International Journal of Multiphysics
Volume 19, No. 1, 2025
ISSN: 1750-9548

Acoustic Study of the Weakening Process in Azarbaijani Turkish of Ardebili, Germi and Parsabad Dialects

Seyed Mohammad Reza Heidari[1] , Seyed Mohammad Razinezhad[2*], Latif Attari[3], Abdolhossein Heidari[4]

1. PhD student, Department of Linguistics, Ardabil Branch, Islamic Azad University, Ardabil, Iran.

2. Assistant Professor, Department of English Language, Mohaghegh Ardabili University, Ardabil, Iran.

3. Department of Linguistics, Ardabil Branch, Islamic Azad University, Ardabil, Iran and Assistant Professor of Department of Linguistics and Foreign Languages, Payam Noor University, Ardabil, Iran.

4. Assistant Professor, Department of Language and Literature, Farhangian University, Ardabil, Iran.

Abstract

Weakening is a process in which a kind of energy reduction occurs during sound production and occurs mostly in consonants and in intervowel, postvowel, syllable-final and word-final environments. The aim of this research is to investigate and analyze the acoustic weakening process in Azerbaijani Turkish of Ardebili dialect. This research was conducted based on field research and all participants are speakers of this language.

Keywords: weakening process, consonant, acoustics.

Introduction

Since language is a social matter, it naturally does not have a fixed and uniform form and therefore, it is always changing based on the needs of the society. Every language in every period of history has specificities that are different from previous and subsequent periods (Bagheri, 2004: 20). Therefore, language can be studied and analyzed from two different historical perspectives, either in time and descriptive or synchronicity. By definition, the synchronicity method is the study of the structural and acoustic characteristics of a language at a specific time, without considering its historical developments. In every period, humans tried to simplify their language in order to establish simple and easy communication. In the Turkish language, changes and developments have also taken place in this language based on need. It is not possible to study languages and follow their evolution from the past to the present without exploring history and historical-comparative study (Zafaranloo et al., 2000: 2). Given that the Turkish language, like other languages, has always undergone phonetic changes, therefore, it seems necessary to study phonological changes, including phonetic weakening. Given the essential structure of language in general and the necessity of knowing the evolutionary and historical development of each language in particular, it seems that in some fields, it is not possible to study the synchrony of linguistic changes except through temporal studies. The process of phonetic weakening is also considered one of the developments that cannot be systematically and comprehensively studied without considering their evolutionary and developmental path. In English, Persian, and other languages, the process of weakening has been studied extensively, but acoustic studies have not been widely conducted. Given that sounds cannot be observed, acoustic studies through spectrograms and sound waves provide us with this possibility. Acoustic studies practically give a seal of approval to theoretical studies and will be evidence for examining other research in this field. Acoustic studies are used worldwide in the analysis of most phonological processes, but unfortunately, in our country, they are new and somewhat unknown, and have not been well introduced. The acoustic study of the challenging process of weakening within the framework of the source-filter theory can be a good reason for the adequacy and efficiency of this approach, and researchers can benefit from this approach in studying the phonological processes of other Iranian dialects. The study of the weakening process in Azerbaijani Turkish of the Tabrizi dialect has been studied by researchers, but this study has not been conducted acoustically in either Azerbaijani Turkish of the Tabrizi dialect or in Turkish of the

Ardebili dialect. The questions raised in this study are: 1. Was the process of phonetic weakening and the different ways in which they occurred in Turkish of the Ardebili dialect random and arbitrary? 2. To what extent has the frequency of these linguistic changes been in Turkish of the Ardebili dialect? 3. Were the changes in this language limited to a specific period?

Research Methodology

First, the mechanisms of different theories were examined, and then articles on the weakening process in other languages were studied. Then, it was analyzed and examined through the data-driven software.

