Laboratory phonology without the lab: evaluating articulatory specification change in a Papuan language

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Phonological patterns of elision (deletion in predictable contexts) can be produced in two ways: the phonology may specify a target and not reach it (reduction) or specify no target at all (deletion). The phonology may not fully specify the phonetic implementation, and the resulting production patterns may appear to be phonological (Cohn 1993). Lindsey (2019) reports such a pattern of word-final /n/-elision in Ende (Pahoturi River; Papuan). This pattern can be explained as either a reduction or a deletion of a phonologically specified target. But which is it? Shaw and Kawahara (S&K; 2018) present a method using electromagnetic articulography (EMA) data to differentiate reduction and deletion processes. However, S&K evaluate EMA data which cannot be obtained in most field situations. We present an extension of S&K's methodology to acoustic data which allows us to evaluate the nature of Ende's /n/-elision pattern using field data.

Our method only requires high-quality recordings with visible formants and capitalizes on the fact that articulatory gestures correlate with particular acoustic features such as formants and tongue position or formant bandwidth and nasalization. These acoustic features can be measured and modeled using readily accessible software such as Praat (Boersma & Weenink 2018) and R (R Core Team 2018).

To answer our question of whether word-final /n/ is reduced or deleted, we analyze the first formant (F1)—a correlate of tongue height—in tokens of /dan#a/, where any change in tongue height would support a reduction analysis. We do this by measuring F1 at 20 equidistant points across the [an#a] sequence in Praat. The F1 track is then transformed using the discrete cosine transform (DCT) via the `dtt` package in R (Komsta 2013). The DCT time-normalizes each token trajectory by transforming their durations to wavelengths, with each token having a duration of 2π. This track provides suitable input for the Bayesian classifier used by S&K to evaluate the hypotheses of deletion, optional deletion, or reduction.

The classifier is trained on tokens which are fully deleted (/a#a/) and those which are fully retained (audible /an#a/). Once trained, the classifier evaluates the /dan#a/ tokens of interest (N=46) and assigns a probability that the given token retains its /n/ (see Fig. 1). We would expect the probability mass to be at 0 if completely deleted, and 1 if fully retained. If the target is optionally deleted, the distribution should be bimodal with modes at 0 and 1. In cases of reduction, the distribution should have a significant probability mass around 0.5 signifying a high degree of tokens between full deletion and retention.

Our results show that the pattern of data in Ende is consistent with variable reduction rather than deletion. Nearly all tokens retain some acoustic features of [n]: some tokens show little more than residual nasalization on the vowel, while others have a clearly articulated [n] (Fig. 1). These results strengthen Lindsey's (2019) claim that /n/-elision in Ende is not a change in progress but rather stylistic variation, and also provide a viable method for investigating articulatory data in field situations without sophisticated equipment.

References

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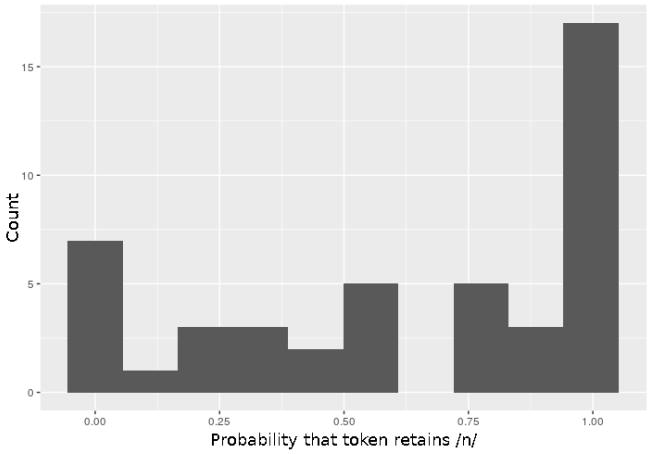

Figure 1: Count (N=46) of tokens with probability of retaining /n/ based on a Bayesian classifier as described in S&K 2018

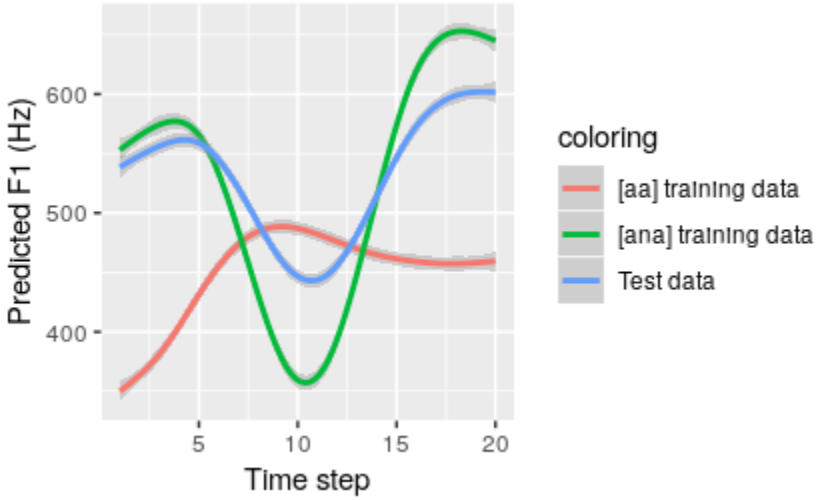

Figure 2: Trajectories for the training and test data predicted from the DCT coefficients