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Existence of Ingma in Urdu Language and its Phonological Features

Abstract: *This paper aims to look into the existence of the velar nasal phoneme known as ingma, /ŋ/, along with its phonological aspects in Urdu Language. Occurrence of ingma is discussed in the paper on the basis of the acoustic and phonological analysis of the data collected for this purpose.*

Keywords: ***U****rdu, ingma, velar, nasal, assimilation, velopharyngeal port*

1. INTRODUCTION

Ingma, /ŋ/, is a velar nasal phoneme known to exist in different languages of the world. This paper explores the existence of ingma in Urdu Language and describes its phonological behavior.

To date, there has been no significant documented effort towards the determination of different features of Urdu Language. Lack of standardization of Urdu consonantal and vocalic sounds proves to be a major hindrance in the development of Urdu computation. This paper attempts to make a small contribution in this regard.

2. LITERATURE REVIEW

This section presents a brief review of literature available about the characteristic features of ingma.

Consonants in a language can be classified accordin to their manner of articulation. Consonantal sounds are generally made by exploiting the articulatory capabilities of the tongue, teeth and lips in such a way that airflow through the mouth cavity is radically constricted or even temporarily blocked. It is possible to block the oral cavity so that the air flows through the pharyngeal and nasal cavities to produce a nasal consonant. Such nasal consonants are produced with the soft palate lowered to allow airflow through the nasal passage and with the mouth cavity blocked for the duration of the consonant (Clark and Yallop, 1992).

During the interval when the oral tract is completely occluded by the articulation of a nasal consonant, the sound produced by the glottal action of the phonation is propagated through the velar port and the nasal passages, and out through the nose. This sound from the nose is called a nasal murmur (Pickett, 1999).

Nasals are further classified according to their place of occlusion in the oral tract. A nasal consonant occluded at the place of velum is a velar nasal, known as ingma, /ŋ/. The oral occluding movement for ingma is similar to that of a voiced velar stop /ɡ/ in that the constricting movement of the tongue is rapid and complete oral occlusion is formed. Because of this similarity some linguists classify ingma as a velar nasal stop (Pickett, 1999).

During the articulation of ingma the following sequence of events occurs

1. If the velum is not already lowered, it is lowered.
2. The oral tract is closed at the velum. Air is free to flow through the nasal cavity.
3. During the oral occlusion, air continues to be expelled from the lungs. Usually the vocal folds are together and are vibrating (to produce a voiced sound source) and both the airflow and the majority of the voiced sound energy pass through the nasal cavity.
4. When the nasal stop phoneme is finished, the oral closure may be released, unless this is prevented by the requirements of the next phoneme.
5. Because air pressure is released through the nose, there is usually not an audible burst when the oral occlusion is released.
6. The active articulator continues to move towards its target for the next phoneme. The velum is free to go back to its original position, unless this is prevented by the requirements of the next phoneme (www.ling.mq.edu.au).

The articulation of ingma is shown in Figure 2.1.

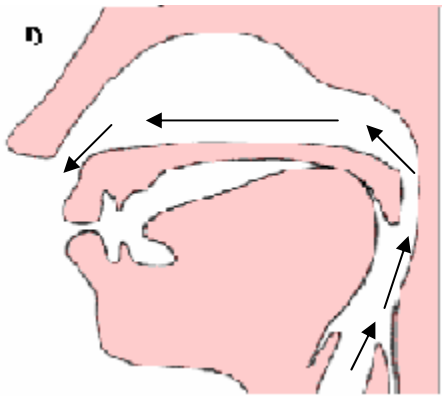

Figure 2.1 Articulation of Ingma (www.ling.mq.edu.au)

The downward movement of the velum for a nasal consonant begins well before the beginning of oral tract

movement towards occlusion, thus the opening of the velar port is complete by the time the oral tract is closed. The velar port remains open during the release of the oral occlusion.

3. PROBLEM STATEMENT

This paper addresses the issue of the existence of ingma in Urdu language. It further explores the phonological behavior of ingma through acoustic analysis, on the condition of its existence in Urdu language.

4. METHODOLOGY

4.1 Selection of words

Words were carefully selected to have voicing, vowel and aspiration contrast. Voicing difference was catered for by the selection of words in which /n/ precedes voiced and unvoiced velar stops i.e. /ɡ/ and /k/ respectively. Further variation in the data was created by selecting different words, each having one of the four cardinal vowels (/i/,/æ /,/ɑ/,/u/) preceding /n/ in both voiced and unvoiced cases. Aspiration contrast was introduced in the data in voiced as well as unvoiced cases. For the list of words selected for analysis, see Appendix A.

