-Final | **Total** |
|---|---|---|---|---|
| AU | 1 | 230 | 28 | **259** |
| ND | - | 130 | 38 | **168** |
| NP | - | 67 | 2 | **69** |
| PF | 5 | 114 | 12 | **131** |
| ZP | 4 | 125 | 8 | **137** |
| **Total** | **10** | **666** | **88** | **764** |

## 3.2. Method

### 3.2.1. Segmentation

Prior to the analysis, Sound Forge Audio Studio (v. 17.0.2 x64) was used to identify words containing *ts* in the recordings and label them according to their morphological information and phrase position. After normalizing the sound volume for each word and extracting them as 48kHz 16-bit wav-files, each word was then manually segmented in Praat (v. 6.4.41; Boersma & Weenink 2025). Judgments on segment boundaries were made based on the combined inspection of spectrogram and waveform. The Show Pulses function was also used to help visualize periodicity in the speech signal. The following principles were used for consistent segmentation:

a. All segment boundaries were placed at a zero-crossing.

b. For vowels, the start boundary was placed at the first regular glottal pulse and the end boundary was placed at the last regular glottal pulse.

c. For voiceless stops word-medially and -finally, the start boundary was placed where there was a large drop in acoustic energy, and the end boundary was placed after the burst (when released) but before the onset of any periodic waves (if there was a following vowel).

d. The start boundary of fricatives was placed where the oscillogram displayed aperiodic high amplitude noise, and the end boundary was placed where this noise ended.

e. Consonant palatalization was identified as a high-frequency spike either preceding or following the consonant. Palatalization was included as part of the consonant. This was also the case for allophonic labialization and aspiration.

### 3.2.2. Statistical Analysis

Segment durations were extracted using a Praat script. The data was modeled in R Studio (v. 4.5.2; R Core Team 2025) using linear mixed-effects models from the lme4 package (v. 2.0-1; Bates et al. 2015) and plotted using the ggeffects package (v. 2.3.2; Lüdecke 2018). The residuals of the regression models were evaluated for non-normality[7] using the performance package (v. 0.16.0; Lüdecke et al. 2021). In order to more accurately compare segment durations between words with *ts* and control words (which will be discussed in further detail in Section 3.2.3), there are several factors influencing segment duration that must be accounted for.

One factor to control for is syllable count. This is based on the assumption that the duration of segments is inversely proportional to the number of syllables in a word (e.g., Windmann, Šimko & Wagner 2015: 36). To avoid omitted-variable bias, syllable count was included as a fixed effect for each linear model.

Naturally, the phonetic environment surrounding *ts* was another factor affecting its duration. During the segmentation process, it was apparent that *ts* was considerably shorter when following /n/ than when following a vowel, and therefore this was controlled for via a fixed effect.

Another important variable affecting segment duration is occurrence at the edges of prosodic domains, such as the prosodic word or phrase. Namely, it has been found that segments at these edges tend to undergo "strengthening" (e.g., Fougeron & Keating 1997; Wightman et al. 1992). Fougeron and Keating (1997: 3737) elaborate on how said "strengthening" manifests, increased segmental duration being one example. In a study on Hungarian affricates, Pycha (2009: 15–16) replicated these effects, finding that the component of the affricate which is closest to the domain boundary is what receives this phonetic lengthening, i.e., word- or phrase-initial affricates experience lengthening of the stop component, whereas word- or phrase-final

[7] The residuals for all models, save the model for Criterion 5 (see Section 4.2.5), showed a normal distribution.

affricates experience lengthening of the fricative component (Pycha 2009: 15–16). In fact, Lippus (2005: 24, 38–39) described the same findings for Võro and Estonian. Turk and Shattuck-Hufnagel (2007: 464) have also shown that phrase-final lengthening may target more than just the final-syllable rime, affecting the rime receiving primary stress, and to a lesser extent any other parts of a phrase-final word. What this means for my dataset is that any tokens in which *ts* appears at a domain boundary, especially word- or phrase-finally, will likely be subject to lengthening of *ts*.

Based on this, I initially added a fixed effect that accounted for segments occurring word-finally as well as another fixed effect for words occurring phrase-finally. The word-finality parameter was not included in the final models as it had no significant effect on total duration, since the effect of word-finality was already captured by the syllable count parameter. This was because nearly all the tokens that had a word-final *ts* were monosyllabic, and all the tokens that were monosyllabic ended with *ts*.

It is also possible that the behavior of *ts* may be influenced by word etymology, that is, whether the word is a loanword from Russian or native word inherited from Proto-Finnic. Depending on how well adapted it is to the phonology of Lower Luga Ingrian, it is plausible that *ts* in Russian loanwords may be realized differently than *ts* in native lexemes since Russian does have the affricate /t͡s/ (Yanushevskaya & Bunčić 2015: 222). Therefore, before assessing the behavior of *ts* according to the established criteria, I compared its duration in loanwords versus native lexemes to see if there were any significant differences.

Additionally, speaker-related effects must be addressed, especially since significant subdialectal and idiolectal variation has been reported in Lower Luga Ingrian (Kuznetsova, Markus & Muslimov 2015: 131; Rozhanskiy & Markus 2019: 306). That is, given speaker differences in village/region and language exposure (such as to closely related Finnic varieties such as Estonian), it may or may not be possible to treat them as a homogenous group. If speakers do in fact show heterogeneous behavior, then they would be modeled separately. Otherwise, the speaker would be treated as a random effect (random intercepts).

Finally, word-specific random effects were also included as a random effect (random intercepts) in each model.

### 3.2.3. Investigation of Criteria

This section will discuss how the data will be specifically used to answer the criteria from Section 2.3. These criteria will be restated below in the order they will be investigated, since

some criteria are contingent on others (e.g., the relevance of Criterion 2 is contingent on the results of Criterion 1).

If *ts* is an affricate, we would expect that:

1) *ts* participates in consonant gradation, since stops in Lower Luga Ingrian do so.
2) Assuming *ts* shows a length contrast, it is the stop component that lengthens and the fricative component that remains roughly the same in duration.
3) The duration of *ts* is approximately similar to that of a singleton consonant and never as long as a stop-fricative cluster.
4) The fricative component of *ts* is shorter than the fricative component of stop-fricative clusters in Lower Luga Ingrian.
5) Second vowel lengthening is observed in words of the structure V*ts*V, assuming Lower Luga Ingrian has second vowel lengthening in words of the structure VCV.
6) *ts* may occur in positions where consonant clusters are forbidden.
7) Noun stems ending in *ts* do not participate in cluster reduction when the partitive suffix *-t* is added.

3.2.3.1. Criterion 1: Participation in Gradation

Words containing *ts* were divided into two groups. The first group was made up of words where, if a grade distinction existed, *ts* would be expected to be in the weak grade, e.g., genitives like *metsän* 'forest.GEN', connegative forms like *katso* 'look.CNG'. The second group was made up of words where, if a grade distinction existed, *ts* would be expected to be in the strong grade, e.g., nominative forms like *metsä* 'forest.NOM', infinitives like *katsoa* 'look.INF'. The total duration of *ts* was compared between these two groups, but also against two control groups.

The first control group (Group C) consisted of singleton consonants, including both stops and fricatives. Stops and fricatives were treated as one group since Fujimura and Erickson (1999: 77) state that affricates should have a similar total duration to either single stops or single fricatives. The second control group (Group CC) consisted of geminate consonants and consonant clusters. As there was no significant difference (2.44 ms on average) in the total duration of these groups ($t(67.7) = 0.20$, $p = 0.84$), and they both were significantly different from singletons (geminates vs. singletons: $t(89.7) = 8.42$, $p < 0.001$; clusters vs. singletons: $t(68.8) = 9.74$, $p < 0.001$), it was decided that geminates and clusters can be treated as the same.

