Nepalese retroflex stops: a static palatography study of inter- and intra-speaker variability

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Abstract

Retroflex sounds are classically defined as produced with the tongue tip curled backward and often in contact behind the alveolar ridge ([1], [2], [3]). The sounds, however, present a great inter-language, inter- and intra-speaker articulatory variation. Retroflex stops in Nepali, an Indo-Aryan language spoken in Nepal, are produced with the tongue tip with no backward curling movement at the alveolar ridge ([4],[5]). For Pokharel [5], this is not a real type of retroflexion, but rather is apico-alveolar with no backward curling of the tongue tip.

The aim of this study is to experimentally verify Pokharel’s statement and the originality is to go beyond this claim. We wish to verify whether there is any co-articulation effect while producing the retroflex in different vocalic contexts. We use the direct palatography method to determine the place of articulation. Our articulatory data reveal an important articulatory inter and intra speaker variability. The majority of the retroflex stops realized in our study are sub-apico-post-alveolar in the case of back vowels and apico-alveolar in the case of the front vowels.

Index terms: retroflex, retraction, Nepali, apical, alveolar, palatograms, linguograms.

1. Introduction

Retroflex sounds are described as being produced with the tip of the tongue curled backward behind the alveolar ridge [6]. Laver [1] states "A retroflex stop segment is one where the tip of the tongue is curled upwards and backward, such that either the tip or the under surface of the tip makes an airtight seal at the post-alveolar or palato-alveolar place of articulation. By definition, retroflexion also involves a degree of displacement of articulation". By definition, this implies the contribution of some sub-lingual activity [7].

Beside the tongue tip curling backward, Bhat [3] mentions the “Retraction” of the tongue body during the production of the sound, though according to the author, this is not an obligatory defining feature. For Bhat, the retraction is necessary for a retroflex but is not unique to these sounds. He claims that the apical alveolar also presents a tongue body retraction. Different studies have shown that the class of retroflex sounds displays considerable articulatory variation ([3], [7], [8]). In particular, the actual gesture of bending the tongue tip backward is, in fact, not a defining property of this class as it can not be observed for all sounds traditionally described as retroflex [9].

Nepali, an Indo-Aryan language principally spoken in Nepal and in some regions of India and Bhutan, has a set of 20 obstruents. The phonological inventory of the Nepalese obstruents is as follows; 1. voiceless unaspirated: [p, t, ʈ, ts, k] 2. voiced unaspirated: [b, d, ɖ, dz, ɠ]. 3. voiceless aspirated: [pʰ, tʰ, ʈʰ, tsʰ, kʰ] and 4. voiced aspirated: [bʰ, dʰ, ɖʰ, dzʰ, ɠʰ]. The digraph Cs or Cz represents the affricates and ʈ or ɖ represents the retroflex.

Pokharel [5] claimed that the production of Nepalese retroflex stops is ‘apico-alveolar’, that is, there is no curling backward movement of the tongue and the segment is articulated directly at the alveolar ridge, rather than further back in the vocal tract as is the case with most Indo-Aryan retroflex stops like those of Hindi [10] and Gujarati [6]. However, to date there is no quantitative experimental study to support this description.

The aim of this study is twofold: first, we want to verify experimentally Pokharel’s classification by means of classic static palatography. Secondly, we want to evaluate patterns of inter- and intra-speaker variability in the production of Nepalese retroflexes and thereby extend Ladefoged and Bhaskararao’s [7] approach based on Hindi and other Indian languages.

2. Method

2.1. Corpus

In order to determine the articulatory configurations of Nepalese retroflex sounds, two different corpora were investigated.

2.1.1. Corpus 1

Table 1. List of first corpus.

<table>
<thead>
<tr>
<th>nepali</th>
<th>roman</th>
<th>pronunciation</th>
<th>voicing</th>
<th>aspiration</th>
</tr>
</thead>
<tbody>
<tr>
<td>baʈa</td>
<td>'vessel'</td>
<td>Voiceless unaspirated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>paʈa</td>
<td>'lambs'</td>
<td>Voiceless aspirated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>gaʈa</td>
<td>'cart'</td>
<td>Voiced unaspirated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>gaʈa</td>
<td>'deep (of color)'</td>
<td>Voiced aspirated</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Corpus 1 focuses on differences in the place of articulation in the production of the following Nepalese retroflex stops: voiceless unaspirated, voiceless aspirated, voiced unaspirated and voiced aspirated. The following vowel context was restricted to [a]. The four different target words were embedded in the carrier phrase “babako _______” (Father’s_______).

