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Existence of Voiceless Velar Nasal in Urdu

Abstract: *This paper aims to look into the existence of the voiceless velar nasal phoneme in Urdu; known as voiceless ingma. It discusses the behavior of the nasalised sound that occurs when n precedes a velar stop. The discussion is based on the acoustic and phonological analysis of the data collected for the paper.*

Keywords: *Ingma, velum, velar, nasalization, velo-pharyngeal port, stop, burst, formants, voicing, nasals.*

1 INTRODUCTION

Voiceless velar nasal stop exists in many languages of the world, e.g., Burmese and Angami, as in [2]. Urdu contains voiced bilabial nasal /m/, voiced alveolar nasal /n/ and it has also been proved that voiced velar nasal /ŋ/ also exists in Urdu. The existence of the ingma at the start of the syllable is not possible because of the phonotactic rule in Urdu, which does not allow two phonemes at the start of syllable and /ŋ/ in Urdu comes as an assimilation of two phonemes /n/ and any velar stop. Whenever, /n/ precedes a voiced velar stop /g/, it goes through place assimilation, and /g/ gets deleted and /ŋ/occurs, as in [3]. However, when /n/ precedes voiceless velar stop /k/, existence of a voiceless velar nasal stop /ŋ^{o}/ is an open question.

2 LITERATURE REVIEW

Nasal consonants are mostly always voiced. But, voiceless nasal consonants are also possible, as in [2].

Urdu contains voiced nasal constants e.g. /m/, /n/ and /ŋ/. /m/ and /n/ can come anywhere in the word. But, ŋ cannot come at the start of the syllable, because there is no phoneme in Urdu, which maps on [ŋ] and no syllable in Urdu can start with more than one consonant. The onset is of either 0 or 1 consonant in Urdu.

Manner of articulation, place of articulation and movement of vocal folds can distinguish oral consonants in a language. Acoustically, F1 transition relates to the obstruction of the oral cavity and F2 transition relates to the place of articulation, as in [5].

Nasal consonants are produced with closure of oral cavity and radiation of the sound through the nasal cavity, as in [1].

Velopharyngeal port is opened and air flows both through the nasal cavity and the oral cavity. In voiced nasal consonants, during the prevoicing period, when oral tract is blocked at some place, light formants are clearly visible in the spectrograms due to air coming through the pharyngeal cavity and the nasal cavity. When, the occlusion is removed, burst appears and the next sound continues. These nasalised formants are known as nasal murmur, as in [1].

3 ACOUSTICS OF NASALS

There is a stable concentration of energy in the lower frequency regions with a first formant at around 300 Hz. Due to presence of anti-formant, coming through nasal cavity from the pharyngeal cavity, there is little energy in the areas around 600 Hz. Also, there exists nasal murmur with a resonant peak at around 250 Hz and a secondary peak at about 700 Hz. Nasal sounds weaken the upper formants of neighboring vowel sounds because they are highly damped. During nasal production, the nasal and oral cavities resonate together resulting in a loss of amplitude at higher frequencies, due to anti-formants. The sound energy of nasals is spread evenly throughout the central frequency (800 – 2300) Hz, as in [7].

As discussed above, the only difference between a nasal and oral sound is the opening of velopharyngeal port. The nasal consonants can also be distinguished by place, manner in the oral cavity and the movement of the vocal folds.

4 PROBLEM STATEMENT

The paper discusses the issue of existence of voiceless velar nasal in Urdu. The existence of voiceless ingma sound is a controversial issue when /n/ precedes voiceless velar stop /k/?

5 METHODOLOGY

5.1 Selection of words

Words were selected using three dictionaries, as in [8], [9] and [10]. Words were selected in minimal pairs, e.g., words with a chance of ingma vs. words with no ingma, for example, /tʃoki/ vs. /tʃonki/; and words with a chance of ingma vs. words with proved existence of ingma, e.g., /tʃunke/ vs. /tʃunge/. Words with /n/ followed by /k^{h}/ and /n/ followed by /g^{h}/ were also analyzed.

Words used in the analysis are shown in Appendix A, B and C.