3.2.3.2. Criterion 2: Component Carrying Length Distinction

If *ts* does participate in gradation, then the ratio of stop component duration to fricative component duration would be measured. If the ratio of t/s is larger in the strong grade than in the weak grade, then the stop component carries the length distinction. If the ratio of t/s is smaller, then the fricative component carries the length distinction. If the strong grade and weak grade have the same ratio of t/s, then both components carry the length distinction.

3.2.3.3. Criterion 3: Total Duration of *ts*

The total duration of *ts* was compared to that of two control groups, singletons (Group C) and geminates/clusters (Group CC). If a statistically significant length difference is observed between *ts* in weak grade environments versus strong grade environments, then *ts* would be split into two groups based on grade environment and be independently compared to Groups C and CC.

3.2.3.4. Criterion 4: Duration of Fricative Component

The individual duration of the fricative component in *ts* was compared to the individual duration of the fricative component in stop-fricative consonant clusters, *ks* in particular, since *ps* clusters were not present in the data. Unfortunately, all instances of *ks* were found in the words *miks* 'why' and *kaks* 'two', meaning there was a lack of examples of *ks* in disyllabic and trisyllabic words. Another shortcoming is that there were only 27 tokens of *ks*, which is a lot fewer than would be ideal. Consequently, the results from the model used for this criterion will be less conclusive.

3.2.3.5. Criterion 5: Second Vowel Lengthening

It must first be said that upon first inspection of the data, it was already clear that Lower Luga Ingrian showed second vowel lengthening in VCV structures. Conversely, significant vowel reduction was observed in VCCV structures. Please see Figure 9 in Section 4.2.5 for a visualization of lengthening and reduction in Lower Luga Ingrian.

Thus, the durations of the first and second vowel were measured in words of the structure V*ts*V, e.g., *metsä* 'forest.NOM', then the ratio of $V_2/V_1$ was calculated[8]. This ratio was compared to that of two control groups. The first control group consisted of words of the structure VCV, e.g., *joki* 'river.NOM', in which lengthening of the second vowel was observed (i.e., $V_2/V_1 > 1$).

[8] The vowel length ratio between the second and first syllables ($V_2/V_1$) was used to measure second vowel lengthening/reduction based on how the phenomenon is defined in Kuznetsova (2016: 4–5) and how previous studies (Lippus 2005; Rozhanskiy & Markus 2020) have investigated it.

The second control group consisted of words of the structure VCCV, e.g., *kissa* 'cat.NOM', in which reduction of the second vowel was observed (i.e., $V_2/V_1 \leq 1$). If the vowel ratio in V*ts*V words is greater than 1 ($V_2/V_1 > 1$), then *ts* behaves like a singleton consonant, i.e., *ts* behaves as we would expect an affricate to. If the vowel ratio in V*ts*V words is less than or equal to 1 ($V_2/V_1 \leq 1$), then *ts* behaves like a cluster.

3.2.3.6. Criterion 6: Occurrence Word-Initially

In Finnic, the most notable position where consonant clusters are disfavored is word-initially; in fact, no word-initial clusters can be found in the native (non-onomatopoeic) lexemes of any Finnic (standard) language (Heinsoo & Saar 2015: 58). That being said, word-initial clusters are attested in loanwords and onomatopoeic/expressive lexemes in languages like Estonian, Votic, and Ingrian (Heinsoo & Saar 2015: 58).

I tabulated every *ts* word in my data according to word structure and consulted Nirvi's (1971) dictionary for words with initial *ts*. If word-initial *ts* could be found in native, non-onomatopoeic/expressive lexemes, then this would be evidence toward considering it an affricate.

3.2.3.7. Criterion 7: Cluster Reduction Before the Partitive Suffix -*t*

Using Nirvi's (1971) dictionary, I looked at the partitive form of *veitsi* 'knife' to see if cluster reduction took place (cf. Viitso (2008) who investigated this criterion in Veps using the word *veitš* 'knife'). *Veitsi* was the only noun with *ts* I found in the dictionary that takes the partitive suffix -*t*. For other nouns containing *ts*, such as *liitsa* 'face.NOM' or *vatsa* 'stomach.NOM', it is the length of the final vowel which distinguishes the partitive from the nominative. If in Lower Luga Ingrian, similar to Veps, *veitsi* + -*t* > *veist* 'knife.PART', then this is evidence of *ts* being a cluster.

# 4. Results

This chapter reports and analyzes the results from the linear models. Section 4.1 first will first discuss findings on the duration of *ts* in *mantsikka* 'strawberry' and the effect of word etymology on the duration of *ts*, since these results influence the factors considered in the analyses of the criteria. Section 4.2 will then present the findings for each criterion.

It must first be said that, though the effect of each speaker on the behavior of *ts* differed in magnitude, it did not differ in direction. That is, the results for each criterion were the same for each speaker. As a result, the speaker has been treated as a random effect (random intercepts) for each model, and this is reflected in the figures and tables presented below.

## 4.1. Results of Preliminary Analyses

### 4.1.1. Total Duration of *ts* in *mantsikka*

Since Kuznetsova (2009: 276, in press) has reported that the total duration of *ts* in the word *mantsikka* 'strawberry' and its wordforms is on average 40 ms shorter than in structurally comparable words, it is important that *ts* in *mantsikka* is not conflated with *ts* in other lexemes. I attempted to replicate Kuznetsova's (2009, in press) findings by comparing *ts* in wordforms of *mantsikka* and *tantsia*, the latter being the only other lexeme in my data with *ts* following a nasal. The mixed model used to compare these lexemes included syllable count and phrase-finality as fixed effects and speaker and wordform as random effects. Note that for this model, wordforms occurring less than five times were not excluded, since there were already so few instances of *mantsikka*.

