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Gemination in Pashto

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Abstract

The purpose of this study was to investigate gemination in the Yousafzai dialect of Pashto, spoken in Khyber Pakhtunkhwa, Pakistan. To achieve this goal, audio data was collected from elder native speakers. The collected data was subsequently discussed multiple times with elders and linguistic experts to ensure accuracy. Later on, a list of ten words was created and presented to native Pashto speakers. The words were presented to participants in Pashto script alongside their English translations, and they were asked to utter them. The recordings were made using a Zoom H6 recorder and analyzed using Praat. During the acoustic analysis, the recorded data was segmented, revealing that geminate consonants have double duration compared to their singleton counterparts. The results revealed that the word /χkar/ means 'horn' carrying a voiceless velar /k/ has 13ms, and the same consonant has 22ms in the word /ra:χkkal/. Similarly, the words /mla/ and /sammla/ were acoustically analyzed and the results displayed that the segment /m/ has 8ms in /mla/ and 15ms in /sammla/ which has almost got twice duration in later. Furthermore, among the phonemes, the most frequently occurring consonants carrying gemination are nasal, dental, alveolar, and velar.

Keywords: Pashto, gemination, singleton, phonemes, duration.

Introduction

Pakistan has got a very diverse background having different languages, among them, Pashto is one of the dominant languages spoken in Khyber Pakhtunkhwa. It is practiced in day-to-day routine in Pashto community and especially in public activities and interaction. Based on the 1998 census, over 80% of the province's population speaks the language (Khan & Khalid, 2017). Pashto is classified within an Indo-European language that is widely spoken in Afghanistan and Pakistan. It has a very rich background in terms of phonology and morphology (Tegey & Robson, 1996). It is also practiced in other countries such as Iran and UEA. To

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consider as whole, it is spoken by almost 50 million speakers (Tegay & Robson, 1996; Hallberg, 1992). According to Rahman, Khan and Bukhari (2012), Pashto has five dialects naming North-Eastern (Yousafzai), North-Western (Central), South-Eastern (Quetta), South-Western (Kandahar), and Middle Tribal.

Many studies have focused on Pashto phonology (e.g., Hallberg, 1992; Tegey & Robson, 1996; Din & Rahman, 2011) in which they have highlighted various aspects of Pashto phonology. These attempts were made to compile a reference grammar of Pashto (Tegey & Robson, 1996), Pashto dictionary (Raverty, 1959), consonantal phonemes (Rahman, 2016), passivization in Pashto (Ali et al., 2019; Furnaz, 2023) and many more. However, the gemination in Pashto has not been under discussion yet; therefore, the current study aims to focus on gemination of Pashto and investigate its process and the involvement of phonemes in it.
In phonology the term 'geminate' normally refers to double or long consonant sound that phonemically contrasts with its singleton counterpart. These contrasts are mainly found in Italian and Japanese languages but not found in Spanish and English (Davis, 2011). Gemination is found in many languages such as Japanese, Swiss German, Italian and Swedish and it is considered one of the essential features of Arabic and Semitic languages as well (Al-Deaibes, 2016; Azam, 2024). Al-Deaibes (2016) also depicted that Arabic has word-medially and word finally gemination and it has two types of gemination e.g., true and fake. True gemination is the one there is no epenthesis of vowel but fake gemination has epenthesis of vowel that breaks the consonant that geminates. Similarly, Kraehenmann and Lahiri (2008) investigated word-initial geminates in Swiss German and identified that geminates (167ms) exhibit a longer linguopalatal contact compared to singletons (112ms). Also, the preceding and following vowels are longer for singletons than for geminates. This allows the preceding vowel to be relatively short when the following consonant is a geminate. In Japanese the preceding vowel is long before geminates and short after geminates. According to Ohala (2007), phonetic studies of singletons and geminates have also shown that C1 in a C1V1C2V2 template lasts longer when C2 is a geminate. In Hindi, C1 lasts longer when C2 is a geminate and shorter when C2 is a singleton. Han (1994) reported similar findings for Japanese geminates. Turco and Braun (2014) linked the lengthening effect of C2 on C1 to long-distance anticipatory effects. The above literature shows that this is an interesting feature of languages which makes a consonant sound double. However, the Pashto gemination has not introduced yet and is focused in the current study. Therefore, the primary objective of the current study was to find out gemination in Pushto and explore the phonemes that are involved in

it. This study is significant in identifying Pashto gemination, which is beneficial for speakers, students, and researchers, as it encourages further research on the language and exploration of its other aspects. Furthermore, it is delimited to a single dialect (Yousafzai). In this dialect, it is limited to investigate gemination at word level.

