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A Phonetic Study of Kashmiri Palatalization

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1. Introduction

Kashmiri is often cited as one of the very few languages in the Indian subcontinent that has extensive use of palatalized sounds in its phonology. Both lexical forms as well as inflected and derived forms can possess palatalized consonants which may contrast with their non-palatalized counterparts. The present study tries to examine the phonetic composition of the phenomenon of palatalization in Kashmiri.

2. Previous Work

A review of the literature[3] related to the concept of Kashmiri 'palatalization' showed that *i-mātrā* vowel, semivowel [j̇], semivowel [**i**] and 'palatalization' were the concepts used by different authors in describing this phenomenon as explained below.

In connection with Kashmiri, the term 'palatalization' was first used by Bailey (1937:5) : "*i-mātrā* has the effect of palatalizing the consonant to which it is attached. This means that the consonant is sounded with an inherent ***i*** resonance; the ***i*** appears to come both before and after the consonant, but is not a separate syllable;" (p. 5). Bailey (p.1) considers Grierson (1911) as the 'chief authority' for his 'grammar and vocabulary'. Based on the description by Kaula (1897-98), Grierson (1911) is probably the first publication in English that postulated a set of so-called *'mātrā vowels'* which includes the "ˈ-mātrā" for the language. "The ***ˈ-mātrā*** is an extremely short ***i***, and has the peculiarity that it is sounded, very faintly, both before and after the consonant

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[3] The authors could not, regrettably, directly access *Kaula (1897-98)* and *Zakharyin (1974)* while the present paper was under preparation and hence are not in a position to state whether any of their present findings were already anticipated and/or interpreted in those works.

which it follows in writing. Thus ***as^{i},*** we, is pronounced something like ***a^{i}s^{i},*** and ***gur^{i},*** horses, sounds like ***gu^{i}r^{i}.***" (Grierson 1911:16).

Out of the various *mātrā* vowels posited by Grierson, Bailey proposed that it is the ^{i}-*mātrā* that 'palatalizes' the consonant to which it is attached. Morgenstierne (1943) recapitulates Bailey (1937:183) saying that Bailey "believes that they [= the *mātrā* vowels] are no real vowels, but that 'the consonant, so to speak, absorbs the vowel, and is velarized, palatalized, centralized or left neutral'. This interpretation of the phonemic value of the matra-vowels appears to be very probable."(p.88). Bailey (1937: 6) after dismissing all the other *mātrā* vowels because they do not have much of a phonetic realization and since 'those which are not pronounced need not be represented', focuses on the ^{i}-*mātrā* (since it palatalizes the relevant consonant leaving a phonetic realization), and for the first time proposes the 'single quote' mark (') to represent 'palatalization'. This is the diacritic that a majority of later authors (except Kelkar and Trisal 1964 and Kelkar 1984) have used to represent the palatalized consonants of the language. The next important work (and arguably the very detailed phonetic analysis of the language extant) by Kelkar and Trisal (1964) makes use of the "*semivowel* i̯" to account for the phonetic process of palatalization.

The original concept of *mātrā* vowels by Kaula (1897-98) which was further expounded by Grierson (1911) was later doubted by some. Bhat (1987) expresses a view on one extreme, when he says: "Grierson's analysis of the language which came before the concept of "phoneme" cann't [sic] be taken as authentic so far as the sound system of Kashmiri is concerned. It is unfortunate that the same system has been followed with little modifications in the subsequent works of Bailey and Morgenstierne. The presence of "Very Short" Vowels in the contemporary Kashmiri has become obsolete if at all it existed at any stage." "However, the functional aspect (grammatical) of mātrā Vowels as meant by Pandit Ishwar Kaula can be taken care off [sic] by other processes i.e. diphthongization e.g. /gur/ 'horse' /guɪr/ 'mare' "(p.20). Bhat's (1987) interpretation of the mātrā vowels being the result of 'diphthongization' has already been predicted by Kelkar and Trisal (1964) through semivowels /i̯ u̯/. It should be noted that Kelkar and Trisal (1964) did not reject the occurrence of some of these *mātrā* vowels when they said : "... for a non-native listener it is rather difficult to hear /C-/ and /-Ci̯/ apart, and that more work in the field and the laboratory is called for in order to investigate the three-way contrast /-C -Ci̯ - Cu̯/" (p.22). They further affirm that a "two-way pair test was administered to the two informants", "and the results left no doubt that the contrast exists" (p.22). Kelkar (1984) resymbolized these semivowels as /^{i}u/ and described that they are "... like extra-short vowels or vowel-colourings of preceding consonants when not followed or preceded by vowels..." (p.66) and also "adopted the convenient practice of writing /^{i}u/ as /y v/ when adjacent to vowels with which they form diphthongs ..." (p.67).

After Grierson's observation in 1911 that the ^{i}-*mātrā* sounded faintly *even before* the concerned consonant, and its phonological reinterpretation by Kelkar and Trisal in 1964 and

Kelkar 1984, Bhat (2008) notes that the palatalization process leaves a mark before the actual 'palatalized consonant' begins, saying: "...plural form is obtained by palatalizing the final consonant and in the process the base vowel is diphthongized by positing an extra short ĭ there" (p.43). "It is an extra short, 'centered' i occupying a position between high and mid-high positions" (p.50). "Its phonetic value was obtained during 'an impressionistic exchange of views of the phonetic quality of the vowel" (p.50). Bhat (2008), however, does not refer either to Grierson(1911) or to Kelkar and Trisal (1964) who had distinctly mentioned about a vocalic segment in the same place where Bhat(2008) posits the extra short ĭ. Handoo (1973), Kachru (1969), Koul (1987), Razdan (2005), Shackel (1984), Wali and Koul (1997) recognize that several consonants in Kashmiri contrast for palatalization but do not go into the details of phonetics of palatalization. Table 1 lists various segments proposed by the previous authors as the phonetic manifestations of the process of palatalization.