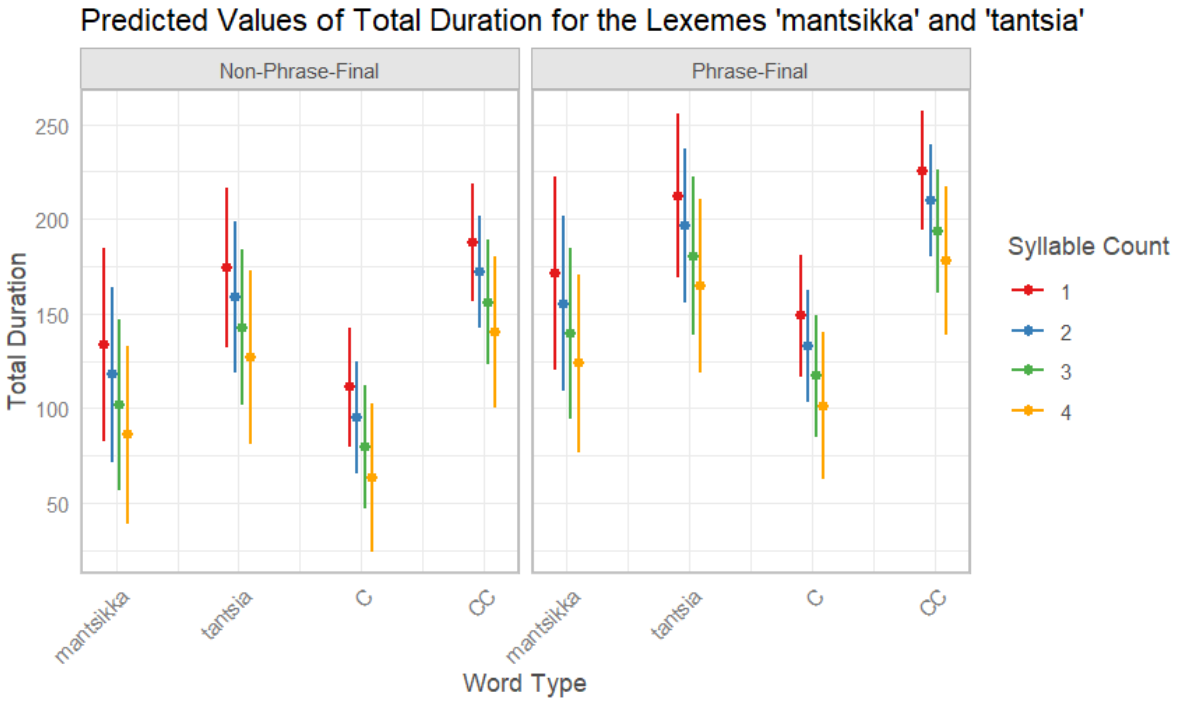


**Figure 4.** Predicted mean values of total duration of *ts* in wordforms of *mantsikka* 'strawberry' (n = 25) and *tantsia* 'to dance' (n = 48) compared to singletons C (n = 278) and geminates/clusters CC (n = 327).

**Table 9.** Table of fixed effects for the model comparing total duration of *ts* in wordforms of *mantsikka* 'strawberry' and *tantsia* 'to dance'. $R^2_m = 0.36$, $R^2_c = 0.82$.

| | Estimate (ms) | SE (ms) | 95% CI | df | t-ratio | p-value |
|---|---|---|---|---|---|---|
| *mantsikka* (intercept)[9] | 133.56 | 25.92 | [82.66, 184.47] | 37.65 | 5.15 | < 0.001 |
| *tantsia* | 40.93 | 23.66 | [-5.53, 87.38] | 129.59 | 1.73 | 0.09 |
| C | -22.45 | 19.73 | [-61.19, 16.29] | 138.65 | -1.14 | 0.26 |
| CC | 54.21 | 19.82 | [15.29, 93.14] | 139.67 | 2.74 | < 0.01 |
| Syllable count | -15.87 | 6.269 | [-28.18, -3.56] | 149.92 | -2.53 | 0.01 |

[9] For all models, the estimate for the intercept term represents the predicted mean value of the dependent variable when the independent variables are set to their reference values. The reference values were 1 for syllable count, No for phrase-finality, and No for after nasal (for other models). The plots, the other hand, show the predicted mean values for the independent variables shown in the plot, which have been averaged over the independent variables not displayed in the plot.

| | | | | | | |
|---|---|---|---|---|---|---|
| Phrase-finality | 37.67 | 4.224 | [29.38, 45.97] | 647.88 | 8.92 | < 0.001 |

**Table 10.** Post-hoc comparison table for the model comparing total duration of *ts* in wordforms of *mantsikka* 'strawberry' and *tantsia* 'to dance'.

| Contrast | Estimate (ms) | SE (ms) | df | t-ratio | p-value[10] |
|---|---|---|---|---|---|
| *mantsikka* - *tantsia* | -40.93 | 23.70 | 124 | -1.73 | 0.26 |
| *mantsikka* - C | 22.45 | 19.70 | 133 | 1.14 | 0.52 |
| *mantsikka* - CC | -54.21 | 19.80 | 134 | -2.73 | 0.03 |
| *tantsia* - C | 63.38 | 15.50 | 118 | 4.10 | < 0.001 |
| *tantsia* - CC | -13.29 | 15.50 | 120 | -0.86 | 0.52 |
| C - CC | -76.66 | 6.53 | 204 | -11.74 | < 0.001 |

In Figure 4 and Table 9 we can see that *ts* in wordforms of *mantsikka* (133.56 ms) was roughly 40 ms shorter than in wordforms of *tantsia* (174.49 ms), though this difference was not statistically significant (p = 0.26) (as seen in Table 10). That being said, Table 10 shows that the duration of *ts* in *mantsikka* was not significantly different from the duration of singletons (p = 0.52) whereas it was significantly different from geminates/clusters (p = 0.03). According to Criterion 3, this is what we would expect from an affricate.

An important consideration is that in the majority of *mantsikka* wordforms (n = 21/25), *ts* preceded a closed syllable (e.g., *mantsikka*, *mantsikkaa*), whereas in the majority of *tantsia* wordforms (n = 35/48), *ts* preceded an open syllable (e.g., *tantsia*, *tantsima*, *tantsisin*). In order to make a fair comparison between these lexemes, the effect of syllable openness on segment length should be controlled for, which would require enough tokens representing both open syllable and closed syllable environments. As a result, I cannot confidently conclude that this difference in the total duration of *ts* reflects its status as an affricate in *mantsikka*. Nevertheless, wordforms of *mantsikka* will be excluded from subsequent analysis since at this point it is not

[10] P-values presented in post-hoc comparison tables for all models have been adjusted via the Holm-Bonferroni method to correct for multiple comparison (i.e., 3 or more comparisons).

possible to disprove Kuznetsova's (2009, in press) conclusion that the *ts* in *mantsikka* is phonologically different from *ts* in all other lexemes. A future study should examine the lexeme *mantsikka* according to the criteria used in this study.

### 4.1.2. Word Etymology as a Factor Conditioning Duration of *ts*

I investigated word etymology as a possible factor conditioning the duration of *ts*. Words with *ts* were classified either as lexemes borrowed from Russian or native lexemes inherited from Proto-Finnic:

- Lexemes of Russian origin: *liitsa* 'face', *maditsa* 'beam, joist', *tantsia* 'to dance'.
- Native lexemes: *etsiä* 'to search for', *itse* 'self', *katsoa* 'to watch', *kutsua* 'to invite', *metsä* 'forest', *otsa* 'end', *vatsa* 'stomach', *vitsa* 'twig'.

The mixed model used included syllable count, phase-finality, and whether *ts* occurred after a nasal (such as in *tantsia* 'to dance') as fixed effects and speaker and wordform as random effects.

