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Russian spoken by Kazakh young adults: a phonetic and phonological analysis

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ABSTRACT: This study examines the phonetics and phonology of Russian spoken by young adults from different regions of Kazakhstan, focusing on stops, fricatives, and affricates absent in Kazakh but present in Russian. The analysis highlights the variability in phoneme production based on regional origins and exposure to Russian. Some participants showed patterns similar to those of Russian native speakers, while others exhibited more variability, including phenomena not typically found in Russian. The study also found a de-palatalization phenomenon in post-alveolar fricatives, suggesting a loss of phonological distinction. These findings provide insights into the linguistic adaptation of Kazakh speakers, revealing how they navigate and assimilate Russian phonological features.

Keywords: Russian; Kazakh; dental affricates; palatalised stops; post-alveolar fricatives.

RESUMEN: *El ruso hablado por los jóvenes adultos kazajos: un análisis fonético y fonológico* . Este estudio examina la fonética y la fonología del ruso hablado por jóvenes de diferentes regiones de Kazajistán, centrándose en oclusivas, fricativas y africadas ausentes en kazajo pero presentes en ruso. El análisis destaca la variabilidad en la producción de estos fonemas según el origen regional y el grado de exposición al ruso. Algunos participantes mostraron patrones similares a los hablantes nativos de ruso, mientras que otros exhibieron mayor variabilidad, incluyendo fenómenos no encontrados típicamente en ruso. El estudio también identifica un fenómeno de despalatalización en las fricativas post-alveolares, lo que sugiere una pérdida de distinción fonológica. Estos hallazgos ofrecen una visión sobre la adaptación lingüística de los hablantes de kazajo, revelando cómo navegan y asimilan las características fonológicas del ruso.

Palabras clave: ruso; kazajo; africadas dentales; oclusivas palatalizadas; fricativas postalveolares.

1. INTRODUCTION

In Kazakhstan, due to their upbringings and historical factors such as their place of origin and the time they lived in, many Kazakh citizens belonging to the Soviet generation have primarily received their education in Russian, considering it their L1, while regarding the Kazakh language as L2. They typically learn Kazakh in a school environment but do not use it in their daily lives. This has led to deviations from the standard pronunciation of the Kazakh language among these individuals (Mukhamedowa, 2015).

As in many post-Soviet countries, language policy is strongly intertwined with both education and language attitudes. The selection of different forms of writing in the Kazakh language makes particularly evident the transition from the Soviet period to recent times: Kazakh originally used the Arabic alphabet but switched to the Latin one in the 20th century to distance itself from Islamic influences. However, this transition was not very smooth. In the 1940s, they switched to the Cyrillic alphabet, which was more widely accepted due to its connection with the Russian language taught in schools. In 2006, Kazakhstan's president Nazarbayev initiated discussions about transitioning from the Cyrillic script to the Latin alphabet for the Kazak language, but practical steps were taken in 2017, when he signed a decree to complete this transition by 2025 (Kambar, 2020). The transition posed challenges because the Kazakh alphabet had more letters than the Latin one. Linguists then decided to remove ten letters and used diacritics to represent the remaining 32 letters. Kazah is not a homogenous language, with multiple varieties within Kazakhstan. These varieties are categorized into three main groups: northeastern, western, and southern. The northeastern variety, with minimal influence from Arabic and Persian, is the most prestigious and served as the basis for modern literary Kazakh. Standardization occurred during the Soviet period. The southern variety was strongly influenced by Uzbek due to its location, and the western variety is similar but has a few distinct features. Kazakh shares grammatical features typical of Turkic languages, such as a SOV word order in neutral contexts, highly agglutinative morphology, and the use of postpositions (Balakaev, 1959 p.202).

Despite the explicitly de-russifying language policy, Terlikbayeva & Menlibekova (2021) point out how a proper language shift in Kazakhstan shows a slow pattern, also due to economic reasons, since Russian is still perceived, together with English, as an important resource for personal development. The authors also argue that, despite the growing legal importance of Kazakh, there is still a strong influence of Russian across the country, and Kazakh is sometimes perceived as less prestigious than Russian, even by young-adult speakers.

This paper aims to investigate the phonetic and phonological aspects of the spoken Russian language by Kazakh speakers of the "new-adult generation", born after the collapse of the USSR, particularly focusing on phonemes not found in the linguistic inventory of the Kazakh language. Subsequently, a comparison will be made with the production of native Russian speakers. The so-called "new adult" generation includes speakers aged between 23 and 28 years old, who attended school during the beginning of the transition from Cyrillic to the Latin alphabet and in a de-russification language ideological environment. According to Smagulova & Madiyeva (2021), the most 'Russified' generation is one of people aged between 45 and 55 years.

The primary goal of this research was to investigate whether Kazakh young adults exhibited signs of "russification" in the way they pronounced certain phonemes. It also aimed to determine if, during their use of the Russian language, they incorporated any phonetic and phonological aspects from the Kazakh language.

We have decided to focus on three target phonemes, namely voiceless dental affricate, voiceless palatalized occlusive, and a sort of *tertium comparationis*, the post-alveolar voiceless fricative. Both the voiceless dental affricate and the voiceless palatalized occlusive are marked sounds up to great phonetic and phonological variability even within the same language. In particular, as we will illustrate later, affricates are not always recognized as autonomous phonemes, since some scholars classify these sounds as occlusive with a long release phase. Indeed, affricates could be phonetically separated into two main moments: an occlusive part and a fricative part, sometimes realized with an evident burst, as in occlusives, and a short silence between the two moments (Meluzzi 2021, who also emphasizes how these realizations have been mainly highlighted in formal and controlled speech). However, there are some cases of plosives with a long fricative release and of clusters involving a nasal resulting in affricate-like pronunciation; furthermore, affrication has been shown to be a secondary phonetic cue in the realization of the palatalized contrast by non-native speakers of Russian (see Kulikov 2010, and also 2.3). Although there is not, to our knowledge, a complete phonetic analysis of affricates as phonological sounds embedded in a language compared with affricate-like realization, and since both the first and the second seem to show different diachronic results (Meluzzi 2021), in this paper we will distinguish "real" affricates from affricate realization of different phonological unit.

The paper is structured as follows: section 2 presents the theoretical remarks of our work, with a sketch of Kazakh and Russian phonology (2.1), a brief remark on sociolinguistic variability of Kazakh (2.2), and some phonetic and phonological considerations concerning the three target sounds analyzed here (2.3). Section 3 presents our experimental materials, by first introducing the research questions (3.1), the methods and materials (3.2), and the annotation protocol (3.3). Section 4 is devoted to the analysis of the target sounds, by presenting data on duration and on spectral information. Finally, section 5 discusses the results in line with previous research on these languages and section 6 presents our conclusions so far, with possible perspectives to further the present analysis.

2. THEORETICAL REMARKS

2.1. Kazakh and Russian

Kazakh and Russian show important phonological differences, in particular for what concerns the target phonemes analyzed here. Phonologically, CVC is the primary syllabic pattern in Kazakh. A CV structure could be found in functional words, whereas other patterns are found in loanwords, mostly from the Russian language. Traditionally, it was believed that stress in Kazakh occurred on the final syllable of words. However, Kirchner (1998, p.30) argues that there are two types of stress: initial stress, marked by increased intensity, and final stress, characterized by rising volume. As for Russian, the primary syllabic pattern is CV, although CVC is also a frequent pattern; fricatives, both voiceless and voiced, are more prone to occur in the coda position (see also Padgett 2001 for an OT explanation of the problem of palatalization contrast in coda position).

The Kazakh vowel inventory has been the subject of numerous discussions among linguists, with varying opinions regarding the number of vowels it contains, ranging from 5 to 11 (Dzhunisbekov, 1972; Kirchner, 1992, 1998; Vajda, 1994; McCollum, 2015). The central debate leading to this variation mainly revolves around diphthongs. As Vajda (1994, p.630) points out, some linguists view diphthongs as combinations of phonemes and not phonemically relevant. For instance, many scholars consider /i̯e/ as a phonemic diphthong. In this work, we adopt the view of those recognizing 9 vowel phonemes for Kazakh.

The classification of Kazakh consonants has been long debated. Although some scholars claim the presence of 18 consonant phonemes, this work adopts Balakaev's (1962) classification of 20 phonemes.

Many consonants show alternations in backness and roundness based on surrounding vowels, making it challenging to determine whether these alternations represent distinct phonemes or allophones of a single phoneme (McCollum & Chen, 2020). While some representations of Kazakh consonants include voiceless dental affricates, labiodental fricatives, and glottal fricatives, these are considered relatively recent additions to the language, primarily appearing in loanwords from Russian and being rarely used in everyday speech. Kazakh exhibits consonant assimilations due to a prohibition on consonant clusters at the beginning of words. Exceptions are made for loanwords, where a schwa vowel is inserted to break up clusters. This schwa insertion is more common in northern Kazakhstan due to Russian influence (Özçelik, 2022).

Consonant clusters, however, are possible at the end of words and in suffixes, following the sonority scale principle. Liquids /l̥, r/ appear in word-final clusters, while liquids followed by voiceless obstruents are mostly found in onomatopoeic words (Vajda, 1994). Lenition processes, where a segment becomes weaker in articulation, occur not just word-finally, but also at the beginning of suffixes.

The classification of Russian vowels and consonants is also quite debated in literature. As for vowels, scholars identify 6 to 10 vowels, because of the distinction between weak and strong vowels. The perspective followed in this study recognizes 5 primary vowels: /a, e, u, o, ɨ/, with /ja jɛ jo ju i/ considered their respective palatalized counterparts. Russian vowels can undergo vowel reduction, which is influenced by both segmental and prosodic contexts. The first is quantitative reduction, which affects /i ɨ u/, primarily altering vowel duration. The second is qualitative reduction, which changes the qualitative characteristics of /o a e/. The degree of reduction depends on the syllable's position within the word and the presence of preceding consonants (Malyševa & Rogaleva, 2012). Additionally, /u i ɨ/ in unstressed positions only experience quantitative vowel reduction, with no change in their qualitative characteristics Cubberley, 2002). The production of these vowels can vary based on their consonantal context, becoming more anterior when preceded, followed or situated between two palatal consonants (Yanushevskaya & Bunčić, 2015, p.224).

The Russian consonant inventory consists of 20 consonants, which can be classified as either hard or soft, except for / t͡s ʒ ʃ/ which are always hard and / t͡ʃj ʃj:/ which are always soft. This classification can also be understood as a contrast between non-palatalized (hard) and palatalized (soft) consonants. Non-palatalized consonants occur at the absolute end of a word, e.g. in dom "house", or when followed by the vowels /a o u ɨ/, e.g. all the consonants in the word golova "head" are non-palatalized (Malyševa & Rogaleva, 2012, p.12).

Palatalized consonants, on the other hand, are followed by the soft sign (ь) or the vowels /ja e i jo ju/, e.g., /tj/ in mat' "mother". Consonants /t͡ʃj ʃj:/ are always produced as soft when preceding /a o u/. In some cases, consonant clusters are formed by two consonants, usually /ʒt͡ʃj/, /zt͡ʃj/, /st͡ʃj/ and in these cases the cluster is pronounced as /ʃj:/ (Wade, 2011, p.8). Palatalization is phonemically distinctive as in the contrast between nos /nos/ "nose" and nës /njos/ "carried". Regarding voicing, at the end of the word, only voiceless consonants can occur. If a voiced consonant appears in a word-final position, it undergoes devoicing, e.g., god /gʊɔt̯/ "year" (Malyševa & Rogaleva, 2012).