<table>
<tr><td>Segments></td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td></td><td>Radical
Vowel =
[V] of [VCʲ #]</td><td>Pre-cosonantal
vocalic segment</td><td>Radical
Consonant =
[C] of [VCʲ #]</td><td>Post-
consonantal
segment</td></tr>
<tr><td>Grierson 1911</td><td rowspan="4">*</td><td>[ᶦ]</td><td>*</td><td>[ᶦ]</td></tr>
<tr><td>Bailey 1937</td><td rowspan="3">-</td><td>Palatalized</td><td>-</td></tr>
<tr><td>Kelkar &
Trisal 1964</td><td rowspan="2">Vowel-coloured</td><td>[i̯]</td></tr>
<tr><td>Kelkar 1984</td><td>[ᶦ]</td></tr>
<tr><td>Bhat 1987</td><td>Forms a diphthong with Segment 2</td><td>[ɪ]</td><td>*</td><td rowspan="2">-</td></tr>
<tr><td>Bhat 2008</td><td>Diphthongized with Segment 2</td><td>Extra short [ĭ]</td><td rowspan="2">Palatalized</td></tr>
<tr><td>Others</td><td>*</td><td>*</td><td>*</td></tr>
</table>

* means nothing was specifically mentioned about the phonetics of this segment; - means no segment was proposed in that position.

Table 1: Analytical structure of the segments of palatalization in Kashmiri proposed by earlier authors

Palatalization in Shina: Shina language is related to Kashmiri. Some of Shina dialects are reported to have palatalization as a phonetic feature. According to Radolff (1999:35) palatalization in Gilgiti Shina is due to a phonological process and palatalized consonants do not contrast with their non-palatalized counterparts. The palatalized sounds occur '... primarily in word-final position in certain adverbs and suffixes. All of these appear to be associated with a persent or historical unaccented word-final /i/'. (p.36).

Schmidt et al (2008) describe Shina of Indus Kohistan. They posit that the phoneme /i/ is phonetically [ĭ] ~ [ʲ] occurring in final unaccented syllables. Example: [sù:rĭ] 'sun'. They further say "Final unaccented short vowels are whispered, not voiced. ... Native speakers can hear these whispered vowels, even if foreigners can not" (p.23). By summarizing the phonetic realization rules given in Schmidt et al (2008: 17, 27, 30), we get the following picture. For

instance, the phonemic input /báli/'(in the) evening' will give the phonetic output [ˈbʌe̯l ʲ] where "/ -i/ is shortened to palatalization and is represented by [e̯]"(p.27). However, /balí/ with an accented /í/ would be phonetically [bʌˈli] because the accented /í/ does not get 'shotened to palatalization'. Another condition says that [ʌe̯] freely varies with [æ] in the environment of ăCĭ, ăC ʲ (p.17). Thus by applying both the phonetic realization rules, /báli/ '(in the) evening' will have four freely alternating phonetic outputs viz., [ˈbʌe̯l ʲ] ~ [ˈbæl ʲ] ~ [ˈbʌe̯lĭ] ~ [ˈbælĭ]. An interesting similarity arises between Grierson's (1911) treatment of *ˈ-mātrā* vowel, and Schmidt et al's (2008:27) description: "/ -i/ is shortened to palatalization and is represented by [e̯]". Thus the unaccented /i/ is reduced to palatalization of the preceding consonant and also is simultaneously copied to left of that consonant as [e̯].

Segments>	1	2	3	4
	Radical [ʌ] or [a] merge with Segment 2 = [e̯] to produce [æ]	[e̯]	Palatalized	[ĭ]

Table 2: Analytical structure of the segments of palatalization in Indus Kohistani proposed by Schmidt etal (2008)

3. Present Work:

Following the need felt for field-cum-instrumental investigation of palatalization (Kelkar and Trisal 1964:22), we investigated the phonetics of this phenomenon with the target of gathering the acoustic details of palatalization and correlate them with the appropriate articulatory gestures. In view of the different interpretations of this phenomenon, it was felt necessary to go into the phonetic details which will not only clarify the concept but also help in teaching and learning of pronunciation of the language[4]. Only words containing 'post-vocalic word final palatalized consonants' are taken up for analysis in this work as those are the consonants that are supposed to carry significant palatalization in the language. The vowel that precedes the palatalized consonant will be termed 'radical vowel' in the following discussion.

Speakers: The five joint authors from the University of Kashmir are native speakers of Kashmiri and their speech is recorded for the purpose of this analysis. Although they come from three different areas in Kashmir (Srinagar, Anantnag, and Baramulla), as far as the phonetic aspect of palatalization is concerned, no significant differences were found in their speech.

Samples: 69 words (nouns or verbs inflected for singular number) were selected alongwith their plural counterparts (making a total of 138 words). The structure of the singular nouns is: CV(N)C_{np} [where C= consonant, V= vowel, N=nasal consonant, C_{np}= non-palatalized consonant. Care was taken to include consonants that differ in manners, places, and phonation types as C_{np}.

[4] Different morphological processes such as pluralization involve 'addition' of palatalization and also several changes in the radical vowel (as in [koʈ] 'boy' > [kəʈʲ] 'boys'). Investigation of such changes is not taken up here.

The plural forms end in a palatalized counterpart of the C_{np} of the singular noun. Three tokens of each of the 138 forms were recorded from each of the 5 speakers.

Recording and Analysis: The recording was made in a sound-proof room using a "Linear PCM digital sound recorder" at 48kHz sampling rate with 16bit depth. The recordings were analyzed using the *WaveSurfer* and *Speech Analyzer* softwares.

