Bayesian Inference of State Feedback Control Model Parameters for Pitch Perturbation Responses

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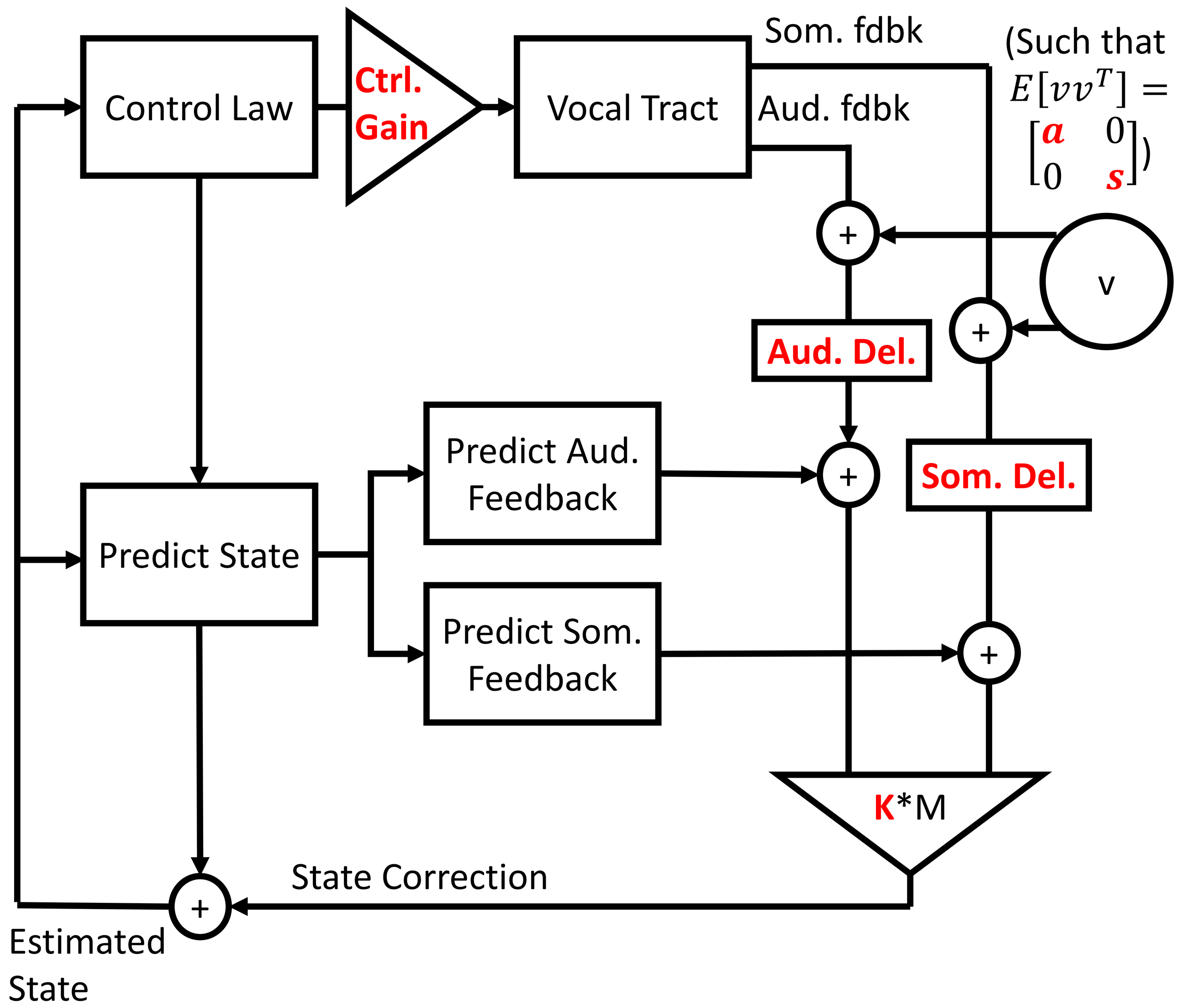
Introduction

- Computational modeling was used to explore the neural mechanisms of speech motor control
- A **state feedback control model** was used to simulate a participant's behavioral response to a pitch perturbation experiment
- Bayesian inference was used to determine the set of model parameters **most likely to produce a pitch perturbation response matching that described by existing data**
- The selected model parameters were **compared between patient and control groups**

