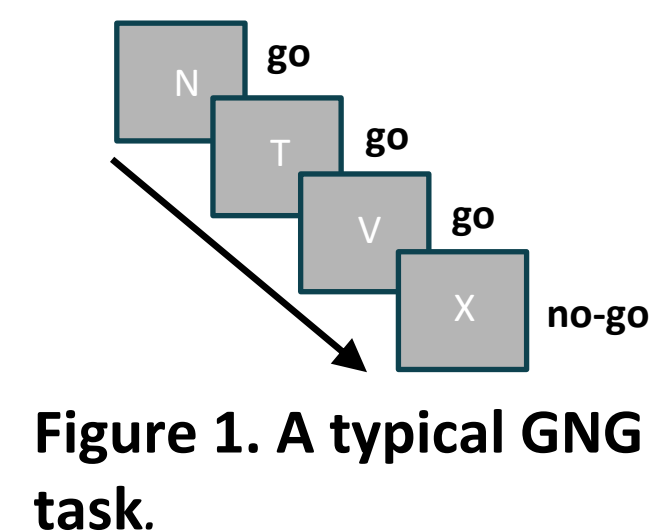


INTRODUCTION

- The go/no-go (GNG) task is a well-known experimental paradigm for studying response inhibition and impulse control.
- Traditional GNG tasks often use repetitive presentations of letters or other visual stimuli, which can lead participants to become disengaged, reducing performance over time^[1].



OBJECTIVES

Develop and test a gamified GNG paradigm to:

- enhance participant **engagement**.
- successfully replicate **key behavioral patterns** seen in traditional GNG.
- reveal **neural signatures of inhibitory control** in prefrontal.
- be used in the epilepsy monitoring unit (EMU).

METHODS

Task Design

- When a **monster** is detected, close the gate (**go trial**).
- When a **human** is detected, leave the gate open (**no-go trial**).