4. Articulatory Gestures in Palatalization

Ladefoged & Maddieson (1996:363) define palatalization as "... the superimposition of a raising of the front of the tongue toward a position similar to that for **i** on a primary gesture. Like labialization it is often more apparent at the release than at the formation of a primary constriction". Hence, its acoustic realization is essentially addition of an **i**-like segment to the concerned consonant. Although the above description holds good for a majority of cases of palatalization, there are languages with palatalization 'more apparent' before the formation of the concerned primary articulation. They recognize that the palatal approximation necessary for producing palatalization may be present before the primary gesture begins. However, no details are available about these approximations before and after the primary gesture. Fig 1 is a schematic that interprets the above description in the case of a post-vocalic palatalized stop that occurs in a VC# type of syllable.

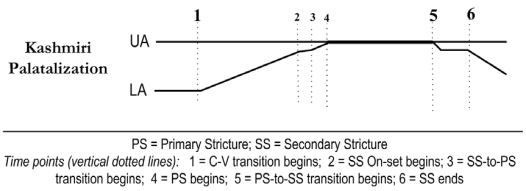


Fig 1: Gestural sequence in a typical case of a palatalized stop (schematized from Ladefoged & Maddieson 1996)

An explanation of the timing of gestures and strictures depicted in Fig.1 follows. Primary stricture (PS) is the stricture by which the consonant sound is named (for its manner and place of articulation) and stricture stricture (SS) is the approximant stricture that defines the nature of secondary articulation. For example, in a palatalized alveolar fricative, the fricative stricture at the alveolar place is the PS and the palatal approximation is the SS. At time-point 1, the open stricture (which is necessary for a vowel that precedes the concerned palatalized stop) starts becoming narrower. At 2, the stricture is made narrow enough to produce approximation and this state is maintained till 3. From 3, the articulators start moving from approximation-stricture for making a narrower stricture targeting the production of the primary stricture for a stop sound. 4-5 is the primary stricture of complete closure. At 5, the stop stricture is released

and 5-6 is the post-release palatal approximation. Thus, 2-3 and its mirror image of 5-6 are the two palatal approximations.

As depicted in Fig. 2 we posit a three-part strictural sequence for palatalization (this may most probably be applicable to other types of secondary articulation such as velarization). Let us call these three sequential parts: onset, nucleus and offset of the secondary stricture (SS). The nucleus of SS is that stretch of it which is concurrent with the primary stricture (PS).

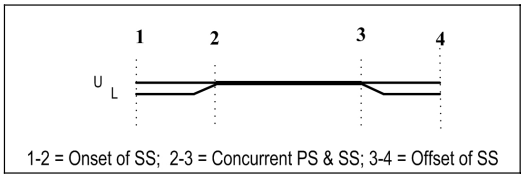


Fig 2: Correlation of gestures of Primary and Secondary Articulations

According to the Ladefoged and Maddieson (1996), most languages exhibit a prominent offset as compared to the onset. However, Gordon (1996) provides examples of Hupa palatalized plosives in its voiceless velar series viz., unaspirated **kʲ** ,aspirated **kʲʰ**, ejective: **kʲ'**. An interesting fact about these palatalized velars of Hupa is "unlike the palatalized velar in Russian which is realized with a much more distinct glide into the following vowel than out of the preceding vowel (Ladefoged and Maddieson 1996:364), the Hupa palatalized velar is realized with a pronounced glide both going into the oral closure as well as coming out of the closure" (Gordon 1996: 165) (see Fig.3). Another interesting feature of Hupa palatalization is that occasionally the original velar stop is replaced by a glottal stop but with the onset and offglide palatal segment is left intact. (Gordon 1996: 167).

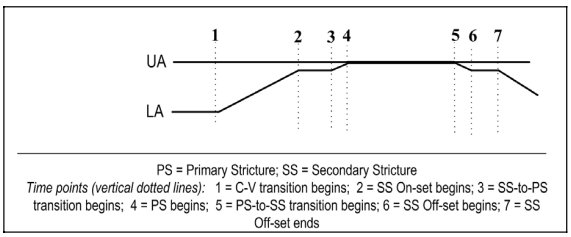


Fig. 3: Gestural sequence in Hupa palatalization
(schematized from Gordon 1996)

An alternative visualization of palatalization is that the SS envleopes the PS as represented in Fig.4. Some implications arise from this type of modelling. For instance, if PS is a closed stricture as in the case of a stop sound, then either the onset or the offset or both of the SS are essential in signalling the acoustic information of secondary articulation. When the PS is also an approximation (just like the SS), then both might merge to produce a palatal PS and then SS might not be distinct from PS. We will notice both these implications are attested in Kashmiri

palatalization. In addition, the PS could be a complex of two consecutive primary strictures as in the case of a consonant cluster. Even then, the SS envelopes the sequence of both the consonants in the cluster. We will discuss this later in the section on onset.

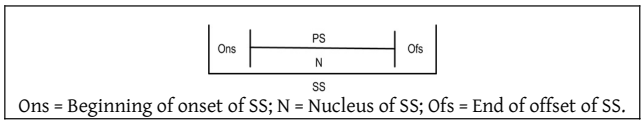


Fig. 4: Schematic showing Secondary Stricture (SS) as enveloping the Primary Articulation (PS).

5. A Model of Kashmiri Palatalization

Fig. 5 is a schematic of typical 3-part strictural sequence in the production of post-vocalic word final palatalized consonants of Kashmiri. We will examine each of the three parts -- the Offset, the Nucles and the Onset in that order.

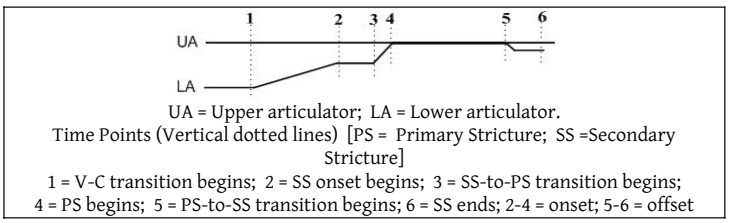


Fig. 5: Schematic Representation of 3-part strictural sequence in Kashmiri Palatalization

5.1. The Offset:

In the available literature on Kashmiri palatalization, the offset was subject of varied description. Our detailed instrumental analysis has revealed that the offset is typically a 'voiceless front unrounded approximant'. Catford (1977:122) categorizes 'close' vowels such as [i], [u] as well as 'semi-vowels' like [j] under 'approximants' and states further that as approximants the airstream in their production becomes 'turbulent when they are made voiceless'. Thus, a front unrounded vowel [i] or its 'semi-vowel' equivalent [j] is expected to be fricativized when it is made voiceless. The offset portion of palatalization in Kashmiri fits this typical description.