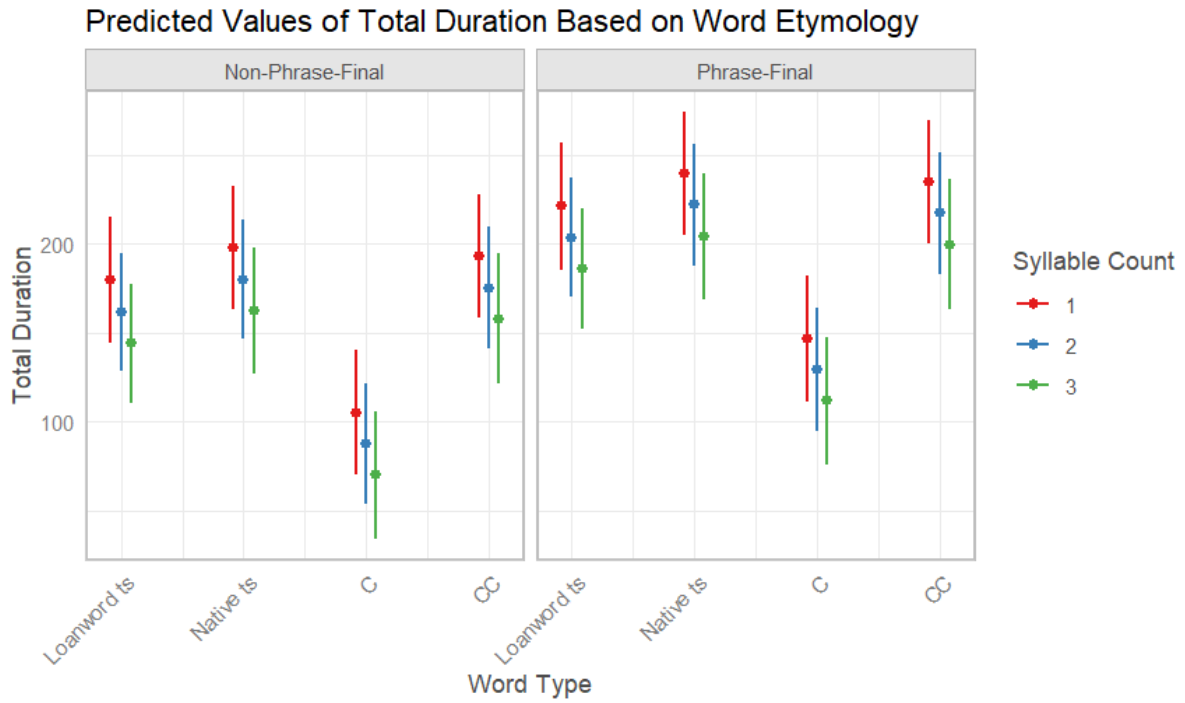


**Figure 5.** Predicted mean values of total duration for lexemes borrowed from Russian (n = 143) and native lexemes (n = 592) compared to singletons C (n = 222) and geminates/clusters CC (n = 238).

**Table 11.** Table of fixed effects for the model comparing total duration of *ts* in loanwords from Russian and native lexemes. $R^2_m = 0.35$, $R^2_c = 0.77$.

| | Estimate (ms) | SE (ms) | 95% CI | df | t-ratio | p-value |
|---|---|---|---|---|---|---|
| Loanword *ts* (intercept) | 182.88 | 18.92 | [145.77, 219.99] | 9.62 | 9.67 | < 0.001 |
| Native *ts* | 18.24 | 9.80 | [-0.98, 37.46] | 130.13 | 1.86 | 0.06 |
| C | -74.24 | 10.35 | [-94.54, -53.93] | 123.30 | -7.17 | < 0.001 |
| CC | 13.51 | 10.63 | [-7.36, 34.37] | 125.42 | 1.27 | 0.21 |
| Syllable count | -17.63 | 4.96 | [-27.36, -7.90] | 103.15 | -3.56 | < 0.001 |
| Phrase-finality | 41.73 | 2.93 | [35.98, 47.48] | 1166.59 | 14.24 | < 0.001 |
| After nasal | -6.87 | 13.893 | [-34.13, 20.39] | 108.31 | -0.49 | 0.62 |

**Table 12.** Post-hoc comparison table for the model comparing total duration of *ts* in loanwords from Russian and native lexemes.

| Contrast | Estimate (ms) | SE (ms) | df | t-ratio | p-value |
|---|---|---|---|---|---|
| Loanword *ts* - Native *ts* | -18.24 | 9.82 | 136 | -1.86 | 0.20 |
| Loanword *ts* - C | 74.24 | 10.40 | 129 | 7.16 | < 0.001 |
| Loanword *ts* - CC | -13.50 | 10.70 | 131 | -1.27 | 0.41 |
| Native *ts* - C | 92.48 | 6.68 | 114 | 13.85 | < 0.001 |
| Native *ts* - CC | 4.74 | 6.68 | 116 | 0.71 | 0.48 |
| C - CC | -87.74 | 6.98 | 152 | -12.58 | < 0.001 |

Figure 5 and Table 11 show that the total duration of *ts* was on average 18.24 ms shorter in Russian loanwords than it was in inherited words. As post-hoc comparison (Table 12) revealed that this difference was not statistically significant (p = 0.20), there was not enough evidence

to conclude that the duration of *ts* is influenced by the etymology of the word. Etymology will, therefore, not be considered as a factor.

It must be pointed out that all three loanwords in the dataset, *liitsa* 'face', *maditsa* 'beam, joist', and *tantsia* 'to dance', do not have corresponding native words with the same word structure. (Wordforms of *mantsikka* 'strawberry' would be an ideal match for those of *tantsia* 'to dance', however, these have been omitted from the data, as mentioned earlier in Section 4.1.1.) That is, there were no native words in the dataset with the structure CVV*ts*V (*ts* preceded by a long vowel), CVCV*ts*V (*ts* between the second and third syllables), or CVN*ts*V (*ts* preceded by a nasal). These structural differences may be responsible for the difference in duration observed. The possibility that the behavior of *ts* is affected by the etymology of the word should be investigated in a proper study based on structurally comparable loanwords and native words.

## 4.2. Results of Criteria

For the models below, fixed effects included syllable count, phrase-finality, and occurrence after a nasal (not applicable for Criterion 5), and random effects included speaker and wordform (both with random intercepts).

### 4.2.1. Criterion 1: Participation in Gradation

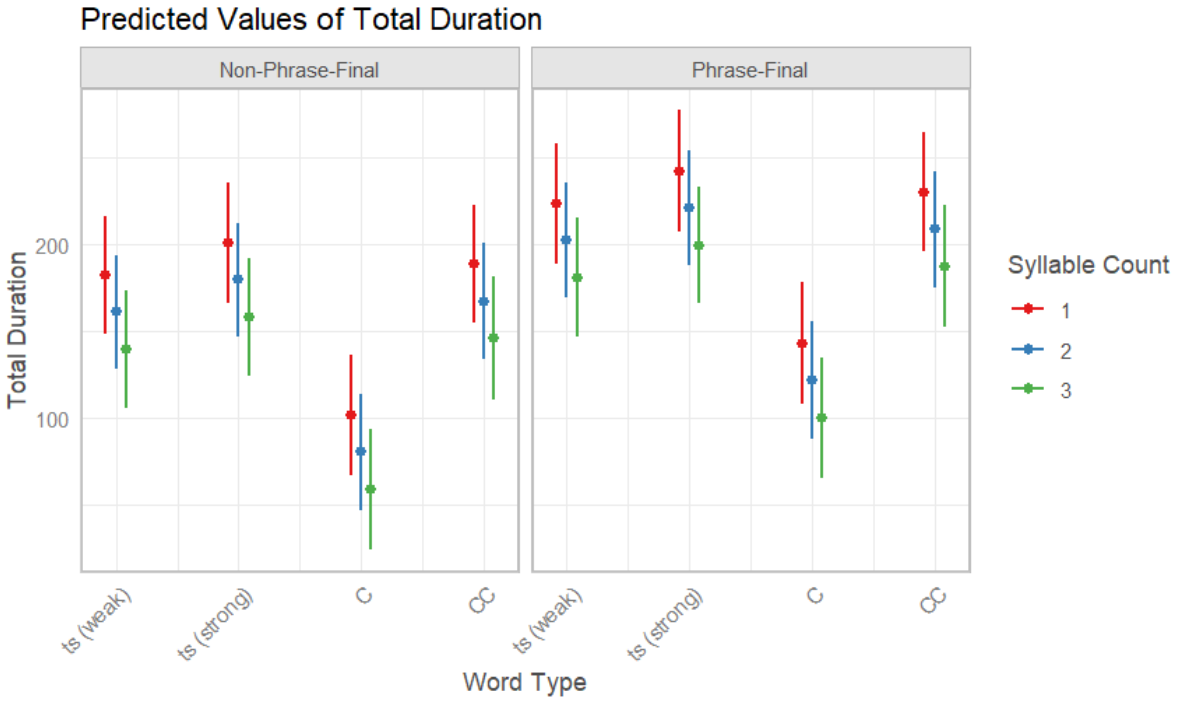

**Figure 6.** Predicted mean values of total duration for *ts* in weak grade environments (n = 344) and strong grade environments (n = 391) compared to singletons C (n = 222) and geminates/clusters CC (n = 238).