Theoretical framework

The weakening process is related to different degrees or types of structure in the production organs. The three most important types of consonants are stops, fricatives, and aspirates (Catford, 1988; cited in Zafaranloo, 2003: 1). The phonetic changes from left to right are: stops > fricatives > aspirates, which are known as the weakening process. Kirschner (2001: 4, 21) also states that the cause of the weakening process is a phonetic stimulus to reduce energy production. The continuation of the weakening process will lead to excessive simplification of the language and the loss of consonants, and will disrupt communication. According to Knestovich (1994: 62), the weakening process is observed in the environment between two vowels or after a vowel or in the environment of the end of the syllable and the end of the word. However, Trask (1996: 57-58) does not consider it to be exclusive to the intervocalic position and considers other situations such as the beginning of a word as places where this process can occur. For example, in Old Japanese, the word pana hana is like this. In general, weakening is a change in the place of production of the sound from obstruent to fricative, fricative to non-fricative, voiceless to voiced, or even reduction to zero, and strengthening is a change in the place of production of the sound in the opposite direction. For example, the consonant /w/ in modern Persian is not considered a phoneme, but this does not mean that weakening always occurs and then strengthening occurs.

Trask (1996: 59-60) believes that the process of weakening should not be allowed to invade and invade the consonant system of the language. We are all constantly communicating with each other, and it would undoubtedly be very difficult to establish this communication by deleting consonants. Therefore, the weakening process must be counteracted in some way so that consonants can be recovered and preserved.

Crystal (1992 143) considers weakening in phonology, both temporally and synchronously, as a kind of reduction in sound power and energy, and Knestwich (1994: 35) states that the most common phonological environment for the weakening process among languages is the post-vowel context. In Jensen's view (2004: 56), weakening is the reduction of the degree of closure of a vowel, which occurs in the following way (Spencer, 1996: 62):

Obstructive > Feminine > Frictional > Nasoed > ø

Phonetic changes in words follow a series of precise rules called phonetic laws. Therefore, the possibility of these changes does not occur randomly and aimlessly, but is based on systematic principles, and all data must be carefully and valuablely examined (Bicks, 2007: 36). Trask (1996: 57) believes that the process of phonetic weakening occurs in the intervowel context. For example, in the British English word /water/, the phoneme /t/ is pronounced as a plosive /ʔ/. In Persian, this process is also transformed into the phoneme [w], subject to the phoneme [v] at the end of the second syllable. In this case, the consonant before it also becomes [o] according to the principle of assimilation.

The process of weakening has always been a challenge for linguists, so finding a framework that can examine this process in relation to this issue from an acoustic perspective is of great importance. In this regard, various acoustic theories were examined and the adequacy and effectiveness of each of these theories were tested and evaluated.

For this purpose, the smooth source theory was accepted as an acceptable and adequate framework for examining the weakening process from an acoustic perspective.:

Source-filter theory

Fant (1960) proposed the source-filter theory to describe sound and how sound is produced in the speech apparatus. In the source-filter model, speech production, transmission, and perception are linked using the acoustic

principles of wave propagation in the vocal tract. This model was first used to produce vowels and then to produce consonants.

Collet (1990) designed a parametric method for producing synthetic speech within the framework of the source-filter model. Using this method, one can change the values of parameters such as the fundamental frequency, the first, second, and third structures and their bandwidths, transient structures, wear noise, and its duration, and produce desired synthetic utterances and fragments. Linguists' judgments about these utterances and fragments are considered a suitable criterion for determining the role of parameters, acoustic cues in understanding the phonemes of the language. This method is still used for research in the field of laboratory phonology, and valuable findings have been obtained in the field of speech information processing and word recognition. Using the Coltgrid artificial speech generator in the Pert software environment, it is possible to design comprehension experiments and obtain clues to speech understanding.

Therefore, the production of speech sounds is a two-stage process. First, in a place in the speech apparatus called the source, the activity of the speech organs leads to the production of sound. At the same time, the dimensions of the reproducing cavities, namely the pharynx and mouth, change in proportion to the activity of the speech organs, and the smoothness of the speech apparatus is formed. The sound created in the source passes through the smoothness and the speech sound is produced. Therefore, by producing sound in the source, the vocal cords open and close regularly. The successive opening and closing or vibration of the vocal cords leads to the production of a sound called a vowel. The wave produced by the vocal cords is a quasi-regular position. Because a pattern of molecular compression and rarefaction of air is repeated in a unit of time. Smoothness plays a decisive role in the audibility of vowels because the oral and pharyngeal cavities are like resonating cavities that amplify certain frequencies. The resonating frequencies of the oral and pharyngeal cavities are called structures that distinguish vowels from each other. Just as metal or concrete structures ensure the strength of a building, frequency structures are also the strength or basis for the production and perception of vowels. In other words, each vowel has its own structural structure that distinguishes it from other vowels.