Stops: The plosion portion of the stop sounds with its characteristic spike is followed by a voiceless fricative noise. This fricative noise is [ɪ]-coloured. Figs. 6A-B give the spectrograms of [koʈ] 'boy' and [kəʈʲ] 'boys' with various expanded views. Fig. 6C gives the power spectra of selected portions of 6B.

The description of some of the earlier writers about the extra-shortness of ***i*** that occurs after the release of stricture are well-founded. However, the offset portion being voiceless most

of the time is now verified instrumentally[5]. Notice that the post-plosion portion (between points 5 and 6 in Fig. 6B) is entirely voiceless. On the otherhand, inspite of its being voiceless, this portion carries the [ɪ]-like vocalic quality as evidenced by the first two spectral peaks (equivalent to F1 and F2 respectively) at around 400Hz and 1900Hz as shown in Fig. 6C. It is not surprising to see [ɪ]-like spectral peaks inside a voiceless fricative as it is well known that sibilant fricatives carry the resonances correspoding to the vocal tract shapes to which they are tuned (Nartey 1982). Thus we can describe the offset portion in palatalization in narrow phonetic terms as a "voiceless front unrounded approximant" and transcribe it as: **[ɪ̥]**. This description comes close to the observation of Kelkar (1984:66) that / ˈ / is like an extra-short vowel or vowel-colouring of the preceding consonant. Fig. 7 gives the power spectrum of the onset which shows an like [ɪ]-like vocalic segment there.

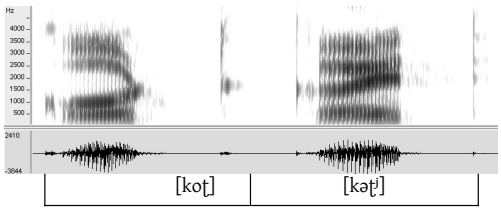


Fig. 6A: Spectrograms of the words [koʈ] *'boy'* and [kəʈʲ] *'boys'*

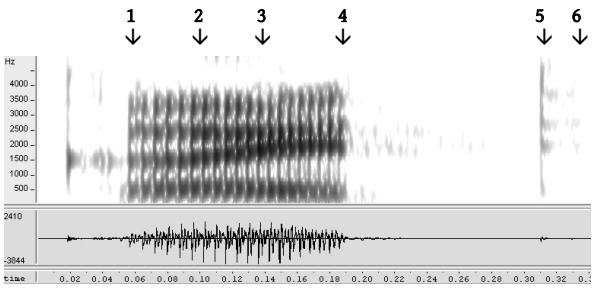


Fig. 6B: Expanded view of the spectrogram of the word [kəʈʲ] *'boys'* of Fig. 6A
[PS=Primary Stricture; SS=Secondary Stricture] ; Time Points (shown by numbered arrows) are
1-2 = Steady-state of the radical vowel; **2-3** = Transition from the radical vowel to the onset;
3-4 = onset; **4-5** = PS+spike; **5-6** = offset

[5] This feature of voicelessness may have something in common with the 'whispered final unaccented short vowels' of Shina of Indus Kohistan (Schmidt et al 2008:23). Masica (1991) seems to have indicated some type of voicelessness of the Kashmiri mātrā vowels when he says : "... these are better described as lost entirely, but leaving effects on preceding consonants and vowels -- e.g., palatalization, unlaut - that may make it analytically convenient stil to posit them as occurring. Saksena notes that the whispered vowels of Awadhi 'do not make a syllable'. The same is noted (Peter Hook, personal communication) with regard to the ultrashort final vowels of Shina" (p.121).

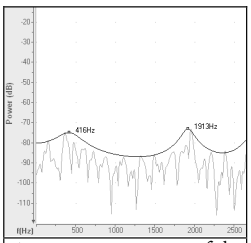


Fig. 6C. Power Spectra of the area between points 5-6 of Fig. 6B.

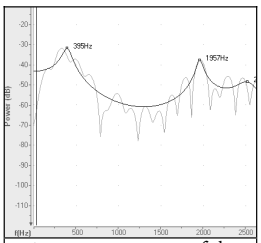


Fig.7 Power Spectra of the area between points 3-4 of Fig. 6B.

The offset remains voiceless even after the release of a voiced plosive. In general, in Kashmiri, both voiced and voiceless plosives (palatalized or otherwise) that are absolutely final (without a following vowel) have only voiceless release. Fig.8 illustrates the voiceless release of a [b] and [bʲ].

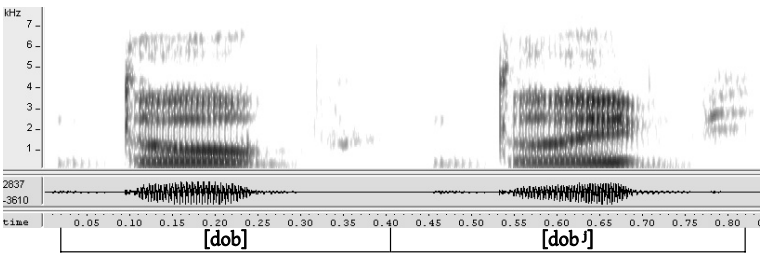


Fig. 8. Spectrogram of [dob] 'washerman' and [dobʲ] 'washermen' showing both the words with voiceless release of the voiced plosives.