In consonant clusters, there is regressive sonorant assimilation. If a voiced consonant appears next to a voiceless one, the latter influences the former, e.g, ložka "spoon" produced as /ˈloʃkə/. The reversed assimilation can also happen, e.g., in takže "also" /ˈtagʒə/. This assimilation can also affect palatalization and place of articulation (Dunn, 2009, p.9).

2.2 Sociophonetic variability of Kazakh

Kazah is not a homogenous language, with multiple variaties within Kazakhstan. These varieties are categorized into three main groups: northeastern, western, and southern. The northeastern variety, with minimal influence from Arabic and Persian, is the most prestigious and served as the basis for modern literary Kazakh. Standardization occurred during the Soviet period. The southern variety was strongly influenced by Uzbek due to its location, and the western variety is similar but has a few distinct features. Kazakh shares grammatical features typical of Turkic languages, such as a SOV word order in neutral contexts, highly agglutinative morphology, and the use of postpositions (Balakaev, 1959 p.202).

To date, a large part of sociolinguistic literature on Kazakh has been dedicated to language attitudes, usually by comparing attitudes towards Kazakh and Russian (see Sharipova 2020). Another significative field of research is interested in language acquisition in post-Soviet countries, thus including Kazakhstan, in particular for what it concerns the acquisition of English as a foreign language (see Zhussupova et al. 2024 and Kambatyrova 2024 for recent reviews of the topic).

2.3. Phonetic and phonological remarks

As stated before, Russian phonological repertoire presents affricates, other than a peculiar phonological contrast between palatalized and not-palatalized consonants. From a phonetic perspective affricates have been usually described as “stops in which the release of the constriction is modified in such a way as to produce a more prolonged period of frication after the release” (Ladefoged & Maddieson, 1996, p.90). According to this perspective, thus, affricates are included among stop sounds, even though, diachronically, they tend to be reduced into fricatives, by losing the first occlusive phase (see Meluzzi 2016, 2020, for data on Romance languages), or even to turn into glides (Żygis et al., 2012, p.307).

Palatalization is also a key feature in Russian phonology, but it is absent in Kazakh. A common phonological representation of these sounds interprets palatalized consonants as a secondary V-place node with the feature [coronal] (Hume 1994). Thus, these V-node will be present for Russian consonants in their geometric representations, but absent for those languages, including Kazakh, not presenting a palatalization contrast (but see also Padgett 2003 for a phonological interpretation within a Dispersion Theory framework). Phonetically, palatalization involves a co-articulatory gesture with the raising of the front of the tongue towards the hard palate. According to the classic description of Russian, palatalization contrast is never neutralized in a word-final position (Avanesov 1972, Bolla 1981).

Studies on the acquisition of palatalization in Russian have shown that palatalized contrast is sensible to syllabic position: Kulikov’s (2010) data show an easier perception of these sounds in pre-vocalic position, but not in coda, thus creating a coda-onset asymmetry. These data have also shown how even advanced learners used other phonetic cues to produce the phonological contrast between palatalized and not-palatalized consonants: one of these cues is affrication, meaning that L2 learners produced Russian palatalized stop consonants as affricates, especially in coda-position (Kulikov 2010, and also Zsiga 2003 for articulatory timing of consonant gestures by English learners of Russian).

3. EXPERIMENTAL PROTOCOL

3.1. Research questions

Considering the variable status that Russian still has on Kazakh speakers, we first wanted to investigate a possible influence of Russian pronunciation on Kazakh young adult speakers. In particular, we wanted to highlight the presence of palatalization, a key feature in Russian phonetics and phonology, in the realization of voiceless dental affricates, alveolar fricatives and voiceless dental plosives.

In particular we wanted to ask the following research questions:

1. To what extent are the target phones realized with a typical Russian palatalized feature by Kazakh speakers?
2. Which of the target phones seems more prone to palatalization and how is it realized?
3. Are there differences among the speakers based on their origin within Kazakhstan?

With respect to the first two questions, we expected a different role played by palatalization in the different target sounds. Dental affricates, due to their complex aerodynamic mechanism, could be reduced into fricatives but it is mostly unlikely that they are realized as palatalized, since this realization is overtly marked and it belongs to the Russian phonological repertoire. A major influence of palatalization is expected on fricatives, due to their high variability. We also expect, in line with previous studies, that Russian palatalized plosives would be realized with some degrees of affrication, thus resulting in a sort of affricates, quite distinct, though, from phonological real affricates.

Finally, we expect a high degree of within-speaker variability, shaped not only by their Kazakh origin but mostly by the different use of, respectively, Kazakh and Russian.

3.2. Methods and materials

Kazakh participants were selected based primarily on their origin, and “key participants” played a significant role in recruiting a diverse set of individuals from different regions (Lupica Spagnolo, 2019, p.110). To participate in the study, speakers had to meet the following criteria:

a. Belong to the “new generation”, typically aged 20-30 years. The older generation (45-55 y.o.) was considered more “russified” due to their upbringing during the Soviet regime (Smagulova & Madiyeva, 2021, p.1009).
b. Hail from various regions of Kazakhstan.
c. Have attended university, as in some parts of Kazakhstan, Russian is primarily taught and used in higher education.

Eight participants were interviewed, with four from Kazakhstan and four from the Russian Federation. All participants belonged to the “new adult” generation, aged between 23-28 y. o. The primary goal of this research was to investigate whether the new generation of Kazakhs still exhibited signs of “russification” in the way they pronounced certain phonemes. It also aimed to determine if, during their use of the Russian language, they incorporated any phonetic and phonological aspects from the Kazakh language (cfr. Table I for the sociolinguistic profiles).

Table 1: Sociolinguistic profile of the recorded speakers.

	Age	Gender	Origin	Education	Profession	L1	Language used in family	Everyday exposure to:
R1	28	F	Saint Pietersburg	Bachelor’s degree	Student	Russian	Russian	Russian
R2	26	F	Saint Pietersburg	Master’s degree	PhD student	Russian	Russian	Russian
R3	23	M	Volgograd	Master’s degree	Linguist	Russian	Russian	Russian
R4	28	F	Moscow	Master’s degree	Employee	Russian	Russian	Russian
K1	25	M	Petropavl	Master’s degree	Student	Kazakh	Kazakh/Russian	Kazakh/Russian
K2	26	M	Šymkent	Master’s degree	Businessman	Kazakh	Kazakh	Kazakh
K3	24	F	Karaganda	Master’s degree	Teacher	Kazakh	Kazakh	Kazakh
K4	25	M	Astana/living in Almaty	Master’s degree	Engineer	Kazakh	Kazakh/Russian	Kazakh/Russian

The interviews of the two “key participants”, one Kazakh (referred to as K1) and one Russian (referred to as R1) were conducted in January 2022. The recordings were made using a VictureV3 recorder with a 16-bit sampling rate and frequency of 44.1 kHz. The interviews with other Kazakhs (K2, K3, K4) and Russian (R2, R3, R4) participants were also recorded in January 2022 using an online software (zencastr.com) that allowed recording in a .wav format with a 16-bit sampling rate and a 44.1kHz frequency. This format, sampling rate and frequency were chosen since they are the standard for recordings used in phonetic and phonological analysis.

Language proficiency was not formally assessed; instead, self-evaluation was used. Russian speakers identified Russian as their L1, while Kazakh speakers identified Kazakh as their L1. Only K1 self-assessed as being proficient in Russian at an advanced level.

The interviews consisted of four parts for the Russian participants:

a. Reading of a Russian tale;
b. A sociolinguistic interview (in Russian)
c. Re-reading of the same Russian tale.
d. Reading the same text with increased familiarity. The emphasis was on quicker reading, unlike tasks (c) and (a), where the focus might have been on careful reading.

For Kazakh participants, the tasks were the same, but an additional task was introduced between (a) and (b). This additional task involved reading the same tale but in the Kazakh language, and aimed to create a more relaxed atmosphere for those who were more proficient in this language. The total duration of the recording is 15’68’’. The corpus analysed is formed by a total of 701 phones.

3.3. Data annotation and analysis

The recordings were then analyzed using PRAAT (Boersma & Weenik, 2022), and the annotation protocol previously described in Meluzzi’s (2020) for the segmentation of affricates. Thus, the phonetic annotation is divided into three tiers:

on the first tier, words were identified; on the second tier, phonetic transcription was conducted. The third tier was used to identify the phoneme of interest (affricate, occlusive, fricative), and the fourth tier was used to separate the occlusive moment from the fricative moment, if necessary (e.g., in palatalized occlusives and voiceless dental affricates).

The affricates were also labelled following the annotation protocol of Meluzzi (2020), using the tag “AFFR” on the third tier, while the occlusive and fricative moments were annotated on the fourth tier using the tags “STOP” and “FRIC” (Figure 1). This annotation was used following the fact that from an acoustic point of view, dental affricates exhibit an initial silent phase, which corresponds to the occlusive moment, followed by a fricative phase characterized by the presence of aperiodicity in the acoustic spectrum (Meluzzi, 2020, p. 51).

We extracted durational values of the whole phone and of its different parts (i.e., occlusive and fricative parts in case of affricate or affricate-like realizations), other than the centre of gravity (CoG) and standard deviation (StD) of the frication noise as indicative of the place of articulation (Jongman et al. 2000). The values were extracted with a PRAAT script at the central moment of the fricative section. CoG value is directly related to the anteriority of the articulation of the affricate, or, at the very least, to its fricative moment (Meluzzi, 2020). In simpler terms, a higher CoG value signifies a more anterior articulation of the phoneme. StD indicates the distribution of the articulation energy on the frequency axis: more diffuse spectra will have high values of standard deviation, whereas spectra that are more concentrated around a particular frequency will tend to have low standard deviation values (Meluzzi, 2020).

As for palatalized consonants, all of the occurrences were identified using the software PRAAT and labelled with the tag “OCC PAL” on the third tier. Consonants articulated without palatalization were not considered. In some cases, speakers produced a post-alveolar affricate /ʧ/ instead of a palatalized occlusive, and these were annotated as “OCC PAL*”.

As mentioned previously, the palatalized occlusive consists of an occlusive moment and a release moment. These two parts were annotated on the fourth tier with the tags “STOP” for the occlusive moment and “RIL” for the release one. In cases where the speaker produced an affricate, the tag “FRIC” was used to indicate the fricative part of the phoneme Figure 2.

During the annotation of K3, it was observed on the spectrogram that this speaker produced voiced dental affricates /d͡z/ in various occurrences during the three reading tasks: in the first reading, he voiced *konce koncov*; in the second task, *solnce*; while in the fourth task, which involved fast reading of the text, K3 articulated five affricates out of eight as voiced These included both the occurrences of *solnce*, *konce*, *koncov* and *udastsja*. In these cases, the phoneme was annotated with the tag “AFFR+” to indicate the sonority feature that the speaker added in his production (Figure 3).

Table 2: Summary table with all collected phonemes divided by type and by speaker.

	Dental affricates	Palatalised stops	Post-alveolar fricatives
R1	30	28	34
R2	26	35	36
R3	24	29	36
R4	26	34	36
K1	24	27	36
K2	29	11	36
K3	23	20	36
K4	25	24	36
Tot	207	208	286

Figure 1: Annotation of a voiceless dental affricate produced by R2.