According to Fourier's theorem, any time signal, such as a laryngeal impulse signal or a speech sound signal, is composed of a large number of sine waves, each of which has a frequency and amplitude of oscillation. The frequencies that make up a signal and the relative amplitude of oscillation or energy of each frequency make up the frequency spectrum of the signal. The frequency spectrum is the most important and common tool for displaying the frequency of a signal, showing how the energy in decibels is distributed over the frequencies in hertz.

The change in air pressure at the site of obstruction leads to the production of sound. The shape of the speech apparatus in front of and behind the obstruction acts as a smoothing of the speech apparatus in the production of consonants. The sound resulting from the obstruction and its passage through the smoothing of the speech apparatus leads to the production of consonants. In the production of fricative consonants, the sound wave resulting from the friction at a point in the speech apparatus is an irregular wave that is created by the point of disturbance at the site of production and is called white noise.

An important point from a sound perspective is that the frequency spectrum of fricatives, plosives, and sibilants is a function of the shape of the speech apparatus in front of the obstruction: in general, the longer the length of the vocal tract in front of the obstruction, the more energy the frequency spectrum will have at lower frequencies, and conversely, the shorter the length of the vocal tract in front of the obstruction, the more energy the higher frequencies will have.

In the production of explosive consonants, the sound wave resulting from the sudden release of the explosion at a point in the speech apparatus is another type of irregular sound wave, followed by a short-term disturbance noise, because the opening of explosive closures is necessarily accompanied by a short-term abrasion. The duration of this abrasion is much longer in consonants. This type of irregular sound wave is called a transient sound. The reason why this signal is transient is that by producing an explosive consonant in speech, the continuous flow of frequency energy is interrupted for a moment and, all at once, with a sudden explosion, the frequencies with sound energy are resumed. This type of disconnection and connection of frequency energy leads to a transient sound. Figure 1-1 shows the transient sound signal in the production of the Persian voiced dental plosive d. As can be seen, because the transient sound has two parts: closure and release. Explosive sounds in a continuous speech

signal are also composed of two separate parts, a closure and a release, which are located one after the other in a unit of time.

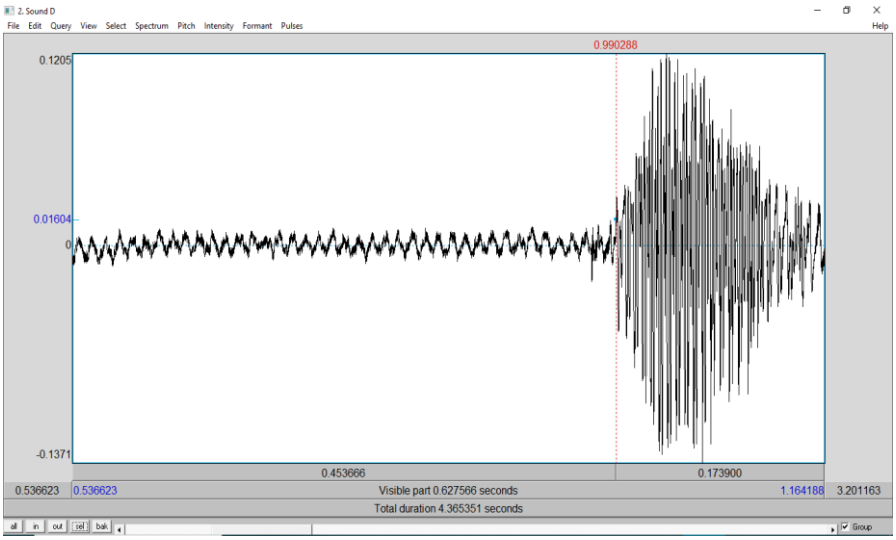


Figure (1-1): Transient sound signal in the production of the sound d

The source of sound in plosive and aspirated sounds is transient sound. And because during the production of these consonants, the passage of air through the speech apparatus is interrupted and resumed in an instant, from the point of view of the source-filter concept for the production they are transient, that is, the energy of the frequencies becomes zero in an instant and after a very short time the frequencies again have sound energy. Figure 2-1 shows the distribution of the energy of the frequencies for two consecutive parts of the closure and release of the sound /d/. As can be seen, the sound energy in the plosive closure part is concentrated at low frequencies, i.e. the range of vibration of the vocal cords, and other frequencies up to 8 kHz do not have significant energy.

