

PALATOMETRIC SPECIFICATION OF HINDI /S/ AND /S/*

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ABSTRACT

The area of tongue-palate contact, the length of front cavity, the place of groove, the width of groove and the length of groove during /s/ and /S/ production were obtained from a native speaker of Hindi using the technique of dynamic palatometry. Nonsense words of the form /bi-ib/, /ba-áb/ and /bu-úb/, containing the sibilants in a symmetrical vocalic context and embedded in a carrier sentence, were used for data collection. On average, the area of tongue-palate contact was greater, while the length of the front cavity and the side-to-side width of the groove were lesser for /s/ than for /S/. Front-to-back length of the groove was similar for /s/ and /S/. Both /s/ and /S/ were found to be produced in the prealveolar zone (anterior part of the alveolar ridge) of the roof of the mouth. However, the location of the groove center for /S/ was about 4 mm behind than that for /s/.

INTRODUCTION

Hindi /s/ and /S/ are, traditionally, said to be produced by placing the tongue tip against the back of the upper front teeth and the palate, respectively, and by leaving an opening along the central line of the tongue tip. (Sharma [1]). There is, virtually, no information on the type of opening (groove/slit), the width of opening (broad/narrow) and the length of opening (long/short). Moreover, there is a complete lack of quantitative data in Hindi on the above production parameters of /s/ and /S/; quantitative data on the place of groove, the length of the front cavity and the area of tongue-palate contact are also not available on Hindi sibilants. Importance of some of these parameters in distinguish-

ing /s/ from /S/ and in constructing electrical or mechanical models of the vocal tract, which may be capable of predicting acoustical consequences of /s/ and /S/ production cannot be over stated. Thus, the purpose of the present study was to generate quantitative data on the /s/ and /S/ production parameters indicated above.

METHOD

An adult male native speaker of Hindi who had no apparent articulatory abnormalities, served as subject.

A custom-made palatometer (electropalatograph) containing 96 electrodes arranged from front-to-back in 11 rows with a 2x2 mm regular grid pattern was used. The first row was located in the dental zone and the eleventh row in the prepalatal zone 5 mm and 25 mm above and behind the edges of the central maxillary incisor teeth, respectively. The front-to-back location of the electrode rows in relation to the maxillary teeth of the subject is shown in figure 1. This figure also shows the typical pattern of tongue-palate contact for /s/ and /S/. Such plots as those shown in Figure 1 were used to take measures of various production parameters of /s/ and /S/. Threshold for generating the plots was 80%.

During recording session, the subject was seated in an anechoic room and was allowed 15 minutes to adapt to the electropalatograph after it was positioned in his mouth. The subject practiced the test sentences during this time. For data collection, the subject produced in a random order 15 repetitions of each of the nonsense words /bisib/, /basáb/, /busúb/, /biSib/, /baSáb/ and /buSúb/ in the carrier sentence /didi-lizije/ "Elder sister -

(please) take". Recording system, described in detail elsewhere (Fletcher et al [2]), was calibrated before data collection began.

RESULTS

Quantitative data on various production parameters of /s/ and /S/ are presented in Table I. As shown in this table, the area of tongue-palate contact, in terms of contacted electrodes, was consistently greater for /s/ than for /S/. It was 43.20 (range 40.33-45.33) electrodes for /s/ and 36.82 (range 36.53-37.00) electrodes for /S/.

The front-to-back length of the groove was slightly greater for /s/ than for /S/. It was 3.69 mm (range 2.93-4.13) for /s/ and 3.16 mm (range 2.27-4.27 mm) for /S/. However, the difference in the individual measures of the groove length between /s/ and /S/ were small and unsystematic. Thus, the groove length for /s/ and /S/ can be deemed as similar.

The side-to-side width of the groove was consistently smaller for /s/ than for /S/. During /s/, the width of the groove was 5.07 mm (range 4.67-5.60 mm), while during /S/, it was 8.44 mm (range 7.20-9.33 mm).

Both /s/ and /S/ were found to be produced in the prealveolar zone of the roof of the mouth. However, the center of the groove for /s/ was consistently located about 4 mm anterior to that for /S/. During /s/, the groove center occurred 1.42 mm (range 1.06-1.66 mm) behind the lateral incisor (gingival incisor) line which forms the boundary between the dental zone and the prealveolar zone, whereas during /S/, the groove center occurred 5.33 mm (range 4.46-5.93 mm) behind the lateral incisor line.

The length of the front cavity was consistently smaller during /s/ than during /S/. It was 8.42 mm (range 8.07-8.67 mm) during /s/ and 12.33 mm (range 11.47-12.93) during /S/. The length of

the front cavity was determined by adding 7 mm - the distance between the edges of the central maxillary incisors and the lateral incisor line - to the measures of the location of the groove center.

DISCUSSION

The area of tongue-palate contact was found to be consistently and substantially greater for /s/ as compared to that for /S/. Fletcher and Newman [3] reported similar differences in the area of contact between /s/ and /S/ of English. This is not an unexpected result since the area of contact and the contour of airflow channel largely depend on the location and the width of the groove: the more anterior and narrower the groove, the larger the area of contact.