The tests are listed in Table 1.
2.1.2. Corpus 2

Corpus 2 focuses on the influence of vocalic context on the place of articulation and on the amount of lingual contact. Here we restricted the analysis to the production of the voiceless unaspirated retroflex stop \([\text{R}]/\). Table 2 contains the words to be uttered by the speakers.

<table>
<thead>
<tr>
<th>Word</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b\text{a}t)</td>
<td>'vessel'</td>
</tr>
<tr>
<td>(m\text{i}t)</td>
<td>'logatom'</td>
</tr>
<tr>
<td>(m\text{u}tu)</td>
<td>'heart'</td>
</tr>
</tbody>
</table>

The three different target items were embedded in the same carrier phrase as in Experiment 1.

2.2. Subjects

Eight native speakers of Nepali with no articulatory defects volunteered as subjects for the articulatory experiments.

2.2.1. Experiment 1

Four male speakers (M1, M2, M3 and M4) aged between 25 and 57, and two female speakers (F1 and F2), aged 39 and 58, participated in this study. All speakers currently live in France and use Nepali within the family and frequently in their day-to-day social life.

2.2.2. Experiment 2

The second corpus was built with the help of a couple of a 38-year old male and his 35-year old wife, both native speakers of Nepali visiting Paris for the first time. Neither of them had ever left Nepal for a long period and neither of them had any noticeable articulatory idiosyncrasies.

2.3. General technique

Information on place of articulation was determined by direct static palatography ([6], [11]). Both palatograms (showing the area of the palate with which the tongue has made contact) and linguograms (showing the area of the tongue that has made contact with the palate) were obtained for all test items with the aid of a digital camera. The term ‘palatography’ is used as a cover term for both experimental methods. Place of articulation was identified with reference to the anatomical distinctions proposed by Catford [1] (Figure 1) and the dentition plan proposed by Firth [3] with a slight modification on my part (Figure 2).

2.4. Articulatory parameters

The anatomical figure of the tongue shown in Figure 1 and the dentition plan shown in Figure 2 are used to determine the place of articulation.

In our discussion of the place of articulation of the retroflex sounds, we will use the following terms, based on the dentition plan suggested by Firth [11] (Figure 2): dental, denti-alveolar, alveolar, post-alveolar and pre-palatal.
3. Results

3.1. Experiment 1

Experiment 1 did not reveal any particular differences with respect to the place of articulation between the four different stops categories, i.e. voiceless, voiced, aspirated and unaspirated. However, sometimes the marks left by aspirated productions were clearer than those left by non-aspirated ones, and the marks left by voiced productions were, in turn, clearer than those left by voiceless productions.

The results of Experiment 1 are summarized in Table 2.

<table>
<thead>
<tr>
<th>Subject</th>
<th>POA</th>
<th>LC</th>
<th>Palatogram</th>
<th>Linguogram</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>PAL</td>
<td>Ap</td>
<td>PAL</td>
<td>Ap</td>
</tr>
<tr>
<td>F2</td>
<td>PAL</td>
<td>Ap</td>
<td>PAL</td>
<td>Ap</td>
</tr>
<tr>
<td>M1</td>
<td>PAL</td>
<td>Ap</td>
<td>PAL</td>
<td>Ap</td>
</tr>
<tr>
<td>M2</td>
<td>Ap</td>
<td>SAp</td>
<td>SAp</td>
<td>SAp</td>
</tr>
<tr>
<td>M3</td>
<td>Ap</td>
<td>SAp</td>
<td>SAp</td>
<td>SAp</td>
</tr>
<tr>
<td>M4</td>
<td>SAp</td>
<td>SAp</td>
<td>SAp</td>
<td>SAp</td>
</tr>
</tbody>
</table>

The results of Experiment 1 clearly indicate that the place of articulation of Nepalese retroflex stop productions is realized as post-alveolar. Some speakers (F1, M1) however, produced more fronter type of the retroflex than others, but they are always behind the alveolar ridge. Figure 3 presents an example of the more fronter retroflex stops than the retroflex stop articulated by the speaker M5 in Figure 5.