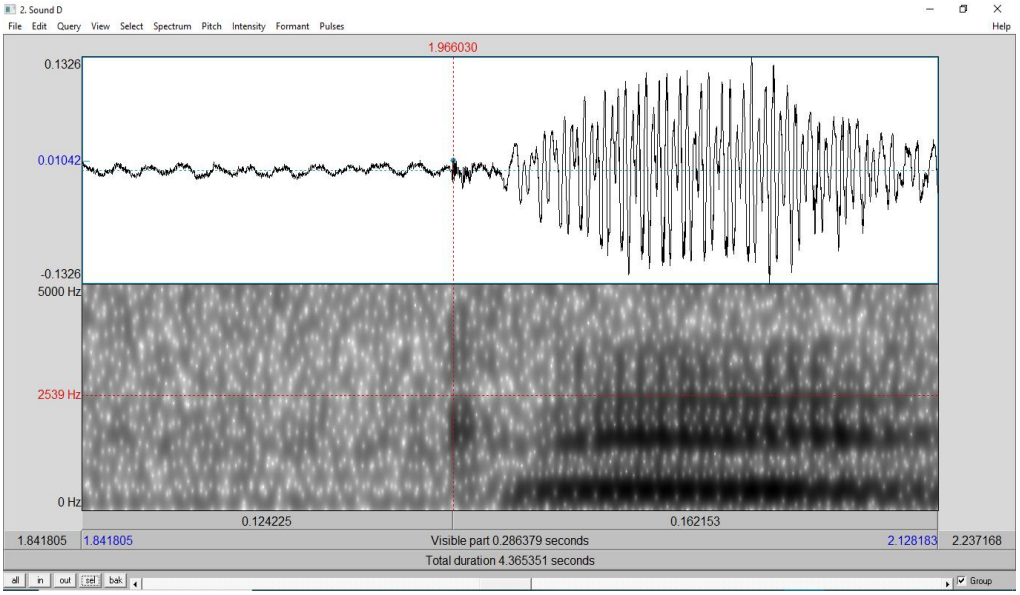
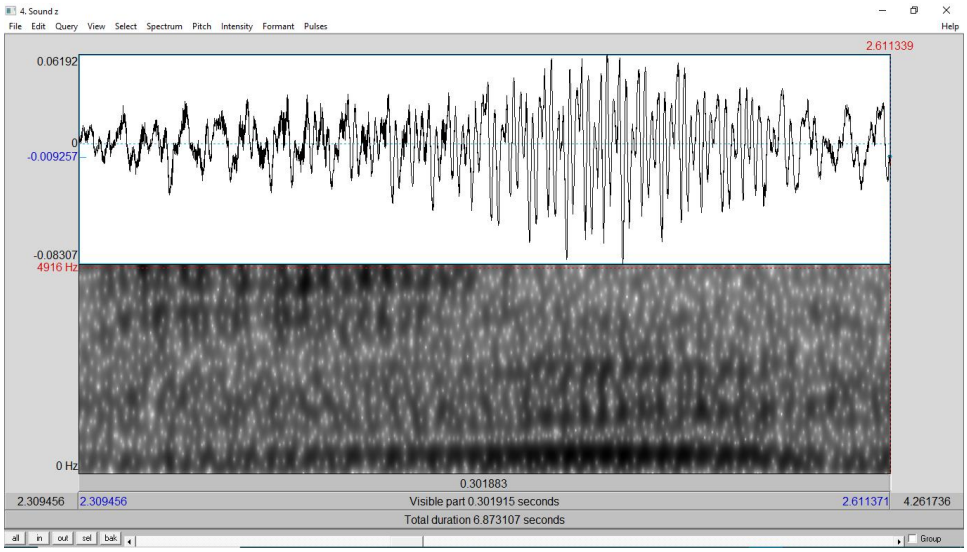


Figure (1-2): Compound source: Spectrogram of the sound /d/

In the release or sudden opening of the closure, the frequency band of 2 to 8 kHz suddenly acquires sound energy. It is clear that the closure of voiceless plosives lacks sound energy at low frequencies because the velar is completely open and the velars do not vibrate. Therefore, in the production of voiced plosives, two sound sources are active: laryngeal impulses in the closure for explosive voicing and the transient sound after the explosive release. For this reason, the sound source in the production of voiced plosives is of the compound source type.