In standard phonetic texts, it is generally assumed that the groove during /S/ from front-to-back is longer and from side-to-side is wider than that during /s/ (See, for example, Pike [4]). Contrarily, the front-to-back length of the groove was found to be similar during /s/ and /S/ in this study. Probably, the groove length does not play any role in separating /s/ from /S/.

On the other hand, the assumption that side-to-side width of the groove was broader during /S/ than during /s/ was strongly supported by the results of the present study. Further support for the above assumption comes from the studies by Fletcher [5] and Fletcher and Newman [3]. Like their studies, the groove for /S/ as compared to that for /s/ was found to be broader by about 3 mm in the present study. However, one of their subjects showed a difference of about 6 mm between the groove widths of these sibilants.

Supporting another assumption of the standard phonetic texts, the place of the groove was found to be more posterior for /S/ than for /s/. The difference in the place of the groove between /S/ and /s/ was about 4 mm. Similarly, a difference

of 3 - 4 mm between /S/ and /s/ groove places was reported in Fletcher [5]. In Fletcher and Newman [3] the difference in the groove places of /S/ and /s/ was, however, about 7 mm. Contrary to the phonetic description of the place of production for /S/ and /s/ given in Sharma [1], both /S/ and /s/ were found to be produced in the prealveolar area about 2 mm anterior to the canine line and about 2 mm posterior to the lateral incisor line, respectively.

The front cavity length was found to be about 8 mm during /s/ and 12 mm during /S/. Similarly, Fletcher and Newman [3] reported the front cavity length of about 7 mm during /s/ and 14 mm during /S/ for one of their two subjects. These measures of front cavity length are close to those used in modeling studies by Heinz and Stevens [6], and Shadle [7]. A 10 mm front cavity length was found to be appropriate by Heinz and Stevens for the production of /s/ resonances using an electrical circuit model; and a 15 mm long front cavity was considered adequate by Shadle to produce /S/-like sibilant noise using a mechanical model of the vocal tract.

CONCLUSION

Consistent and substantial differences observed in the measures of the groove width, the place and the front cavity length suggest that these parameters singly or in a certain combination play an important role in distinguishing /s/ and /S/.

It is expected that the measures of the

above parameters, reported in this study, will be useful in constructing electrical circuit models or mechanical models of the vocal tract, which may be capable of predicting acoustical consequences of /s/ and /S/ productions.

Vocalic context did not influence systematically any of the production parameters of /s/ and /S/ suggesting their resistance to coarticulatory effects.

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*/S/ = /ʃ/

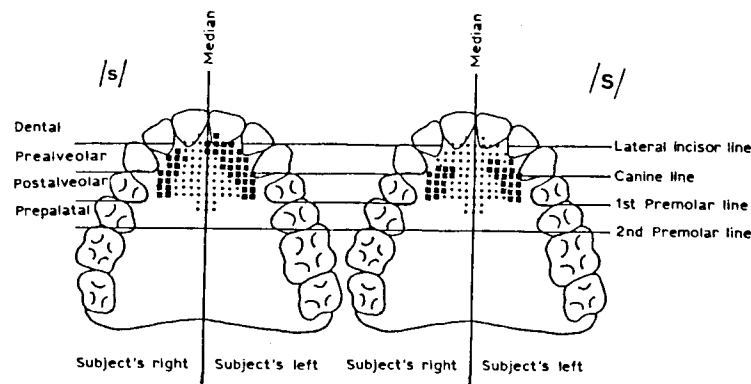


Figure 1. Front-to-back location of 11 rows of 96 electrodes on the oral surface of the palatometer in relation to the maxillary teeth of the subject. Also shown are the typical patterns of tongue-palate contact for /s/ and /S/. The electrodes contacted in 80% or more of the tokens are shown by filled squares. Notice that the airflow channel is skewed to the right of the subject's mouth.

Table 1. Means (\bar{X}) and standard deviations (SD) for the area of tongue-palate contact, the front-to-back length of the groove, the side-to-side width of the groove, the place of the groove from the lateral incisor line, and the front cavity length from the edges of the central maxillary incisors to the location of the groove center.

Context	Area Contacted		Groove Length (mm)		Groove Width (mm)		Groove Place (mm)		Front Cavity Length (mm)	
	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
/s/										
/i-i/	40.33	2.19	2.93	1.28	5.60	1.12	1.53	0.63	8.53	0.64
/a-a/	45.33	3.09	4.13	1.19	4.67	1.45	1.06	0.59	8.07	0.59
/u-u/	43.93	2.96	4.00	1.51	4.93	1.03	1.66	0.81	8.67	0.82
Group	43.20	3.45	3.69	1.41	5.07	1.25	1.42	0.72	8.42	0.72
/S/										
/i-i/	36.53	2.00	2.93	1.03	9.33	0.98	4.46	0.51	11.47	0.52
/a-a/	37.00	3.30	2.27	0.70	7.20	1.26	5.60	1.18	12.60	1.18
/u-u/	36.93	3.43	4.27	1.98	8.80	1.01	5.93	0.59	12.93	0.59
Group	36.82	2.92	3.16	1.57	8.44	1.41	5.33	1.02	12.33	1.02