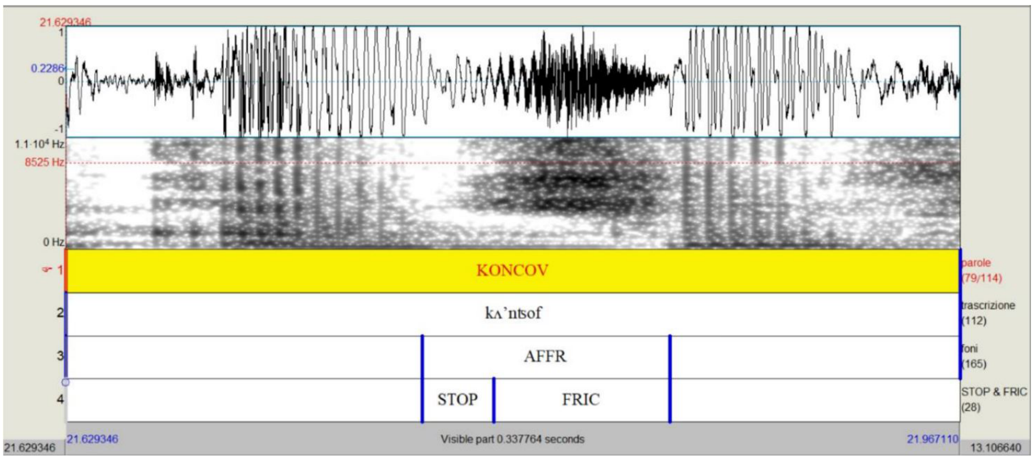


Figure 2: Spectrogram of the word *dut'* produced with a post-alveolar affricate instead of palatalised dental occlusive by R2.

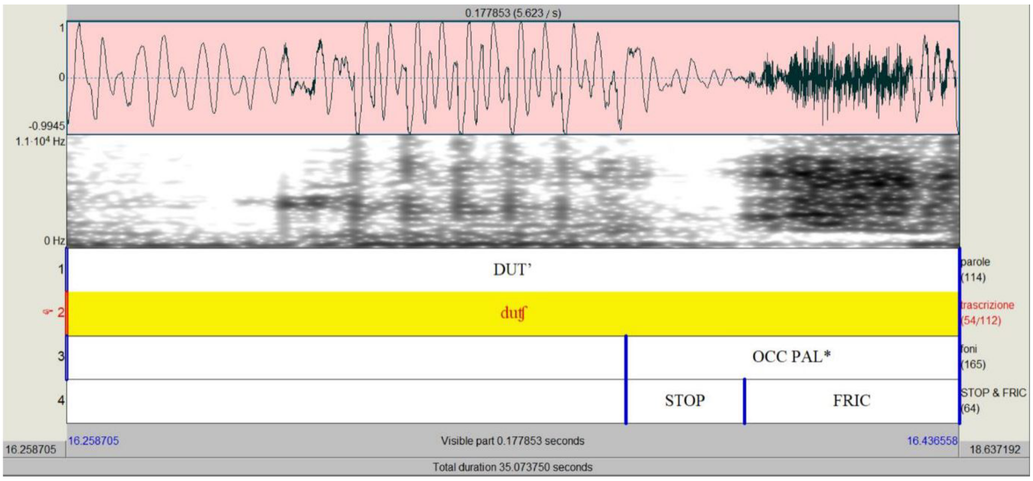
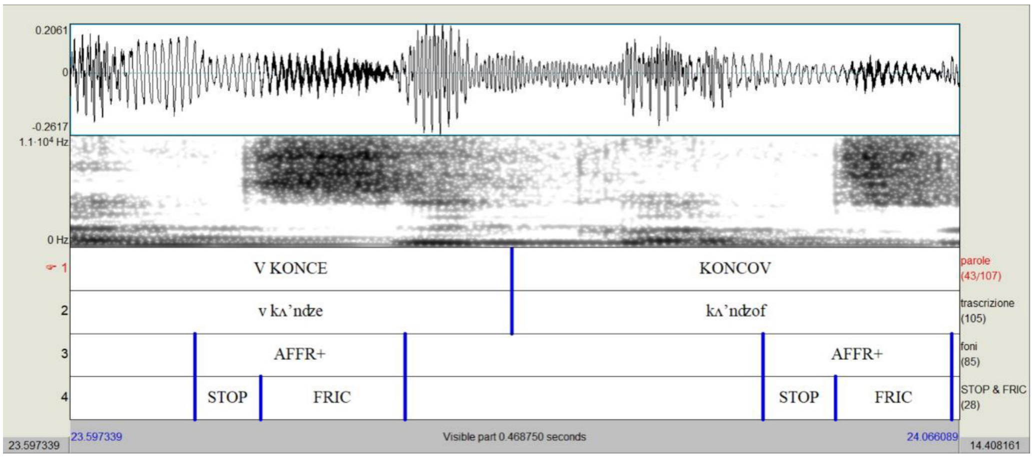


Figure 3: Spectrogramand annotation of the occurrences of the voiced dental affricates *konce* and *koncov* produced by speaker K3 during the third reading.



According to Vasiliev (2004, p.4), palatalization is visually evident on the spectrogram as a fricative moment. As Figure 4 shows, palatalization manifests as friction with a higher density of noise, represented by increased blackening. However, this figure in Vasiliev (2004, p.6) is not fully explanatory.

The spectrogram, in fact, has a limited view of the frequencies, with the maximum at 5000 Hz, focusing on a central place of articulation, whereas, as will be seen later, the analysed speakers have a CoG at even higher frequencies. Furthermore, in the image only the fricative moment of the realization of the palatalised consonant is considered, without observing the preceding moment of occlusion of the consonant.

From a qualitative point of view, it was observed that in some realizations of the palatalized phones, there was a presence of a burst between the occlusive moment and the release. In some cases, multiple bursts were noted, which are typically associated with hyper-articulated speech but were found in the fourth task of fast reading in this analysis (Figure 5).

Figure 6 shows the presence of aspiration between the occlusion phase and the release, with this aspiration being more prominent in Kazakh speakers.

An interesting case is K3, the Kazakh participant from Karaganda, whose spectrograms show both the burst and the aspiration (Figure 7).

Figure 5 and Figure 6 are particularly interesting because they reveal a short release phase between the occlusive moment and the release, which is imperceptible to the naked ear. As Meluzzi (2020, p.56) states, this short break has been identified by Howell & Rosen (1983) in English palatalised affricates and by Foulkes & Jones (2011) in English alveolar occlusives, defined as post-burst aperiodicity (PBA).

Figure 4: Spectrogram of /t/ and /t'/ produced in isolated contexts (Vasiliev, 2004, p.6).

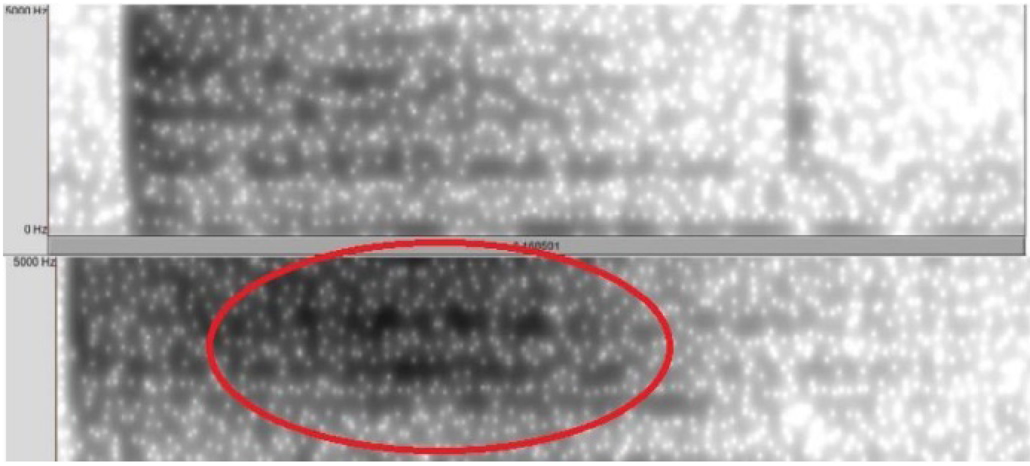


Figure 5: Spectrogram of the word *veter* produced by the speaker R4, with the burst highlighted by a red circle.

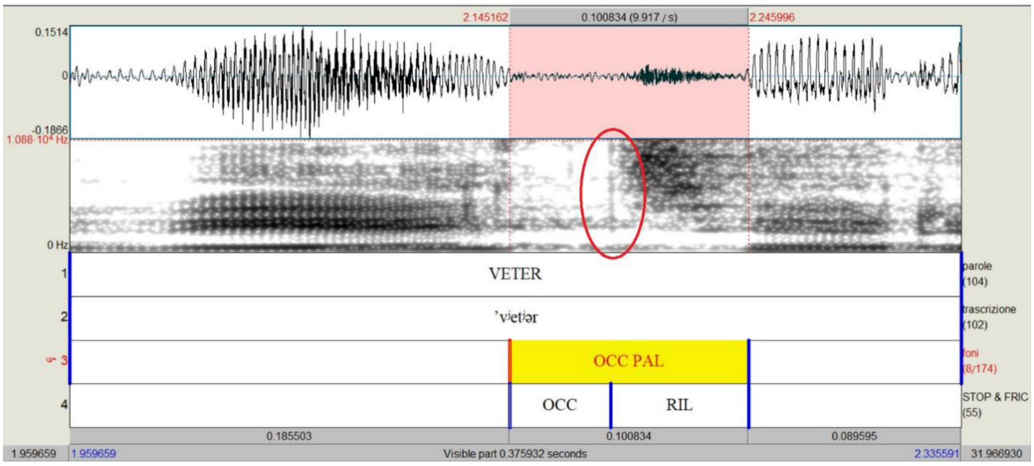


Figure 6: Spectrogram of the word *zametili* produced by the speaker K1, with the aspiration highlighted by a red circle.

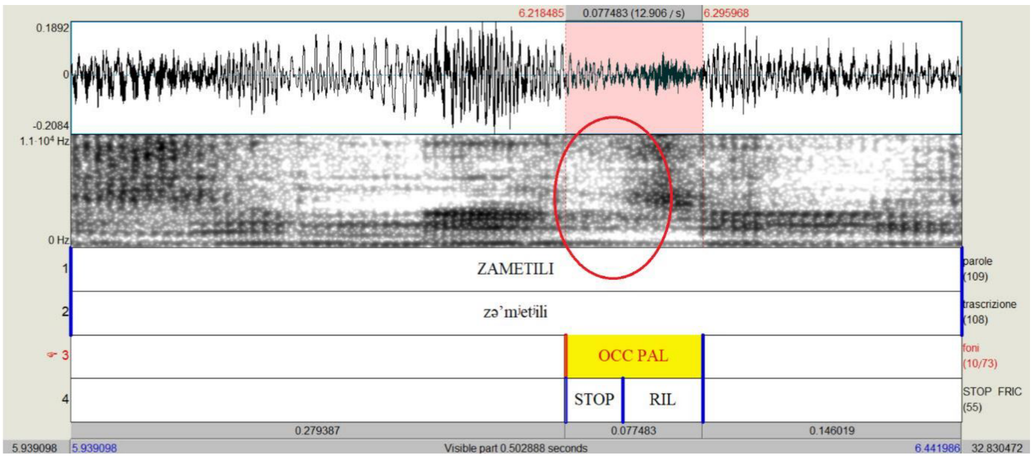
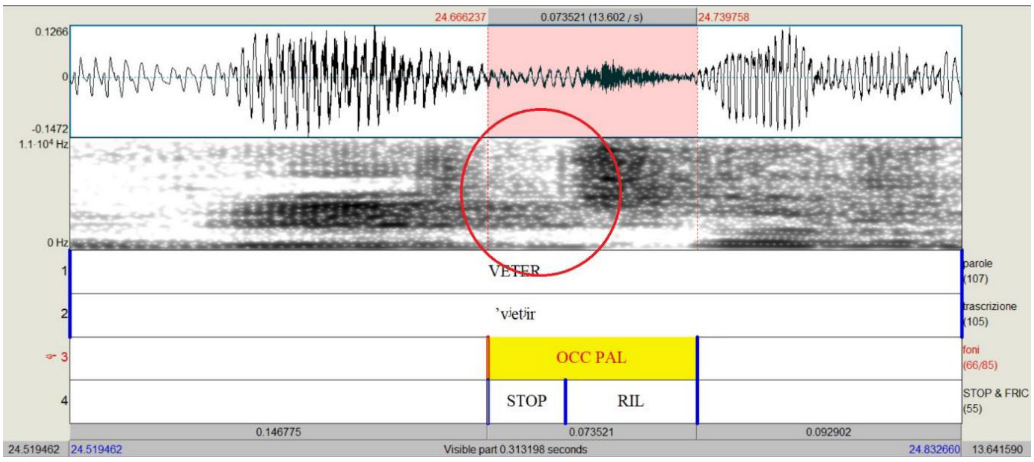