Flaps and Taps: Voiced flaps and taps are characterized by momentary strictures and require a vocalic release. Kashmiri taps (which are allophones of the trill phoneme) and flaps -- palatalized as well as non-palatalized contain a short voiced vocalic offset of around 20-30ms duration. Fig 9 shows [ɽ] and [ɽʲ] with vocalic offsets. The vocalic offset of [ɽ] is about 30ms in duration and that of [ɽʲ] is 20ms. Since the vocalic offset is voiced, it contains clear formant structures that reflect the resonances of the glottal pulses. As shown in Fig. 10, the offset of [ɽʲ] contains spectral peaks at 1958Hz and 2348Hz. Fig.11 contains spectrograms of [guːɾ] and [guːɾʲ] showing the vocalic offset of voiced tap [ɾ] and its palatalized counterpart [ɾʲ]. In both the cases, the voiced offset is around 30ms in duration. In the case of [ɾʲ] the vocalic offset contains spectral peaks at 1965Hz and 2620Hz. The spectral peaks in the vocalic offsets of both [ɽʲ] and [ɾʲ] are parallel to the F2 and F3 of the vowel [ɪ].

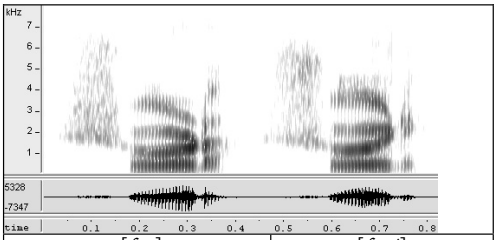


Fig.9. Spectrogram of [ʃuɾ] 'child' [ʃuɾʲ] 'children'

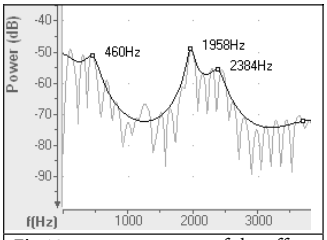


Fig.10. Power spectrum of the offset vocalic release of [ʃuɾʲ] 'children'

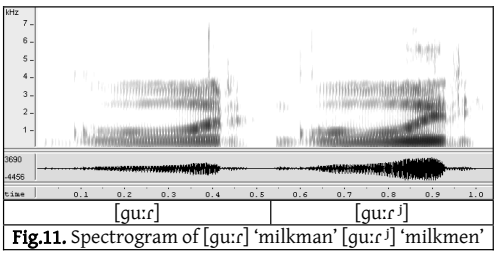


Fig.11. Spectrogram of [guːɾ] 'milkman' [guːɾʲ] 'milkmen'

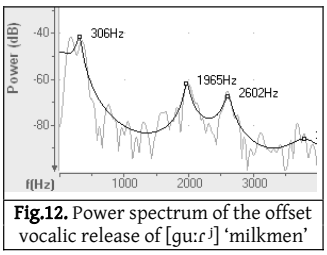


Fig.12. Power spectrum of the offset vocalic release of [guːɾʲ] 'milkmen'

Fricatives: In Kashmiri, the alveolar fricatives [s] and [z] have palatalized counterparts: [sʲ] and [zʲ]. The fricative noise of all these four fricatives (whether palatalized or not) carries the resonances of the cavities that are adjacent to its stricture. The fricative portion of palatalized fricatives contains resonances similar to a front unrounded resonant (as in the case of the noise portion after the release of a stop sound). Kashmiri voiced fricatives are partially voiced (in a temporal sense) -- a voiced fricative starts with regular voicing but trails off into voicelessness. The 'front unrounded resonance' continues throught the whole fricative -- both during the voiced and the voiceless phases. Figs.13-16 depict spectrograms and power spectra of words containing [s, sʲ z, zʲ]. The power spectra of the fricatives [sʲ , zʲ]. show spectral peaks around 1.8kHz corresponding to the F2 of an [ɪ].

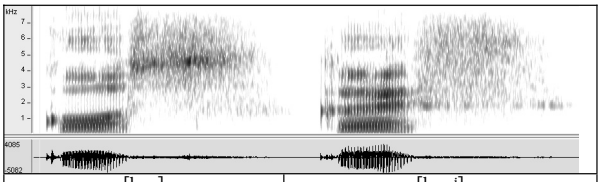


Fig. 13. Spectrogram of [kos] 'I tightened one (sg. object)' [kosʲ] 'I tightened many (pl. object)'

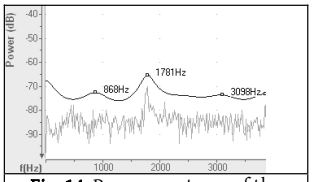


Fig. 14. Power spectrum of the fricative in [kəsʲ] showing a spectral peak around 1.8kHz

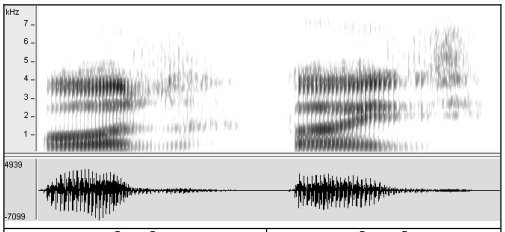


Fig. 15. Spectrogram of [poz] 'truth (sg)' [pəz ʲ] 'truth (pl)'

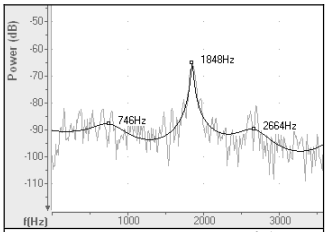


Fig. 16. Power spectrum of the fricative in [poz ʲ] showing a spectral peak around 1.8kHz

Affricates: The fricative portion of an affricate has a behaviour similar to that of a fricative. The palatalized alveolar affricate [ʦ ʲ] ends in alveolar frication which carries 'front unrounded resonance' characterized by a prominent spectral peak around 1.8kHz (similar to the case of palatalized alveolar fricative). Figs. 17 and 18 illustrate this.