**Table 13.** Table of fixed effects for the model comparing total duration of *ts* in weak grade environments and strong grade environments. $R^2_m = 0.36$, $R^2_c = 0.78$.

| | Estimate (ms) | SE (ms) | 95% CI | df | t-ratio | p-value |
|---|---|---|---|---|---|---|
| *ts* (weak) (intercept) | 193.07 | 16.66 | [160.39, 225.76] | 5.83 | 11.59 | < 0.001 |
| *ts* (strong) | 18.54 | 7.42 | [3.97, 33.10] | 93.84 | 2.50 | 0.01 |
| C | -80.60 | 7.35 | [-95.02, -66.18] | 107.85 | -10.97 | < 0.001 |
| CC | 6.33 | 7.37 | [-8.12, 20.79] | 109.18 | 0.86 | 0.39 |
| Syllable count | -21.38 | 4.81 | [-30.81, -11.94] | 103.70 | -4.45 | < 0.001 |
| Phrase-finality | 41.33 | 2.93 | [35.59, 47.07] | 1167.44 | 14.123 | < 0.001 |
| After nasal | -21.07 | 11.83 | [-44.29, 2.14] | 99.96 | -1.78 | 0.08 |

**Table 14.** Post-hoc comparison table for the model comparing total duration of *ts* in weak grade environments and strong grade environments.

| Contrast | Estimate (ms) | SE (ms) | df | t-ratio | p-value |
|---|---|---|---|---|---|
| *ts* (weak) - *ts* (strong) | -18.54 | 7.42 | 97.1 | -2.50 | 0.04 |
| *ts* (weak) - C | 80.60 | 7.36 | 111.6 | 10.96 | < 0.001 |
| *ts* (weak) - CC | -6.33 | 7.37 | 113.0 | -0.86 | 0.39 |
| *ts* (strong) - C | 99.14 | 7.58 | 107.1 | 13.09 | < 0.001 |
| *ts* (strong) - CC | 12.21 | 7.69 | 109.1 | 1.59 | 0.23 |

| | | | | | |
|---|---|---|---|---|---|
| C - CC | -86.93 | 6.99 | 152.5 | -12.44 | < 0.001 |

For this model, we see that the average total duration of *ts* was slightly longer in strong grade environments (211.61 ms) than weak grade environments (193.07 ms), a difference of 18.54 ms (Figure 6, Table 13). Despite being statistically significant (p = 0.04) (Table 14), we must ask if a difference of 18.54 ms is sufficient to constitute a grade alternation. We can compare this to the difference between singletons and geminates, which was on average 86.93 ms (Table 14). Given that the length difference we observe for *ts* in strong and weak grade environments was significantly shorter than this ($t(119) = -12.58$, $p < 0.001$)[11], we cannot conclude that *ts* participates in gradation. For this criterion, we must conclude that *ts* behaves like a cluster.

### 4.2.2. Criterion 2: Component Carrying Length Distinction

Since the data discussed above in Criterion 1 do not provide evidence that *ts* participates in gradation, Criterion 2 is no longer applicable.

### 4.2.3. Criterion 3: Total Duration of *ts*

Figure 7 and Tables 15 and 16 below use the same model as Figure 6 and Tables 13 and 14 in Criterion 1 except they combine all *ts* tokens regardless of grade environment, since sufficient evidence of a grade distinction for *ts* was not found.

[11] The difference between *ts* (weak) and *ts* (strong) was compared to the difference between C and CC and was found to be statistically significant. This calculation was performed separately and is not shown in the tables.

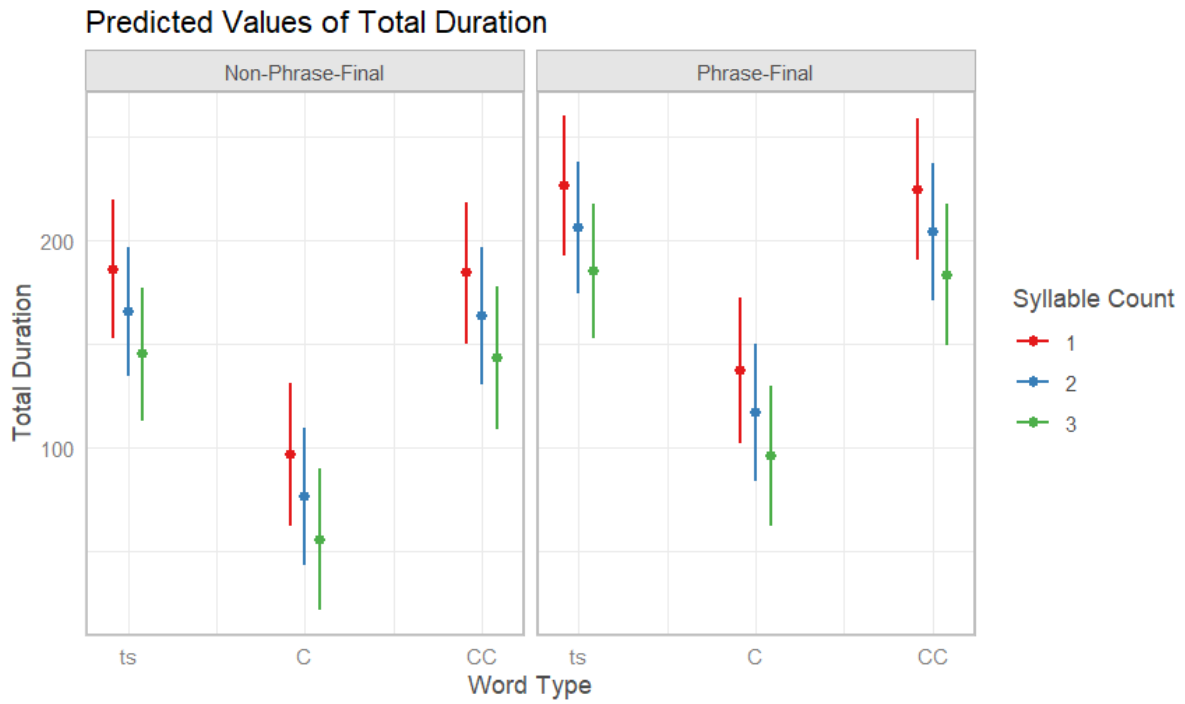


**Figure 7.** Predicted mean values of total duration for *ts* (n = 754) compared to singletons C (n = 222) and geminates/clusters CC (n = 238).

**Table 15.** Table of fixed effects for the model comparing total duration of *ts* to singletons C and geminates/clusters CC. $R^2_m = 0.35$, $R^2_c = 0.77$.

| | Estimate (ms) | SE (ms) | 95% CI | df | t-ratio | p-value |
|---|---|---|---|---|---|---|
| *ts* (intercept) | 201.08 | 16.42 | [168.87, 233.30] | 5.51 | 12.25 | < 0.001 |
| C | -89.16 | 6.61 | [-102.12, -76.20] | 115.92 | -13.50 | < 0.001 |
| CC | -1.87 | 6.68 | [-14.97, 11.23] | 118.08 | -0.28 | 0.78 |
| Syllable count | -20.52 | 4.82 | [-29.97, -11.08] | 109.34 | -4.26 | < 0.001 |
| Phrase-finality | 40.32 | 2.86 | [34.70, 45.94] | 1193.34 | 14.08 | < 0.001 |
| After nasal | -29.89 | 10.28 | [-50.06, -9.72] | 107.22 | -2.91 | < 0.01 |

**Table 16.** Post-hoc comparison table for the model comparing total duration of *ts* to singletons C and geminates/clusters CC.

| Contrast | Estimate (ms) | SE (ms) | df | t-ratio | p-value |
|---|---|---|---|---|---|
| *ts* - C | 89.16 | 6.61 | 119 | 13.48 | < 0.001 |
| *ts* - CC | 1.87 | 6.68 | 121 | 0.28 | 0.78 |
| C - CC | -87.29 | 7.11 | 161 | -12.28 | < 0.001 |

The average total duration of *ts* was 201.08 ms (Table 15), which was significantly different from the average duration of singletons, 111.92 ms ($p < 0.001$) but not significantly different from the average duration of geminates/clusters, 199.21 ms ($p = 0.78$) (Table 16). It is clear from this that the total duration of *ts* is most similar to that of geminates/clusters, which is expected if *ts* is a cluster.

