

## A comparison of articulatory coordination within and across phonemes

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We present an analysis of electromagnetic articulography (EMA) data relevant to the question of whether phonological representations are phonemic, or represented only in terms of gestures or distinctive features and syllables. We analysed the relative coordination of upper lip and tongue body movements in /w/ (within phoneme), and in /j/ and a following rounded vowel belonging to the same syllable (across phonemes). Tighter coordination within phonemes compared with coordination across phonemes would provide evidence in support of the existence of the phoneme as an organisational unit.

We collected EMA data from 8 speakers of Scottish English. We analysed movement of sensors attached to the upper lip and tongue body (as far back on the tongue as possible). Speakers read sentences of the form “say a [target] again”, where the targets were “wee”, “way”, “you” and “yo”. Articulate Assistant Advanced (AAA) was used to annotate resulting EMA data for beginning and endpoints of movements towards the target positions for the phone of interest (/w/ for both articulators in “wee” and “way”, /j/ for tongue body and /u/ or /o/ for upper lip in “you” and “yo”). We analysed 1022 tokens (519 within phoneme and 503 across phonemes). Bespoke software, EMATViewer, was used to calculate the first principal component of the EMA signal for each articulator, and the timings of the following seven kinematic landmarks: (L1) movement onset; (L2) 20% velocity maximum nearest onset; (L3) maximum acceleration; (L4) peak velocity; (L5) minimum acceleration; (L6) 20% velocity maximum nearest offset; (L7) movement offset.

We selected the tongue body as the reference articulator, and designated the 20% velocity maximum nearest the offset to be the reference point, because it is near the endpoint of the movement, but less affected by annotation decisions based on low velocities than the annotated movement offset. We refer to this reference point as R6. We then subtracted the times of each of the seven landmarks of the upper lip movement, from the time of R6 of the tongue body movement. Figure 1 is a violin plot displaying the results. Descriptively, the results show that variability is lower for within-phoneme articulations than across-phoneme articulations for all intervals. This indicates that movements of largely independent articulators are more tightly coordinated when the articulators are both involved in the production of the same phoneme, compared with when they are involved in the production of two adjacent phonemes in the same syllable. These results therefore provide support for the existence of the phoneme as an organisational unit in speech production.

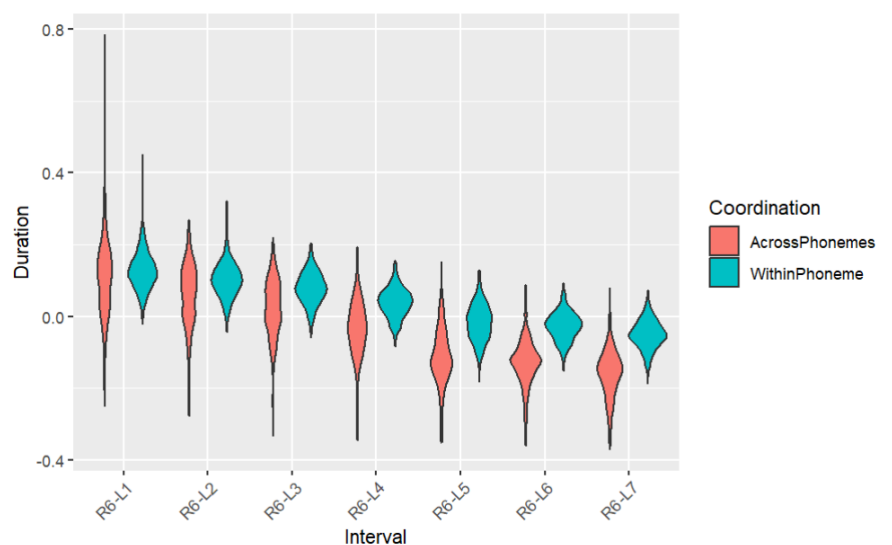


Figure 1: Violin plot displaying results of subtracting times of successive kinematic landmarks of the upper lip movement from the time of the 20% velocity maximum nearest the offset of the tongue body movement.