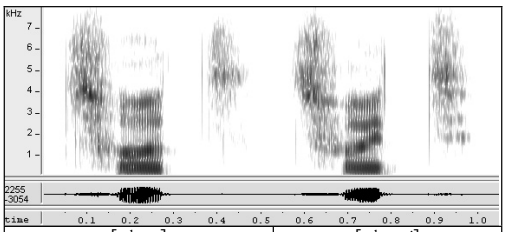


Fig 17. Spectrograms of [tsʰots] 'empty (sg.)' and [tsʰots ʲ] 'empty (pl.)'

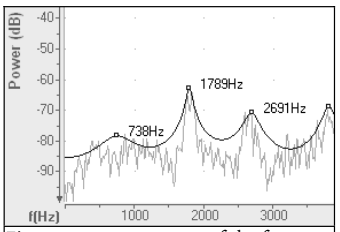
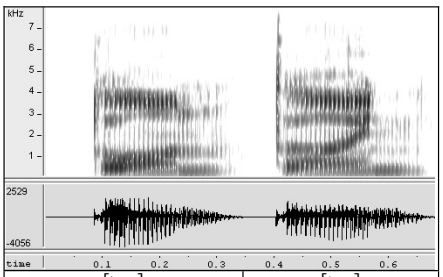


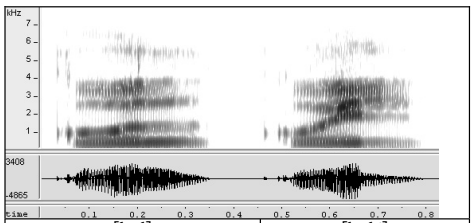
Fig. 18. Power spectrum of the fricative portion of the final affricate in [tsʰots ʲ] showing spectral peak around 1.8kHz

Sonorants: Among the sonorants,the nasal [n] and the lateral [l] that belong to the alveolar series undergo a substantial change when they are palatalized. [n ʲ] is phonetically realized as [ɲ] and [l ʲ] as [ʎ]. Compared to the effect on the offset of stops, flaps and taps, fricatives, affricates, palatalization directly effects the nucleus part of the sonorants. Interestingly, there is no offset portion in these sounds. However, a brief palatal onset is available in them. Fig. 19 gives spectrograms of [ton] 'slim (sg.)' and [tən ʲ] > [təɲ] 'slim (pl.)' showing the clear onset and the palatal nasal in the plural form. Fig. 20 contains spectrograms of [kul] 'tree' and [kul ʲ] > [kuʎ] 'trees' and Fig. 21 shows the typical spectral peaks at around 1.8kHz and 2.6kHz corresponding to F1 and F2 of an [ɪ] type of vowel. These spectral peaks are available in the onset portion as well as during the PS of 'lateral' itself confirming that it is the palatal lateral [ʎ].



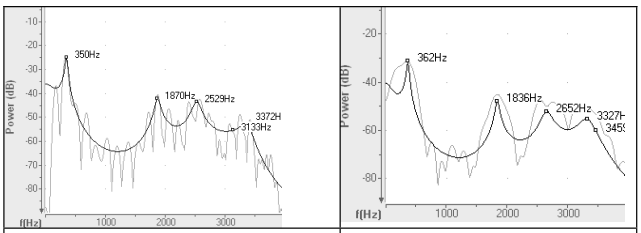
[ton]	[təɲ]

Fig. 19. Spectrogram of [ton] 'slim(sg.)' [tənʲ] > [təɲ] 'slim(pl.)'



[kul]	[kulʲ]

Fig. 20. Spectrogram of [kul] 'tree'; [kulʲ] >[kuʃ] 'trees'



A	B
Power Spectrum of the onset paltalization of [ʲ] showing the formant peaks typical of vowel [ɪ] F1 around 350Hz, F2 around 1900Hz and F3 around 2550Hz.	Power Spectrum of the central portion of [ʲ] showing the formant peaks typical of a palatal [ʃ].

Fig 21. Power Spectra of different portions of the word [kulʲ] 'trees' of Fig. 19

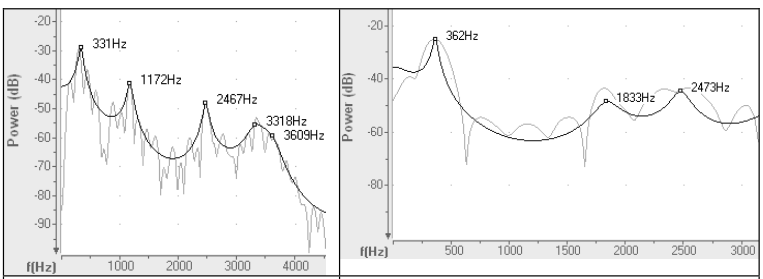
5.2. The Nucleus:

After examining the phonetic realization of the offset, we now examine the phonetics of the nucleus of palatalized consonants in the language. It may be recalled that the nucleus of a palatalized consonant essentially is composed of simultaneously occurring secondary stricture (SS) and primary stricture (PS). The SS is a 'palatal approximation' and the PS is the stricture appropriate for the concerned manner of articulation. In Kashmiri palatalized consonants, the onset and the offset carry sufficient amount of acoustic information to signify that it is a palatalized consonant. When the PS is a closed stricture as in the case of stops and affricates, most of the acoustic information generated by the SS portion is attenuated by the closed articulators. When the PS is opener as in the case of sonorants and fricatives (either as the

stand alone part of a regular fricative or as the fricative portion of an affricate), then the acoustic information conveyed by the SS is combined with that of PS. The result is an [ɪ] like 'front vowel' resonance within the PS. It is interesting to note that when SS information is intermingled with the signal generated by the PS, the need for an offglide becomes minimal. Thus, alveolar palatalized fricatives and affricates absorb the offglide into the fricative stricture. On the other hand, in the case of the alveolar nasal and lateral, the PS and SS merge to become a palatal place of articulation i.e., the SS is completely absorbed into the PS -- the 'palatalized alveolar lateral' becomes 'palatal lateral' and the 'palatalized alveolar nasal' becomes 'palatal nasal'. It should be noted that this is the phonetic situation. The phonology of the language can still treat them conventionally as palatalized units and derive the phonetic structure by a rule. In the case of the palatalized flap and tap in the language, the situation is similar to that of palatalized stops. Again the momentary stricture and the necessary offglide for these two types of sounds preserve a good amount of acoustic information of palatalization in the offset and also in the onset.

