Prosodic prominence effects on laryngeal and supralaryngeal properties of Nepali stops

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Research over the last several decades has shown that prosodic structure affects the articulation of segments, with initial edges of prosodic domains exhibiting relatively strong articulations with respect to both laryngeal and supralaryngeal properties (e.g., Fougeron and Keating 1997; Keating et al. 2003). Domains that exhibit these effects include the syllable, the word, and the phrase. Strengthening is said to be cumulative, with increasingly strong effects at higher domains. Recent work on phonetic and phonological effects of focus have also found that narrow focus can have hyperarticulatory effects on segments (e.g., Avesani et al. 2007; Müche and Grice 2014).[1] This paper investigates effects of prosodic prominence on Nepali stops, which have a four-way contrast in voicing and aspiration (voiceless unaspirated, voiced unaspirated, voiceless aspirated, and voiced aspirated). Specifically, I examine both boundary and focus effects on laryngeal properties (degree of aspiration and deaspiration of phonemically aspirated stops), and supralaryngeal properties (sporadic spirantization). Periods of longer aspiration or prevocalic intervals (in the case of unaspirated stops) are taken as evidence of stronger laryngeal articulations; shorter periods of aspiration or prevocalic intervals and deaspiration are taken as evidence of weaker laryngeal articulations; and spirantization is taken as evidence of weaker supralaryngeal articulations. It is demonstrated that there is evidence for weakening in prosodically less prominent positions, with different conditioning factors for the laryngeal and supralaryngeal weakening. There is, however, minimal evidence for domain initial strengthening for the prosodic positions tested.

A production experiment was conducted to test the following hypotheses.

Hypothesis 1: Stops in higher positions in the prosodic hierarchy (i.e., word-initial, focus) will be stronger and exhibit more distinctive contrasts than those in lower positions.

Hypothesis 2: Stops in lower positions in the prosodic hierarchy (i.e., word-medial, non-focus) are more likely to lenite, reducing overall contrastive differences.

Hypothesis 3: Narrow focus will contribute to the strength of stops by creating a stronger phrase boundary before the focused element, a hyperarticulatory effect on the focused element, or both.

The dental stops /t, t^h, d, d^h/ were taken as representative of the four-way contrast, and tested in 32 disyllabic words, 4 each in word-initial and word-medial (intervocalic) positions. The words were embedded in two types of question-answer dialogues (for a total of 64 test items), one in which the target word had new information (narrow) focus in the answer and the other in which the target word was given information in the answer, and therefore not expected to be under focus. These are illustrated in Table 1. In the non-focused context, there is corrective focus on the verb to reduce a tendency to emphasize the target word.

	Focus context	**Non-focus context**
Q	Sita-le ke b^hanin? Sita-ERG what said 'What did Sita say?'	Sita-le X pə$ɖ^h$in? Sita- ERG X read? 'Did Sita read X?'
A	Tini-le **X** b^hanin. She- ERG **X** said. 'She said **X**.'	Hoina, tini-le X **lek^{h}in**. No she-ERG X **wrote**. 'No, she **wrote** X.'

Table 1. Dialogue types (X = target word; focused element is shown in bold).

[1] DiCanio, Benn, and Castillo Garcia 2018 have also found suprasegmental hyperarticulatory effects on tone.

Four native Nepali speakers were recorded reading each dialogue twice, for a total of 512 target stops. The experiment was presented and recorded using MATLAB.

An initial test of the syllable duration before the target word was conducted; a two sample *t*-test found significantly longer durations in the focus condition dialogues, indicating a greater degree of phrase final lengthening. I thus take word-initial stops to be initial in a higher prosodic domain in the focus condition, giving us three positions relative to prosodic boundaries. I refer to these as phrase initial (word-initial focus), word initial (word-initial non-focus), and word-medial.

The stops were measured for their prevocalic interval (PVI), similar to VOT but more effective for languages with aspirated voiced stops (Berkson 2012; Schwarz, Sonderegger, and Goad 2019) and qualitatively coded for spirantization. Phonemically aspirated stops were additionally coded as deaspirated if their PVI was within two standard deviations of the mean PVI of unaspirated stops.

Both categorical weakening processes (spirantization and deaspiration) were observed only in word-medial stops; however, while spirantization affected /d, d^h, t^h/, deaspiration only affected /d^h/. Additionally, logistic regression models were run with spirantization and deaspiration as response variables and focus as a fixed effect. These found focus to be a significant factor for deaspiration, which occurred less frequently under focus, but not for spirantization.

As the boxplots in Figures 1 and 2 show, PVI duration for unaspirated stops is not substantially affected by prosodic structure. However, in the aspirated stops, particularly /d^h/, PVI in the word medial non-focus context is considerably shorter than in the other three environments. These patterns were confirmed by a linear mixed effects model with PVI duration as the response variable, and stop type, focus, word position, and the focus – word position interaction as fixed effects, which found focus, word position, and their interaction to be significant. A post hoc *t*-test confirmed word medial focus and non-focus to be significantly different for /d^h/. By contrast, additional *t*-tests found no differences between focus and non-focus word initial position (i.e., between word and phrase initial and just word initial) for /d^h/ or /t^h/.

