Electromyography analysis of coarticulation in speech and smile movements

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[1]Facial expressions and speech movements impose conflicting demands on articulators. For instance, the lip spreading movement associated with smiling is incompatible with bilabial closures such as /m/, /b/, or /p/, where production demands touching of the lips. Though this discussion has been controversial [Ladefoged & Maddieson 1996, p.18], anecdotal evidence suggests this conflict may resolve as labiodental stop variants [Wells, 2012]. The simplest model of coarticulation – one of unmediated superposition of muscle activations [Gick et al., 2013, POMA 060207] – predicts that the outcome of this conflict should be determined by summing opposing forces due to competing muscle activations. If so, varying degrees of smile and varying degrees of closure force (e.g., for different stop consonants) should be expected to produce distinct outputs. To add to the puzzle, previous work suggests that closures for /m/, /b/ and /p/ vary increasingly in both intraoral pressure (pressure between opening of vocal folds and mouth) [Lubker & Parris 1970, JASA 47: 625] and muscle force [Gick et al. 2012, JASA 131: 3345]. In this paper, we propose that the frequency of labialized bilabials will vary due to differences in intra-oral pressure, where greater levels of intra-oral pressure will negatively influence the likelihood of labiodentalization. On the other hand, higher degrees of smiling, thus greater degree of stress on articulators, will positively influence the frequency of labiodentalization. An experiment will be presented in which bilabial stops are produced under varying smile conditions. Twelve undergraduate students from the University of British Columbia were recruited to participate in this experiment. Participants were video recorded and tasked to read aloud 31 different sentences, each containing one bilabial consonant, under three facial conditions (neutral, smiling, and laughing). Participants were also given electromyography (EMG) electrodes, attached to their orbicularis oris and zygomaticus major, to accurately measure the degrees of muscle activation in differing states of smiling and phoneme production. Results indicate that labiodental stop variants occur more frequently for lower-force stops, such as /m/, under higher-force smile conditions, such as cases where the participant is laughing-as predicted. Across participants, p-values have shown to be critical across all states and all conditions, though they differ within participants. Preliminary EMG data building on our results illustrate that levels of muscle activation differ between bilabial states and target labiodentalized states. Further analysis aims to determine whether active reduction of muscle activation occurs during production of different phonemes in varying facial conditions. With a better understanding of coarticulatory mechanisms such as this, we hope to better determine the underlying control mechanisms in speech and add to the existing literature examining articulatory conflict.

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