Enhancing Co-Adaptive Myoelectric Interfaces with Eye Tracking

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Introduction

PRIOR RESEARCH

- Adaptive decoders improve neural interface (NI) performance[1,2].
- Eye movements evolve as users learn sensory-motor mappings[3].

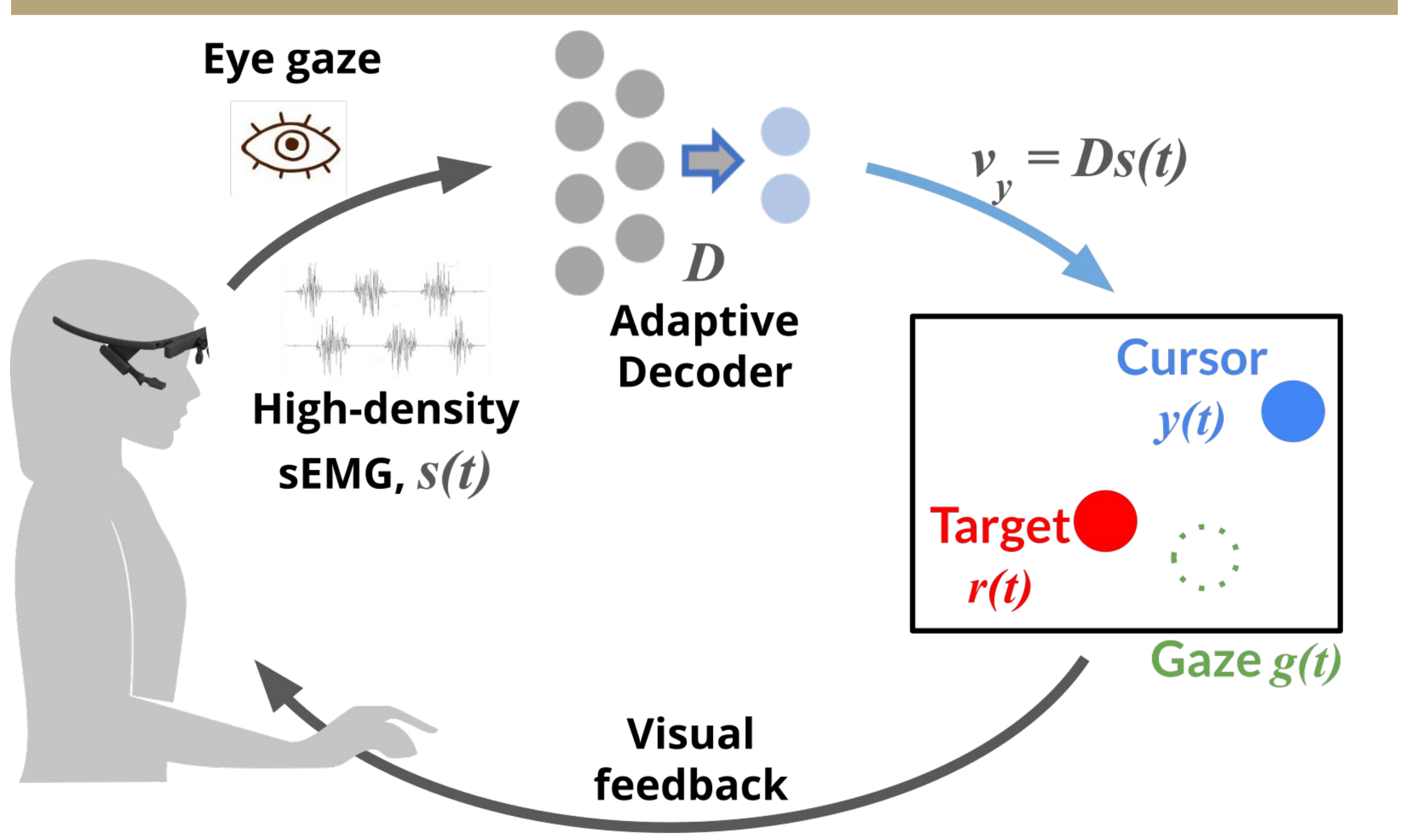
CHALLENGES/OPEN QUESTIONS

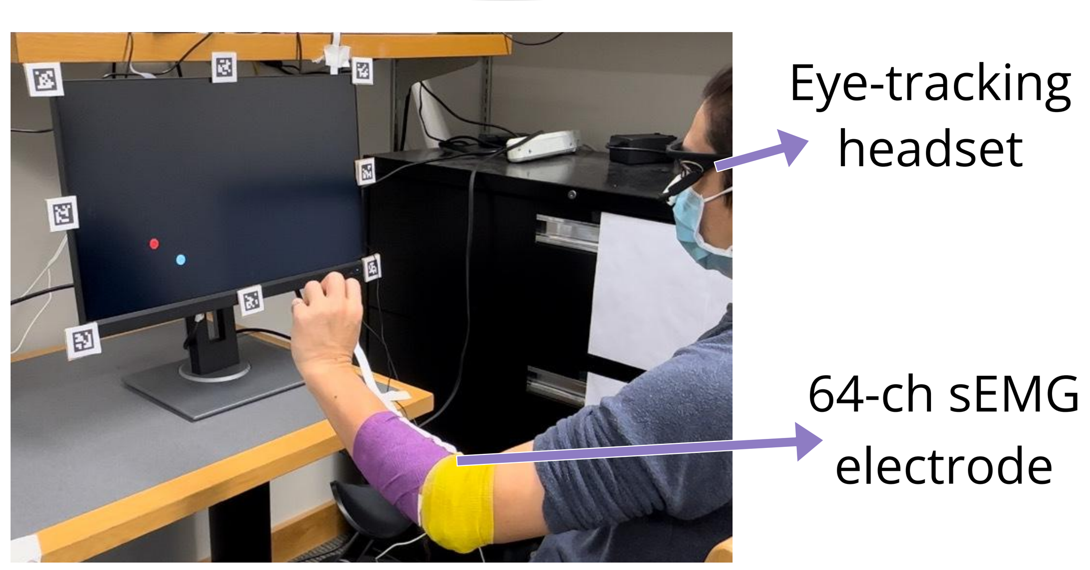
- Identify link between NI learning and eye movement.
- Current adaptive algorithms rely on structured tasks to train decoder, which limits user autonomy.

OUR GOALS

- Quantify relationship between user learning and eye movement to identify biomarkers of learning.
- Adapt interface based on eye movement biomarkers.

Co-Adaptive Myoelectric Interface





- Participants control cursor using forearm sEMG to follow a continuous moving target.
- Decoder D is adapted using gradient-based learning that minimizes **task error**:

