Prediction errors drive auditory-motor adaptation in a hierarchical FACTS model

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Introduction and Method

- Auditory prediction error-based mechanisms involved in speech auditory-motor adaptation were examined via the feedback aware control of tasks in speech (FACTS) model.
- Consistent with theoretical perspectives in both non-speech and speech motor control, the hierarchical architecture of FACTS relies on both the higher-level task (vocal tract constrictions) as well as lower-level articulatory state representations.

**Design A**
Auditory prediction errors updated the forward model that predicted the current articulatory state.

**Design B**
Auditory prediction errors updated the auditory forward model.

**Design C**
Used a new hierarchical architecture with separate state feedback control loops for the articulatory level and the task level.

Auditory prediction errors updated the articulatory-to-task transformation.

Results

- Updating forward articulatory state (Design A) or sensory prediction models (Design B) did not cause adaptation.
- Updating the task state transformation model produced adaptation (Design C).
- The adaptive changes in Design C could also be observed in the articulatory space (e.g., tongue height).
- Nonetheless, the simulated adaptation was smaller and slower than adaptation observed in experimental data because the Kalman filter assumed a high magnitude of random noise in the sensory signals.

Conclusions

- We found that adaptive behavior was present only when prediction errors updated the articulatory-to-task state transformation.
- In contrast, designs in which prediction errors updated forward sensory prediction models alone did not generate adaptation.
- FACTS demonstrated that prediction errors can drive adaptation through task-level updates.