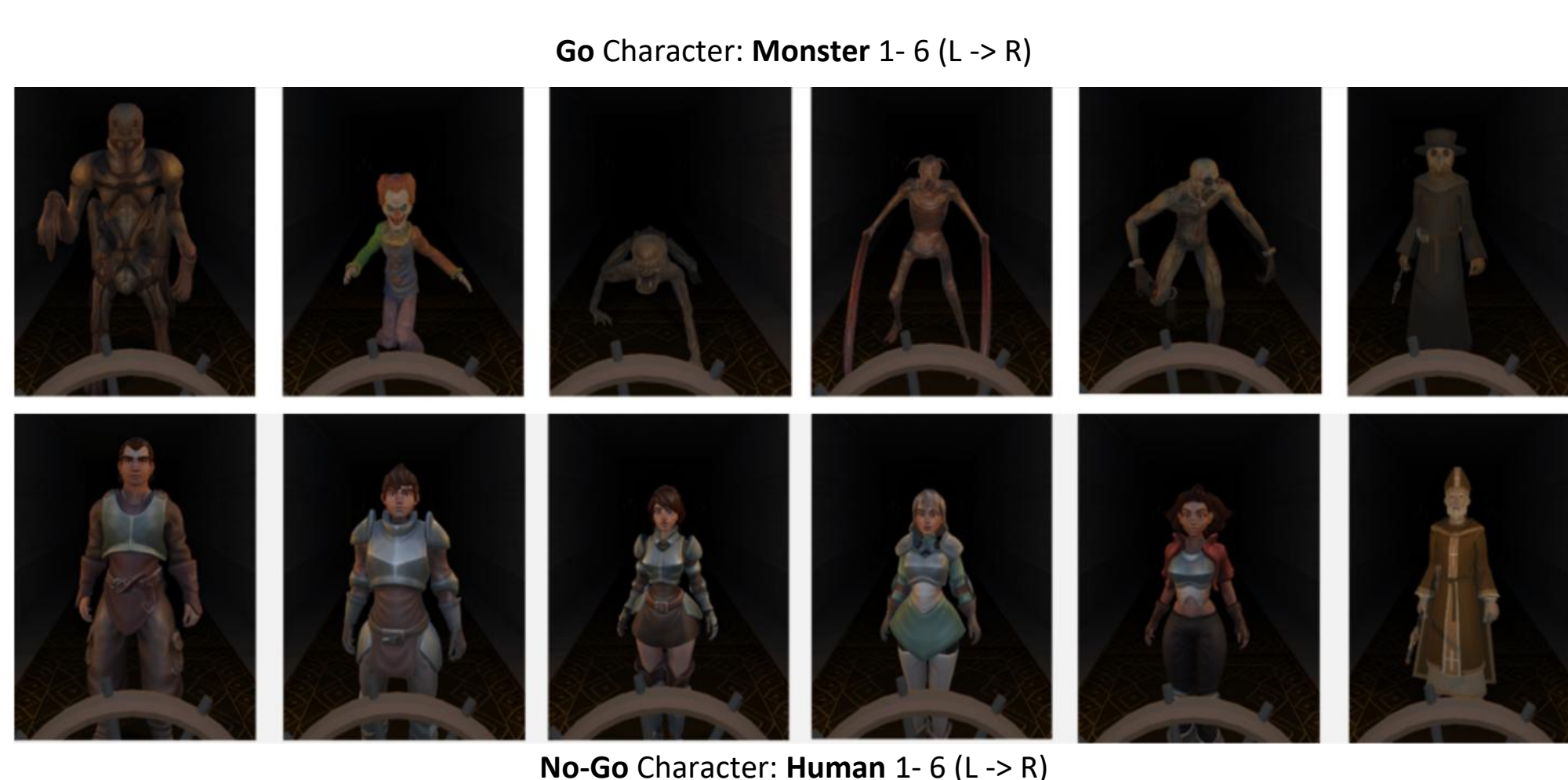


Figure 3. Characters used in the task. Monster #6 moves in the same way as human #6, for increased difficulty.

- Fog density increases and light decreases after **correct** responses, with the opposite changes after **mistakes**.

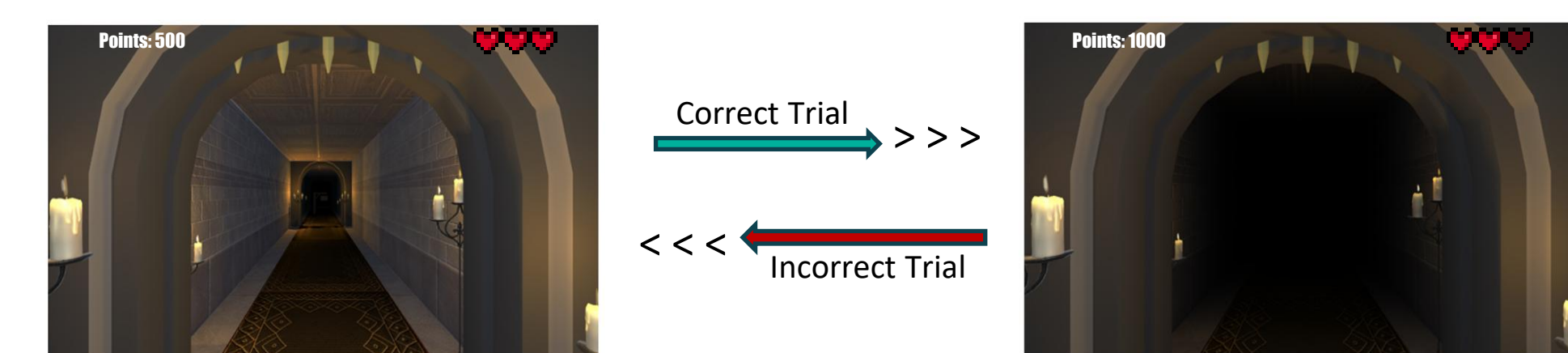


Figure 4. Dynamic difficulty adjustment. Hallway visibility alters the ability to identify the character at a distance, increasing difficulty.