4.2 Selection of speakers

For the acoustic analysis the selected words were recorded as spoken by different speakers. The selected speakers had a Punjabi-Urdu accent. A total of six speakers, three males and three females were chosen. Special care was taken while selecting the speakers to ensure that their speech was clear and none of the speakers had a nasal voice.

4.3 Recordings

The recording was carried out in a noise free environment. Each speaker was made to speak the selected words within a carrier phrase (see Appendix B). The sentences were randomized to ensure the natural delivery of the words. Every sentence was recorded five times to remove any discrepancies. The equipment for recording consisted of a high fidelity microphone and a Teac integrated stereo amplifier.

4.4 Acoustic analysis

Acoustic analysis of the speech was carried out using two different softwares,

1) Winsnoori 1.3
2) Praat 3.9.35

For the acoustic analysis of the data, spectrograms were read to study burst, duration, nasalization and voicing of alveolar nasal /n/ preceding velar stops /ɡ/,/ɡʰ/,/k/,/kʰ/. The effects on the preceding vowels were studied by their formants and their bandwidths. The values of formants and bandwidths were evaluated by the spectrum created using LPC roots.

4.5 Phonological analysis

The results of the acoustic analysis of the data were used to identify the phonological rules for ingma. The assimilation of place, nasality, aspiration and voicing was studied to generate the phonological rules.

5. RESULTS

Careful analysis of the spectrograms and the spectrums of the recorded data revealed the following results.

5.1 Existence of Ingma

In Urdu, ingma exists when /n/ precedes a voiced velar stop /ɡ/ or voiced aspirated velar stop /ɡh/. An alveolar nasal /n/ becomes a velar nasal, /ŋ/, when it is followed by a voiced velar stop /ɡ/ or its aspirated version /ɡʰ/. In Figure 5.1, the spectrogram shows the nasal band throughout the duration of the closure of the velar stop, which clearly shows that velopharyngeal port remains open during the closure of oral tract. Thus this observation proves the existence of ingma when /n/ precedes /ɡ/ or /ɡʰ/.

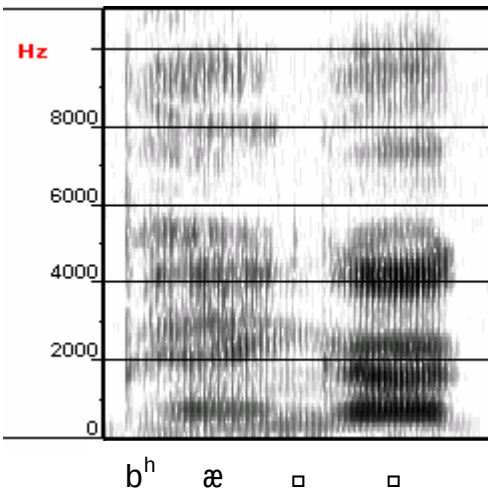

Figure 5.1 Spectrogram of /n/ preceding /ɡ/

When the alveolar nasal /n/ precedes the unvoiced velar stop /k/, the spectrogram in Figure 5.2 clearly shows that the nasal band finishes during the closure of the velar stop, which means that the closure of velopharyngeal port occurs during the closure of oral tract. Thus velopharyngeal port closes before the oral tract opens, proving the nonexistence of ingma in case of unvoiced velar stop. The above statement holds for both, aspirated and unaspirated versions of unvoiced velar stop, /k/ and /kʰ/.

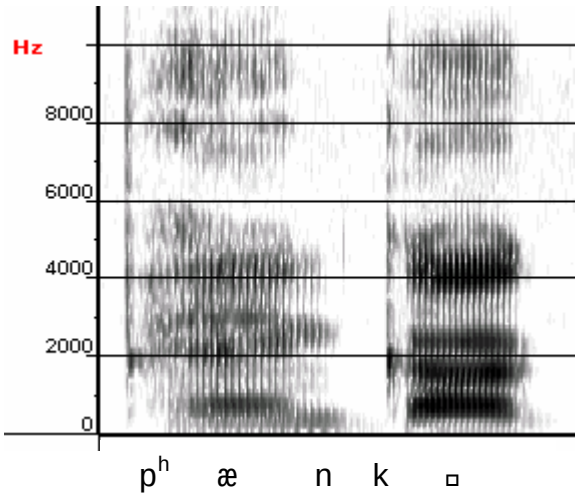

Figure 5.2 Spectrogram of /n/ preceding /k/

5.2 Nasalization of Previous Vowel

The velar nasal ingma, /◻/, nasalizes its preceding long vowel. From the analysis of the spectrum of the recorded cardinal vowels occurring before /◻/, it was deduced that the ingma makes its preceding vowel nasal. The vowel /◻/ is partially nasalized, whereas the rest of the cardinal vowels are completely nasalised. This result is supported by observations gathered by examining the bandwidth and frequency of the first formant of the vowels recorded by the speakers.

