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5aSCb48. Acoustic characteristics of glottalized obstruents in Gitksan
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Glottalized obstruents are a defining feature in the phonetic inventory of languages of the Pacific Northwest. Gitksan (Tsimshianic), an endangered and understudied language in this region, is no exception. However, these segments, which have typically been labelled as ejectives by fieldworkers, have also been variously described as implosives or even as voiced ejectives. Evidently, the ability of fieldworkers to perceive these segments has proven difficult, even by those who have worked on the language for many years. This project seeks to describe some of the salient acoustic cues associated with glottalized obstruents in Gitksan by comparing glottalized stops in Gitksan by comparing glottalized and plain stops. While previous work has examined these stops only in word-initial position, the present study compares stops across positions within the word and across stressed and non-stressed environments. Speech tokens were collected from three fluent native speakers of three dialects of Gitksan in order to describe the prominent acoustic cues which characterize glottalized obstruents in Gitksan.

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INTRODUCTION

Glottalized obstruents in the phonemic inventories of the languages of the Pacific Northwest are a common and defining feature. Gitksan (Tsimshianic) is a language of this area, and is not an exception. Compared to neighbouring languages, the glottalized obstruents of Gitksan, which are typically labelled as ejectives by fieldworkers, have been described as 'lenis' and difficult to categorize (Rigsby & Ingram 1990). This difficulty in perception of these obstruents has also resulted in their being described as implosives or even voiced ejectives. The present experiment is an instrumental analysis and comparison of plain and glottalized stops to describe some of the salient acoustic cues that signal a glottalized obstruent in Gitksan.

BACKGROUND

Gitksan is a member of the Tsimshianic family of languages, and like all languages of the Pacific Northwest, the languages of this family are severely endangered. Tsimshianic includes mutually intelligible Nisga'a, as well as Coastal Tsimshian (Sm'algyax), and Southern Tsimshian (Sgũüxs). Current estimates place the number of first language speakers between 1200 and 1300 (Lewis 2009, FPHLCC 2010) at the most and 400 (Peterson 2010) at the least. In addition to the small speaker population, Gitksan is also one of the more underdocumented languages of the area: it does not have a published grammar, nor does it have a comprehensive dictionary. Resources for language instruction are few in number, outdated, and are limited in usefulness and scope.

As is typical for the region, Gitksan's consonant inventory has voiceless stops that are in contrast with glottalized stops. Voiceless stops become voiced when they occur before vowels and word final voiceless stops are lightly aspirated.

Ejectives occur in approximately 18% of the world's languages (Ladefoged & Maddieson 1996). They are produced with a glottalic egressive airstream mechanism, in contrast to plains stops which are produced by a pulmonic egressive airstream mechanism. A quick description of the articulations involved in the production of a typical ejective follows. First, an oral closure is formed and a glottal closure is also formed. The timing of these two closures varies between languages; one can occur after the other, or they can occur simultaneously. Second, the larynx raises, compressing the air between the glottal and oral closure. Finally, the oral closure is released, resulting in the compressed air being released from the oral cavity. The release of this closure causes the burst to have a higher amplitude compared to a plain oral stop. After these articulations, the glottis opens and voicing can follow.

Bruce Rigsby, in "A Gitksan Grammar" (1986) noted the 'lenis' quality of ejectives in Gitksan as did Rigsby & Ingram (1990). Previous research also described glottalized resonants in Gitksan as post-glottalized (Wickstrom 1974) and even implosive (Hoard 1978). Ingram & Rigsby (1987) demonstrated through acoustic analysis, and using the same speaker as Hoard, that Gitksan does not have implosives. They concluded that the impression of perceiving implosives by Hoard was due to the lenis nature of Gitksan ejectives.

A typology of fortis and lenis ejectives is described in Kingston (1985) and Fallon (2002). The typology consists of several features that are split into fortis (or tense) and lenis (or lax). For example, a fortis ejective is defined as having a longer VOT, and a lenis ejective a shorter VOT, while the stop burst of a fortis ejective is intense and followed by silence, and stops bursts for lenis ejectives are weak and followed by low intensity noise. This typology assumes a binary distinction cross-linguistically, that ejectives belong to either the fortis group and share the properties of that group, or they belong to the lenis group and likewise share those properties.