Figure 7: Spectrogram of the word *veter* produced by the speaker K3, with aspiration + burst highlighted by a red circle**.**



Finally, for what concerns the post-alveolar fricative, they were isolated in PRAAT on the third tier as “FRIC” when they were non-palatalised fricative and “FRIC PAL” when they were palatalised. Figure 8 shows the annotation of various fricatives. As the spectrogram presents, the two non-palatalized fricatives have more density in the low-frequency range, which weakens toward higher frequencies (around 7000 Hz).

On the other hand, the palatalized fricative has a higher density in the higher frequencies. In fact, the low-frequency range is white, indicating a lack of noise, while it becomes darker up to around 9000 Hz, signifying much higher frequencies compared to the non-palatalised phoneme.

4. ANALYSIS

4.1. Dental Affricates

As previously stated, dental affricates are present in the Russian consonant inventory, but absent in the Kazakh one. There was a total of 9 occurrences of voiceless dental affricates in the text, which can be divided into three contexts:

a. 4 “real” voiceless dental affricates (e.g., *solnce* “sun”).
b. 3 combinations of a voiceless dental occlusive /t/ with a voiceless fricative /s/: *sčitat’sja* “to consider”*, udastsja* “to succeed”*, otkazat’sja* “to drop out”).
c. 2 with a voiceless dental occlusive /t/ in a word-final position followed by a voiceless fricative /s/ at the beginning of the following word (e.g., *ot svoej* “from its”).

None of the 8 participants produced all 27 expected occurrences of dental affricates. R1 and K2, in particular, strengthened the voice less fricative /s/ in solnce in the affricate /t͡s/, articulating /'t͡sonʲt͡si/.

In total, we recorded 207 occurrences of dental affricates (Table III).

Figure 8: Spectrogram of the recording of R2.

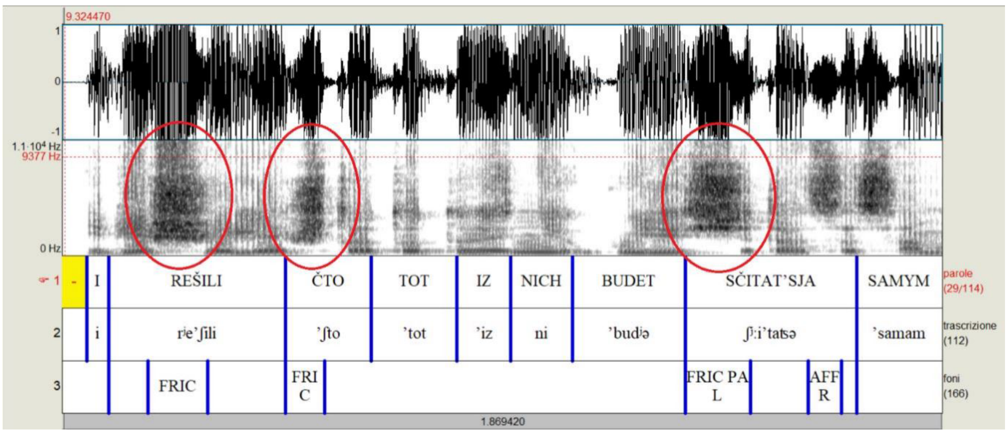


Table 3: The number of productions of voiceless dental affricates divided by Russian and Kazakh speakers.

Russian speaker	Occurrences	Kazakh speaker	Occurrences
R1	30	K1	24
R2	26	K2	29
R3	24	K3	23
R4	26	K4	25
Tot	106	Tot	101

4.1.1. Place of Articulation

Notably, during the first task, the values were all slightly lower compared to the other tasks, possibly due to the uncertainty associated with reading an unfamiliar text. Table IV and shows the average values of the CoG and StD, divided by speaker and linguistic context.

First, we analyse the "real" dental affricates in *solnce*, *konce* and *koncov*. R1 and R2, both from Saint Pietersburg, exhibit very similar CoG values, suggesting a central articulation of the fricative moment. In contrast, R3 from Volgograd has higher values than R1 and R2, indicating a more anterior pronunciation of the phoneme. Lastly, R4 from Moscow shows the highest CoG values, nearly suggesting an interdental articulation. Regarding the StD values, R1 shows a wide dispersion of energy, while R2, despite being from the same city, presents significantly lower values than R1. R3's values display minimal variation and are very similar to those of R4.

Kazakh speakers, on the other hand, exhibit notably greater variability in their values, both across different speakers (with a variation of more than 1000 Hz for the CoG) and within the values of the same speaker.

K1, who uses the Russian language daily, maintains a high average CoG value, exceeding 7500 Hz, suggesting an interdental articulation. His CoG values also show considerable variation approaching 1000 Hz.

In contrast, K2 demonstrates even higher variation, exceeding 1000 Hz, and his average CoG is around 5700 Hz, indicating a more central articulation of the fricative moment. Interestingly, the CoG of the strengthened fricative in *solnce*, produced as /ˈt͡sonʲt͡si/, is higher than the other affricates articulated by K2, signifying a more anterior realization of the phoneme. The StD (5500 Hz) are lower than those of K1, suggesting less diffusion articulation energy. Remarkably, this value is nearly identical to that of the strengthened fricative, with a difference of only 43 Hz.

Table 4: Average centre of gravity (above) and standard deviation (below) values expressed in Hz, divided by occurrences and speaker.

	Solnce	Solnce*	Konce	Koncov	Average value	Sčitat'sja	Udastsja	Otkazat 'sja	Average value	Ot svoej	Tut severnyj	Average value
R1	5986.3	5478.6	6015.0	5585.0	5766.2	5756.4	6458.2	6312.7	6175.8	6591.3	6743.3	6667.3
	5022.1	4433.6	5123.1	5149.4	4859.6	4778.4	5396.4	5095.6	5090.1	4788.4	4517.4	4652.9
R2	5907.1	-	6648.7	5383.1	5979.6	6039.2	6334.7	6910.9	6428.3	6850.1	6387.2	6618.7
	3650.0		3452.8	3500.0	3534.3	3223.3	2557.9	3373.0	3051.4	3201.4	4078.6	3640.0
R3	6382.2	-	7195.5	6694.9	6757.3	7034.4	7116.6	6682.5	6944.1	7720.9	7415.0	7568.0
	4032.4		4070.7	4035.7	4046.3	3397.1	3782.8	3985.5	3721.8	3775.2	3384.1	3579.7
R4	8971.5	-	9113.4	8621.6	8902.2	9574.4	-	9203.3	9388.9	9424.2	9326.5	9375.4
	4168.8		4505.7	4222.0	4298.8	3661.1		4002.5	3831.8	3590.3	3695.7	3643.0
K1	7092.8	-	8066.9	7414.8	7524.8	6485.2	-	6659.1	6572.2	8303.1	8565.9	8434.5
	5183.1		5051.5	5407.7	5281.7	5328.5		5157.5	5625.9	4620.1	5223.7	4921.9
K2	6330.9	6738.4	5913.3	5026.4	6002.3	8006.6	6693.8	7766.1	7488.8	6782.8	8472.0	7627.4
	5217.9	5260.4	5595.1	5893.3	5491.7	5357.0	5097.5	5592.4	5201.4	5301.6	4889.0	5095.3
K3 (-)	5549.7	-	4653.5	4886.4	5029.9	5014.3	6512.3	6054.1	5860.2	6847.9	-	6847.9
	4373.0		4223.4	3787.8	4128.1	3636.7	341.5	3143.2	3373.8	2581.8		2581.8
K3 (+)	5200.4	-	5588.2	5271.3	5353.3	-	6299.2		6299.2	-	-	-
	3716.8		3576.3	4025.4	4128.1		3243.1		3243.1			
K4	6973.5	-	8878.6	7891.0	7314.4	7791.4	9951.7	7369.5	8370.9	7856.7	8057.9	7957.3
	5490.9		5298.5	5281.7	5357.0	5154.2	5203.8	5625.9	5328.0	5636.7	4236.6	4936.7

Moving to K3, which primarily used the Russian language in academic contexts, there is almost 1000 Hz of variation in the CoG values. The average CoG value is 5000 Hz, showing a central articulation. Interestingly, the dental affricates produced as voiced also have a central place of articulation. However, the CoG of the voiced affricate in solnce is lower than the voiceless phoneme in the same context, while the CoG values of the voiced affricates in *konce* and *koncov* are higher than the voiceless counterparts in the same contexts.

Analysing the articulation energy, the StD values for the voiceless affricates produced by K3 are lower than those for both K1 and K2, with an average value of 4000 Hz, while the voiced value is even lower (3700 Hz).

K4, who frequently uses the Russian language, shows a notable variability in his CoG values. The highest value is observed in *konce*, reaching almost 9000 Hz, while the lowest is in *solnce* (7000 Hz). These values suggest an interdental articulation of the phonemes. In contrast, the StD values for K4 are similar to those of K1 and K2 (5350 Hz).

Moving to the affricates formed by the voiceless dental occlusive /t/ followed by the voiceless fricative /s/ in *sčitat'sja* (be considered), *udastsja* (manage to), *otkazat'sja* (to give up). Table IV indicates that the CoG values of these affricates produced by Russian speakers are slightly higher than those of Kazakh speakers. It also shows that the StD values, on the other hand, are lower than those observed for the "real" affricates analysed previously.

R1 maintains an average CoG value higher than 6000 Hz, indicating a more anterior articulation of the phoneme compared to the "real" affricates. Although his StD values show variability of almost 300 Hz, the average value (5090.1 Hz) is nearly identical to that of the "real" affricates (5098 Hz).

R2 has a slightly higher average CoG value (6425.9 Hz) than R1, but his StD value is lower (3051.4) than R1's. It is worth noticing that R1 and R2, both from Saint Pietersburg, exhibit more similar articulation patterns for the "real" affricates other than the ones analysed in this context.

R3, from Volgograd, has an average CoG value of 6944.5 Hz, which is 200 Hz higher than that of the "real" affricates. However, his StD value (3721.8) is 300 Hz lower.

R4, unlike the other speakers, does not produce the affricate in *udastsja* in any of the three reading tasks. His average CoG value is very high (9388.9 Hz), more than 500 Hz higher than the "real" affricates, while the StD value (3831.8 Hz) is 450 Hz lower than those observed in other contexts analysed.