5.3. The Onset:

The palatal onset is present with all the varieties of PS. Again, its quality is similar to that of [ɪ]. Grierson (1911), Bhat (1987) and Bhat (2008) have rightly noticed the onset, although each of them interprets its functional status in a different way. Schmidt etal (2008) recognized a similar segment (viz., [e̯])in Shina of Indus Kohistan. However, the narrower phonetic description of the onset has not been provided by the previous authors. Our investigations revealead that the onset segment is close to [ɪ] in its acoustic quality. Fig. 22 gives the power spectra of the radical vowel [o] and the onset segment [ɪ] in the word [dobʲ] 'washermen'. The radical vowel [o] contains formant structure typical of a back rounded opener vowel. However, the onset segment shows typical [ɪ]-like formant structure (with the three peaks corresponding the F1, F2 and F3 typical to that vowel) as explained in Fig.21B.



A	B
Power Spectrum of the Radical-Vowel [o] with F1 around 330Hz, F2 around 1170Hz and F3 around 24670Hz.	Power Spectrum of the offset showing F1 around 360Hz, F2 around 1830Hz and F3 around 2470Hz typical of [I]

Fig 22. Power spectrum of the Radical-vowel and onset of the word [dobʲ] 'washermen' [Re: spectrogram in Fig. 8]

Another important feature of the onset is that it extends even over a nucleus composed of a consonant cluster. Recall Fig.4 represented SS as a kind of an envelope surrounding the PS. This approach is strengthened by the occurrence of an onset to the left of a palatalized consonant cluster. Nasal+stop/fricative is the most common consonant cluster in non-initial position of a word in the language. Fig 4a is a modified version of Fig.4 extended to show that the PS can be composed of two cosonants (PS1 and PS2) and the onset segment of palatalization begins before the first consonant of the cluster begins. The offset segment comes after the end of the PS of the last consonant. This finding clearly shows that palatalization spreads across the whole of the consonant stretch to which it is attached.

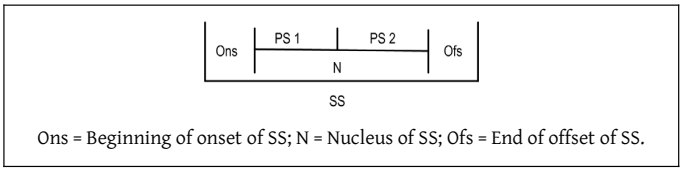


Fig. 4a: Schematic showing Secondary Stricture (SS) enveloping a sequence of two Primary Strictures

Fig. 23 gives the spectrogram of the words [thomb] 'handful (sg.)' and [thomb ʲ] 'handfuls (pl.)'. Fig. 24 shows the power spectrum of the vocalic segment that occurs before the cluster [mb ʲ] of [thomb ʲ] indicating clearly that the segment is typically [ɪ] -like. Fig 25 is an expanded view of the spectrogram of [thomb ʲ] 'handfuls (pl.)' with various segments demarcated.

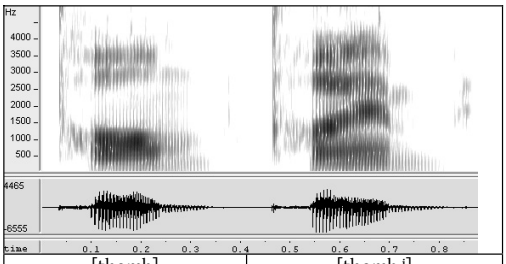


Fig. 23: Spectrogram of [thomb] 'handful (sg.)' [thomb ʲ] 'handfuls (pl.)'

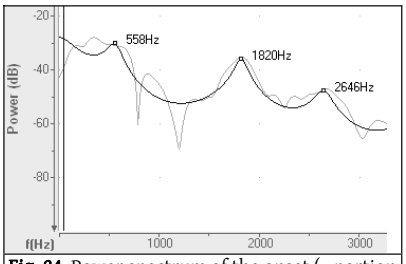


Fig. 24. Power spectrum of the onset (= portion 3 in Fig.36) in showing the formants for a typical [ɪ] : F2 1820Hz and F3 2650Hz.

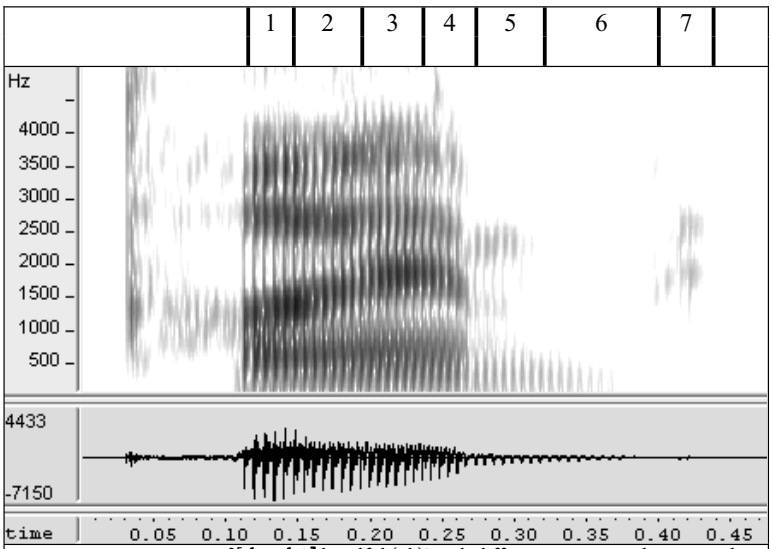


Fig. 25. Spectrogram of [**thomb** ʲ]'handful (pl.)' with different segments demarcated