### 4.2.4. Criterion 4: Duration of Fricative Component

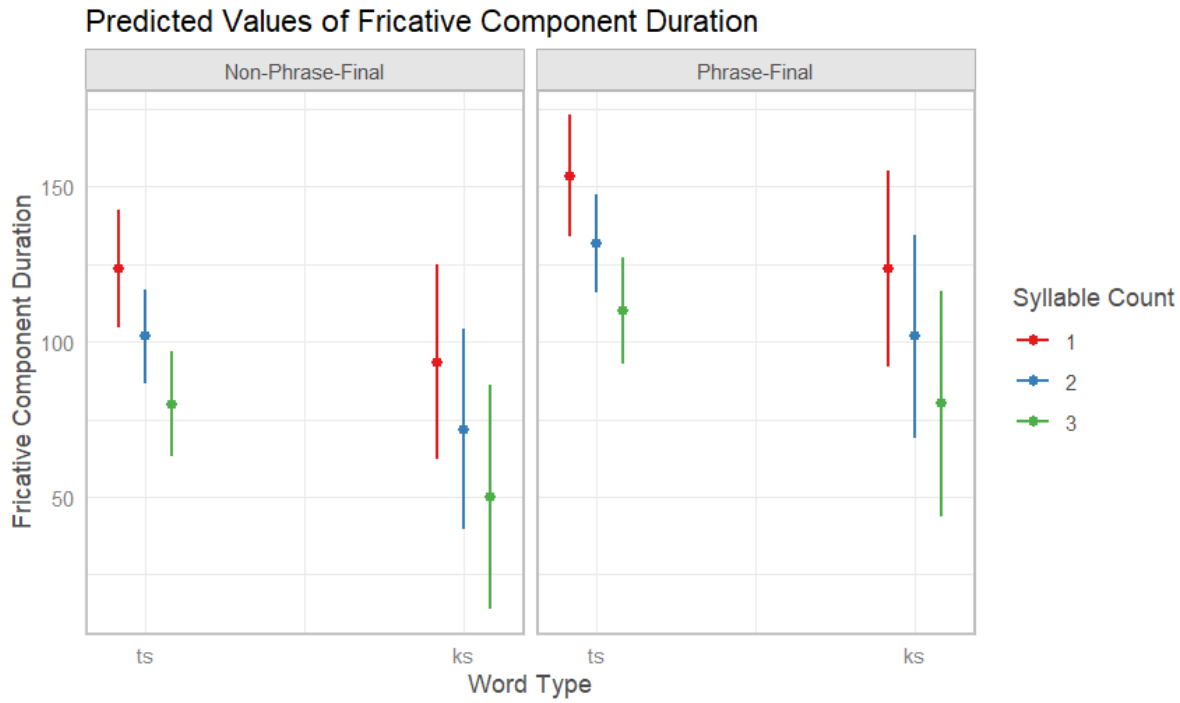


**Figure 8.** Predicted mean values of fricative component duration in *ts* (n = 754) and in *ks* (n = 27).

**Table 17.** Table of fixed effects for the model comparing fricative component duration in *ts* and in *ks*. $R^2_m = 0.14$, $R^2_c = 0.50$.

| | Estimate (ms) | SE (ms) | 95% CI | df | t-ratio | p-value |
|---|---|---|---|---|---|---|
| *ts* (intercept) | 120.08 | 8.90 | [102.60, 137.56] | 12.40 | 13.49 | < 0.001 |
| *ks* | -29.91 | 15.28 | [-59.90, 0.08] | 53.43 | -1.96 | 0.06 |
| Syllable count | -21.74 | 5.01 | [-31.58, -11.90] | 59.30 | -4.34 | < 0.001 |
| Phrase-finality | 30.04 | 3.05 | [24.06, 36.02] | 765.51 | 9.86 | < 0.001 |
| After nasal | 6.77 | 7.74 | [-8.43, 21.97] | 64.44 | 0.88 | 0.39 |

The duration of the fricative component was longer when part of *ts* (120.08 ms) than when part of *ks* (90.17 ms) (Figure 8, Table 17). If *ts* were an affricate we would expect it to have a shorter fricative component than *ks*. Since we do not observe this (in fact, we observe the opposite), this result is consistent with *ts* being a cluster.

### 4.2.5. Criterion 5: Second Vowel Lengthening

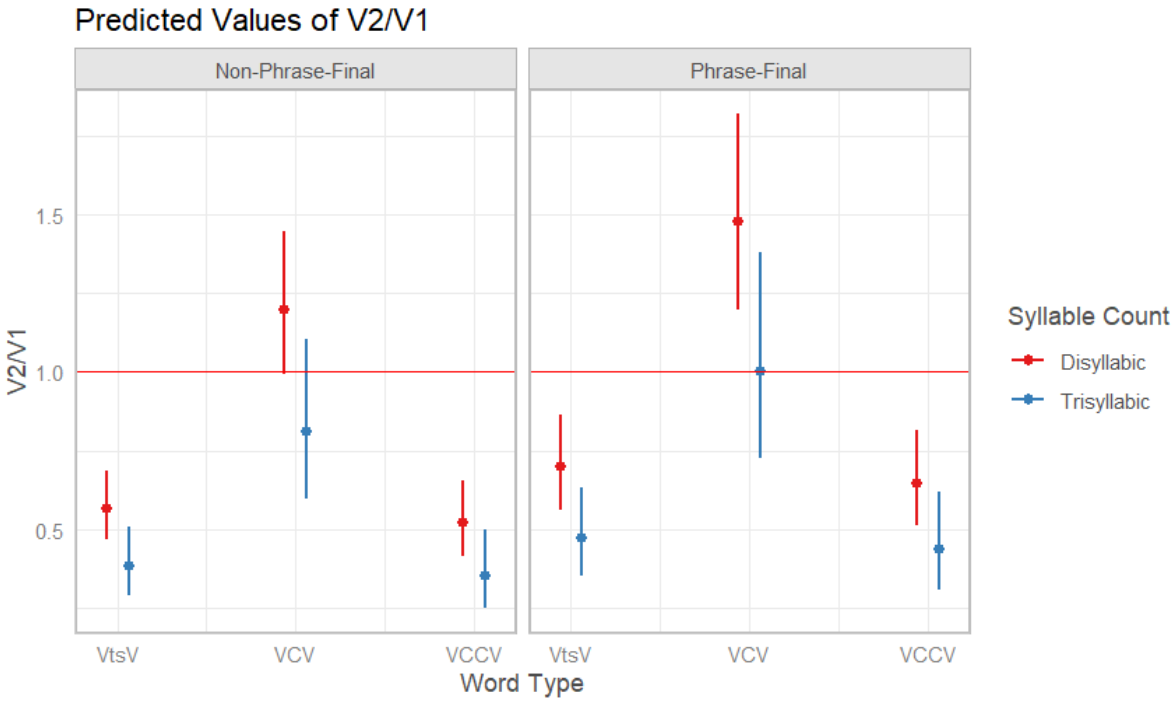


**Figure 9.** Predicted mean values of $V_2/V_1$ in V*ts*V (n = 237) compared to VCV (n = 166) and VCCV (n = 98). The red line at $V_2/V_1 = 1$ shows the threshold for lengthening (above the line) and reduction (below the line).