$$\text{task error} = ||(\dot{\tau} - \dot{y}) - D \cdot s||_2^2$$

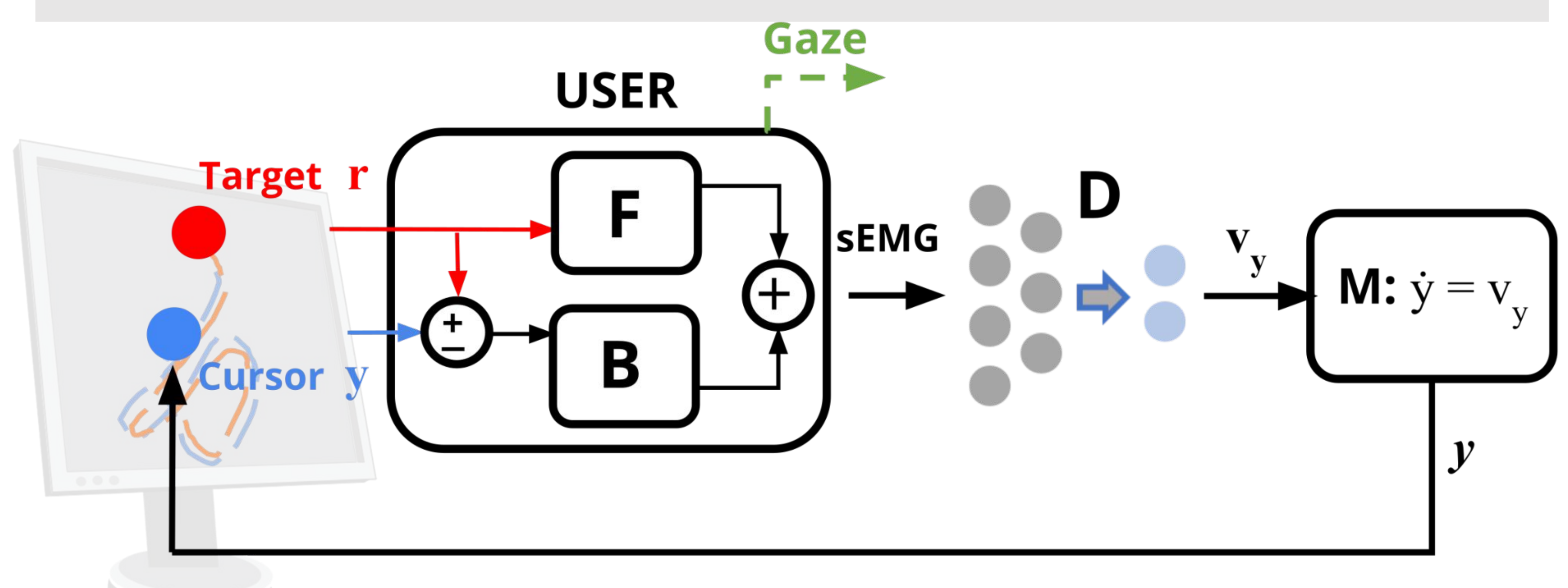
- In current methods[1,2], intended goal τ is the target.
- D is initialized randomly and updated iteratively using 20-second batches of data.

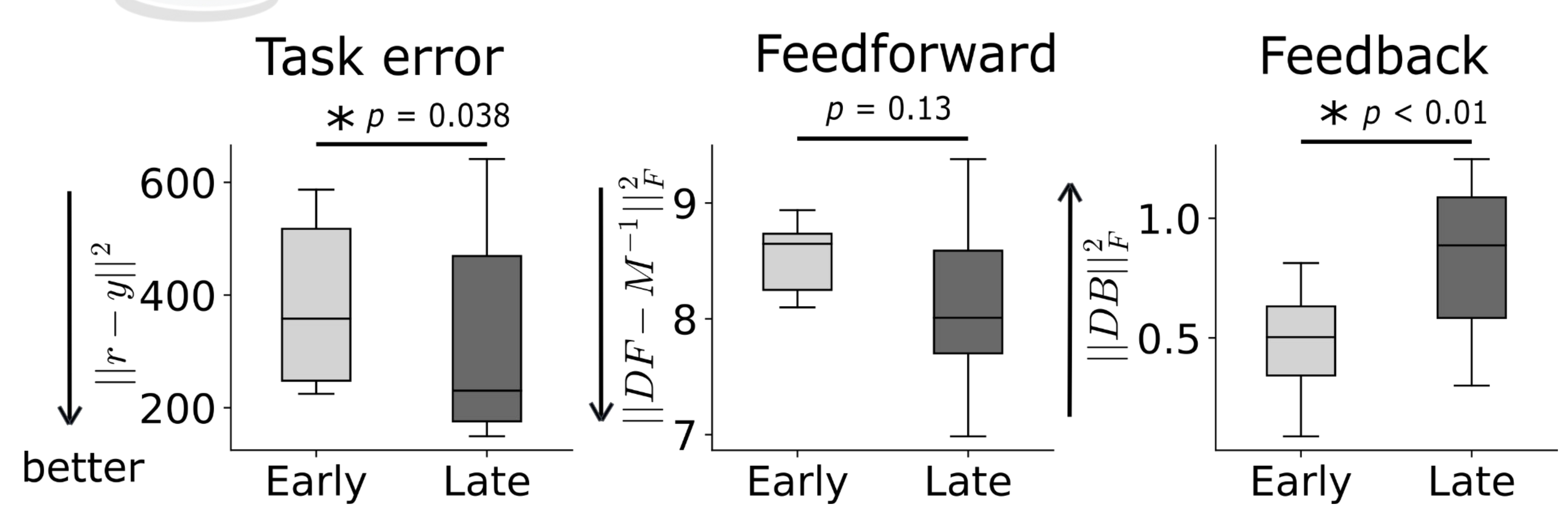
Experiment 1: eye gaze in interface learning

OBJECTIVE: Identify relationships between user learned controllers and gaze during adaptive myoelectric learning.