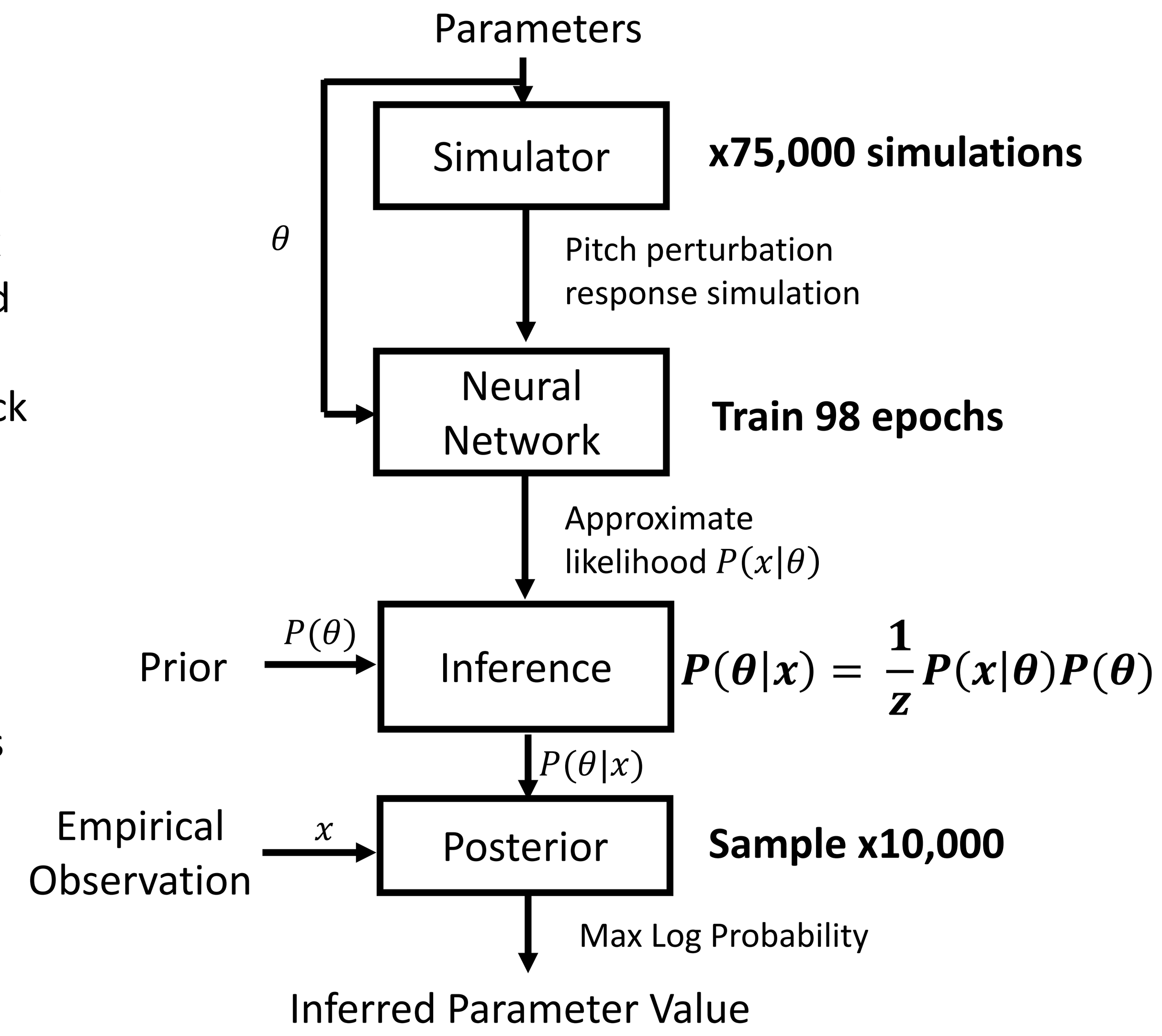
Simulator

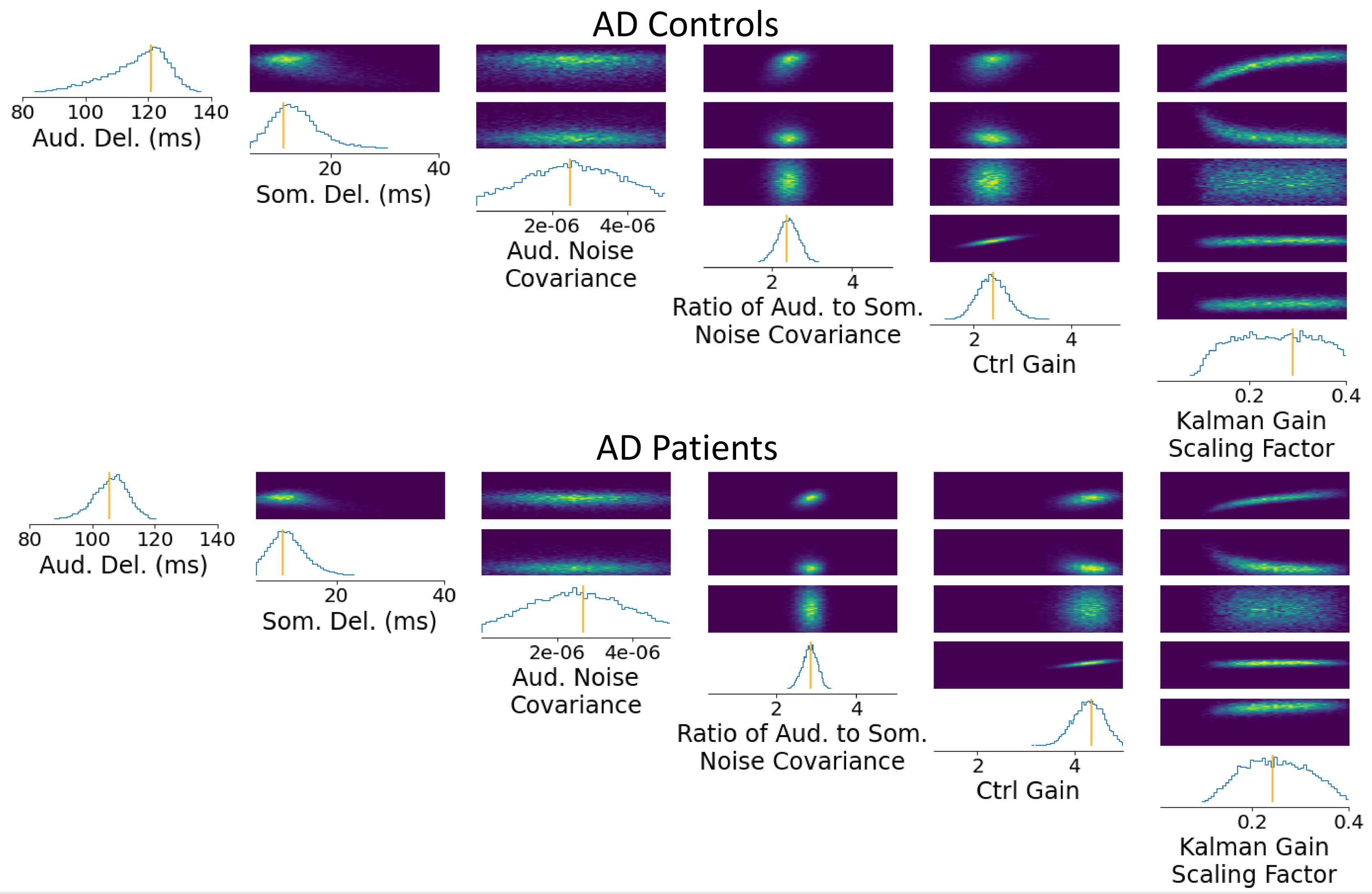
- The state feedback control model architecture [1] is shown below. The parameters fit are auditory feedback delay (Aud. Del.), somatosensory feedback delay (Som. Del.), auditory noise covariance (a), the ratio of auditory noise covariance (a) to somatosensory noise covariance (s), controller gain (Ctrl. Gain), and a uniform scaling factor (K) on optimal Kalman gains (M) associated with auditory and somatosensory feedback.



