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When humans speak, there is variability in the acoustics reflecting different phonemes, as well as fluctuations within phonemes, some of which results from the surrounding phoneme sequence (?coarticulation?). Knowing if and how cortical activity covaries with different types of acoustic variability is critical to understanding speech and language. To examine these issues, we analyzed ?single-trial?, high-resolution, multi-electrode neural activity from human ventral sensory-motor cortex (vSMC) during the production of consonant-vowel sequences. Population cortical activity could accurately predict acoustic variability both across vowels and within individual vowels. Predictive activity for vowels extended through preceding consonants, demonstrating anticipatory activity during consonant production. Furthermore, a portion of perseveratory coarticulation of vowel acoustics could be attributed to immediately preceding vSMC activity. Finally, vSMC network states for individual phonemes were biased towards adjacent phoneme states. These results reveal the cortical processes generating cardinal vowels and provide definitive evidence of a cortical source for coarticulation.