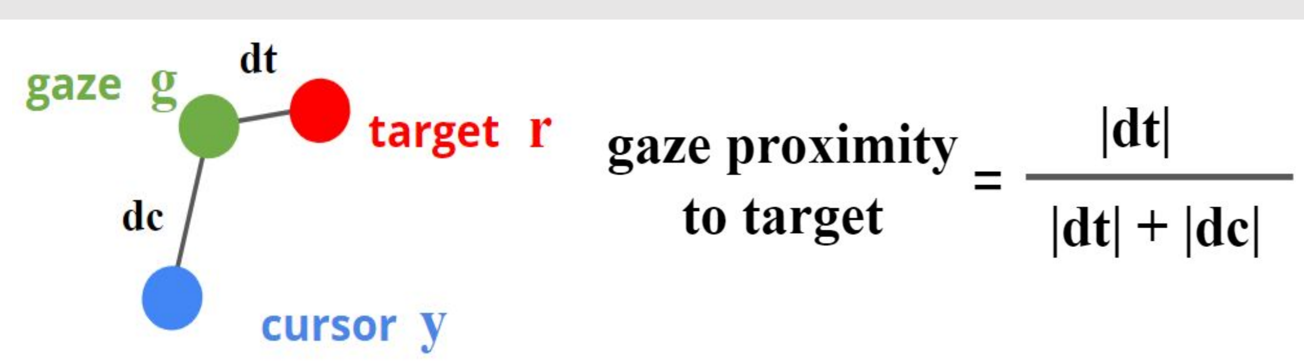
- Participants (N = 7) did tracking task with myoelectric interface.
- Eye gaze was measured during task operation.
- Each trial was 4-minute; total 12 trials.

RESULT 1: Time-domain Task Performance, Frequency-domain Feedforward and Feedback [4] Improved During Adaptation.