The sound [z] also has a compound source: laryngeal impulse for voicing and white noise for blade abrasion. Figure 1-3 shows the signal and spectrogram of the sound [z].



Doubt (1-3): Compound Source: Signal and Spectrogram of the Sound /z/

The laryngeal impulse activity in the time domain (figure above) causes the sound wave [z] to be regular despite being noisy. In fact, the signal of the sound [z] is noise that is riding on a regular wave, which means that the sound source wave is complex. The laryngeal impulse activity in the frequency domain can be seen with the presence of energy at low frequencies and also the presence of vertical impulses in the range of 0 to 8 kHz. A fundamental difference in the compound source of voiced plosives and fricatives is that in the production of voiced fricatives, the laryngeal impulse and fricative are activated simultaneously, but as mentioned, in the production of voiced plosives, the laryngeal impulse and the transient appear one after the other in a unit of time: first the laryngeal impulse in the closure section and then the transient in the release section. This fundamental difference can be obtained by comparing Figures 1-3 and 1-2.

Therefore, within the framework of source-filter theory, an acoustic description in the time domain (signal) and the frequency domain (spectrum) can be provided for each phoneme, such that this description links the production and perception of language sounds. The connection between the production and perception of language sounds through the acoustic description of phonemes in the time and frequency domains arises from the fact that, on the one hand, the time and frequency domains of the sound signal are caused by the movement of the articulation organs and the geometric structure of the reproducing cavities in the speech apparatus, and acoustic cues corresponding to the production characteristics can be obtained; and, on the other hand, by manipulating acoustic cues, new artificial speech stimuli can be created and the judgment of speakers regarding the perception of language sounds can be tested, and in this way the role of acoustic cues in speech perception can be determined.

Data Analysis

As explained in the theoretical framework section, the weakening process is the reduction of the degree of closure of a vowel and occurs in one of the following ways:

Obstructive > Aspirative > Frictional > Nasood > ø

Voiceless aspirate > Simple voiceless > Vowel

Given that the most common phonological environment where the weakening process occurs in most languages is the postvowel environment, in this study, the data presented in both Azerbaijani languages of the Ardebili dialect and the Parsabad and Germi dialects are examined and analyzed in the CV.CVC and CVC.CVC environments. Table 1-1 presents examples of weakened words in Azerbaijani Turkish of the Ardebili dialect.

International Journal of Multiphysics
Volume 19, No. 1, 2025
ISSN: 1750-9548

Table (1-1): Examples of weakened words in Azerbaijani Turkish of the Ardebili dialect

Row	Turkish word ""Dorundat	Turkish word output	Persian equivalent:	Row	Turkish word ""Dorundat	Turkish word output	Persian equivalent:
1	tʃø.ræk	tʃø.ræh	Bread	7	get.mæk	get.mæh	Going
2	ur.dæk	ur.dæh	Duck	8	min.mæk	min.mæh	Riding
3	po.fæk	po.fæh	Puff	9	gyl.mæk	gyl.mæh	Laughing
4	sev.mæk	sev.mæh	Love	10	syr.mæk	syr.mæh	Driving
5	gæl.mæk	gæl.mæh	Come	11	ul.mæk	ul.mæh	People
6	ye.mæk	ye.mæh	Eat	12	toh.mæk	toh.mæh	Pour

According to the data in Table 1-1, it is clear that the weakening process has occurred in the phonetic environments CV.CVC and CVC.CVC, and in all consonants in the second syllable that are located at the end of the syllable and at the end of the word, the degree of closure has decreased, and the obstruent phoneme /k/ has changed to the fricative phoneme /h/.

To confirm the presented material, due to the increase in data, only one example of the data in Table 1-1 is presented according to the spectrogram and sound wave numbers 1-1 and 1-2 in the input and output of the word tʃø.ræk in Azerbaijani Turkish of the Ardebili dialect.