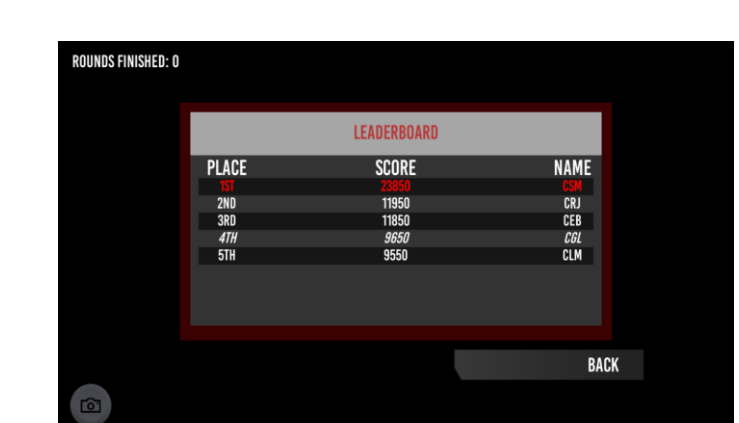


Figure 5. Leaderboard.

Participants

- 10 patients** with drug-resistant epilepsy undergoing intracranial monitoring at the EMU (3 males, age range 20-68 y).
- 3 healthy controls** (2 males, age range 19-27 y).

METHODS

Data Collection

Enrolled participants found the task **entertaining** and completed **187-606** trials.

Behavioral Data

- Collected from both patients and controls.
- Logged in real-time.

Neural Data

- Recorded from patients undergoing intracranial monitoring at EMU.
- Single-Unit Activity (SUA) in orbitofrontal cortex (OFC): obtained through Behnke-Fried probes (8 recording microwires extending from the tip of the sEEG probe), sorted using Wave_clus^[2].

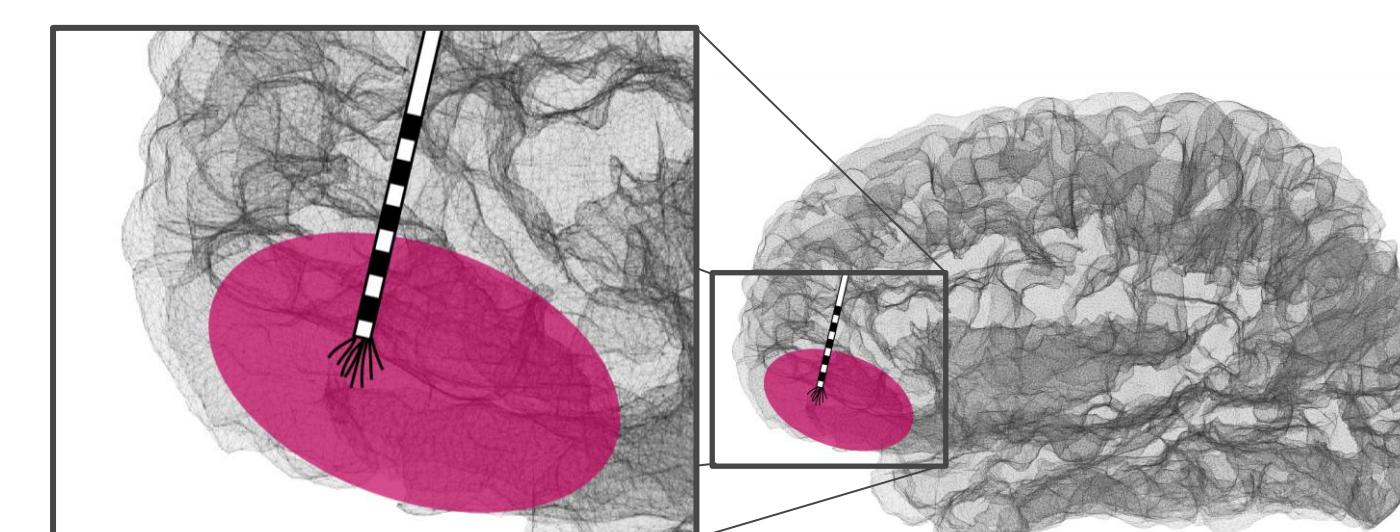


Figure 6. The cortical surface showing microwire placement in OFC.