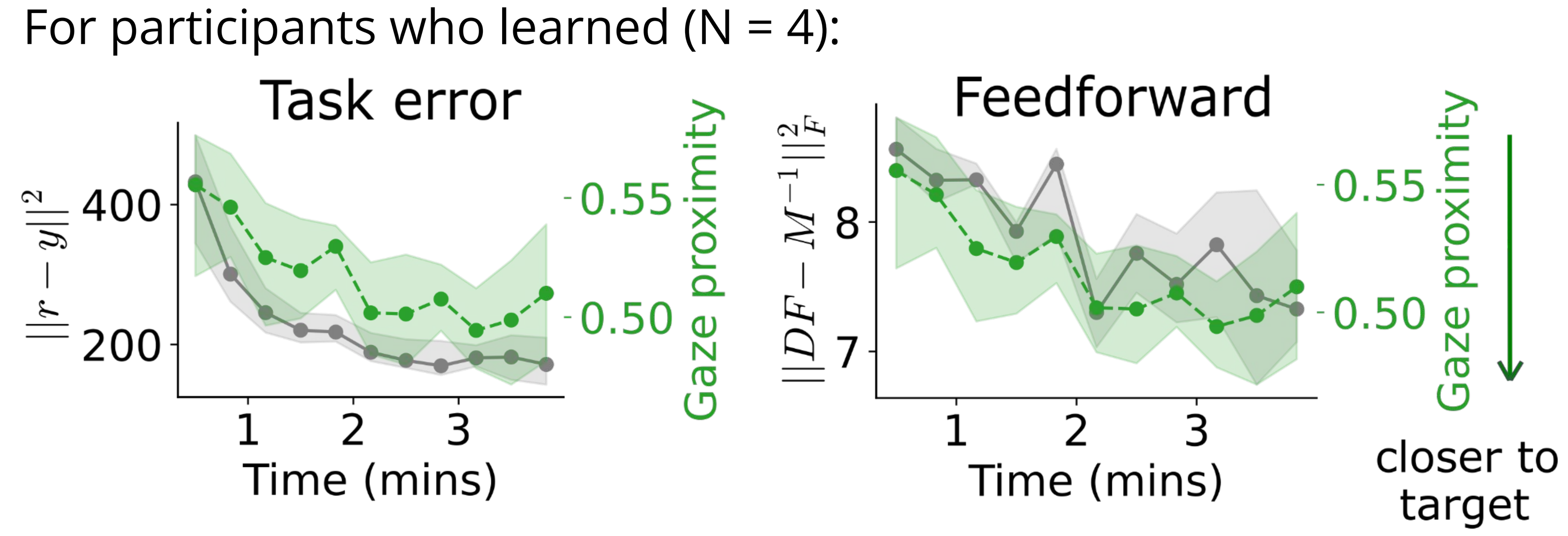




RESULT 2: Gaze Shifted Closer to the Target Compared to the Cursor as Performance and Feedforward Control Improves.