Literature Review

Geminates are long consonants that differ from singletons in terms of duration (Davis, 2011;). Gemination is mostly studied cross linguistically e.g., Khattab and Al-Tamimi (2014), Kraehenmann (2008), and Ridouane (2007). Phonetically, it is an increase in the duration of consonants (Payne, 2015). Davis (2011) extends the point further by stating that geminate consonant phonologically refers to a double or long consonant which phonemically differentiates it from another shorter counterpart consonant. Delattre (1971) has the view that gemination is double articulation of consonant, one is articulated in the coda and another is in the onset of the syllable. Chomsky and Halle (1968) mentioned the term gemination as having distinctive feature of [+long] even it is a single consonant. As Leben (1980) claims, gemination is long consonant but behaves like the sequence of two segments. Similarly, Ladefoged and Maddieson (1996) have the view that the duration of geminate consonant is considered double of a singleton counterpart. Aldubai (2015) also depicts the same by stating that gemination is twice in duration in comparison with singleton.

Thus, in autosegmental phonology, as implemented for example by Leben (1980), Clements and Keyser (1983) and Hayes (1986), long vowels and geminated consonants are distinguished from short vowels and single consonants purely on the basis of how many segments they spread across on the timed tier. The reasoning behind this is to reflect that the same sounds are pronounced but with either shortened or lengthened in period i.e. short versus long vowels and simple compared to geminate consonants. A melodic tier is formed by segmental features that do not correspond to timing or CV-structure. Association lines connect the melodic and timing tier representations, specifying (corresponding to) which time position is indicated in each melodic element (Lahiri & Hankamer 1988). Moreover, the reported duration ratios for singleton and geminate consonants vary greatly. According to Lehtonen (1970), Finnish geminates are approximately twice as long as their corresponding singleton consonants. According to Richardson (1998), Finnish /t:/ is approximately three times longer than /t/. Similarly, Han (1992) reports

that the duration ratio of Japanese singleton and geminate consonants ranges between 1:2 and 1:3.

Cross-linguistically, languages in which this contrast is made are not very common. Of 317 languages in a database, Maddieson (1984) found just 11 with contrastive singleton-geminated consonants. Geminated consonants manifest a broad typological diversity as they occur in word-initial (Swiss German: Lahiri & Hankamer, 1988), intervocalic (Italian: Esposito & Benedetto, 1999), or word-final position (Maltese: Hume et al., 2014). For instance, all types of geminates are well-formed in Tashlhiyt Berber (Ridouane 2010).

In addition, some studies examined acoustic formants as well. Geminate consonants in Cypriot Greek are observed to not influence the quality of surrounding vowels, neither the steady state quality nor the transitions into or out of a geminate sound, as Arvaniti and Tserdanelis (2000) claim from initial data on vowel formant F1 and F2 frequencies in test words used in that language. The plosives geminates in Moroccan Arabic are longer to be articulated (Tan et al., 2008).

According to cross-linguistic studies, voiceless geminates outnumber voiced geminates. In some languages, such as Tokyo Japanese, voiced geminates are partially devoiced (Kawahara, 2015). This devoicing is commonly attributed to aerodynamic constraints. Maintaining voicing and long closure duration in voiced geminates is difficult in terms of articulation (Ohala, 1983). Punjabi, an Indo-Aryan language, has been shown to distinguish between voiceless/voiced singletons and geminates (Bhatia, 1993). It is unknown, nevertheless, whether voiced geminates in Punjabi are fully voiced and how long they last in comparison to voiceless geminates. According to Bhatia (1993), geminates in Punjabi are limited to word-medial position and are always preceded by short vowels. Conversely, singletons can occur freely with both short (/ɪ ə ʊ/) and long (/i e ɛ a o ɔ u/) vowels. According to Hussain (2015), closure duration is the most significant acoustic correlate for Punjabi word-medial geminate stops. This is also evident in other languages, where geminate closure duration is significantly different from singletons (Hindi: Ohala, 2007; Bengali and Turkish: Lahiri & Hankamer, 1988).

Mahootian and Gebhardt (1997) focused the Dari Persian and introduced that its geminates are mostly found at medial positions. Gill and Gleason (1969) explored that Punjabi gemination is commonly found at middle positions, but it is rarely found in initial and final positions. Moreover, the study of Shackle (1980) analyzed Hindko and presented that it contains

gemination in barrowed words more than in native words. He also has the view that aspiration in Hindko sometimes is confused with gemination that effects perception. This literature indicates that gemination is a characteristic of many languages but has not been investigated in Pashto, which is the focus of the current study.