The carrier sentence used is shown in Appendix D.

One problem faced was that we could not find words with all vowels in minimal pairs.

5.2 Selection of Speakers

Seven male adult speakers and three female adult speakers were selected for recordings. Special care was taken for the selection of speakers for the clarity of speech. And none of the speakers had a nasal voice. Also, only clear recordings were used for analysis.

5.3 Recording Equipment

The recordings were carried in a noise free environment and each sentence was recorded three times for each speaker, to ensure least error. The equipment consisted of a high fidelity 600 ohms moving coil microphone, a Teac integrated stereo amplifier (power output 195 Watts per channel) and two high quality speakers with impedance of 8 ohms.

The tools used for recording, editing and acoustic analysis were: -

1) Praat 4.11
2) Winsnoori 1.3

5.4 Acoustic Analysis

The recordings were analyzed for the following values: -

1) Formants and duration of nasal consonant before the stop.
2) Duration of the stop.
3) Duration of nasalized vowel.
4) Values of formants and bandwidths of nasalized vowels.

These values were used to compile the results.

6 RESULTS

The analysis of spectrograms uncovered the following facts.

6.1 Existence of Voiceless Ingma

Figure 6.1 and 6.2 show the spectrograms of /banga/ and /banka/. The observations reveal that voiceless velar nasal does not exist in Urdu.

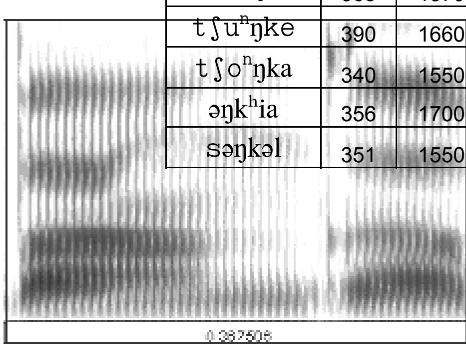


Figure 6.1 Spectrogram of /banga/

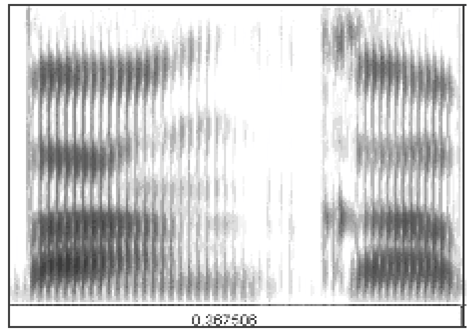


Figure 6.2. Spectrogram of /banka/

It is clear from the spectrogram readings given in table 6.1.1 and 6.1.2, that the duration of the nasalized vowel is the same in both cases. Also, the nasal vowel has approximately same value for F1 and F2. Analyzing the timing tier and durations, we see that the total duration of the nasal consonant, after the nasalized vowel, and the stop before the

burst of /k/ is approximately equal to the total length of /ŋ/ before the burst. Furthermore, the F1 of both nasal consonants is about 300-350 Hz, independent of the preceding vowel and speaker, and F2 varies speaker to speaker and also with the preceding vowel. However, F2 was approximately same for the same vowel and speaker in

Table 6.1.2 Acoustic analysis on the recordings of adult female speakers

Words with /n/ preceding /k/					Words with /n/ preceding /g/			
Word	F1 (Hz)	F2 (Hz)	Duration of nasal consonant. (msec)	Duration of stop (msec)	Word	F1 (Hz)	F2 (Hz)	Duration of nasal consonant, /ŋ/. (msec)
ba^{n}ŋka	434	1490	75.4	37.45	ba^{n}ŋa	441	1552	95.47
ri^{n}ŋka	451	1650	71.63	38.04	ri^{n}ŋa	447	1690	96.43
p^{h}æ^{n}ŋka	455	1807	70.15	38.15	b^{h}æ^{n}ŋka	447	1850	94.56
tʃu^{n}ŋke	395	1862	71.92	38.882	tʃu^{n}ŋe	410	1874	94.565
tʃo^{n}ŋka	447	1763	69.9	39.95	bo^{n}ŋa	448	1767	94.125