**Table 18.** Table of fixed effects for the model comparing $\log(V_2/V_1)$[12] in V*ts*V, VCV, and VCCV. $R^2_m = 0.51$, $R^2_c = 0.76$.

| | Estimate (ms) | SE (ms) | 95% CI | df | t-ratio | p-value |
|---|---|---|---|---|---|---|
| V*ts*V | -0.57 | 0.10 | [-0.76, -0.38] | 10.44 | -5.78 | < 0.001 |
| VCV | 0.75 | 0.09 | [0.58, 0.92] | 37.86 | 8.70 | < 0.001 |
| VCCV | -0.08 | 0.11 | [-0.29, 0.13] | 37.78 | -0.73 | 0.47 |
| Syllable count | -0.39 | 0.13 | [-0.65, -0.13] | 35.79 | -2.95 | < 0.01 |
| Phrase-finality | 0.21 | 0.05 | [0.11, 0.31] | 481.98 | 4.22 | < 0.001 |

**Table 19.** Post-hoc comparison table for the model comparing $\log(V_2/V_1)$ in V*ts*V, VCV, and VCCV.

| Contrast | Estimate (ms) | SE (ms) | df | t-ratio | p-value |
|---|---|---|---|---|---|
| V*ts*V - VCV | -0.75 | 0.09 | 38.5 | -8.70 | < 0.001 |
| V*ts*V - VCCV | 0.08 | 0.11 | 38.4 | 0.73 | 0.47 |
| VCV - VCCV | 0.83 | 0.11 | 38.8 | 7.78 | < 0.001 |

In disyllabic words, Figure 9 shows that the vowel ratio was greater than 1 ($V_2/V_1 > 1$) in VCV structures and less than 1 ($V_2/V_1 < 1$) in VCCV structures. Table 19 confirms that the difference between these vowel ratios was statistically significant ($p < 0.001$). Thus, this establishes that Lower Luga Ingrian has second vowel lengthening in VCV structures and reduction in VCCV structures.

In V*ts*V structures, the vowel ratio was less than 1 ($V_2/V_1 < 1$), indicating reduction of the second vowel. As seen in Table 19, V*ts*V and VCCV were not significantly different from one

[12] The log of $V_2/V_1$ was used for this model since the residuals showed a non-normal distribution. This was expected though since the combined number of V*ts*V and VCCV structures outweighted the number of VCV structures, meaning that there would be more data points with values below 1. The estimates and 95% confidence intervals in Tables 18 and 19 use the log scale, whereas the scale in Figure 9, however, has been back-transformed.

another ($p = 0.47$), while V*ts*V and VCV were ($p < 0.001$). These results support interpreting *ts* as a cluster.

Another finding was the frequent elision of the second vowel in VCCV and V*ts*V structures when word-final, so words like *kissa* 'cat.NOM' and *metsä* 'forest.NOM', for example, would often be realized as [kis:] and [mets], respectively. (Final vowel elision is not captured in Figure 9 and Tables 18 and 19 since the lack of second vowel means that the duration of $V_2$ is 0 ms, which would make $V_2/V_1 = 0$.)

Notably, second vowel lengthening does not appear to occur for VCV structures in trisyllabic words (e.g., *küsüsin* 'ask.PRS.1SG'). In non-phrase-final positions, we actually see slight second vowel reduction in trisyllabic words, though there still is a large difference in $V_2/V_1$ between VCV structures and V*ts*V/VCCV structures. This is an interesting finding since VCV lengthening was expected to occur in both disyllabic and trisyllabic words.

### 4.2.6. Criterion 6: Occurrence Word-Initially

**Table 20.** All word-positions where *ts* occurred in my data. *ts* was observed in word-final position in realizations where final vowels were elided.

| | | Native Lexemes | Loanwords |
|---|---|---|---|
| Word-Initially | | - | *tsepa* 'chain.NOM' |
| Word-Medially | Intervocalically | *katsoa* 'look.INF' | *liitsan* 'face.GEN' |
| | After consonant | *mantsikka* 'strawberry.NOM' | *tantsia* 'dance.INF' |
| Word-Finally | After vowel | *metsä* 'forest.NOM' > [mets] | *liitsa* 'face.NOM' > [li:ts] |
| | After consonant | - | *tantsi* 'dance.CNG' > [tants] |

Table 20 above shows the five word-positions where *ts* occurred in the data. Of note is word-initial position: word-initial *ts* could only be found in Russian loanwords, e.g., *tsementa* 'cement', *tsepa* 'chain', *tsepotška* 'chainlet'. In Nirvi (1971: 599, 601–602), *tselkka* 'virgin', *tsirinapū* 'lilac', and *tsollu* 'dugout' also have word-initial *ts*, but these are also all Russian loanwords[13] (Rozhanskiy & Markus 2020: 448). Since word-initial *ts* did not appear in native lexemes, this suggests that *ts* behaves like a cluster phonotactically.

[13] The forms *tselkka*, *tsirinapū*, and *tsollu* have been documented in Soikkola Ingrian, but it is unknown whether they occur and how they are pronounced in Lower Luga Ingrian.

### 4.2.7. Criterion 7: Cluster Reduction Before the Partitive Suffix *-t*

Nirvi (1971: 651) gives the partitive form *veist* for the noun *veitsi* ‘knife’. Words like *lapsi* ‘child’ and *uksi* ‘door’, which have the clusters *ps* and *ks* in the same position, show similar partitive forms *last* (Nirvi 1971: 249) and *ust* (Nirvi 1971: 622). This confirms that the sequence *ts* behaves just like the clusters *ps* and *ks* when the partitive suffix *-t* is added.

# 5. Discussion and Conclusion

## 5.1. Research Question 1

Table 21 lists the results of the analysis of each criterion and whether they support the interpretation of *ts* as an affricate or as a cluster.

**Table 21.** Results of the analysis of each criterion.

| | Supports affricate interpretation | Supports cluster interpretation |
|---|---|---|
| 1. Participation in gradation | | ✓ |
| 2. Component carrying length distinction | N/A | N/A |
| 3. Total duration of *ts* | | ✓ |
| 4. Duration of fricative component | | ✓ |
| 5. Second vowel lengthening | | ✓ |
| 6. Occurrence word-initially | | ✓ |
| 7. Cluster reduction before the partitive suffix *-t* | | ✓ |

For each criterion (with the exception of Criterion 2, which was not applicable), the behavior of *ts* did not align with expectations on how an affricate should behave. On the grounds that all criteria are in complete agreement, we must therefore favor the analysis that *ts* is a consonant cluster in Lower Luga Ingrian.

Previously, Kuznetsova (2009, in press) concluded that the affricate /t͡s/ is present in at least one native lexeme, *mantsikka* ‘strawberry’, and one loanword, *tsepa* ‘chain’. She based this on her finding that the total duration of *ts* in these lexemes was shorter than in other structurally similar lexemes but noted that this data was still preliminary. In my data, I also found that *ts* was shorter in *mantsikka* than in *tantsia* ‘to dance’, but this difference was not statistically significant (Table 10). As explained in Section 4.1.1, it is plausible that whether the syllable following *ts* was open or closed is the reason why *ts* in *mantsikka* was shorter than in *tantsia*. Given this, I believe the simplest analysis is that Lower Luga Ingrian lacks the affricate /t͡s/, and all instances of *ts* represent the cluster /ts/.

