VELAR AND GLOTTAL ACTIVITY IN A SPEAKER OF ICELANDIC

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ABSTRACT

The realization of Icelandic preaspirated plosives and voiceless nasals is examined, particularly the timing and extent of the devoicing gesture and of velar excursion. The segmental status of preaspiration is discussed and it is suggested that the voiceless nasals can be quite simply regarded as "ordinary" nasals coarticulated with a following preaspirated plosive.

INTRODUCTION

In this paper we examine an aspect of Icelandic that is particularly interesting from the point of view of interarticulatory timing - the realization of the preaspirated plosives and voiceless nasals (henceforth abbreviated to HC and NH). These sounds have also been of central interest in the phonological analysis of Icelandic. They are both subject to considerable restrictions on where they can occur in the word: HC occurs only after short vowel medially or finally ("seppi", "lúpp") and in combination with other consonants only before /r/ and /n/ ("erpli"). NH is subject to dialectal variation but in southern Icelandic occurs principally before /p, t, k/ following short vowel, i.e. in the position in which HC also occurs. The emergence of these two groups of sounds has also been linked diachronically /s/ through a shift in the timing of the devoicing gesture on the plosive. Synchronically accents have varied, however. Óttarrson /s/, in a phonemic description, analyzes preaspiration as the phoneme /h/ based on his phonetic investigations; and based on the existence of minimal pairs such as "dempi" vs. "demi" ([demp] vs. [demi] ) assumes the existence of separate voiceless and voiced nasal phonemes. There is thus no apparent relationship between these two groups of sounds. In other analyses /h/ this relationship is preserved, preaspiration being introduced by rule as an auto-segment, and modifying the adjacent nasal if one is present.

The questions just briefly touched on provided the motivation for examining these sounds in as homogeneous an environment as possible. This also gave the opportunity to return to a question raised in our earlier /s/ investigation of German where varying oral articulations in word-pairs such as "fette" vs. "feste" seemed to be combined with a constantly timed glottal gesture when viewed from the onset of the preceding vowel.

SUBJECT, MATERIAL AND METHOD

A male speaker of Southern Icelandic acted as subject. Based on the considerations outlined above the speech material was chosen to permit contrast of preaspirated plosives, unaspirated plosives, voiceless nasal plus plosive and voiced nasal plus plosive. This led to the following list of 10 words, the sounds of interest all being in medial, post-stress position.

"hittt" preaspirated
"hitt" unaspirated
"henti" voiceless nasal
"hendi" voiced nasal
"seppi" preaspirated
"sepli" unaspirated
"demp" voiceless nasal
"demi" voiced nasal
"hetta" preaspirated
"sempinn" voiceless nasal

This list was subjected to six different randomizations, the words being embedded in the sentence frame: "ég segi ..... ãa"

The following procedure was followed for the recordings: Glottal activity was assessed by the transillumination technique and velar activity by Künzel's photoelectric method /s/. For obvious technical reasons velar and glottal activity had to be recorded separately. Precautions were taken to ensure that both recordings were spoken at roughly the same time. A third recording of oral air-pressure will not be discussed further here; however, it enabled the audio-signal measurements to be based on 18 tokens per word (3 recordings x 6) rather than 6 tokens per word as in the case of the physiological signals.

RESULTS

The results will be presented in three sections: first, the temporal measurements made on the speech signal (summarized in Table 1); and then the results for glottal and velar activity.

Figure 1 shows ensemble averages for glottograph and velograph signals and audio envelope for eight of the ten words. Note that the velar and glottal signals were not, of course, recorded simultaneously. The audio envelope represents an average over both recordings.
Segment Durations

The words will be treated as consisting of a maximum of three basic segments (cf. Table I):
1. the vowel preceding the consonantal group,
2. the nasal or prenasalization section,
3. the occlusion phase of the plosive.

Vowel length divided the material into two groups, one group consisting only of "sepi" and "hetti" in which the 
(plosivized) vowel was 120-140 ms in length (segment 2 being completely lacking here, of course) and a second group con-
taining all other words, in which the length of the vowel was roughly 60-85 ms. As far as segment 2 is concerned, the length of prenasalization was clearly shorter than that of the nasals: 50-70 ms vs. 110-120 ms. Within the nasals the 
voiceless sounds tended to be longer than the voiced counterparts.

The length of the plosive occlusion tended to counterbalance the length of segment 2 with much shorter 
shorter plosives following the nasals than in the prenasalized or unaspirated conditions: ca. 80 ms vs. ca. 120-140 ms. The relative lengths of prenasalization and the 

The plosive occlusion are comparable to those in /sa/ and /sa/, while in /ha/ the prenasalization was 
sometimes as long as the following occlusion. Clearly this did not occur here. Nonetheless, there seems to be a feeling in the literature that prenasalization is so long that it cannot be a 
narrow-band of postnasalization but rather is an independent segment. We believe this argument has 
been over-valued (but see discussion). The fact that occlusions for prenasalized and 

Table 1

Main segment durations averaged over all three 
recordings (n = 18).