Table 6.1.1 Acoustic analysis on the recordings of adult male speakers

Words with /n/ preceding /k/					Words with /n/ preceding /g/			
Word	F1 (Hz)	F2(Hz)	Duration of nasal consonant. (msec)	Duration of stop (msec)	Word	F1 (Hz)	F2 (Hz)	Duration of nasal consonant, /ŋ/. (msec)
ba^{n}ŋka	364	1550	71	48	ba^{n}ŋa	378	1595	104
p^{h}æ^{n}ŋka	365	1570	56	60	b^{h}æ^{n}ŋa	335	1500	99
tʃu^{n}ŋke	390	1660	52	44	tʃu^{n}ŋe	341	1700	85
tʃo^{n}ŋka	340	1550	60	54	bo^{n}ŋa	380	1558	95
əŋk^{h}ia	356	1700	52	53	əŋia	350	1700	104
səŋkəl	351	1550	60	57	səŋəl	370	1760	105

the nasal consonant of both pair of spectrograms or minimal pair.

As in case of every nasal, F1 is about 300 Hz, so in this case the first formant clarifies the existence of the nasal. The voicing proves that the nasal consonant is voiced which shows that there is no voiceless ingma. To know that which particular nasal is this, we have to verify it through F2 as in [11] and we see that the F2 is about 1500 in this case and we know that the F2 for /n/ is about 1000-1200 and for /ŋ/ is above 1500, as in [11], so the nasal consonant is /ŋ/ not /n/, as shown in the table. However, its duration is approximately double when /n/ proceeds /g/ than when /n/ proceeds /k/.

We also analyzed some words with /g^{h}/ and /k^{h}/ and got similar results. When /n/ precedes /k^{h}/, vowel before /n/ is nasalized, /n/ assimilates to ŋ and /k^{h}/ sound follows.

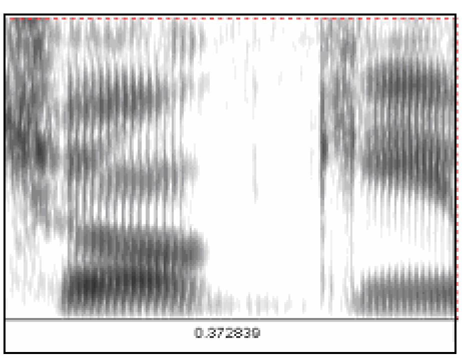
Table 6.2.1 Acoustic analysis on the recordings of adult male speakers

Words with /n/ not preceding /k/						
Word	F1 (Hz)	F2 (Hz)	BWD1 (Hz)	BWD2 (Hz)	Duration of Vowel (msec)	Duration of stop (msec)
tʃoki	571	1050	84	133	91	107
əkəl	670	1339	94	184	85	91
baka	730	1325	149	436	106	74

Figures 6.3 and 6.4 show the spectrograms of /tʃoki/ and /tʃonki/. The spectrogram readings show that the length of nasal consonant + length of stop in /tʃonki/ is approximately 30^{+} msec greater than the length of stop in /tʃoki/, see Table 6.2.1 and 6.2.2; which shows that there is one more timing tier in /tʃonki/ than in /tʃoki/, and this show the presence of voiced velar nasal consonant /ŋ/.

Table 6.2.2 Acoustic analysis on the recordings of adult male speakers

Words with /n/ preceding /k/							
Word	F1 (Hz)	F2 (Hz)	BWD1 (Hz)	BWD2 (Hz)	Duration of Vowel. (msec)	Duration of Stop. (msec)	Duration of /ŋ/ (msec)
tʃo^{n}ŋki	672	940	237	311	107	55	52
əŋkəl	656	1367	159	201	92	51	65
ba^{n}ŋka	736	1359	279	274	104	50	65



tʃ o k i

Figure 6.3 Spectrogram of vowel preceding /k/

Also, a comparison between the vowels of both /tʃoki/ and /tʃonki/ shows that, the bandwidth of the vowel has increased when it preceded /ŋ/ than when it preceded /k/, which shows that the vowel before /k/ in /tʃoki/, has been nasalized when it comes before /n/ in /tʃonki/, as in [1].