Trubetzkoy (1969: 55) has said that distinguishing between a single phoneme and a combination of phonemes is not always easy, due to the "uninterrupted movement" of the speech event. In the context of affricates, this means that it is not necessarily a straightforward forward task to determine if a stop-fricative sequence should be considered an affricate or a consonant cluster. The present study emphasizes that using multiple, well-defined criteria, which ideally are specific to the language in question, is the key to differentiating between an affricate and cluster.

## 5.2. Research Question 2

Section 2.2.4 showed that *ts* should be considered an affricate in Votic, namely due to its participation in consonant gradation and the second vowel lengthening observed in V*ts*V structures. Section 2.2.5 showed that in Soikkola Ingrian, some evidence, like the fact the historic *s* > *š* shift did not affect *s* in *ts*, suggests *ts* is an affricate. Other evidence, like the lack of participation in consonant gradation and lack of second vowel lengthening in V*ts*V structures, suggests *ts* is a cluster. Therefore, *ts* is either an anomalous affricate or anomalous cluster in Soikkola Ingrian. This study showed that *ts* should be analyzed as a cluster /ts/ in Lower Luga Ingrian, which is supported unanimously the analysis of all criteria.

Given these findings, we can reasonably conclude that Lower Luga Ingrian did not inherit the Votic affricate /t͡s/, as if it had, we would not expect such cluster-like behavior of *ts* in Lower Luga Ingrian. Soikkola Ingrian must be the source of the cluster /ts/ in Lower Luga Ingrian. Knowing that the consonant system of Lower Luga Ingrian is so structurally similar to that of Lower Luga Votic (Kuznetsova in press), this begs the question of why Lower Luga Ingrian is deviant with regard to *ts*. Is there something about affricates that make them less likely to be inherited than other segments? This is a question that requires further research to answer. The presence/absence of affricates should be studied in more mixed/convergent languages in situations where both parent languages have affricates, where neither has affricates, and where one has affricates but the other does not.

We have seen that, despite Proto-Finnic being reconstructed with affricates, Finnic languages show a lot of variation in the phonological status of stop-fricative sequences like *ts*. For some of these languages, like Livonian, Võro, and Votic, there is strong evidence that *ts* is an affricate. There are also languages, like Veps and Soikkola Ingrian, where there is evidence for both affricate and cluster interpretations of *ts*. Finally, there are languages, like Lower Luga Ingrian, where there is no evidence that supports *ts* being an affricate. The case of Finnic makes

it clear that it is dangerous to assume the presence or absence of affricates in a language based on closely related languages.

## 5.3. Limitations and Future Directions

There were several limitations to this study, the most important being that there were not many instances of *ks* (n = 27) to serve as control words for Criterion 4. A further disadvantage was that the 27 words with *ks* in the data were all monosyllabic, e.g., *miks* 'why' and *kaks* 'two'. Ideally, there should not only be more control words with *ks*-sequences, but there should also be more instances of *ks*-sequences in disyllabic and trisyllabic words. Words with *ps*-sequences should also be included as control words.

Secondly, there were few instances in the data where *ts* occurred word-initially, so words with initial *ts* did not feature in Criteria 3 and 4 and were only used in Criterion 6. It is entirely possible that in word-initial position, *ts* may behave differently regarding Criteria 3 and 4 than in other positions.

Thirdly, the potential effect of etymology on the duration of *ts* could not be fully investigated. The word structures of loanwords and native lexemes containing *ts* were simply not similar enough to definitively say that *ts* had a significantly shorter duration in loanwords. A future study should look at whether the status of *ts* as an affricate or cluster differs between native lexemes and loanwords.

Fourthly, while it was found that the total duration of *ts* was shorter in wordforms of *mantsikka* 'strawberry' than in those of *tantsia* 'to dance', the wordforms of *mantsikka* and *tantsia* present in the data were not structurally similar enough to conclude that this difference in duration was lexical and unbiased by phonetic factors. Kuznetsova (2009, in press) also reported short *ts* in another word, *tsepa* 'chain', but this word was not investigated in this study. Future research should investigate whether *ts* in *mantsikka* 'strawberry' and *tsepa* 'chain' behaves as an affricate or cluster according to the criteria in Section 3.2.3 (specifically Criteria 1–4).

Finally, an analysis of *tš* could not be given due to insufficient data (i.e., there were not enough occurrences of *tš* in my material to give it a complete investigation according to the criteria). Understanding *tš* will give a better understanding of the status of affricates in Lower Luga Ingrian in relation to Soikkola Ingrian and Votic, as well as Finnic languages as a whole. Kuznetsova's (2009: 283–284, in press) work has suggested that *tš* in Lower Luga Ingrian is an affricate /t͡ʃ/. If future research examines the behavior of *tš* according to the criteria in this

study and finds that it does indeed pattern like an affricate, we must then ask why *tš* is an affricate but *ts* is a cluster in Lower Luga Ingrian.

## 6. Summary

This study investigated Lower Luga Ingrian, an endangered and understudied Finnic language, with respect to two main research questions, 1) whether the sequence *ts* is an affricate or a consonant cluster in Lower Luga Ingrian, and 2) how the status of *ts* in Lower Luga Ingrian compares to that of *ts* in Votic and Soikkola Ingrian. Phonetic, phonological, and morphological characteristics of affricates were discussed in order to understand how they differed from consonant clusters composed of a stop and fricative, and the phonological status of affricates in various Finnic languages was covered. This was used to build a set of criteria for distinguishing between affricates and consonant clusters in Lower Luga Ingrian.

The analysis showed that *ts* did not behave as an affricate in terms of consonant gradation, total duration, duration of the fricative component, second vowel lengthening, occurrence word-initially, and cluster reduction before *-t*, thus it was concluded that *ts* in Lower Luga Ingrian should be analyzed as a consonant cluster. When compared to *ts* in Votic, which clearly behaves as an affricate, and *ts* in Soikkola Ingrian, which shows properties of both affricates and clusters, it was clear that Lower Luga Ingrian did not inherit the affricate /t͡s/ from Votic even though the rest of its consonant system closely resembled that of Votic. Ultimately, this study demonstrated that the phonological status of affricates can vary greatly even between closely related languages, and that affricates may be less likely to be inherited from a parent language than other segments.

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## Alam-Lauga isuri *ts*-järjendi fonoloogiline staatus: afrikaat või konsonantühend? Kokkuvõte

Käesolevas uurimuses käsitletakse häälikujärjendi *ts* foneemilist staatust Alam-Lauga isuri keeles, mis on ohustatud ja väheuuritud läänemeresoome keel. Selleks et määrata, kas *ts*-i tuleks selles keeles analüüsida afrikaadi või konsonantühendina, hinnatakse seda foneetiliste, fonoloogiliste ja morfoloogiliste kriteeriumide alusel. Need kriteeriumid põhinevad afrikaatide keeleteaduslikult üldistel omadustel ning nende erinevustel võrreldes konsonantühenditega, tuginedes varasematele uurimustele, mis on käsitlenud afrikaatide foneemilist staatust läänemeresoome keeltes. Uurimuses kasutatakse viielt Alam-Lauga isuri keele kõnelejalt kogutud välitööandmeid ning analüüsitakse 764 *ts*-järjendi kestusmõõtmist lineaarsete segamudelite abil. Tulemused näitavad, et *ts*-il ei esine afrikaadile omaseid tunnuseid, vaid see käitub pigem konsonantühendina nagu *ps* või *ks*. Selle põhjal järeldatakse, et Alam-Lauga isuri keeles tuleks *ts*-i käsitleda konsonantühendina.

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