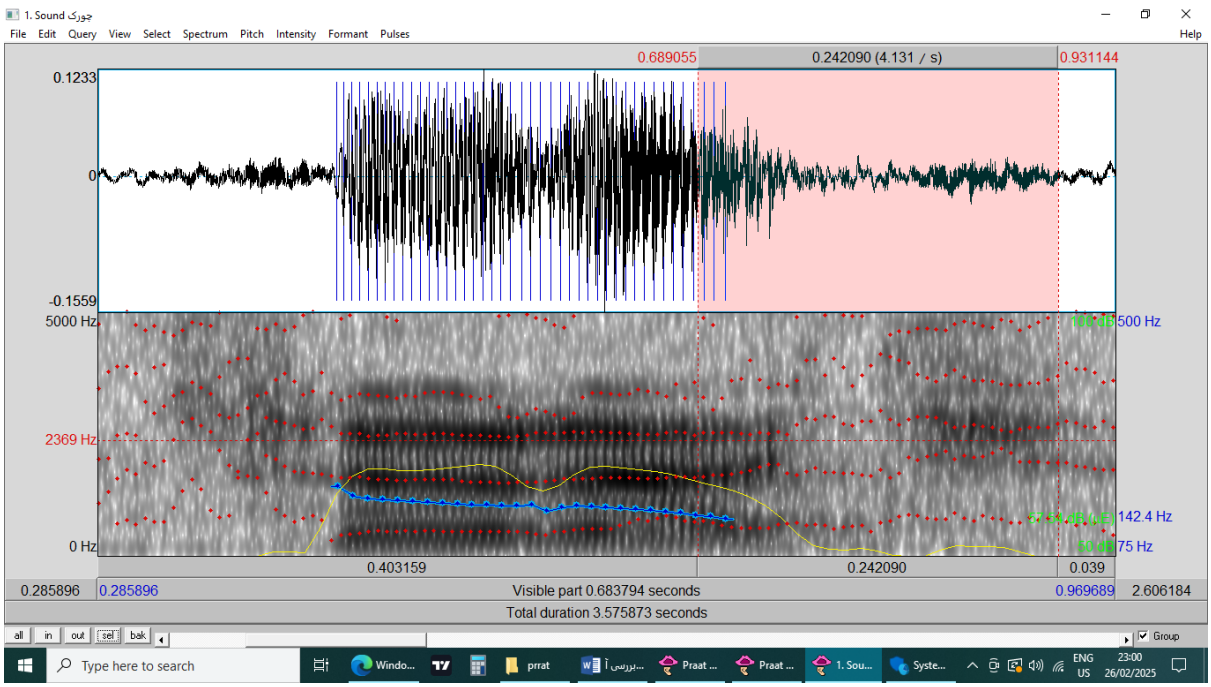


Figure (1-1): Spectrogram and sound wave of the word tʃø.ræk in the CV.CVC phonological environment in the Ardebili and Germi dialects