RESULTS

Impact of Dynamic Difficulty on Reaction Time (RT)

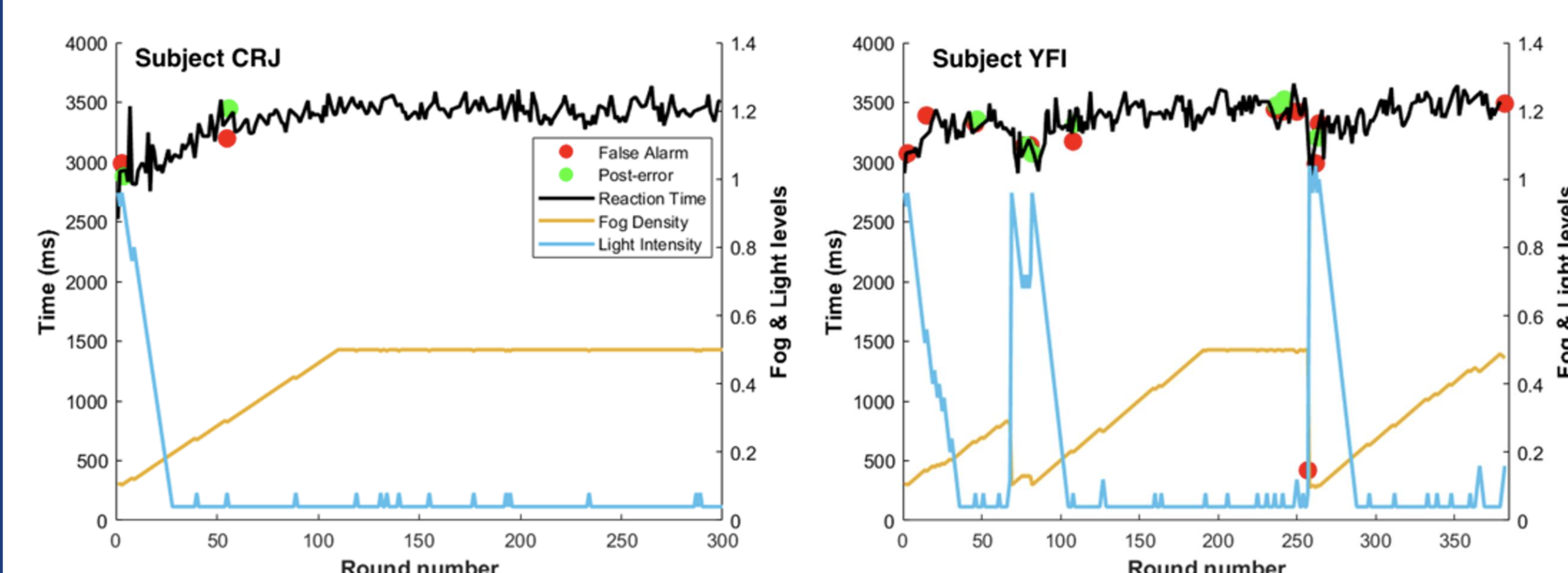


Figure 7. Effects of fog density and light intensity on RT.

- The correlation between fog density and RT was statistically significant for 12 out of 13 participants ($r=0.25-0.88$, $p<.001$).
- In **control** group, RTs **plateaued** at peak difficulty.
- No sustained plateau** was observed among **patient** participants (more mistakes).