These findings show that all Russian speakers produced the voiceless dental affricates formed by /t/+/s/ with a place of articulation more anterior and less articulation energy dispersion than the "real" affricates analysed above.

Moving to K1 from the north region of Kazakhstan, we observe a place of articulation that is more posterior than the previously analysed affricates, as indicated by the lower CoG value. Interestingly, the StD values for both contexts are similar to each other.

In the case of K2, there is a notable variability in CoG values, exceeding 1300 Hz, and the average value (7488.8 Hz) shows a more anterior articulation compared to the articulation of the real affricates (which was 5700 Hz). Additionally, the StD is 5201.4 Hz, indicating a narrower dispersion of articulation energy compared to the other context.

In line with the patterns observed in K2's production, the articulation of K3 of the voiceless affricates follows a similar trend: the average CoG value is higher than that of the "real" phonemes, while the StD value is lower. Notably, the StD value closely aligns with that of Russian speakers. It is worth noting that K3 produced the affricate in *udastsja* as voiced /d͡z/, and both the CoG and StD values are lower than their voiceless counterparts. This is surprising, given that in languages distinguishing between /d͡z/ and /t͡s/, the standard deviation of the voiced phoneme is typically higher than that of the voiceless affricates (Meluzzi, 2020).

Analysing K4, it becomes clear that this speaker has a degree of articulatory uncertainty, as reflected in the variability within his values. Similar to previous observations, K4 has an almost interdental articulation, since the CoG of the affricates in *sčitatsja* and *otkazat'sja* are around 7500 Hz, while the one in *udastsja* is 9000 Hz. However, the StD values indicate that this speaker has a similar dispersion of articulation energy across all three affricates.

The final set of affricates analysed are those formed by a voiceless dental occlusive in word-final position followed by a voiceless fricative in a word-initial position, as in *tut severnyj veter* ("and so the North wind) and *ot svoej* ("from its").

Among the two Russian speakers from Saint Pietersburg, R1 and R2, there is a noteworthy degree of similarity in their CoG values, while their StD values differ by 1000 Hz. Specifically, R1 presents an average CoG of 6667.3 Hz, surpassing the CoG value of the previously analysed consonant group by 500 Hz, and exceeding the real affricates value by 1000 Hz, signifying a more anterior articulation. Conversely, the average StD is nearly 400 Hz lower than in other contexts.

Similarly, R2 also has a high CoG value (6618.7 Hz), surpassing the CoG value of the previously analysed consonant group by 200 Hz and exceeding the "real" affricates value by nearly 700Hz. Unlike R1, R2 has also a higher StD value than that observed in other contexts.

Following a similar pattern as R1, R3 showcases an anterior place of articulation with the lowest StD value compared to the other two contexts. Additionally, his CoG values are also 1000 Hz higher than those of R1 and R2.

Contrarily, R4 production leans towards an almost interdental articulation. However, both the CoG and StD values are lower than those observed in the previous contexts. Interestingly, this speaker demonstrates a similar energy dispersion to that of R1 and R3.

Regarding the Kazakh speakers, K1 has produced this type of affricate with a more anterior articulation compared to the previously analysed affricate, as indicated by CoG values that are more than 2000 Hz higher. However, his StD is lower than those of other contexts, although it aligns with the values of R1, R3 and R4.

K2 follows a similar trend to K1, with an average CoG value higher than that of the other types of affricates and a lower average StD value, which is nearly identical to K1's value differing by just 173,2 Hz.

In this context, K3 articulated only voiceless phonemes, and only in *ot svoej*, dividing the two words in *tut severnyj* not producing an affricate. The average CoG value of the phoneme analysed suggests a more anterior place of articulation compared to the other contexts, aligning with the other speakers. However, the StD value, is notably low, indicating little energy dispersion during the production process (2581.8 Hz).

As for K4, the values show a very anterior articulation of the affricates. Nevertheless, the average CoG value (7957.3 Hz) is lower than that of the consonant group contexts analysed earlier. However, K4's StD value follows the trend observed in others, being lower than those of all the other contexts analysed before.

It is worth noticing that the participant from Moscow R4 articulates highly anterior affricates, as evidenced by the highest values among those analysed. This observation raises an interesting possibility to investigate whether this could be a case of idiosyncrasy, given that regional varieties within a city can exhibit distinctive phonetic characteristics (Kochetov, 2017).

4.1.2. Duration

In addition to investigating the place of articulation, our analysis explored the overall production of dental affricates and examined the two distinct phases of occlusion and friction within the phoneme.

Our particular focus was on the duration of the occlusive moment, as this aspect exhibits substantial variability in the production of dental affricates across different languages.

To obtain these values, we extracted data from the spectrogram and then normalized by word duration. Table V shows all the average values.

Table 5: Average production time divided by the entire phoneme (above), occlusive moment (below left), and fricative moment (below right).

	Solnce	Konce	Koncov	Sčitat'sja	Udastsja	Otkazat'sja	Ot svoej	Tut severnyj
R1	233 71-162	302 129-173	218 57-161	264 86-178	316 173-143	191 85-106	455 53-402	207 42-165
R2	230 34-196	311 109-202	278 80-198	216 33-183	-	200 108-92	382 34-348	247 55-192
R3	244 64-180	256 80-176	225 75-150	224 91-133	218 67-151	138 78-62	398 50-348	261 78-183
R4	211 47-164	266 85-181	200 47-153	152 72-80	-	173 67-106	432 112-320	288 62-226
K1	273 59-214	308 66-242	265 45-220	214 48-166	-	191 58-133	-	270 47-223
K2	213 47-166	323 110-213	178 70-108	223 98-125	296 114-182	190 91-99	294 114-180	-
K3 (-)	358 55-303	-	-	223 109-124	-	184 46-138	300 86-214	192 31-161
K3 (+)	272 60-212	320 102-218	314 121-193	-	214 18-196	-	-	-
K4	292 72-216	337 72-265	227 59-168	88 53-135	265 18-247	3 68-135	409 95-314	259 88-171

Concerning the "real" dental affricates, both speakers from Saint Pietersburg R1 and R2, have nearly identical temporal values, with a difference of 0.03 ms. However, when we focus on the occlusive moment, R1's is shorter than R2's. Interestingly, R2 produced s strengthened fricative, forming an affricate in the word *solnce*, which is longer than the other phonemes, yet its occlusive phase is similar to that of R1 concerning the overall word duration.

In the case of R3, the affricate produced in *solnce* is longer than what is observed in other Russian speakers. Nonetheless, its occlusive moment closely resembles that of R1 when considering the entire word. In contrast, the phoneme in *konce* is 12 ms longer than the one in *solnce*, but it remains notably brief in comparison to the other Russians. Conversely, the occlusive moment is longer than the moments produced by R1 and R2. Furthermore, the affricate in *koncov* closely resembles the one articulated by R1.

Interestingly, R4 produces the dental affricate in *solnce* with a shorter duration compared to everyone else. However, it is noteworthy that the occlusive moment in this case is longer than that of any other Russian speaker. Moreover, the phoneme analysed in konce is 10 ms longer than that produced by R3, although the occlusive parts articulated by these two participants are nearly identical. As for the affricate in *koncov*, it appears to be short, and the occlusive moment does not exhibit a significant difference compared to the other speakers.

In summary, among all the Russian participants, it is evident that *koncov* emerges as the shortest affricate in terms of duration, except for R2, who produced the most temporally variable phonemes and articulated *solnce* as the shortest.

One prominent observation in the durations of the Kazakh participants is that they tend to be longer overall, although they still align with the trend observed among the Russian speakers, where the affricate in the word *koncov* is the shortest, except for K3, who articulates the voiced affricates as shorter than the voiceless ones.

In the case of K1, the phoneme in *solnce* is longer than the Russians. However, the occlusive moment in this instance is nearly identical to that of R4. Moreover, K2 articulates this phoneme very similarly to R4, including the occlusive part. This is very interesting considering that this speaker does not frequently use the Russian language. K4, on the other hand, produced a long affricate, yet the occlusive moment is comparable to that articulated by the Russians. Notably, the voiceless dental affricate in *solnce* produced by K3 is 100 ms longer than the voiced one, but the occlusive part of the voiceless phoneme is shorter than that of the voiced one.

As previously discussed, *koncov* has the shortest affricate produced by Kazakhs (except for K3). K1 and K4 articulate a phoneme that closely resembles that of the Russians, although the occlusive part of K1 is shorter than the fricative phase. K2, on the other hand, produces a very brief affricate, but its occlusive moment is relatively long compared to the entire word. In the case of K3, this participant articulates a lengthy voiced dental affricate, with a durative occlusive moment.

The analysis of the duration of "real" affricates reveals that Russian speakers tend to have more similar results.

Interestingly, K1 has different values from the Russians, despite using Russian in daily communication. In contrast, K2, who rarely uses Russian, demonstrates similarity to a Russian speaker. K3 shows variability, likely influenced by the addition of sonority in his affricates, but his values are similar to those of the other speakers. Lastly, K4 presents the most variable values, although the occlusive moments he articulates closely resemble those of the Russian speakers.

Analysing the dental affricates formed by the consonant group occlusive /t/ + fricative /s/, the initial observation is that their duration is similar to that of the "real" phonemes.

The first affricate analysed is the one in *sčitat'sja*. R1 and R3 produced the occlusive part of the phoneme with a duration like the "real" ones. In contrast, R2 articulated a short occlusive part in relation to the fricative one, which is longer. R4 produced a shorter phoneme, with the occlusive moment almost identical to the fricative one. Kazakh speakers, on the other hand, show a duration for the affricate in this context that is generally more similar to each other and even to the Russian speakers. K1 and K4 articulated the phoneme with a very short occlusive part, whereas K2 and K3 produced this part almost as long as the Russians.

The second word analysed is *udastsja*, for which we have fewer occurrences. This is because R2, R4 and K1 did not unify the articulation of the two phonemes into the affricate in the fourth task, likely due to the complexity of the consonant group. This context is also the most variable among those analysed. R1 articulated the affricate 100 ms longer than R3, and the occlusive part of this phoneme is also longer compared to the one produced by R3. In the case of K3, who articulated a voiced affricate in this word, there is a very short occlusive moment compared to the duration of the entire phoneme. A similar pattern is observed in the articulation of the occlusive part of K4.

The last word analysed in this consonant group context is *otkazat'sja*. The phonemes articulated by the Russians in this word were very variable, but overall, their durations were shorter compared to the other words analysed. It is noteworthy that in the phonemes produced by R1 and R4, the fricative part is longer than the occlusive one, while R2 and R3 articulated the "standard affricate" where the occlusive part is longer than the fricative.

4.2. Palatalized consonants

For this research, we decided to investigate another typical Russian feature that is not found in the Kazakh phonological inventory: the palatalization of consonants. Palatalization occurs when consonants are followed by soft vowels or soft signs (see Section 1.2).

4.2.1. Voiceless dental occlusive palatalised

The first phoneme analysed is the voiceless dental occlusive /t'/. In total, there were 11 occurrences of this phoneme in 4 different linguistic contexts, amounting to 33 occurrences across the three reading tasks. The contexts are:

a. 4 occurrences in word-ending position, indicating the infinitive form of a verb: *zastavi<u>t'</u>* "to oblige"; *snja<u>t'</u>* "to remove"; *du<u>t'</u>* "to blow"; *prizna<u>t'</u>* "to acknowledge".

b. 1 occurrence before the vowel /i/: *zameṯili*, that is the past plural form of the verb *zametit'* "to notice".

c. 2 occurrences before the vowel /e/: *ṯem*, that is "then" in the comparative form; *zaṯei* "ventures".

d. 4 occurrences in *veṯer* "wind", which has a standard production as /vjetjir/, but it changed in each speaker. For this reason, we decided to analyse *veter* individually and not with *zametili*.