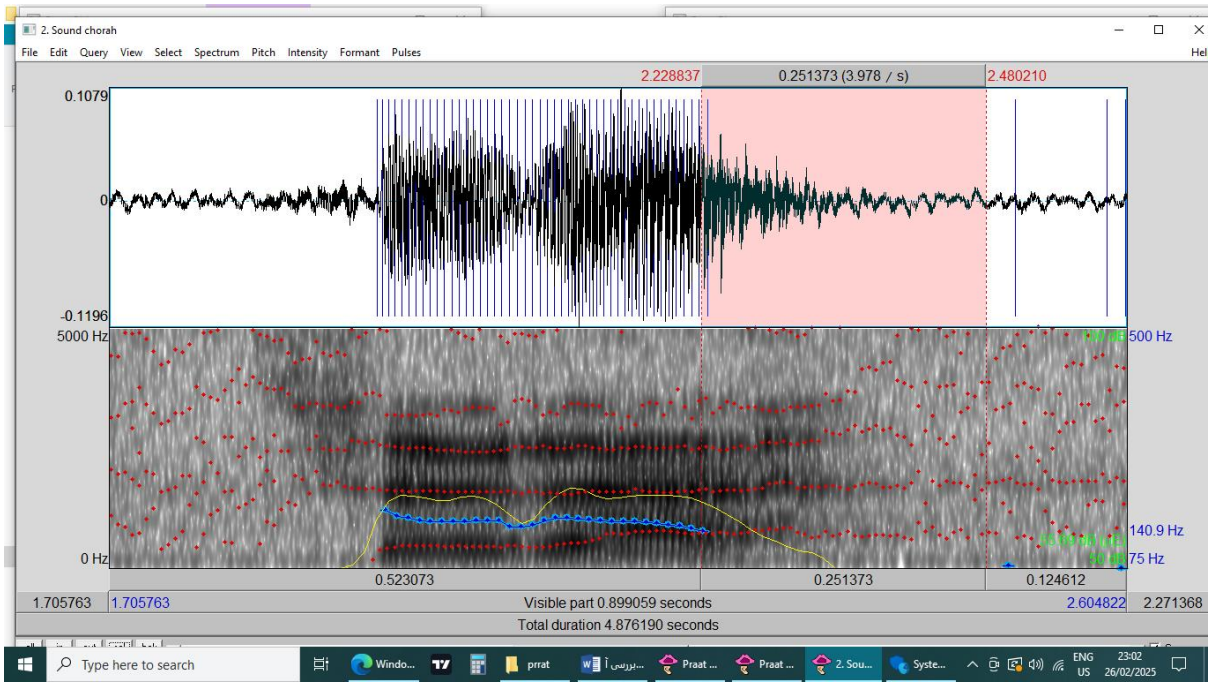


Figure (1-2): Spectrogram and sound wave of the word tʃø.ræh in the CV.CVC phonological environment in the Ardebili dialect.

As can be seen in the spectrum of the map number 1-1, the yellow line indicates the intensity of energy used in the word tʃø.ræk. The selected part in the image in pink indicates the phoneme /k/ at the end of the word. As can be seen, when the structure passes from the vowel /æ/ to the consonant /k/, energy reduction occurred, but this process occurred more in the spectrum of the map number 1-2, and simultaneously with the weakening process, the size of the yellow line has halved and energy reduction has occurred. Therefore, it can be concluded that there is a risk of consonant deletion in this language during the weakening process.

Table number 1-2 shows examples of data from the Azerbaijani Turkish language of the Germi and Parsabad dialects:

Table (1-2): Examples of weakened words in the Azerbaijani Turkish language of the Germi and Parsabad dialects

Row	Turkish word ""Dorundat	Turkish word output	Persian equivalent:	Row	Turkish word ""Dorundat	Turkish word output	Persian equivalent:
1	tʃø.ræk	tʃø.ræj	Bread	7	get.mæk	get.mæj	Going
2	ur.dæk	ur.dæj	Duck	8	min.mæk	min.mæj	Riding
3	po.fæk	po.fæj	Puff	9	gyl.mæk	gyl.mæj	Laughing
4	sev.mæk	sev.mæj	Love	10	syr.mæk	syr.mæj	Driving

5	gæl.mæk	gæl.mæj	Come	11	ul.mæk	ul.mæj	Dying
6	ye.mæk	ye.mæj	Eat	12	toh.mæk	toh.mæj	Shedding

As can be seen in Table 1-2, the weakening process has also occurred in the Azerbaijani Turkish language of the Germi and Parsabad dialects. It is observed that the consonant /k/ has changed to the consonant /j/ in the CV.CVC and CVC.CVC phonetic environments, and a reduction in energy binding has occurred. To confirm the above, a sample of the data in Table 1-2 is examined in the form of a spectrogram and sound wave in Figure 1-3:

