

Spatial and temporal variability of corrective speech movements as revealed by
vowel formants during sensorimotor learning

Eugen Klein

Jana Brunner

Institut für Deutsche Sprache und Linguistik, Humboldt-Universität zu Berlin,
Germany

Phil Hoole

Institut für Phonetik und Sprachverarbeitung, Ludwig-Maximilians-Universität
München, Germany

Running title: Spatial and temporal variability of corrective speech movements

Abstract

Previous perturbation studies demonstrate that speakers can reorganize their motor strategies to adapt for articulatory or auditory perturbations (Savariaux, Perrier & Orliaguet, 1995; Rochet-Capellan & Ostry, 2011). However, across most studies we observe a fluctuating amount of inter-individual differences with respect to the adaptation outcome. To evaluate the predictions of the hypotheses put forward to explain these differences, we conducted a multidirectional auditory perturbation study investigating F2 perturbation with native Russian speakers. During participants' production of CV syllables containing the close central unrounded vowel /i/, F2 was perturbed in opposing directions depending on the preceding consonant (/d/ or /g/). The bidirectional shift was intended to encourage participants to produce the vowel /i/ with two different motor strategies and allowed us to investigate intra-individual variation of adaptation patterns as a function of the perturbation direction and the consonantal context. To examine the evolution of the adaptation process, we performed generalized additive mixed modelling (GAMM) on the averaged and individual formant data using the experimental trials as discrete time points. By doing this, we were able to examine sudden changes in participants' adaptation strategies which appeared as nonlinearities in the F2 curve. Our results suggest that previously formulated hypotheses regarding individual adaptation processes make empirical predictions which are not confirmed by the bidirectional perturbation data. Therefore, we propose a more general hypothesis that the successful adaptation is dependent on speakers' ability to coordinate the perceived auditory errors with appropriate compensatory movements, which is influenced in turn by the complexity of the adaptation task. We discuss this hypothesis in the context of individual adaptation patterns and show that it not only can explain the inter-individual, but also the inter-study variability observed in previous perturbation studies.