Research Methodology

The current study employed a quantitative research methodology as it focused on the duration of geminated and non-geminated phonemes which is a quantifiable aspect of speech. For doing this, the analysis was conducted using Praat to gain a comprehensive understanding of the complex language phenomenon that exists in Pashto. This is one of the features that involves doubling the articulation of phonemes in Pashto nouns and verbs.

This study has taken a multifaceted approach to data collection to enable a comprehensive analysis of Pashto gemination. In order to create an audio corpus, the first step in the data collection process was interaction with native Pashto speakers. In it, the audio recording features different words and forms of Pashto gemination. Secondly, the data was listened many times carefully and focused on words having geminated sounds. In addition to this primary data source, a comprehensive review of the literature in the field of Pashto linguistics has been conducted. The secondary data includes words carrying this feature of the language from a wide range of sources, including dictionary, books, and magazines. This review of the literature serves as an additional source of information for strengthening the study objective and allowing for a comparative analysis of the gemination found in Pashto. Finally, ten male Pashto native speakers from Yousufzai dialect (35-42 years with a mean of 38.8) participated an audio data collection. The selected age range was chosen because speakers in this group exhibit stable speech patterns. Female participants were not included, as males and females differ in pronunciation, phonetic variation, and articulation. To ensure consistency and avoid gender-based variation in analysis and comparison, only male speakers were selected. All the participants were invited into a quiet room at University of Buner, Khyber Pakhtunkhwa, Pakistan. Before conducting the actual recording, different recording sessions were conducted for understating and familiarizing the participants with the given tasks. The list of target words was written in Pashto scripts with English translation and presented to participants. They were asked to utter

the words with near minimal pair to contrast singleton and geminate in the language. Each participant uttered the words with their singleton six times (10 words x 10 participants x 6 repetitions = 600 tokens) and their utterances were recorded. This recording was conducted using Zoom H6 with a sampling rate at 44.1 KHz.

The current study adopted Autosegmental Phonology as a theoretical framework proposed by Goldsmith (1976). It provides a non-linear representation of different phonological structures that carry various features for analysis as compared to traditional linear models. It has the features to provide more structured and flexible approach for analyzing gemination and represents length/duration explicitly which are essential for acoustic analysis. On the other hand, liner phonology represents segments only in sequence, but doesn't carry the feature to represent gemination, nasalization, vowel length and tone separately. This framework proposes that phonological segments and their features, such as length, stress, or tone, are represented on separate tiers. These tiers interact through association lines, allowing researchers to analyze multiple phonological features simultaneously and understand their interactions more clearly. Therefore, it is suitable for this study as it entails non-linear and structured representation of gemination. It also effectively captures the phonetic and phonological properties of geminate consonants.

Data Analysis

The acoustic analysis of the current study was conducted using the framework of Goldsmith (1976). Based on this, the analysis was done to identify the physical properties and recognition of gemination. The geminate consonants were investigated with comparison to their singletons. This process entailed measuring and analyzing auditory parameters such as length and spectral properties. Moreover, the duration of consonants showed the significant difference between singleton and gemination. Duration referred to the amount of time a sound is kept during speech production and revealed information about temporal structure of speech. The spectral analysis of a segment entailed breaking down the soundwave into its different frequency components, which provides insight into the phoneme's acoustic structure. All of the above-mentioned gemination-related features were observed in this study for the acoustic analysis of Pashto gemination. Therefore, the findings of the acoustic analysis of gemination produced by Pashto speakers are presented below. This detailed procedure was carried out to achieve the objective of the study.

The recorded data for the present study was analyzed according to the required analysis. In it, Praat was used to segment the data and analyze each word separately. All words having the properties of gemination were analyzed acoustically and their spectrograms were taken accordingly. Although, the recorded data set had six tokens for each word, among them, five tokens were used for acoustic analysis. Five tokens were taken from the utterances of each participant, that made a collection of 500 tokens for acoustic analysis. In these tokens, the main focus remained on geminate consonants and their durations were carefully marked and measured. The process was done acoustically for each word and their spectrograms were taken as some are shown below.