None of the participants articulated the expected 33 occurrences. Specifically, the Russian speakers did not produce the ones in the word-ending position: instead, they articulated a long vowel. In total, we analysed 208 palatalized occlusives, with 126 produced by the Russians (plus the occlu sive articulated as an affricate by R2); and 82 voiceless occlusive palatalised by the Kazakhs (plus 12 affricates).

It is worth noting that there were 3 unexpected occurrences: those in *kutalsja*, the masculine past form of "cover himself"; *kotoryj*, a relative pronoun; and *zakutannogo* "wrapped up". All these occurrences are shown in Table VI divided by speakers

Table 6: Number of occurrences divided by speakers.

Russian speaker	Occurrences	Kazakh speaker	Occurrences
R1	28 (of which 1 in *kutalsja*)	K1	27 (of which 1 in *kutalsja*, 1 in *zakutannogo* + 2 affricates)
R2	35 (of which 1 in *kutalsja*, 1 in *kotoryj* and 2 in *zakutonnogo* + 1 affricate)	K2	11 (+2 affricates)
R3	29 (of which 1 in *kutalsja* + 1 affricate)	K3	20 (+ 7 affricates)
R4	34 (of which 1 in *kutalsja* and 1 in *zakutonnogo*)	K4	24 (+ 1 affricate)
Tot	126 (+2 affricates)	Tot	82 (+12 affricates)

4.2.2. Place of articulation

First, we analysed the place of articulation of the voiceless dental occlusive when produced with palatalisation. To do so, we extracted the average values of the release moment using the software PRAAT (see Table VII). The fricative phases of those phonemes articulated as dental affricates were also analysed, and these are shown in Table VII with the '*' symbol.

The first noticeable thing is that the Russian speaker R1 produced the lowest number of palatalised phonemes, only 27. This number of occurrences is similar to K1's, which articulated 25 palatalised occlusives. This can be explained by the fact that R1 moved from Saint Pietersburg to Italy 10 years ago, and during the interview task, he confessed that she tried to eliminate all the traits typical of Russian when speaking Italian.

She felt that these traits could create a linguistic divergence between him and the interlocutor (cfr. Bratkowsky, 1980 for the palatalisation of German consonants and their perception in Russian speakers). This fact has led to possible linguistic accommodation, which is the process whereby a listener makes adjustments in response to the speaker's behaviour.

We proceed now with the analysis of the expected occurrences.

R1 articulated the voiceless dental palatalised occlusive similarly in all the linguistic contexts observed. In *veter*, he produced a phoneme with a CoG of 5486.5 Hz, which is closer to the value of *zametili* (5830.0 Hz) rather than the '-te-' context (6157.7 Hz). This suggests that this speaker articulates the vowel following the palatalised occlusive in veter similarly to the standard pronunciation /vjetjir/.

R2 exhibits slightly more variability than R1. The average value of *veter* (5241.0 Hz) indicates that he articulates the vowel more like /jɛ/ than /i/, as it is closer to the value of the '-te-' context (5191.1 Hz) than the *zametili* one (4824.2 Hz). This speaker also produced the affricate when reading the word *dut'*, which showed a higher CoG value of 200 Hz compared to the other contexts. The StD of R2 is 1000 Hz less than R1's, indicating that even though these two speakers are from the same city, they disperse articulatory energy differently when producing palatalised occlusives.

In the word *veter* produced by R3 from Volgograd, the CoG value is similar to that of *zametili*, which is the highest among all contexts. To better understand this, we analysed the F2 of the /i/ following the occlusive in zametili. The second formant (F2) is related to the degree of backness: the more front the vowel, the higher its value. In R1 and R2, the F2 value is 1800 Hz, while in R3 it is higher than 2000 Hz, indicating that he not only produced an anterior consonant, but also affected the following vowel. This speaker also produced an affricate in the '-te-' context, but the average value of the fricative moment is 750Hz lower than those of the release part of the occlusive This suggests that he articulated this affricate in a more central position.

The average StD value shows less energy dispersion compared to R1, but it is similar to R2. The lowest is the '-te-' one (3319.6 Hz), not significantly different from the value of the affricate in the same context (3834.7 Hz).

Table 7: Average centre of gravity (above) and standard deviation (below) values expressed in Hz, divided by occurrences and speaker.

	T’	-te-	Zametili	Veter	Kutalsja	Kotoryj	Zautonnogo
R1	5246.4 4982.6	6157.7 4860.9	5830.0 4547.7	5486.5 4702.9	3585.6 3596.8	-	-
R2	4291.9 3418.6	5191.1 3510.2	4824.2 3715.4	5241.0 3526.9	3260.2 3494.0	3613.4 3102.5	3841.9 4225.9
R2*	4468.8 4098.1	-	-	-	-	-	-
R3	5138.4 3858.0	6183.1 3319.6	6525.1 3675.2	6637.9 3670.2	3200.0 4112.4	-	-
R3*	-	5432.8 3834.7	-	-	-	-	-
R4	7443.2 4763.4	8540.9 3937.6	7756.3 5121.7	7972.8 4548.6	4063.7 4632.9	-	4394.1 4772.5
K1	3928.9 4728.4	6731.5 4833.2	5573.8 5222.7	5444.3 5401.9	4903.7 5785.8	-	7059.4 6687.4
K1*	-	6101.1 4760.5	-	-	-	-	-
K2	6453.9 6520.6	6230.4 5721.5	6682.8 5737.1	5368.6 5943.4	-	-	-
K2*	-	7315.4 6132.6	-	-	-	-	-
K3	4471.2 3822.1	5822.4 4620.0	4968.2 4033.5	5156.4 3587.7	-	-	-
K3*	4985.5 3310.1	5286.4- 4057.4	-	5335.8 3242.5	-	-	-
K4	5591.7 4784.0	6854.6 4997.6	6012.5 5273.7	6115.3 5319.4	-	-	-
K4*	5395.2 4543.6	5777.7 4360.7	-	-	-	-	-

R4 follows the trend seen above where she produces the highest values of all speakers: the highest is the ‘-te-’ context, with a CoG of 8540.9 Hz. The value of the occlusive in the word *veter* is more similar to the *zametili* one, suggesting that she produces a standard pronunciation.

The average StD values are higher than those of R2 and R3, but they are close to the values of R1. As said above, the presence of palatalised occlusives in *kutalsja*, *zakutonnogo* and *kotoryj* was unexpected. In the cases of *kutalsja* and *zakutonnogo*, the reason for the palatalisation can be attributed to the vowel following the consonant. These vowels were expected to undergo reduction, a phenomenon typical of Russian, and should be reduced in /ʌ/. However, during the transcription of the recordings, it was noted that some of the speakers articulated /æ/ instead of /ʌ/. When /æ/ was preceded by a /t/, the speakers tended to palatalise it in /t’/.

The average CoG values of R2 (3841.9 Hz) and R4 (4394.1 Hz) suggest that they produced a more central palatalised occlusive, possibly due to a co-articulation phenomenon with the central vowel /æ/. In the word *kutalsja* all speakers realised a palatalised occlusive with a similar point of articulation, as there is little variation between the values, which range between 3200-4000 Hz. Interestingly, these are low values, suggesting a more central place of articulation compared to the contexts where the phoneme is followed by /jɛ/ and /i/. However, this central articulation could be attributed to the more central vowel /æ/.

Finally, the case of *kotoryj* is unexpected, as the palatalised occlusive is followed by the vowel /o/. However, only one occurrence was found out of a total of 209 occlusives analysed. This was produced by R2, suggesting that it represents a different articulation from the standard one. Since the phoneme was followed by the back vowel /o/, the CoG and StD values are lower (CoG 3613.4 Hz, StD 3102.5 Hz).

The Kazakhs, on the other hand, show less confidence in producing the palatalisation, as they articulated 45 palatalised occlusive less than the Russians, and 12 affricates.

Starting with K1, his average CoG values are higher than those of the Russians. The highest is 7059.4 Hz in *zakutannogo*, with an almost interdental articulation. The StD is also high, indicating a great dispersion of articulatory energy. In the ‘-te-’ context, the CoG of the palatalised occlusive is 6731.5 Hz, while the one of the affricates is 6101.1 Hz.

More central are the occlusives in *zametili* (CoG 5573.8 Hz; StD 5222.7 Hz), *veter* (CoG 5444.3 Hz, StD 5401.9 Hz) and *kutalsja* (CoG 4903.7 Hz, StD 5785.8 Hz). It is important to note that veter is similar to *zametili*, suggesting that this speaker articulates veter in a standard way. In the word-final context, the CoG value is 3928.9 Hz, nearly 3000 Hz lower than that of *zakutonnogo*. However, its StD value is 4728.4 Hz, which aligns with the other contexts observed. In conclusion, K1 exhibits diverse values, but they do not significantly differ from those of Russian speakers.

Secondly, K2 is the speaker with the lowest number of occurrences, having produced voiceless dental occlusives without palatalisation, totaling 11 phonemes analysed. His CoG values vary from 5368.6 Hz in veter to 6682.8 Hz in *zametili*. Interestingly, these values suggest that he articulates *veter* with a more anterior position than the standard pronunciation. The StD values for these occurrences are similar to each other, as 5943.4 Hz is the one of *veter* and 5737.1 Hz the *zametili* one. The StD of the '-te-' context is similar to that of *zametili*. In this context, the CoG of the occlusive is 6230.4 Hz, while the CoG of the affricates is 7315.4 Hz, indicating an almost interdental articulation, and the speaker disperses more articular energy when producing them. In the word-final context '-t'', K2's values are intermediate between the '-te-' context and *zametili*. The CoG in this case is 6453.9 Hz, and the StD 6520.6 Hz, which is higher than in the other contexts.

Continuing with the analysis of the Kazakhs, K3 exhibits significant variability in his articulation. In the '-te' context, he produces the most anterior palatalised occlusive (5822.4 Hz), while the least anterior is the word-final context, like K1, with a CoG of 4471.2 Hz. Interestingly, K3 frequently substitutes occlusives with affricates. In the -t' contexts, the CoG is 4985.5 Hz, higher than the palatalised occlusive in the same context; whereas in the '-te-' context it is 5286.4 Hz, which is lower than the occlusive. He also articulated an affricate in *veter*, where the CoG value is 5335.8 Hz, higher than the palatalised phoneme in the same context (5156.4 Hz). In *zametili*, K3 only articulated the palatalised occlusive, with a CoG value (4968.2 Hz) similar to veter, suggesting a standard pronunciation in this context. The StD values reveal that the speaker disperses more articulatory energy when producing occlusives compared to affricates in the same contexts.

Finally, K4 articulates the occlusives similarly to R1, with the highest CoG value in the '-te' context (6854.6 Hz) and the lowest in the '-t'' context (5591.7 Hz). The *veter* value (6115.3 Hz) is more similar to *zametili* (6012.5 Hz), suggesting a standard pronunciation. The CoG values of the affricates produced K4 are articulated more posteriorly. The StD is also similar to K1, with a maximum difference between the two speakers of 100 Hz. The StD of the affricates is lower than that of the palatalised consonant in the same linguistic contexts.