Incase of the vowel /u/, the nasal band merges with F1 and the correct values of frequency and bandwidth of F1 cannot be determined.

But, the presence of nasal band in the spectrogram proves that the vowel /u/ preceding /◻/, is nasalized.

The average values of the frequency and bandwidth of the first formant of the male and female speakers for each cardinal vowel are given in Table 5.1.

Table 5.1 Average Values of Frequency and Bandwidth of the First Formant for Nasal and Non-Nasal Utterances

Vowels	Male				Female			
	Nasal		Non-Nasal		Nasal		Non-Nasal	
	F1	BWD	F1	BWD	F1	BWD	F1	BWD
◻	725.1	174.9	704.2	105.5	864.1	302.6	883.0	128.5
æ	638.1	212.7	633.2	121.0	735.3	223.1	733.7	137.2
□	362.9	177.1	296.3	85.5	326.7	109.2	305.3	145.6
□ᵘˡ	x	x	356.7	130.5	x	x	367.3	155.7

No effects of ingma were observed on the phoneme following it.

Table 5.2 Average Values of Frequency and Bandwidth of the First Formant for Utterances involving Ingma

Vowels		Male		Female	
		F1	BWD	F1	BWD
◻	start	661.1	91.5	801.7	147.7
	middle	745.6	140.2	909.1	288.3
	end	586.9	230.8	627.6	344.9
æ	start	619.7	209.3	729.9	287.4
	middle	649.9	226.5	662.7	363.7
	end	707.9	363.9	521.3	288.4
i	start	315.8	137.8	290.2	93.5
	middle	327.0	180.7	310.3	119.3
	end	309.3	174.6	327.4	120.9
uʱ	start	357.6	107.1	415.7	123.5
	middle	X	x	x	x
	end	351.7	173.7	x	x

5.3 Aspiration

Observations show that aspiration of the velar stop does not affect the above-mentioned results in Urdu. Language. Ingma exists in the case when /n/ precedes voiced aspirated velar stop /◻ʰ/ and becomes /◻ʰ/ , whereas it does not exist in the case when /n/ precedes an unvoiced aspirated velar stop /kʰ/ in Urdu Language.

6. DISCUSSION

Ingma is a nasal phoneme produced by the oral constriction at the velum. Existence of ingma is proved in Urdu Language by the presence of minimal pairs. A few examples of the minimal pairs in Urdu Language, which prove ingma to be a distinct phoneme, are given in Table 6.1.Thus, ingma is a separate phoneme, but there is no distinct orthographic character corresponding to it in Urdu Language. A phonotactic constraint forbids ingma appearing syllable-initially in Urdu Language.

Table 6.1 Minimal pairs for Ingma

IPA Symbols	Words	IPA Symbols	Words	IPA Symbols	Words
/bɑ◻ɑ/	باگ	/bɑ◻n/	بان	/bɑ◻ɑ/	بانگ
/tɑ◻ɑ/	تگ	/tɑ◻n/	تن	/tɑ◻ɑ/	تنگ
/rɑ◻ɑ/	رگ	/rɑ◻n/	رن	/rɑ◻ɑ/	رنگ

Our study based on the words of Urdu language involving occurrences of alveolar nasal /n/ before a velar stop, reveals the fact that transformation of /n/ into ingma takes place only when it is followed by a voiced velar stop /◻/ and not when it is followed by an unvoiced velar stop /k/. Similarly, ingma occurs in case of voiced aspirated velar stop /◻ʰ/ and not in case of unvoiced aspirated velar

[1] x denotes the fact that F1 and the nasal band were merged and could not be measured.

stop /k^h/. Refer to Appendix C for word pairs with ◻ / k contrast.

6.1 Articulation

Articulation of ingma involves two types of articulatory features. Oral tract is completely occluded by the tongue at velum. The velopharyngeal port is opened by the lowering of the velum to allow air flow through the nasal tract. The process of articulation of ingma involves a sequence of steps which start by the opening of nasal tract during the vowel preceding ingma. This is followed by the oral closure at the place of velum. Velopharyngeal port remains open during the complete interval of closure of oral tract. Velopharyngeal port assumes the position of opening or closing, according to the requirement of the following phoneme, after the opening of the oral tract. The articulation of ingma nasalizes its preceding vowel but has no effect on its following phoneme.

6.2 Rule

When an alveolar nasal /n/ precedes a voiced velar stop /◻/ or /◻^{h}/, a phonological rule of place assimilation is applied. Place of the alveolar nasal assimilates to the place of the velar stop. /n/ gets the place of /◻/ becoming /◻/ and /◻/ is deleted in the process. This is depicted by the phonological rule shown in Figure 6.1.

