Denasalization and the Phonological Representation of Voiced Stops in Lushootseed

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Denasalization is a sound change where nasal stops have historically changed to voiced oral stops (i.e., */n/>/d/ and */m/>/b/). There are several languages in the Pacific Northwest that lack contrastive nasals, among them Lushootseed. The historical literature claims that in Lushootseed nasals became voiced stops (Hockett 1955, Thompson & Thompson 1972). However, there hasn‘t been an acoustic phonetic study of these sounds. In this study, I perform an acoustic phonetic analysis to look for residual nasality in voiced stops. High quality archival recordings were examined. The research question is whether some nasality was present for the voiced stops /b/ and /d/ in Lushootseed. Prenasalization of voiced stops occurs in prosodic domain-initial position for some languages (Gudschinsky et al. 1970, Iverson & Salmon 1996, Piñeros 2003). Therefore, nasality may be observed in similar positions in Lushootseed. I compare voiced stops /b d/ in prosodic domain-initial position with /b d/ in intervocalic and non-prominent (unstressed) initial positions. I predict that partial (or weak) nasality can be observed for the voiced stops /b/ and /d/ in domain-initial position (realized as prenasalized stops [ᵐb] and [ⁿd] respectively) but not intervocalic or non-prominent initial position.

I conducted a qualitative and quantitative analysis of voiced stops by listening for audible nasal murmur as well as inspecting spectrograms and waveforms. Frequency components of the voiced stops /b/ and /d/ were compared with nasal stops /m/ and /n/ in the word /mimuʔan/ ‘small, little’, which is the only word in Lushootseed that retained its nasals (the word occurred only once in these recordings). Nasals have the property of introducing extra pole zero pairs in the transfer function below and above frequencies of the first formant (Chen 1996, Fujimura & Lindqvist 1964). The zeros are located near the peak of F1, which introduces peaks below F1 (near 250Hz) and above F1 (near 1000Hz). In this study, the amplitudes of the peaks were calculated from an LPC. The amplitude of the peak corresponding to the extra peak above F1 (near 1000Hz) was labelled P1, whereas the amplitude of F1 was labelled A1. These measures were compared between the voiced bilabial stop [b], prenasalized bilabial [ᵐb], and the bilabial nasal [m] in the word /mimuʔan/ ‘small’. The percentage of voiced stops that were prenasalized was also calculated.

Results: There were 68 voiced bilabial stops /b/ and 50 voiced alveolar stops /d/ that were produced by the speaker. 19 of the 68 voiced bilabial stops /b/ and 13 of the 50 voiced alveolar stops /d/ occurred word-initially (domain-initially). For the voiced bilabial stops /b/ in word-initial position, 63.2% (12/19) were realized with partial (weak) nasality. For the voiced alveolar stops /d/, 62% (8/13) were realized with partial (weak) nasality. Of the 5 word-initial voiced alveolar stops /d/ that were not partially nasalized, 2 were devoiced (as in [d̥]). Partial (weak) nasality occurred to voiced stops /b d/ only in prosodic domain-initial position (i.e., word-initial position or initially under focus). Figure 1 and 2 shows the partial nasality of /b d/ in prosodic domain-initial position. None of the voiced stops were realized with partial nasality in intervocalic position or initially in unstressed environments. Amplitudes A1 and P1 for the bilabial stops [b], [ᵐb] and [m] are summarized in Table 1. As Table 1 summarizes, A1 for [ᵐb] was greater than [b]. Moreover, A1 and P1 for the prenasalized variant [ᵐb] was considerably lower than [m]. This suggests that prenasalized variants were produced with a weaker nasal airflow than fully nasalized stops.

Discussion: These results indicate that there is partial (weak) nasality for voiced stops in Lushootseed. However, partial nasality is restricted to domain-initial position exclusively. There are two explanations for the partial nasality of voiced stops in these recordings. One explanation is that the nasal series was partially preserved in domain-initial position for voiced stop reflexes. Under this view, voiced stops pattern with sonorants in Lushootseed, where voiced stops lack an underlying [voice] feature (Rice 1993). On the other hand, the partial nasality could be interpreted

as voice *enhancement* in prosodically strong environments (Wetzels & Nevins 2018). The low-frequency amplitude of the voiced stop is increased by preventing a buildup of intraoral pressure during a portion of the closure interval (Stevens et al. 1986:439). This enhances the audibility of the low-frequency noise that is characteristic of voiced stops. The view that partial nasality is due to voice enhancement makes the most sense because partial nasality is observed exclusively in prosodic domain-initial position. Moreover, the partial nasality is observed in only a portion of the stops in this position (it is not observed initially in unstressed syllables). For this reason, voiced stops should underlyingly be represented with a [voice] feature, contrary to Rice (1993).

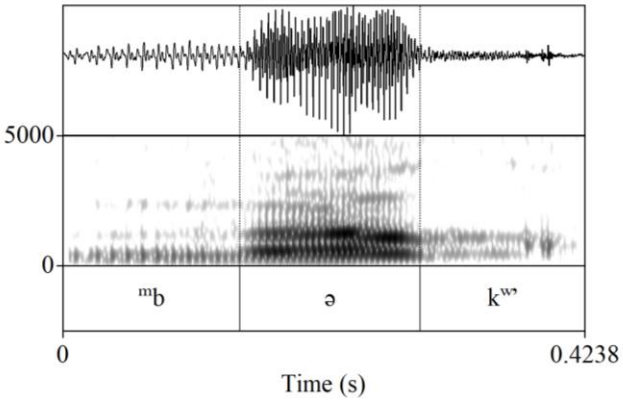

Fig.1 Prenasalized bilabial stop [ᵐb] in prosodic domain-initial position, from the word /bəkʷʾ/ 'all'.

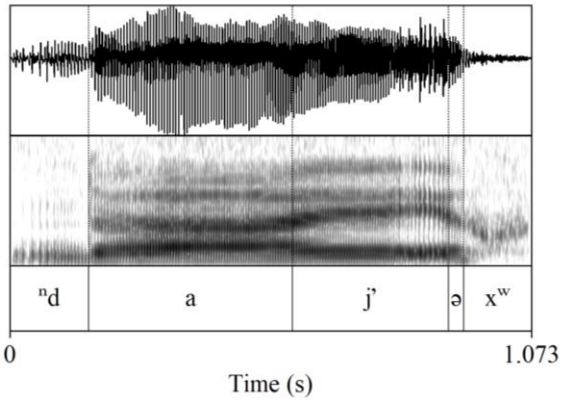

Fig.2 Prenasalized alveolar stop [ⁿd] in prosodic domain-initial position, from the word /dajʾəxʷ/ 'just now'.

Table 1. Amplitudes A1 and P1 for voiced bilabial stop [b], prenasalized [ᵐb], and nasal stop [m] at the beginning of the word /mimuʔan/ 'small'

Segment	A1 (in dB)	P1 (in dB)
[b]	23.0 dB	N/A
[ᵐb]	33.9 dB	11.4 dB
[m]	53.2 dB	25.2 dB

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