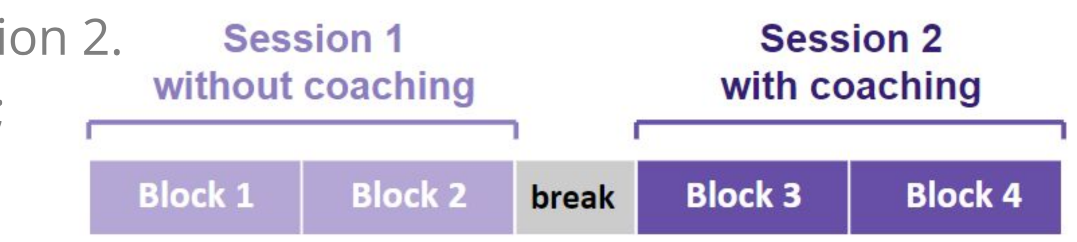
For participants who learned (N = 4):



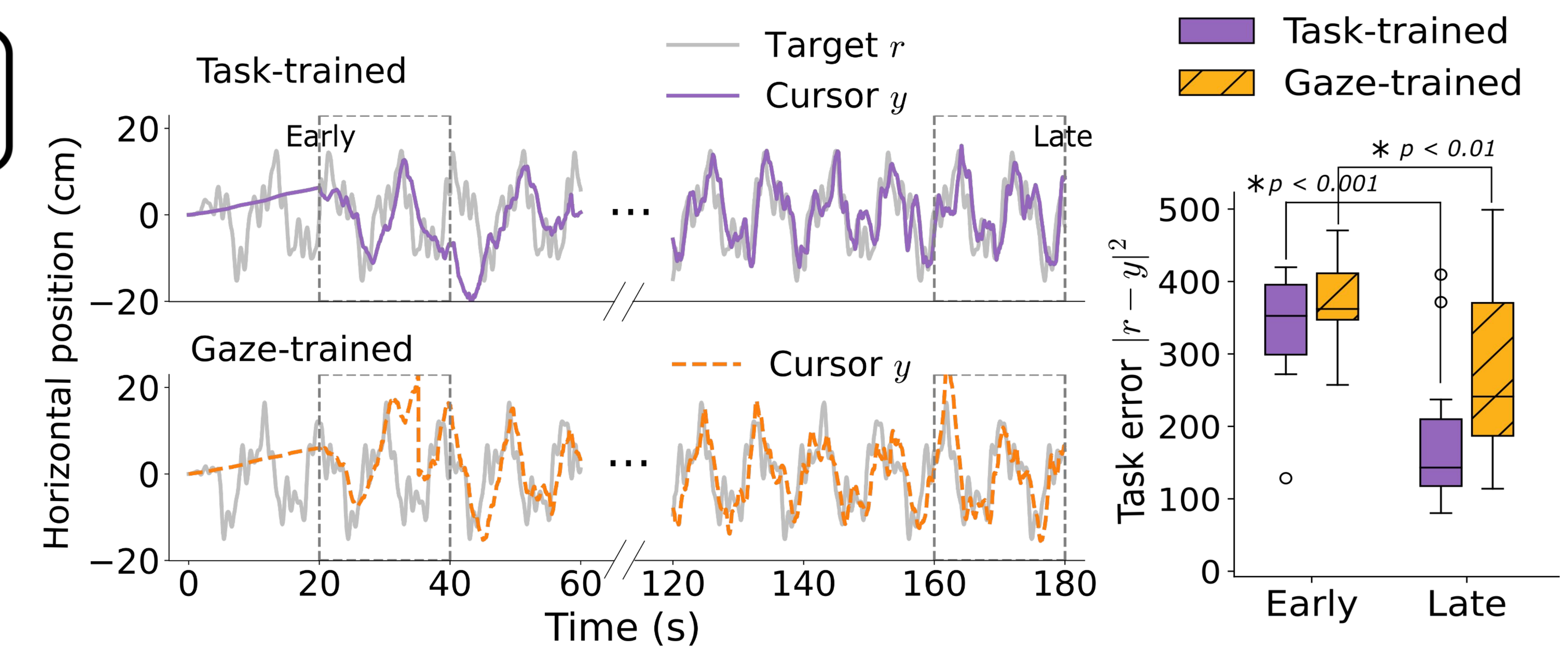
Experiment 2: using eye gaze to train decoder