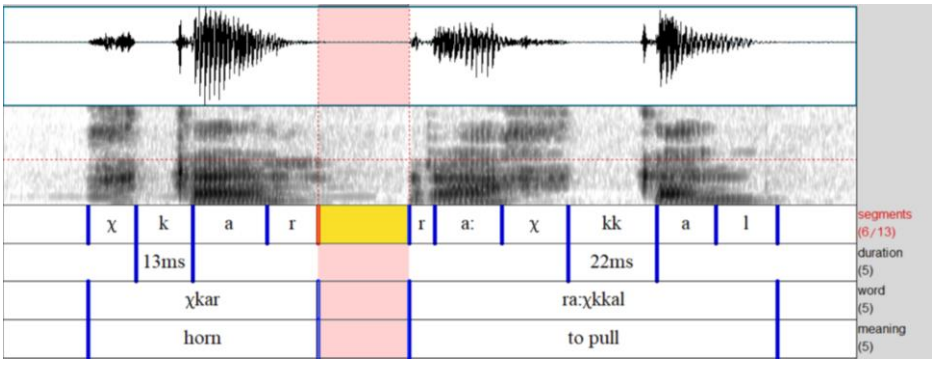

Figure 1: ***Spectrogram of the words 'χkar' and 'ra:χkkal'***

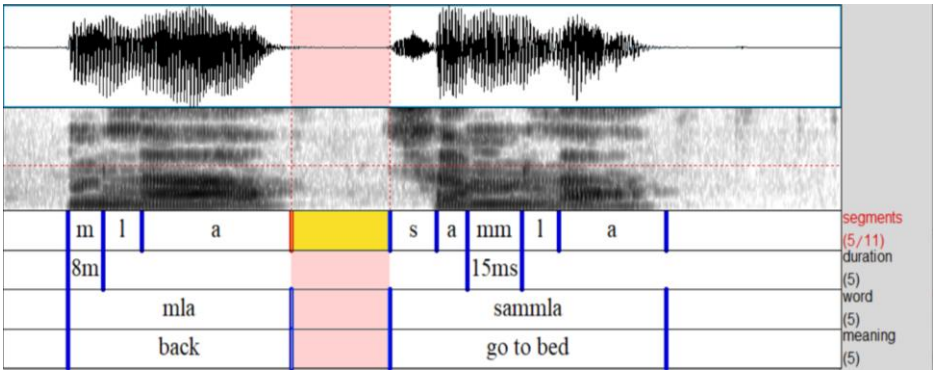

Figure 2: ***Spectrogram of the words 'mla' and 'sammla'***

Figures 1 and 2 above have depicted the spectrograms of two singleton and geminate consonants. They showed various characteristics of these consonants. The above acoustic analysis showed that waveforms are shown at the top, followed by the spectrographic depiction, and then there are four tiers. The first tier carries the segments, the second represents their duration which is the most important, the third one shows the selected word, and the last one carries the meaning of both words.

Discussion

Gemination is the feature of many languages (e.g., Japanese, Swiss German, Italian and Swedish) and it is considered one of the essential features of Arabic and Semitic languages (Al-Deaibes, 2016; Azam, 2024). The findings of the present study are aligned with the above-mentioned studies, as they identified that gemination is also a feature of Pashto and plays a vital role in its phonology.

Geminates are long consonants that differ from singletons in duration (1970; Payne, Davis, 2011; Aldubai, 2015; Lehtonen, 2015). Delattre (1971) has the view that gemination is double articulation of consonant, one is articulated in the coda and another is in the onset of the syllable. According to Chomsky and Halle (1968), the term gemination as having distinctive feature of [+long] even it is a single consonant. Moreover, gemination is long consonant but behaves like the sequence of two segments (Leben, 1980; Ladefoged & Maddieson, 1996). The findings of the present study also match with the above studies in terms of consonant duration (gemination). In it, consonants exhibiting gemination have double duration compared to their singleton counterparts.

According to Bhatia (1993), in Punjabi, geminates are restricted to the word-medial position and are always preceded by short vowels. In contrast, singletons can occur freely with both short (/ɪ ə ʊ/) and long (/i e ɛ a o ɔ u/) vowels. Similarly, Gill and Gleason (1969) explored Punjabi phonology and investigated that its gemination is commonly found at middle positions. Mahootian and Gebhardt (1997) focused the Dari Persian and introduced that geminates are found at medial positions. However, the duration of geminates is sometimes reduced in fast spoken speech. Al-Deaibes (2016) depicted that Arabic has word-medially and word finally gemination. The findings of the current study align with those of Bhatia (1993), Gill and Gleason (1969), Mahootian and Gebhardt (1997), and Al-Deaibes (2016), as these findings reveal that Pashto gemination also occurs in the medial position of words. However, the current study contrasts with Gill and Gleason (1969) and Al-Deaibes (2016) findings, as Pashto does not exhibit gemination in the final position.