The glottalized obstruents in Gitksan have been described as lenis. This experiment is an investigation into whether or not Gitksan conforms to the definition of lenis as described in the above typology.

METHODS

Consultant Selection

All three consultants are first-language speakers of Gitksan and currently live in the Vancouver area. Each consultant speaks a different dialect of Gitksan: Eastern, Western, and Gitanyow dialects.
Token Candidate Selection

All tokens were selected from "A Short Practical Dictionary of the Gitksan Language" (Hindle & Rigsby 1973) which is one of the only dictionaries currently available. The conciseness of the dictionary meant that in many cases only near minimal pairs could be selected as token candidates. Before recording, all potential tokens were reviewed. If a token candidate was presented to the consultant who then indicated he or she was unfamiliar with the word, it was discarded. The remaining potential tokens were then randomized for each consultant.

Recording

The consultant was fitted with a head-mounted microphone and tokens were recorded on a Marantz PMD660 digital recorder at a sampling rate of 44.1k Hz and were saved in lossless .WAV format. All tokens were recorded for one consultant in one session. The microphone positioning was not adjusted during the recording and no breaks were taken. When prompted by the desired word in English, the speaker said the Gitksan equivalent three times. If the word was forgotten, the speaker would be prompted with the Gitksan word.

Token Selection

Tokens from the recording were selected based on how natural they sounded to the researcher's ear. The most natural sounding token was selected from one of the three repetitions produced by the consultant. An unnatural sounding token included those that were, for example, accidentally mispronounced, very creaky, very breathy, too loud, or too soft. The selected tokens were extracted from the larger recording using Praat, and were saved into separate .WAV files per token.

Measurements

Token labelling and segmenting was done in Praat. Stop bursts were marked starting at the initial downspike in the waveform. The burst was labelled as complete after maximal peaks were reached. Voice Onset Time was measured from offset of the first stop burst, in cases of multiple bursts, to the onset of voicing periodicity. Closure was measured from the cessation of periodicity to either a stop burst downspike, or to the beginning of periodicity of the following vowel. Vowels were marked at the beginning of periodicity and formants to either closure, if followed by a consonant, or to the ending of periodicity and formants. Acoustic measurements were done through scripts run in Praat.

RESULTS AND DISCUSSION

The present discussion is focused on the speech of one of the consultants, BS. Each speaker was analysed separately due to different dialects having different phonetic and phonological properties. Additionally, the amount of time a consultant has spent away from their speech community is unknown and frequency of language use away from the speech community may have an effect on the productions of these tokens.

The first feature examined is voice onset time. Figure 1 is a comparison of VOT for plain and ejective stops in three places of articulation. The plain stops in all three places of articulation show short voice onset time durations. Both /k'/ and /q'/ have longer VOT than their plain counterparts, however some /t'/ tokens also had short VOT. This result was unexpected but may be explained as a result of the influence of English. The tokens that had short VOT for /t'/ were in intervocalic environments and may have been slightly flapped or tapped instead of being fully closed for the ejective articulation.

The second feature examined is stop burst amplitude. Figure 2 is a comparison of stop burst amplitude for plain and ejective stops in the same three places of articulation as VOT. The plain stops pattern similarly in that the plain stops have a burst amplitude that is higher than the ejective counterpart. For uvular stops, this pattern reverses and burst amplitude of the ejective is higher than that of the plain stop. The results for the uvular stops were expected, but the results for velar and alveolar were not. Because ejectives are produced by compression of air, the expectation is that the resultant pressure produces a burst of higher amplitude.

These data show that, at least in regards to VOT and burst amplitude, a cross-linguistic binary typology of ejectives may not be appropriate. While the results for velar and uvular stops were as expected for VOT, only the...
results for uvular stops were as expected for burst amplitude. One explanation could be that the articulations for the production of uvular stops are more "Gitksan", as they are not found in the English phonemic inventory. A larger sample of tokens and productions from more consultants will shed light on whether the results presented in this study are a property of the language or whether they are the effects of interspeaker variability.

**FIGURE 1.** Voice onset time of plain obstruents and glottalized obstruents.

**FIGURE 2.** Stop burst amplitude of plain obstruents and glottalized obstruents.
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REFERENCES