<table>
<thead>
<tr>
<th>vowel</th>
<th>nasal or</th>
<th>occlusion</th>
<th>presap.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>sd</td>
<td>sd</td>
<td>sd</td>
</tr>
<tr>
<td>hetti</td>
<td>75</td>
<td>9.0</td>
<td>51.6</td>
</tr>
<tr>
<td>hetti</td>
<td>142</td>
<td>14.5</td>
<td></td>
</tr>
<tr>
<td>henti</td>
<td>63</td>
<td>10.4</td>
<td>11.5</td>
</tr>
<tr>
<td>henti</td>
<td>63</td>
<td>6.0</td>
<td>11.5</td>
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<tr>
<td>sephi</td>
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<td>10.0</td>
</tr>
<tr>
<td>sephi</td>
<td>125</td>
<td>14.4</td>
<td></td>
</tr>
<tr>
<td>dempi</td>
<td>66</td>
<td>3.4</td>
<td>143.5</td>
</tr>
<tr>
<td>dempi</td>
<td>86</td>
<td>6.2</td>
<td>108.2</td>
</tr>
<tr>
<td>hetta</td>
<td>70</td>
<td>7.2</td>
<td>67.4</td>
</tr>
<tr>
<td>sperm</td>
<td>62</td>
<td>4.5</td>
<td>130.6</td>
</tr>
</tbody>
</table>

Glottal Activity

Fig. 1 shows that the amplitude of the devoicing gesture for /h/ and /ni/ was very large, being larger 
great than for the pre-vocalic fricatives (e.g. /h/ in "sephi"), this agrees with /h/ 
whilst being generally noted rather smaller 
for the glottal openings for /h/. The unaspirated plosives 
(e.g. "henti") also had a clear devoicing gesture but 
the amplitude was reduced for the plosives in the 

The above remarks refer to aspects of the glottal gesture that are so prominent as to be una-

Glottal Activity

This is a natural consequence of the broad sim-

Velar Activity

Regarding the nasals as a group it has already 
been pointed out that the voiceless nasals as 
measured from the audio signal were clearly 
shorter than the voiced counterparts. This result 
was quite consistent. There was, however, no 
reciprocally adjustment in the length of the fol-

Fig. 1. Averaged audio envelops (AE), transillumination (GW), and velograph signals (VE), timed-up at onset of arrowed 
vowel.
DISCUSSION

The first question to consider here is the segmental status of prespiration. Since we were unable to reproduce Pétursson's observations of velar behaviour in the prespirates the main point is how much weight should be attached to comparisons of the length of prespiration and other kinds of segment. In our material HC seems to be behaving like a single consonant since 1) prespiration was shorter than the nasal segments in the nasal- plosive clusters, 2) the occlusion for prespirated and unaspirated plosives is the same length, 3) plosive occlusions in the nasal- plosive clusters are much shorter than in the simple prespirated or unaspirated plosives, 4) the shortening effect on the plosive of introducing a preceding nasal is virtually identical in the hypotheticl prespirated case and in the unaspirated case.

There is still perhaps an extremely cogent reason for retaining the segmental status of prespiration; as Arnason points out /l/, words with prespiration are given contrastive stress by lengthening the prespiration phase, which in this respect behaves completely independently of the following plosive. It would be interesting to examine this phenomenon glottographically.

Turning to the glottal activity one could argue that the similarities for HC and NH suggest that two voiceless segments are present in both cases. However, one might equally well point to the great difference between pre-vocalic and postvocalic preconsonantal /h/.

Thus, this kind of argument does not get us very far, the same being true to a lesser extent for the segment-length arguments.

I believe that it is more fruitful to consider the aerodynamic and physiological constraints within which the language's contrasts must be produced.

Thus, it is, for example, by no means clear that prepiration and postaspiration of equal length are equally perceptually prominent, the one being superimposed on a closing, and the other on an opening movement of the vocal tract. Moreover, reliable devoicing with an unconstituted vocal tract, as at the beginning of the prespiration phase, requires a large-amplitude glottal opening. This may explain why prespiration does tend to be longer than postaspiration and perhaps also a less common phenomenon. Yet the fact that they are not perfect mirror-images of each other clearly need not mean that fundamentally different types of segments are involved.

The question of perceptibility may, as Pétursson has pointed out /9/, also explain why voiceless nasals are longer than voiced ones: these voiceless segments must be distinguishable from the quite large number of other voiceless segments that Icelandic can allow in this position.

We thus believe that up to this point there are no compelling reasons for regarding prespiration as a separate segment, whether analyzed as an /h/ phoneme or as an auto-segment that has moved from its plosive place of origin. This opens the way for viewing the existence of the voiceless nasals from the point of view of the speech motor system as a simple coarticu-

atory phenomenon. We would suggest that the voicelessness of the nasals is essentially a mirror-image of the voicelessness of the /l/ segment in English "plea". It was shown here that, as in the earlier German example, HC and NH share a very similar glottal gesture, but with reorganisation of the supra-glottal articulation. We would hypothesize that pairs such as "plea" and "pea" in English also superimpose a constant glottal gesture on reorganised oral articulation. While we believe that our results allow a coherent description of these sounds from a motor-speech perspective the restricted nature of the material examined naturally leaves a number of questions unanswered. In particular it would be desirable to include a more comprehensive range of voiced and voiceless continuants plus plosive in the description and to examine the realization of these sounds under contrastive stress.

REFERENCES