Moreover, the above analysis showed that Figure 1 carries the word /ra:χkal/ that has only one voiceless velar sound /k/. However, when it is uttered in this word, it is uttered twice. This word carries two syllables and this sound has got its occurrence in both. For the clarification, the word /χkar/ means ‘horn’ was recorded and found that voiceless velar /k/

has 13ms, and the same sound has 22ms in the word /ra:χkkal/. That's why, the voiceless velar /k/ is represented twice here. Similarly, the words /sammla/ and /mla/ were recorded. Both of them were acoustically analyzed and found that the segment /m/ has 8ms in /mla/ and 15ms in /sammla/. These analyses showed that in both words, the geminated segments carry double duration of their singleton occurrences. This process was done for all tokens of each speaker. Furthermore, along with the acoustic analysis, other words carrying this feature were categorized for understanding and examples. These words were categorized based on their classes and given below.

Table 1. *Stimuli for gemination in Pashto: /n/ and stop consonant*

Words/Transcription	**Meaning**	**Category**
sanggal	Elbow	Noun
sa:ngga	Branch	Noun
kanggal	Ice	Noun
manggwəl	Claw/paw	Noun
ʤʊnggaʈə	Home	Noun
zanggal	Forest	Noun

haɣa za:nla sanggal χʊg kɽa. He hurt his elbow.

haɣa ɖa wani: na jaw sa:ngga ma:ʈa kɽa. He cut a branch of tree.

The above examples clearly show that Pashto carries gemination which is formed using nasal /n/ followed by velar /g/. Mostly, this combination identifies the existence of gemination in the selected language. This uniformity shows that both of them are voiced and /g/ is articulated twice longer more than as it is articulated in singleton. In this pattern, gemination is preceded by /n/ and followed by long, short vowels, voiced and voiceless consonants.

If /g/ is not preceded by /n/ then there is no gemination like /magal/ 'to rub' and /gʊra:reɪ/ 'whispering'. This aspect also shows that gemination is always found in medial position of words. It does not occur at initial position /garmi:/ 'heat' and final position /marg/ 'death' of words. It is also noticed that gemination is found in disyllabic and trisyllabic words,

but doesn't occur in monosyllabic. Most of the time, the velar phonemes /g/ is occurring in Pashto gemination when it is preceded by nasal /n/.

Table 2. *Stimuli for gemination in Pashto: /n/ and stops/fricatives*

Words/Transcription	**Meaning**	**Category**
t̪nd̪d̪ak	Stumbling	Noun
ʤwənd̪d̪ʊn	Life	Noun
χand̪d̪al	Smile	Noun
ɣwandda:ri:	Lump	Noun
kwəndda	Widow	Noun
band̪d̪awal	To close	Noun
prandʒdʒeɪdal	To sneeze	Noun

haɣa yawa:zi: ʤwənd̪d̪ʊn t̪erawal ɣwa:ɽi:. He spends life lonely.

st̪a:su: χand̪d̪al ma:t̪a haɣa ja:d̪a wi:. Your smile reminds me of his.

The above examples also show that Pashto gemination exists in different combined patterns of consonants such as form with nasal /n/ followed by stops or fricatives. The observed uniformity above was noticed here too that both of them are voiced and the phoneme preceded by nasal /n/ is articulated longer more than it is articulated in singleton.

It is not necessary and common that every phoneme after nasal /n/ is geminated in the language, e.g., /ranzʊr/ 'sick' and /manda:w/ 'veranda' are the examples in which there is the combination of nasal /n/ and other phonemes like stops or fricatives, but don't have the features of gemination. Moreover, it is similar to the above examples that that gemination is always found in medial position of words but doesn't find at the initial and final positions of words. Along with this, it is always clear and identified that it is found only in disyllabic and trisyllabic words.

Table 3. *Stimuli for Pashto gemination in verb*

Words/Transcription	Meaning	Category
ʤʊχt̪t̪awal	To get close	Verb
tʃɪt̪t̪eɪɖ̪al	To get low	Verb
ʊtʃat̪t̪eɪɖ̪al	To rise	Verb
zɣəmmal	To bear	Verb
nammri:	Not dying	Verb
səmmla	Go to bed	Verb

dwa saɾi: lɪgja wʊ kamari: ji: pa la:r ki: ʤʊχt̪t̪awale. Two men tried to get close stones in the way.

haɣu: largi: swəzzawal. They were burning wood.