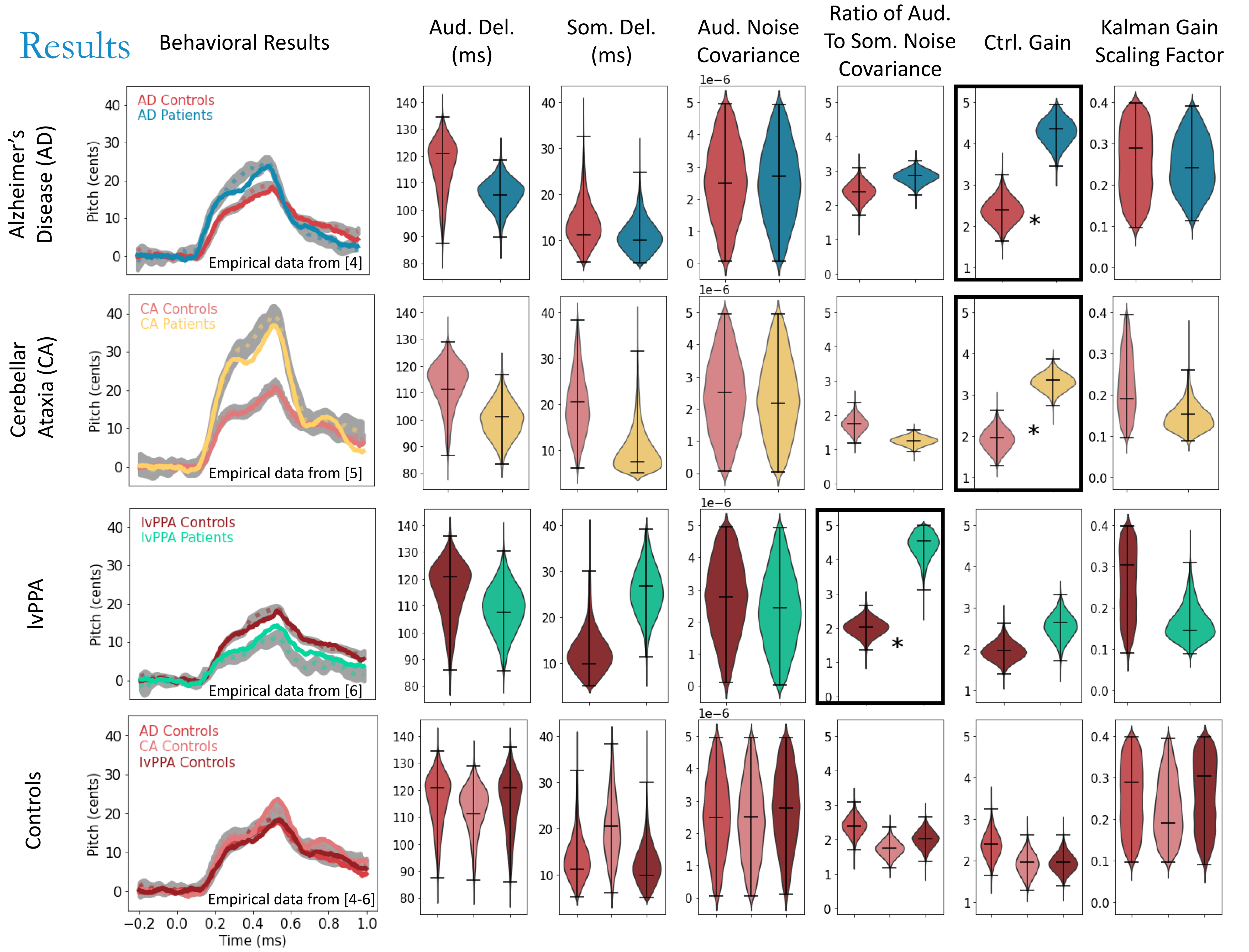
Inference

- The Python package `sbi` [2,3], a toolbox for simulation-based inference, was used to fit a state feedback control model to pitch perturbation data
- A distribution and inferred value for each parameter was determined by sampling the posterior





Results



Conclusions

- The results suggest that **AD and CA patients** differ from controls in what is represented in the model as **controller gain**. This would imply a change in the motor cortex of patients to increase the scale of the behavioral adjustment to a pitch perturbation
- The results suggest that **logopenic variant primary progressive aphasia (lvPPA) patients** differ from controls in what is represented in the model as the **ratio of auditory to somatosensory noise covariance.** This may imply a change in the sensory cortex of patients that affects the relative scale of noise for different feedback modalities, or that affects the relative weight of errors in different feedback modalities (Kalman gains)
- These results generate hypotheses that can be tested with additional speech studies.

References

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[6] In Preparation

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