In a nutshell, all retroflex realizations in our experiment were clearly produced behind the alveolar ridge, which presents a considerable difference from the data provided by Pokharel [5]. No subject has produced retroflex stops as apico-alveolar as claimed by Pokharel [5].

Furthermore, some variation among speakers can be observed, as a single speaker may vary with respect to the place of articulation. The voiceless retroflex of speaker M1 is more fronter whereas his voiced retroflex is more posterior, they are however produced behind the alveolar ridge. The articulation is usually (sub) apical and post-alveolar. However, some of our examples of retroflex sounds were produced only with the tip and the rim of the tongue, suggesting that the sub-lingual activity may not be necessary to produce retroflex stops in Nepali. Nevertheless, all subjects reported having had the impression of curling back the tongue tip. As the dynamic aspects of the sound production cannot be visualized via static palatography, we are not able to verify this impression.

Figure 3 presents an example of an apical retroflex. Speaker F1 produces a voiceless unaspirated retroflex [t]. Contact is made exclusively by the apex and rim of the tongue. The sound is articulated as post-alveolar.

3.2. Experiment 2

Experiment 2 differed from Experiment 1 by the use of three different vocalic contexts. As Experiment 1 showed no difference in the place of articulation between voiced and voiceless retroflex or between aspirated and non-aspirated retroflexes, we only used the simple voiceless unaspirated retroflex [t] for Experiment 2.

The results of Experiment 2 are summarized in Table 3.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Vocalic context</th>
<th>POA</th>
<th>LC</th>
</tr>
</thead>
<tbody>
<tr>
<td>F3</td>
<td>a</td>
<td>Post-alveolar</td>
<td>Sub-apical</td>
</tr>
<tr>
<td></td>
<td>i</td>
<td>alveolar</td>
<td>Apical</td>
</tr>
<tr>
<td>M5</td>
<td>u</td>
<td>Post-alveolar</td>
<td>Sub-apical</td>
</tr>
<tr>
<td></td>
<td>a</td>
<td>alveolar</td>
<td>Sub-apical</td>
</tr>
<tr>
<td></td>
<td>i</td>
<td>alveolar</td>
<td>Apical</td>
</tr>
<tr>
<td></td>
<td>u</td>
<td>Post-alveolar</td>
<td>Sub-apical</td>
</tr>
</tbody>
</table>

Experiment 2 clearly demonstrates that there is intra-speaker variation for Nepalese retroflexion.

Both speakers produce their retroflex segments at the post-alveolar region with the underside of their tongue in the case of the low vowels [a], and against the alveolar ridge in the case of the high vowel [i]. These results show that there is articulatory variation.

The place of articulation differed according to the different vocalic contexts. The retroflex stops tended to be produced at the anterior part of the vocal tract with the tip and rim of the tongue when they were flanked by the high front vowel [i]. In this case, the retroflex articulation can be defined as apico-alveolar. The segment is produced with the tongue tip...
curling back behind the alveolar region with the underside of the tongue when it is preceded and followed by back or and low vowels, i.e. [u] or [a].

These co-articulation effects are clearly seen for speaker M5 via his three occurrences. In Figure 5, we can observe that the place of articulation and the lingual contact are not the same throughout the three different vocalic contexts. The retroflexion is more retracted in the context of [a] and [u], whilst it is more anterior in the front vowel environment. We observe in Experiment 2 that there is variability is not only among the different speakers but also within the same speaker depending on the vocalic context. This co-articulation effect was expected, but it is proven experimentally in this second experiment.

4. Conclusion
The retroflex stop productions investigated in this study showed a considerable degree of articulatory variation - inter-speaker as well as intra-speaker. All retroflex stops uttered in the vocalic context [a] during Experiment 1 have been produced as post-alveolar. We notice that the realization of retroflex consonants is influenced by the different vocalic contexts. The retroflex sounds are produced as alveolar in the context of high front vowels, as the vowels are more anterior, but as post-alveolar in the context of back vowels like [a] and [u], which are more post-alveolar.

This study raises another important question. Retroflexion was very prominent for the two subjects of Experiment 2, who both live in Nepal. This could imply that Nepalese speakers who live abroad for a longer period and speak other foreign languages might lose their subapical retroflexion. However, some of the subjects in Experiment 1 also had subapical articulation in spite of residence abroad. Our data are not sufficiently exhaustive to verify this claim and further studies are needed.

5. Acknowledgements
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References