4.2.3. Duration

Following the same methodology as for the dental affricates, we also analysed the duration of the palatalised occlusives. The data was extracted from the third reading task and then normalized (Table VIII).

First, we analysed the expected occurrences. For all the speakers, *zametili* was the shortest value, and the occlusion phase was not significantly different for R1, R2, R3 and K3. However, R4 and K1 displayed a very rapid occlusion phase, which was more relevant compared to the release phase. On the other hand, K1 and K1 showed a longer occlusion phase.

The '-t'' context appears to be heterogeneous among the expected occurrences. The Russian participants all had similar occlusive moments, while the overall duration of the entire phoneme varied. R3 produced the longest one (301 ms), followed by R4 with 281 ms, R1 with 269 ms, and R2 had the shortest value at 172 ms, which resembled the value found in *zametili*.

Interestingly, the affricate produced by R2 was longer than the palatalised occlusive, but its occlusive moment was similar to that of the palatalised phoneme.

Kazakh speakers exhibited slightly higher values. K1's duration is similar to R3, with an imperceptible difference of 2ms; however, the occlusion phase than that of the other participants. K2 has the longest duration (334 ms), but the occlusion moment is similar to that of the Russians. K3 and K4's durations were more akin to the Russian speakers. The affricates of K3 and K4 were long (378 ms for the former and 274 ms for the latter), but their occlusion phases were like R2's.

In the '-te' context, the palatalised occlusive had the longest value for all participants, except for K1, who produced the longest phoneme in the '-t'' context. R1, R2 and K1 had very brief occlusion phases. R4 and K3 had the occlusive moment identical in proportion to the entire phoneme, and the latter was similar to K4. R3 produced a very long palatalised occlusive (422 ms), and the occlusive moment was also lengthy, with these val ues being slightly higher than that of the affricates produced by K2, who did not articulate any palatalisation in this context during the third reading task.

In the *veter* context, R1 had similar values to R2, but the occlusion phase of the latter was very brief, while the moment of R1 was quite similar to R3, albeit slightly higher than R4. Among the Kazakhs, K1's values are similar to K2, but the occlusive part is longer than the release phase. K3's duration is 57 ms shorter than K4, but the occlusion phase is similar between the two. Lastly, the affricate produced by K3 was shorter than the palatalised occlusive counterpart.

Analysing the unexpected occurrences, we have two instances of kutalsja by R3 and K1. R3's value is slightly higher than K1's, but they both show the same duration of the occlusion phase, which is higher than the release moment. The same pattern, where the release phase is shorter than the occlusion, is also found in *kotoryj* by R2 and in *zakutannogo* by R4 and K1. On the other hand, in this last context R2 articulates a very short occlusion in relation to the entire phoneme.

Table 8: Average production time divided by the entire phoneme (above), occlusive moment (below left), and release moment (below right).

	-T'	-TE-	Zametili	Veter	Kutalsja	Kotoryj
R1	269 117-152	304 74-230	143 53-90	247 88-159	-	-
R2	172 65-107	37 93-280	171 71-100	241 43-198	-	186 104-82
R2*	371-135-236	-	-	-	-	-
R3	301 121-180	422 202-220	226 78-148	278 95-183	159 102-57	-
R3*	-	-	-	-	-	-
R4	284 122-162	376 111-165	141 19-122	313 106-207		
K1	303 187-116	295 64-231	153 64-89	255 139-116	135 85-50	
K1*	-	-	-	-	-	-
K2	334 138-196	-	150 70-80	253 133-120	-	-
K2*	-	385 170-215	-	-	-	-
K3	247 115-132	327 97-230	190 62-128	279 89-190	-	-
K3*	378 147-231	-	-	186 55-131	-	-
K4	295 107-188	392 127-295	233 52-181	336 102-234	-	-
K4*	231 103-128	-	-	-	-	-

In summary, Kazakh speakers exhibit a higher degree of variability in the occlusion moment, where the release phase is sometimes shorter than the occlusive one. Notably, when considering the two speakers who use Russian daily, K1's articulation shows significant variability, while K4's values closely resemble those of Russian native speakers.

4.3 Voiceless post-alveolar fricative

The final phoneme under analysis is the voiceless post-alveolar fricative. This sound exists in both the Russian and Kazakh languages, but the palatalized /ʃʲː/ is specific to the Russian. According to Kochetov (2017), the palatalized voiceless post-alveolar fricative is phonologically distinctive, and only a few languages feature it. Furthermore, during spontaneous speech, it undergoes a phenomenon of de-palatalization. In the study by Bolla (1981), it is demonstrated that /ʃʲː/ is 1.55 times longer than /ʃ/. Bolla also notes that the spectrogram of the palatalized fricative exhibits greater noise density at higher frequencies, around 5000 Hz, while the non-palatalized fricative has a noise density of around 3500/4000 Hz.

In his articulatory study of palatalized consonants, Vasiliev (2004) compares the spectrograms of /ʃ/ and /ʃʲː/: the duration of /ʃʲː/ is greater compared to that of /ʃ/. The spectrogram of the palatalized consonant shows more intense frication, as indicated by greater darkness in the fricative noise. Unlike /ʃ/, the spectrogram of /ʃʲː/ exhibits no friction in the lower frequency band (Figure 9). Even in this case, Vasiliev presents an image of a fricative where the display frequencies are low, with the image 'cut' at 3500 Hz; however, we know that fricatives develop at higher frequencies, around 4000/5000 Hz for palatals. Additionally, the phoneme is presented in isolation, without the phonotactic context in which it occurs, making the spectrogram difficult to interpret.

Based on this previous information, we aimed at analysing the production of fricatives.

In the text, there were 12 occurrences, of which 5 palatalised:

a. 4 occurrences in final-word position in *plašč* ‘coat’.
b. 1 in the compound /stʃ/ that, as discussed in Section 1.2.2, becomes /ʃʲː/ in *sčitat’sja* ‘to be considered’.
c. 1 non-palatalised fricative in a word-initial position in *šel*, the past form of ‘to go’.
d. 1 non-palatalised fricative in an inter-vowel position, in *rešili*, the past form of ‘to decide to’.
e. 3 occurrences of the non-palatalised in *čto* ‘that’, where the phoneme /tʃ/ is pronounced as /ʃ/.
f. 1 non-palatalised fricative in a post-sonorant position in *ran’še* ‘before’.
g. 1 occurrence in the word *solnyško*, ‘sun’.

In total, 286 fricatives were analysed, as R1 produced the word *solnyško* as *solnce* during two tasks.

4.3.1. Place of articulation

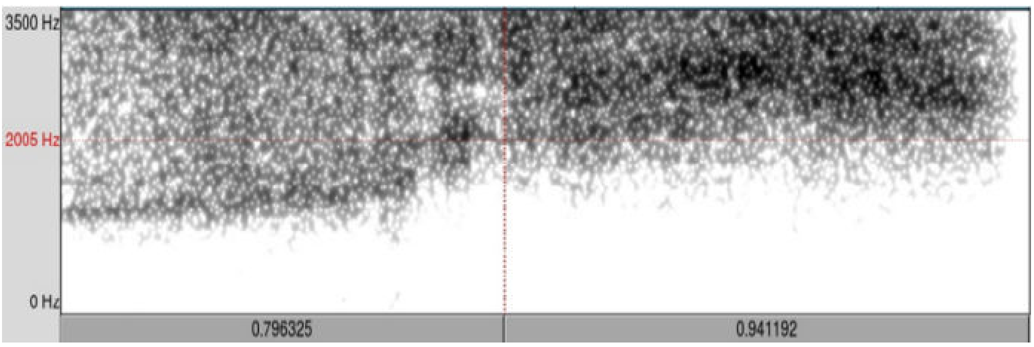
As for the phonemes seen before, for the analysis of the fricatives we used PRAAT to identify and annotate the phonemes with the tags “FRIC” and “FRIC PAL”. We then extracted the CoG and StD values (Table IX).

Table 9: Average centre of gravity (above) and standard deviation (below) values expressed in Hz, divided by occurrences and speaker.

	Plašč (PAL)	Sčitat’sja (PAL)	Šel	Rešili	Čto	Ran’še	Solnyško
R1	3719.5	4223.7	3630.5	3572.5	4625.2	3858.6	3872.4
	3804.3	3720.0	3476.6	3115.8	3984.9	3762.0	3856.0
R2	3471.2	4575.3	3687.9	4346.3	3976.8	4480.5	4332.5
	2904.6	2925.5	3027.1	3665.1	3114.9	3469.7	3331.7
R3	4498.1	4828.4	4484.8	4071.9	4349.9	4178.1	3869.8
	3286.6	3127.0	3216.6	2905.0	3292.1	3153.9	3223.2
R4	4951.4	5905.6	5405.0	4976.2	6627.3	5122.7	5080.2
	3207.9	3450.6	4107.7	3738.2	3534.7	3825.5	3744.7
K1	4872.9	5502.8	5394.6	5644.8	6029.0	4561.1	5127.8
	4352.1	4466.3	4701.3	4537.7	4693.6	4529.1	4680.5
K2	5070.8	6162.4	4824.8	4141.9	6025.1	4934.6	4575.2
	4771.3	4966.8	4928.0	4745.4	5037.7	4910.7	4784.7
K3	4657.8	5403.9	4734.1	5038.3	5489.9	4575.8	4486.4
	3482.0	3213.8	3273.9	3067.4	3270.8	3272.7	3585.0
K4	4549.7	5428.6	4978.0	4479.1	5440.1	4522.7	4130.1
	3975.7	4046.1	4475.0	3375.9	4236.1	3863.2	3981.0

The data reveals considerable variation among the speakers. For Kazakhs, R2 and R4, the /ʃʲː/ in the final-word position has a significantly lower CoG value than the initial-word position, with a difference of nearly 1000 Hz. One possible explanation for this variation is co-articulation, as the /ʃʲː/ is followed by the vowel /i/ in the word *sčitat’sja*. To

Figure 9: Spectrogram of /ʃ/ and /ʃʲː/ articulated in isolated contexts (Vasiliev, 2004, p.8).



support this hypothesis, we examined the F2 values of the vowels /i/ in *sčitat'sja* and /a/ in *plašč*. The average F2 value for /a/ was 1753.64 Hz, while for /i/ it was 2457.24 Hz. This indicates that /i/ is articulated more anteriorly than /a/, which influences the articulation of the preceding or following fricative.

Russian speakers did not exhibit significant differences between palatalised and non-palatalised fricatives. However, there was notable variety among their values. For instance, R1 had the most anterior and energy-dispersive phoneme in the word *čto*, while for R2, the other speaker from Saint Pietersburg, this was one of the lowest values. R3 produced fricatives with CoG values consistently above 4000 Hz, and he was the only speaker with notably high values for the palatalised fricatives, even though the differences between these and the non-palatalised ones were negligible. This similarity also extended to the StD values. R4, on the other hand, had the highest values among all participants, following the patterns observed in the previously analysed phonemes. His values displayed significant variation, with a difference of almost 2000 Hz, where *čto* had a CoG of 6627.3 Hz and *plašč* of 4951.4 Hz. The StD values showed a 900 Hz variation, compared to the 500 Hz variation observed for the other Russian participants.

