Perception of glottalized consonants in Babine/Witsuwit'en

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Abstract: This study examined native listeners' perception of the glottal/non-glottal contrast in Babine/Witsuwit'en. Natural tokens (test and control items) from two native speakers were presented to 12 subjects. Listeners perceived control items with 98% accuracy but glottal/non-glottal pairs with only 88% accuracy. The most consistent perceptual cue to the contrast was closure duration/VOT ratio.

BACKGROUND

Though the glottal/non-glottal contrast among stops and affricates in Babine/Witsuwit'en is well-established on synchronic and historical grounds, fieldworkers and language students have reported difficulty in hearing the contrast. This difficulty motivated two production studies of the contrast among alveolar stops in initial (I) and intervocalic (2) position. These studies revealed considerable variation in production type within and across speakers. Three types of /t'/ were identified: (a) a "tense" (3) or "fortis" (4) /t'/ which contrasts with /t/ on the basis of VOT and/or post-release silent period, (b) a "lax" or "lenis" /t'/ which contrasts with /t/ on the basis of lowered f0, and (c) a /t'/ which is not distinct from /t/ on the basis of any of the acoustic parameters investigated. In the absence of a single distinguishing factor, the question arises as to how, or even whether, native listeners perceive the glottal/non-glottal contrast. The current study investigates this issue.

METHOD

Twelve native listeners were presented with 8 naturally produced minimal pairs (16 tokens) contrasting glottalized and voiceless unaspirated stops or affricates. Test tokens contained alveolar or uvular glottalized stops or affricates in initial, post-vocalic or post-nasal position. Eighteen control minimal pairs contrasted voiced vs. voiceless fricatives, voiceless unaspirated vs. aspirated stops, palatal vs. uvular consonants, or voiceless fricative vs. voiceless aspirated affricates. Test tokens and control tokens were interspersed and presented in random order. Listeners' judgments were recorded on a forced-choice answer sheet. Subjects performed the task twice, first with productions from a male speaker (GH), then with productions from a female speaker (LZ).

RESULTS

A dichotomous inter-subject correlation test was performed on correct/incorrect scores for each token. Ten of the twelve subjects showed high correlation (r>.7). Scores from two outlier, hearing impaired subjects (r<.7) were excluded from further analysis. In order to investigate acoustic cues to glottal perception, each glottalized token was measured for closure duration (non-initial consonants only), burst duration, VOT1 (to onset of voicing), VOT2 (to onset of F2), and f0 of the following vowel.

A pair of tokens (test or control) could receive a maximum correct score of 20. A test pair was considered poorly perceived if at least one member received an identification score at chance levels. The average score for test pairs was 17.6 (88%), and for control pairs, 19.6 (98%). Tokens produced by both speakers (GH and LZ) showed similar perceptibility in the controls (19.4 and 19.7, respectively), but among the glottal/non-glottal pairs GH was harder to perceive than LZ (16.9 vs. 18.4). Two of GH's pairs were poorly perceived, whereas all eight of LZ's test pairs were well-perceived. In GH's productions, glottalized and non-glottalized consonants were not significantly different by any of the acoustic measures (although f0 tended towards significance at p=.06). In LZ's data, tokens differed significantly along both VOT measures (p=.01) as well as closure duration/VOT1 (p<.02).
TABLE 1. Significance levels (p ≤ .05, 2-tailed unequal variance t-test), glottal vs. non-glottal test items, by speaker

<table>
<thead>
<tr>
<th>closure dur*</th>
<th>burst dur</th>
<th>VOT1</th>
<th>VOT2</th>
<th>f0</th>
<th>closure dur/VOT1*</th>
</tr>
</thead>
<tbody>
<tr>
<td>LZ</td>
<td>.49</td>
<td>.22</td>
<td>.01</td>
<td>.01</td>
<td>.84</td>
</tr>
<tr>
<td>GH</td>
<td>.44</td>
<td>.27</td>
<td>.26</td>
<td>.12</td>
<td>.06</td>
</tr>
</tbody>
</table>

*for intervocalic tokens only

The six intervocalic pairs produced by LZ were all distinguishable by the closure duration/VOT1 ratio (neither closure duration alone nor VOT alone could distinguish every pair). Her two initial pairs were distinguishable by VOT. For GH, although none of the acoustic measures showed statistical significance, six (five intervocalic, one initial, all alveolar) of the eight pairs were well-identified. Four of the intervocalic pairs were distinguishable by closure duration/VOT1 ratio. The other intervocalic pair differed in the quality of the following vowel, which was lowered after the glottalized consonant (5). The one well-identified initial pair differed in f0. The two tokens that were not well-identified (one intervocalic, one initial) both contained uvulars.

TABLE 2. Cues distinguishing glottal/non-glottal tokens

<table>
<thead>
<tr>
<th>closure dur/VOT1</th>
<th>VOT1</th>
<th>f0</th>
<th>V quality</th>
<th>not distinguished</th>
</tr>
</thead>
<tbody>
<tr>
<td># of tokens (16)</td>
<td>10</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

DISCUSSION

The acoustic parameter most associated with the correct identification of glottal/non-glottal pairs was the closure duration/VOT1 ratio. Although in the present study the significance of this ratio is largely due to the VOT difference between the plain and glottalized stops, VOT alone could not distinguish as many pairs as could the ratio. Interestingly, this measure has been used as the basis for a cross-linguistic typology of ejectives (6) but its role in the production and perception of ejectives within a single language has not previously been noted. Reexamining the intervocalic data from (2) for significance of the closure duration/VOT1 cue, we found results consistent with those of the present study. Closure duration/VOT1 was significant for LZ (p<.01) but not for GH (p=.59).

As noted in both earlier production studies, cues to the glottal/non-glottal contrast were not produced consistently across speakers. Nonetheless, VOT, f0 and post-release silent period sufficiently distinguished the contrast in some cases. Results of the present study suggest that the closure duration/VOT1 ratio alone could cue the contrast in intervocalic position, but in view of the production variability, it would be interesting to manipulate all of these cues synthetically (individually and in combination) in order to determine which cues best facilitate the perception of glottalization.

REFERENCES