Figure 3 compares the PVI distributions of all stops, with two curves for each stop type: 'weakening' (= non-focus medial), and 'non-weakening' (= other three contexts). The aspirated stops are closer to the unaspirated stops in the weakening contexts, with the mode of /d^h/ nearly as low those of /d/ and /t/. A *t*-test nevertheless shows weakening /d^h/ to be significantly longer than /d/.

In sum, the aspiration results (PVI duration and deaspiration) indicate that the aspirated stops are more distinct from their unaspirated counterparts in prosodically stronger (non-weakening) contexts, and that in non-initial positions, PVI duration is shorter, particularly for /d^h/. This offers support for Hypotheses 1 and 2. There is not, however, evidence of cumulative domain initial strengthening, since the main effects of prosodic position are only for word medial non-focus /d^h/, whereas we would expect cumulative strengthening to affect all stop categories and show differences between more environments. Finally, we see a difference between the spiranzation and aspiration results, such that focus has a significant effect on degree of aspiration in word medial stops, but not on spirantization. This suggests two possibilities about the manifestations of focus in Nepali. One is that there is a difference between the way focus affects laryngeal and supralaryngeal articulations in Nepali, having a hyperarticulatory effect on laryngeal articulations (i.e., associated with aspiration), but not on supralaryngeal ones. Alternatively, there could be a difference between how focus hyperarticulation affects the strength of contrastive and non-contrastive properties, since there are no phonemic dental fricatives in Nepali and thus spirantization does not affect the system of contrasts, whereas reduced aspiration does.

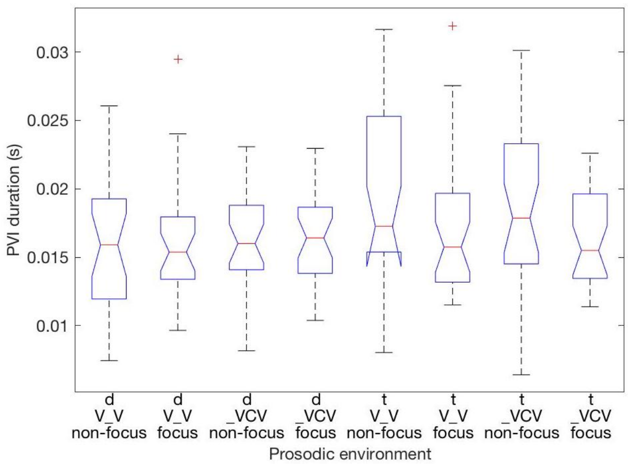

Figure 1. PVI duration for unaspirated stops (s).

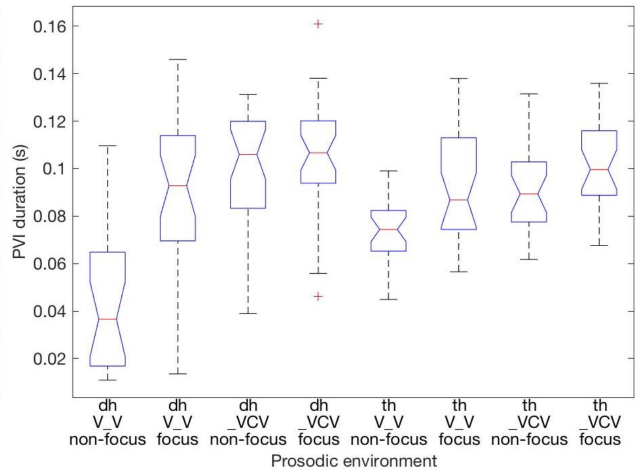

Figure 2. PVI duration for aspirated stops (s).

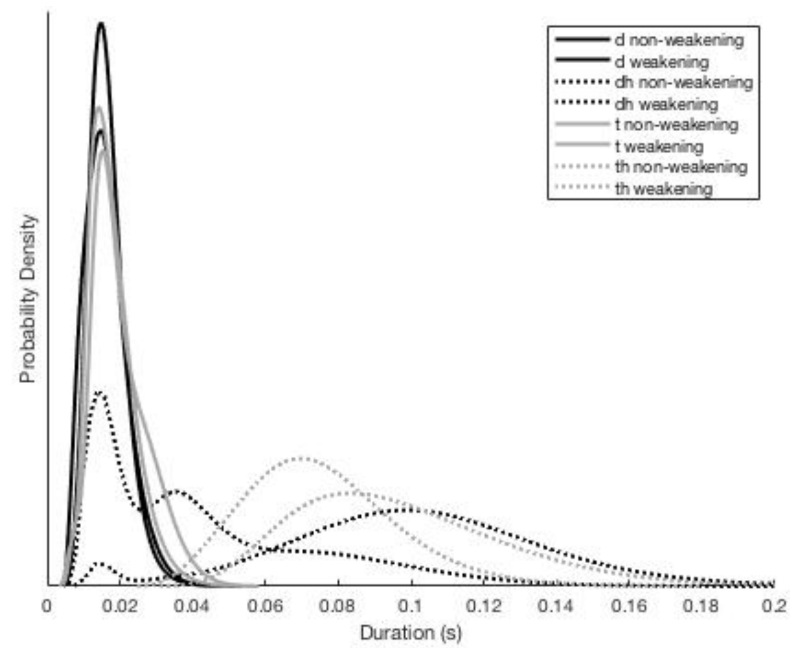

Figure 3. Distributions of PVI duration for each stop type in weakening and non-weakening environments.

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