Regarding the Kazakh participants, their values displayed significant variation. In most cases, speakers had the highest CoG values in *čto*, similar to the trend observed for R1 and R2, except for K2, who had the highest value in *sčitat'sja*. Notably, the Kazakh speakers dissipated more articulatory energy compared to the Russians, except for K3, who had values more akin to the Russian speakers. These values also showed less linearity compared to the CoGs. As for the lowest StD values, all the Kazakhs had them in the word *rešili*, while K1 had his lowest value in *plašč*, like R2 and R4. The highest StD value depended on the contexts, and it is worth noting that K1 and K4 had it in *šel*, like R4. Another interesting observation is that K2 had his highest StD value in the *čto* context, similar to R1 and R3, with a value of 5037.7 Hz, the highest among all the participants.

The CoG and StD values also exhibit significant variation within the same speaker. K1, for instance, has a 1200 Hz variation, while K2 shows a 2000 Hz variation. In K2's case, *rešili* has the lowest value, and *sčitat'sja* is the highest. This is interesting since both fricatives are followed by the /i/ vowel, indicating that K2 is aware of the difference between palatalised and non-palatalised fricatives and is trying to emphasize this contrast. K3 and K4 exhibit values more similar to the Russian speakers. It is worth noting that K3 has a low CoG value in *solnyško*, but a high StD value, suggesting a posterior articulation with a considerable amount of energy dispersion.

In conclusion, there is no clear and consistent distinction between the two phonemes, except in the case of K2, where he hyper-articulates the difference. These results confirm the findings of Spinu, Kochetov & Lilley (2018), who compared palatalised and non-palatalised fricatives and concluded that there is no distinctive difference between them.

4.3.2. Duration

The duration of the fricatives was also analysed, following the same methodology used for the other phonemes. The values are presented in Table X.

Table 10: Average production time divided by the entire phoneme (above), occlusive moment (below left), and release moment (below right).

	Plašč (PAL)	Sčitat'sja (PAL)	Šel	Rešili	Čto	Ran'še	Solnyško
R1	400	291	430	371	591	314	-
R2	416	381	638	337	313	375	115
R3	324	235	427	310	382	341	155
R4	382	268	613	364	467	339	184
K1	358	251	389	275	474	325	136
K2	376	272	426	302	306	228	149
K3	360	350	530	337	459	388	206
K4	370	372	492	309	415	336	199

Firstly, it is evident that *solnyško* is the shortest fricative for all the participants, except for R1, who articulated solnce instead of the expected word. The shorter duration of *solnyško* can be attributed to the fact that this fricative is preceded by /ɨ/, which has an average F2 of 1650 Hz. This F2 value places the articulation more posteriorly than that of /ʃ/. Additionally, /ʃ/ is followed by /k/, an occlusive with a longer voice onset time (VOT) as discussed by Zmarich, Bortone, Vayra, & Galatà (2013). This long VOT can lead to a more posterior articulation or aspiration. Since there was no aspiration evident in the spectrograms, the participants articulated it in a more posterior manner. The fricative in *solnyško* is positioned between two posterior phonemes, which contributes to its faster articulation, emphasizing the surrounding phonemes.

All participants produced the non-palatalised fricative in a word-initial position as the longest in duration. Specifically, R2, R3, R4, K2, K3 and K4 articulated the longest fricative in *šel*, while R1 and K1 did in *čto*. The second longest fricative varied among participants: for R1 and K1, it was in *šel*, while for R3, R4, K3 and K4 in *čto*, and for R2 and K2 in *plašč*. Kochetov and Lobanova (2007) studied the Russian language in Komi-Permyak and found that fricatives in a word-final position are generally shorter than those in a word-initial position. This finding is partially reflected in our participants, as two speakers articulated the fricative in *plašč* as longer than the one in *čto*.

5. DISCUSSION

The three analyzed phonemes have provided different results in the realizations of our speakers.

Starting with dental affricates, it was possible to notice how Kazakh speakers articulated significantly longer affricates compared to the Russians. Notably, it is evident that the occlusive part is much shorter in duration compared to the fricative moment for all the Kazakh participants, except for K2, the speaker from the south. K2's affricate has an average duration of 190ms, with 91ms is the occlusive moment and 99ms is the fricative part.

When a dental affricate emerges as the result of a cluster between a voiceless dental occlusive /t/ in a word-final position and a voiceless fricative /s/ in a word-initial position, all Russian speakers articulated the affricate in ot svoej in all occurrences. Among the Russian participants, R1, R2 and R3 produced a very brief occlusive part in relation to the entire affricate, while R4 has a duration similar to the Kazakhs, except for K2, who articulated the shortest affricate. Among the Kazakh speakers, K1 did not produce the phoneme during the third reading task, and K2 articulated the two phonemes separately as an occlusive and a fricative. Notably, all participants articulated a very long affricate.

The other context in which this type of affricate appeared is in *tut severnyj*. Russian speakers produced this phoneme with a duration similar to the "real" affricates, but also similar to the Kazakhs. Upon closer examination of the occlusive parts, Table V shows that Russians have similar time values, while the Kazakhs K1 and K3 articulated short occlusive parts. Conversely, K4 produced longer occlusive moments in relation to the entire word.

If we consider the linguistic context, it was possible to observe that among Kazakh speakers who used the Russian language (K1 and K4), we observed a variable place of articulation, with a variation that is more similar to other Kazakh participants, K2 and K3, even though the latter do not typically speak Russian outside of academic contexts. This variability is distinct from that of the Russian speakers. The duration of affricates varies across different linguistic contexts, and it is important to note that this variation is not exclusive to Kazakh speakers but is also observed among the Russian participants.

It is interesting to briefly examine the Kazakh participant K3, who produced a voiced dental affricate in all the CCV contexts analysed. When the affricate is preceded by a fricative or nasal consonant, this speaker introduces the voiced feature into the fricative phase of the affricate. One potential explanation for this phenomenon can be found in Bolla (1981, p.83), which suggests that nasal consonants in the Russian language are inherently voiced. In this case, K3 may be undergoing a process of progressive partial assimilation, where the following phoneme (the affricate) assimilates the sonority feature. When the affricate is preceded by a fricative, it is possible that the speaker added to separate the phonemes, simplifying the articulation. Interestingly, this participant produced phonemes that do not exist in his linguistic inventory and introduced the sonority feature to them. The duration of his voiced affricates aligns with languages that feature the opposition between voice/voiceless affricates (Meluzzi, 2020). This speaker also exhibits a higher degree of variability in his articulation patterns.

Concerning the palatalized alveolar occlusive, it was possible to note that speakers that tended to articulate reduced vowels were more prone to palatalisation. This phenomenon aligns with findings in Bratkowsky's study on the predictability of consonant palatalisation in Russian (1980, p. 331), which suggests that Russian speakers often palatalise the consonant before /æ/. The fact that the Kazakh speaker K1 also palatalised these occlusives demonstrates a deep understanding of the contexts where Russian palatalisation occurs. Surprisingly, K2, who rarely uses the Russian language, also palatalised some of these occurrences, even though he had palatalised very few expected occurrences. Therefore, Kazakh speakers exhibit more uncertainty in the articulation of palatalised occlusives, as they tend to produce more affricates and fewer palatalised phonemes. They also display greater variation in both CoG and StD values. However, the similarity in StD values between K1 and K4 and the Russian speakers is notable, and this might be attributed to the fact that these two participants use the Russian language more frequently.

Finally, for post-alveolar fricative, we expected that /ʃʲː/ would be longer than /ʃ/: however this was found only in the word-final position, and this difference was not consistent in all contexts. For instance, the /ʃʲː/ in *sčitat'sja* produced by R1, R3, R4 and K1 was relatively short, making it one of the shortest fricatives. This observation supports Kochetov (2017), who states that the temporal difference between these two phonemes has diminished over time. Additionally, the variability in the duration of /ʃ/ in the *ranše* context might be because it follows a nasal sound, which, according to Bolla (1981), involves an alveo-palatal occlusion before transitioning to the fricative. This articulation is relatively complex and depends on the preceding nasal occlusion. Thus, the data provide support for the findings of Spinu, Kochetov & Lilley (2018), which suggest that there is uncertainty and confusion between the place of articulation of the two phonemes, leading to a lack of distinction between /ʃʲː/ and /ʃ/. The similarity of the CoG, StD and temporal values analysed indicates that the distinctive difference between these two phonemes may be diminishing.

The analysis section leads to two key reflections. First, it raises the question of whether participants are articulating the phonemes and then unconsciously perceiving them as a single phoneme /t͡s/, or as a sequence of phonemes, /t/ + /s/. The presence of post-burst aperiodicity (PBA) in the articulation of the palatalised voiceless dental occlusives of all Kazakhs, but not in the Russians, is noteworthy. It is important to note that K2 also exhibited PBA in the production of some voiceless dental affricates. This suggests that Kazakh speakers, who do not have voiceless dental affricates and palatalised occlusives in their linguistic inventory, may articulate these sounds as two distinct entities with no cohesion between them. This sequential articulation aligns with previous debates in the field, particularly related to affricates (Meluzzi, 2020).

Secondly, this analysis raises questions about the potential transfer of phonetic patterns between the participants' L1 and their L2, in this case from Kazakh to Russian. The similarity in values between K1 and K4, who use Russian in their daily lives, is particularly relevant, especially concerning the StD of the palatalised voiceless dental occlusives and the post-alveolar fricatives. This suggests that they might transfer the articulation patterns from their L1 to L2, as these phonemes in Russian are similar to those in the Kazakh inventory, i.e., the non-palatalised occlusives and the fricatives. However, the voiceless dental affricate does not exhibit similar values across the participants, indicating that this phoneme is entirely new for them and not subject to transfer from their L1.

It is indeed interesting to discuss the unexpected occurrence of palatalisation in the occlusive in *kutalsja*, which we observed may be influenced by the following vowel /æ/. This result is entirely new, as Bratkowsky (1980) states that palatalisation is influenced by the following vowel, but just to predict palatalisation in the occlusives. However, our findings suggest that palatalisation can be subject to variability connected to the following vowel.

6. CONCLUSIONS

In conclusion, this analysis aimed to examine the production of Kazakh speakers from different regions. Regarding voiceless dental affricates, K1 appears to be the most similar to Russian native speakers, while K3 exhibits more variability since he also articulated voiced affricates. With occlusives, Kazakh speakers often produced affricates instead of palatalisation, and K2 even produced a voiceless dental affricate. This suggests that since palatalisation does not exist in the Kazakh phonological inventory, speakers employ alternative strategies to account for this distinction.

For post-alveolar fricatives, the results were unexpected, indicating a de-palatalisation phenomenon. The values show no temporal variation, suggesting a loss of a phonological distinction between the two fricatives. Although K1 is from a region where Russian is predominantly spoken, there are influences of the Kazakh language in his Russian production. He shares similarities with Russian native speakers, much like K4. On the other hand, K2 and K3 are the most distinct from Russian. However, considering that these two participants rarely use Russian, it is important to note that they have partially learned typical Russian language phenomena.

This research was limited by the small number of participants, but this limitation was offset by the extensive number of tokens analysed. For further research, increasing the number of participants (to examine for instance the Russian spoken in Moscow and see if their values are just as high as that of R4), exploring a broader geographic area, and analysing vowels (given the presence of vowel harmony in Kazakh and the vowel reduction in Russian) or examining frequent words (see Mousikou & Rastle, 2015) and spontaneous speech would provide further insights into the research.

DECLARATION OF COMPETING INTEREST

The authors of this article declare that they have no financial, professional or personal conflicts of interest that could have inappropriately influenced this work.

AUTHORSHIP CONTRIBUTION STATEMENT

Rebecca Andrea Pisati: Data acquisition, Data analysis, Writing - original draft.

Chiara Meluzzi: Conceptualization, Methodology, Validation, Writing - review & editing.

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