OBJECTIVE: Adapt a myoelectric interface using eye gaze as training data.

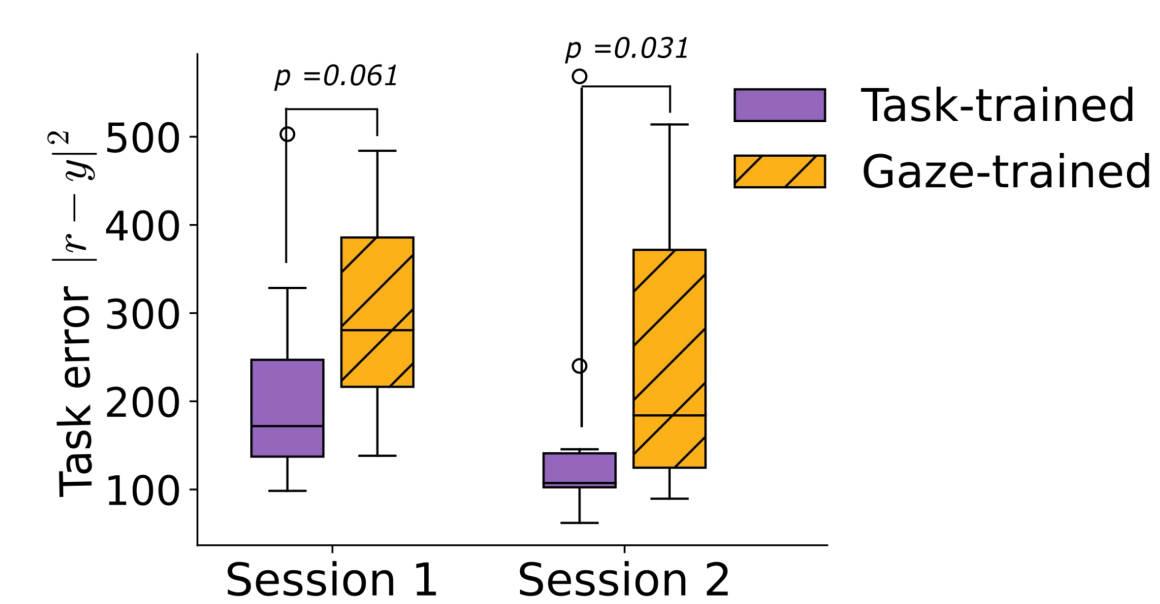
- Participants (N = 11) did tracking task with myoelectric interface trained on eye gaze. User intended goal **τ** is the gaze position.
- Users gazed on target in Session 2.
- Each trial was 3-min adaptive; total 12 trials.



RESULT 1: Time-domain Task Performance Improved for Both Gaze-Trained and Conventional Task-Trained Decoders



RESULT 2: Gaze-Trained Decoder Performed Comparably to Task-Trained Decoder; With & Without Fixation on Target.



Video Demo

Preprint

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