1 = steady-state of radical vowel [o]; 2 = transition from [o] to onset segment [ɪ]; 3 = steady-state of onset segment [ɪ]; 4 = transition from [ɪ] to a bilabial closure; 5 = [m]; 6 = [b]; 7 = voiceless release of [b] with [ɪ]-like spectrum

Supplementing the above figures, Figures 26 and 27 give the spectrograms of the words [ponz] 'monkey' and [pənz ʲ] 'monkeys' and power spectrum of the onset in [pənz ʲ] 'monkeys'. These data reinforce the observation of spread of onset over a consonant cluster.

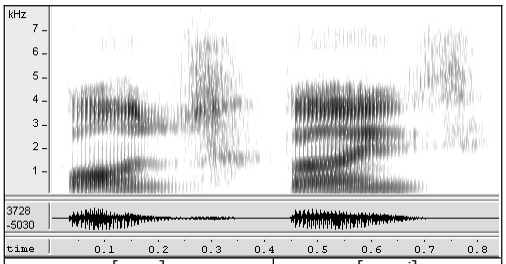


Fig. 26: Spectrogram of [ponz] 'monekey' [pənz ʲ] 'monkeys'

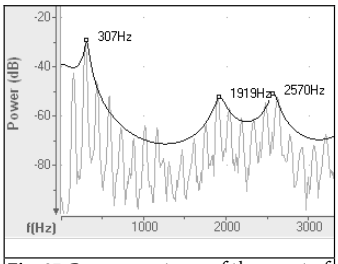


Fig. 27. Power spectrum of the onset of [pənz ʲ] 'monkeys' in Fig.22 showing the formants for a typical [ɪ] : F2: 1920Hz and F3: 2570Hz.

6. Conclusions:

Palatalization of consonants in Kashmiri is spread around the concerned consonant. We have shown that 'palatalization' of word-final consonants and consonant clusters is a secondary stricture (SS) composed of three parts: the onset of palatalization, its nucleus, and its offset. Table 3 summarizes the phonetic nature of various parts of palatalization.

		1	2	3	4
		Radical Vowel = [V] of [VC^{J} #]	onset	Nucleus	offset
A	Stops, Fricatives, Affricates		+	+	voiceless
B	Flaps/Taps		+	+	voiced
C	Resonants (n, l)		+	+ merged with PS to become palatal place of articulation	absent

Table 3. A representation of various parts of SS of palatalization occurring with different PSs.

The onset begins before the primary stricture (PS) for the consonant (or of the first consonant in the case of a consonant cluster) begins. The onset continues into the nucleus of SS which is concurrent with the PS (single or cluster). The acoustic quality of the SS-nucleus is not significant when the PS is a closed type (such as in the case of stops) because there is little energy emerging from the closed PS. The SS-nucleus then continues into its offset. The offset is always voiceless if the PS is a stop, fricative or an affricate -- whether they are voiced or not. The offset is voiced if the PS is a flap or a tap. When the PS is a resonant ([n] or [l]), two processes take place: the offset is absent, and the nucleus of SS merges with that of PS giving rise to a 'palatal' place of articulation instead of a 'palatalized' sound. The spectral characteristics of the onset and the offset (whether it is voiced or voiceless) are similar to those of the vocoid [ɪ] which is structurally palatal.

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Appendix

Palatalized consonants have been represented by various symbols in the available sources. A majority of them (perhaps following Bailey (1937)) use an apostrophe [’] as the palatalization symbol. E.g, [p’] standing for a ‘palatalized *p’.*

However, Kelkar and Trisal (1964), the earliest comprehensive descriptive phonological work on Kashmiri and Kelkar (1984), the latest such comprehensive work do not set up a separate phonological unit that palatalizes the concerned consonant. Instead, Kelkar and Trisal (1964) use a phonetic realization of ‘semivowel’ [i̯] for generating palatalization, and Kelkar (1984) uses the ‘semivowel’ [i] for the same purpose.

Since Kelkar’s (1984) proposal to handle ‘palatalization’ by means of the ‘semivowel’ [i] seems to be adequate enough, we have not taken up the topic of phonemic representation of ‘palatalization’ in this paper. However, a thorough discussion on this issue is a desideratum.

For the sake of enumerating the consonants in the language, we adopt the phonemic inventory and nomenclature given by Kelkar (1984) as given below while showing the IPA equivalents in parentheses.

	BL	*AD*	*AA*	*Rt*	*Vr*	*LA*	*LP*	*Gl*
Vl Ua St	p	t		ṭ (ʈ)	k	c (ts)	č (ʧ)	
Vl As St	pʰ	tʰ		ṭʰ (ʈʰ)	kʰ	cʰ (tsʰ)	čʰ (ʧʰ)	
Vd St	b	d		ḍ (ɖ)	g	j (dz)	ǰ (ʤ)	
Ns(Vd)	m		n					
Fr(Vl)						s	š (ʃ)	
Lt(Vd)			l					
Tr(Vd)			r					
Frn Vc								h

Vl = Voiceless; **Ua** = Unaspirated; **St** = Stop; **Vd** = Voiced; **Ns** = Nasal; **Fr** = Fricative; **Lt** = Lateral; **Tr** = Trill; **Frn Vc** = Friction Vocoid

BL = Bilabial; **AD** = Apico-dental; **AA** = Apico-alveolar; **Rt** = Retroflex; **Vr** = Velar; **LA** = Lamino-alveolar; **LP** = Lamino-palatal; **Gl** = Glottal