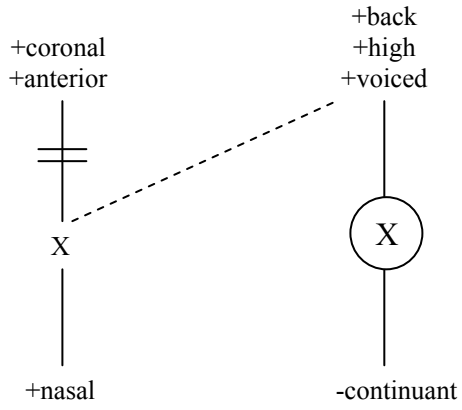

Figure 6.1 Assimilation Rule of Place

6.3 Vowel nasalization

When an alveolar nasal /n/ precedes a voiced velar stop /◻/ or /◻^{h}/, it becomes an ingma due to the place assimilation phonological rule described above. This ingma nasalizes its preceding vowel. The rule for the nasalization of preceding vowel is given in Figure 6.2.

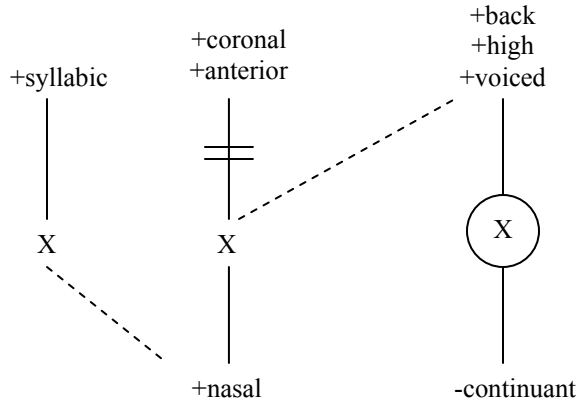

Figure 6.2 Assimilation Rule of Nasalization of Preceding Vowel

When an alveolar nasal /n/ precedes an unvoiced velar stop /k/ or /k^h/, its articulation starts by the opening of nasal tract during the vowel preceding /n/. This is followed by the oral closure at the place of velum. Velopharyngeal port closes during the interval of closure of oral tract. But the articulation of ingma involves oral opening followed by velar port closing. Hence, /n/ followed by an unvoiced velar stop does not qualify as ingma in Urdu Language. This observation is clearly depicted the Figure 5.2. Refer to Appendix C for word pairs having ◻ / k contrast.

7. SUMMARY

Ingma is articulated in a manner in which velar port opening leads oral occlusion and velar port closing lags oral opening. This pattern of articulation in Urdu Language is found when an alveolar nasal /n/ is followed by a voiced velar stop /◻/ or /◻^{h}/. But this does not happen in case of /n/ followed by an unvoiced velar stop /k/ or /k^h/. Ingma induces place assimilation of an alveolar nasal to velar, which is followed by the deletion of the velar stop and the nasalization of the preceding vowel. However, the phoneme following ingma bears no effect of nasalization due to ingma.

REFERENCES

- Catford J.C. *A Practical introduction to Phonetics.* Clarendon Press, Oxford. 1992.

- Clark John and Yallop Collin. *An Introduction to Phonetics and Phonology.* Blackwell Publishers. 1992. Word pairs for ◻ / k contrast.

- Ladefoged Peter and Maddieson Ian. *Sounds of World Languages.* Blackwell Publishers. 1999.

- Laver John. *Principles of Phonetics.* Cambridge University Press. 1994.

- Shah Syed Mustafa "Urdu nasal consonants and their phonological behavior". *Akhbar-e-Urdu.* Muqtadra -
- Qaumi Zuban, Islamabad, Pakistan. April-May, 2002.

- Pickett J. M. *The Acoustics of Speech Communication.* Allyn And Bacon. 1999.
- www.ling.mq.edu.au

APPENDIX A

/n/ preceding Voiced Velar Stop

IPA Transcription	Words
d□^{h} i□□	جھینگا
b^{h}æ □□	بھینگا
ʈ□□□	ٹانگہ
du□i	ڈونگی
u□^{h}n□	اونگھنا

/n/ preceding Unvoiced Velar Stop

IPA Transcription	Words
ʈ□^{h}i□k□	چھینکا
p^{h}æ □k□	پھینکا
ʈ□□k□	ٹانکا
p^{h}u□k□	پھونکا
□□k^{h}e □	آنکھیں

APPENDIX B

Carrier Phrase

Following is the carrier phrase used while recording the words for the analysis of Ingma.

کہا__میں نے

APPENDIX C

IPA Symbols	Words	IPA Symbols	Words
ʈ□□k□	ٹانکا	ʈ□□□	ٹانگہ
ʈ□^{h}i□k□	چھینکا	d□^{h} i□□	جھینگا
p^{h}æ □k□	پھینکا	b^{h}æ □□	بھینگا