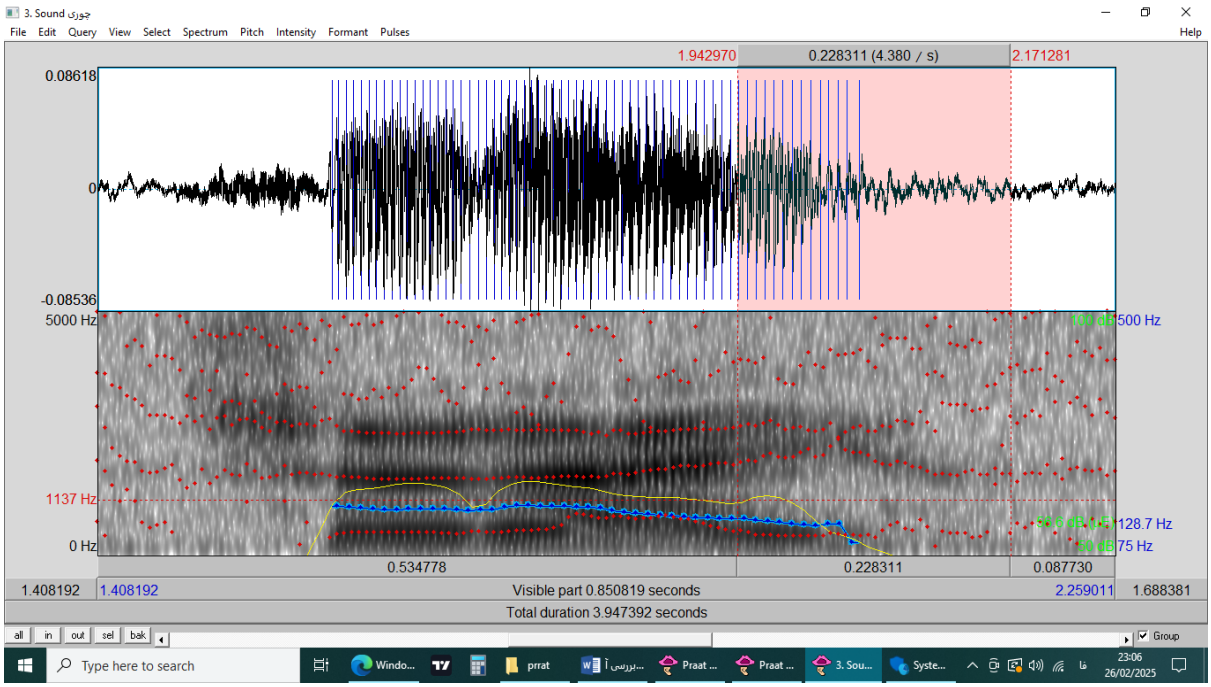


Figure (1-3): Spectrogram and sound wave of the word tʃø.ræj in the CV.CVC phonological environment in the Germi and Parsabad dialects

Considering that the input of the words is the same in both the Ardebili and Germi and Parsabad dialects, by comparing the spectrograms No. 1-1 and 1-3, it can be seen that in the Germi and Parsabad dialects, the consonant /k/ has been transformed into a roll /j/ and a weakening process has also occurred in this dialect. It can be concluded that according to the formula:

Obstructive > vesicular > erosive > non-vesicular > ø, the existence of a weakening process is also confirmed in the word tʃø.ræj in the Azerbaijani Turkish language of the Germi and Parsabad dialects.

Conclusion

The present study shows that in the Azerbaijani Turkish language, the Ardebili, Germi and Parsabad dialects, like other languages, including English, which were studied based on the Trask framework and the source-filter acoustic theory, the weakening process has taken place and it can be concluded that the weakening process occurred for ease of pronunciation and was not arbitrary, and as was studied in two different dialects, it is subject to specific phonetic rules and operates in accordance with them.

References

1. Bagheri, Mehri (2001), Historical Phonology of the Persian Language, Tehran: Ghatre Publishing.
2. Bagheri, Mehri (2003), History of the Persian Language, 11th edition, Tehran: Payam Noor University Press.
3. Bagheri, Mehri (2004), Introduction to Linguistics, Tehran: Payam Noor University Press.
4. Bix, Robert (1996), An Introduction to Comparative Linguistics of Indo-European Languages, translated by Esfandiar Taheri, 2010 Tehran: Institute for Humanities and Cultural Studies Publications.
5. Kord Zafaranloo, Alie, Eslami, Firoozeh and Aghagolzadeh, Ferdows (2010), A Study of Syllable Structure and Articulation Sequence in Old Persian, Vol. 4, Quarterly Journal of Comparative Language and Literature Research.
6. Kord Zafaranloo, Alie, Tajabadi, Farzaneh (2012), A Comparison of Intensification and De-Intensification in Persian and Iranian Dialects, Vol. 1, P. 9, Tehran: Quarterly Journal of Comparative Language and Literature Research.
7. Gussenhoven, C. and Jacobs, H. (2011), Understanding Phonology, third edition, Hodder Education publishers.
8. K.Z. Kambuziya, Aliyeh. (2003), Lenition in Phonological Patterns of Persian. J. Humanities. Vol.10 (2).
9. Ségéral, Philippe & Scheer, Tobias. (2008), Positional factors in Lenition and Fortition.
10. Trask R.L. (1996), Historical Linguistics. Oxford University Press.