The above examples illustrate the existence of Pashto gemination having various patterns. In these patterns, one of them is having /t̪/ that is articulated twice longer than its singleton. It occurs after voiceless fricative and short vowel and is followed by vowel. Another pattern has nasal /m/ and indicates that it is preceded by vowels and followed by both vowels and consonants.

Furthermore, the existence of the above sounds/phonemes does not make sure gemination features everywhere in the language. There are numerous words carrying their occurrences but don't have gemination such as /waχt̪i:/ means 'early' and /kamar/ means 'stone'. This pattern has got similarity with the above by showing its occurrence in medial positions of words.

Table 4. *Stimuli for Pashto gemination*

Words/Transcription	Meaning	Category
zajəwwal	To fit/accommodate	Verb
ra:wwɽəm	To bring	Verb
ɣwəssawal	To cut with knife	Verb

tʊmbbal	To nail	Verb
tʃi:χχawal	To prick	Verb
ɖa:ɣɣawal	To cauterize	Verb
ra:χkkal	To pull	Verb

jaw saɽi: pa jawa alma:raı ki: kɪɖa:bʊna zajəwwal. A man tried to fit the books into the cupboard.

haɣa pa za:n pa se darwa:za ra:χkkal. He pulled the door after himself.

The above examples clarify that Pashto carries different patterns of gemination in which different phonemes are involved. In these occurrences, both voiced and voiceless phonemes have the features of gemination. Among them, /w/ and /s/ are preceded by vowels and followed by both vowels and consonants. Rest of them are preceded and followed by both vowels and consonants. Their articulations show that consonants are longer in gemination in contrast to their singletons. Similarly, these sounds don't have gemination everywhere in the language e.g., /awram/ means 'I hear' and /asa:n/ means 'easy'. These examples carry the same phonemes as mentioned in gemination but don't have the features of gemination here. Furthermore, these patterns have similar characteristics with the above by showing their existence in medial positions of words.

Conclusion

Pashto is an Indo-Iranian language spoken in Pakistan and Afghanistan. This language has been focused by different researchers and investigated various aspects of it. However, the present study focused on its phonology, particularly its gemination and identified different features which has not received the attention of researchers yet. To achieve the objective of the study, the data was collected from native speakers who speak the Yousafzai dialect. The elders were joined during conversation with each other and focused remained on lexical words. Their conversation was focused during lunch/dinner time, daily activities, formal tasks, and educational activities. Along with this, Pashto books and dictionaries were also used for this purpose to collect data and pinpointed the above-mentioned feature of the language. The collected data was discussed several times with elders and experts. The meaning of each word was

checked in the dictionary to ensure that these words are frequently used in everyday life. After this, these words were categorized in different classes and used in carrier sentences again to make sure their meaning and usage in daily routine. Later on, a list of words was presented to 10 participants in Pashto script with English translation. All were native speakers and uttered the list of words with singleton and geminated with six repetitions. The data was saved in laptop and analyzed acoustically using Praat. The findings of the study showed that Pashto carries this aspect in different classes and has been used in day-to-day routine. The findings revealed this features that geminated segments carry almost twice duration of their singleton segments such as /χkar/ means ‘horn’ carries velar /k/ and has 13ms, and the same sound has 22ms in the word /ra:χkkal/. The later carries the feature of gemination. Similarly, the words /sammla/ and /mla/ were recorded and analyzed acoustically. The results showed that the segment /m/ has 8ms in /mla/ and 15ms in /sammla/ that has got twice duration in the later. Furthermore, other words were taken that have the features of gemination such as /sangɡal/ means 'elbow' and /manɡɡwəl/ means 'paw'. These examples were taken from nouns and it turns out that most of the geminations are found in it. Moreover, this aspect of language was also found in the category of verb, such as /sasseɪɖal/ meaning 'to drip', and /ɖrazzawal/ meaning 'to hit'. This feature was predominantly observed in different phonemes such as /ɡ/ after nasal /n/. Among phonemes, the most frequently occurring phonemes are nasal, dental, alveolar, and velar. It is considered that gemination is a characteristic of Pashto and is recognized in nouns and verbs. It is now suggested that further research should be done on this to identify Pashto gemination in the other parts of speech.

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