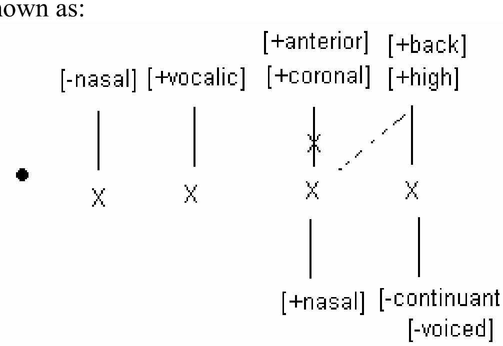
tʃ õ ŋ k i

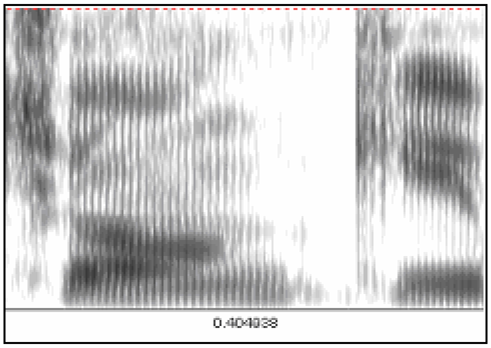
Figure 6.4 Spectrogram of /n/ preceding /k/

The difference between the duration of stops is clearly visible in the tables 6.2.1 and 6.2.2. The duration of stop in words with /n/ preceding /k/ is approximately half the duration of stop in other words, where /n/ does not precede /k/. Duration of vowel has remained approximately same in both cases, with a little change. Also, the difference in stops before /k/ in /tʃonki/ and /tʃoki/ is approximately equal to the length of /ŋ/ in words with /n/ preceding /k/.

6.2 Assimilation Rule

The ingma does not always occur whenever /n/ precedes /k/. Sometimes, /n/ precedes /k/ but both do not come in one syllable. This happens in two cases, when vowel before /n/ is a high front short vowel or the consonant before /n/ is a nasal, e.g., in /manka/, we get two syllables /man.ka/ and /ŋ/ is not produced. The rule can be shown as:





W	[illegible]	[illegible]	ic riptio
[illegible]	[illegible]	[illegible]	a
رینکا	ri^{n}ŋka	رینگا	ri^{n}ŋa
چونکہ	tʃu^{n}ŋke	چنوگے	tʃu^{n}ŋe
چونکا	tʃo^{n}ŋka	بونگا	bo^{n}ŋa
بانکا	ba^{n}ŋka	بانگا	ba^{n}ŋa

7 Conclusions

The voiceless velar nasal stop does not exist in Urdu. However, whenever /n/ proceeds /k/ or /k^{h}/ and both are in same syllable then the vowel preceding /n/ is nasalised, /n/ undergoes place assimilation and becomes /ŋ/ and /k/ or /k^{h}/ sound follows.

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Word	Phonetic Transcription	Word	IPA Transcription
عقل	əkəl	انکل	əŋkəl
چوکی	tʃoki	چونکی	tʃo^{n}ŋki
باکا	baka	بانکا	ba^{n}ŋka

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APPENDIX A

Words having /n/ preceding /k/ and /n/ preceding /g/ contrast:

APPENDIX B

Words having /n/ preceding /k/ and /k/ contrast:

Appendix C

In the following words, /n/ precedes /k/ but /ŋ/ does not occur, as described in article 5.2.

Words	IPA Transcription
انقباض	ɪnkbaz
انکار	ɪnkar
انقطاع	ɪnkṭaʔ
انقباض	ɪnkbaz
انقسام	ɪnksam
منقسم	mʊnkəsɪm
منقاش	mɪnkaʃ
منقوله	mənkulah
منقلب	mʊnkəlɪḅ

منقصت	mʊnkɪsəṭ
منقصب	mʊnkɪsəb

Appendix D

میں نے ۔۔۔ بولا

Its IPA Transcription is: /me^{n} ne … bola/
This sentence was selected because the stop of /b/ made the onset of actual word very clear.