RT: Go Correct vs. False Alarm

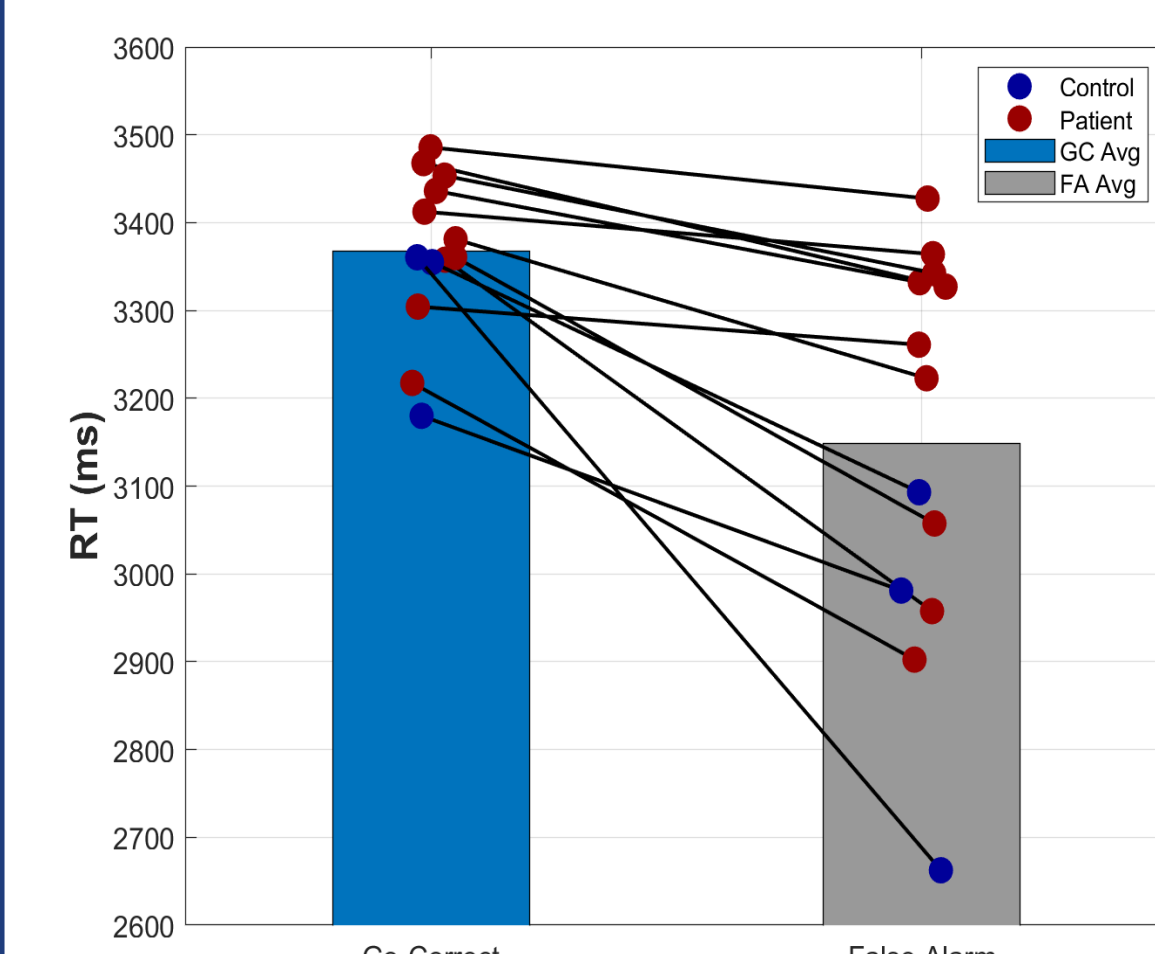


Figure 8. RTs for false alarm trials were significantly faster than those for go correct trials ($t_{12}=4.31$, $p=.001$).

RT: Post-Error Trials

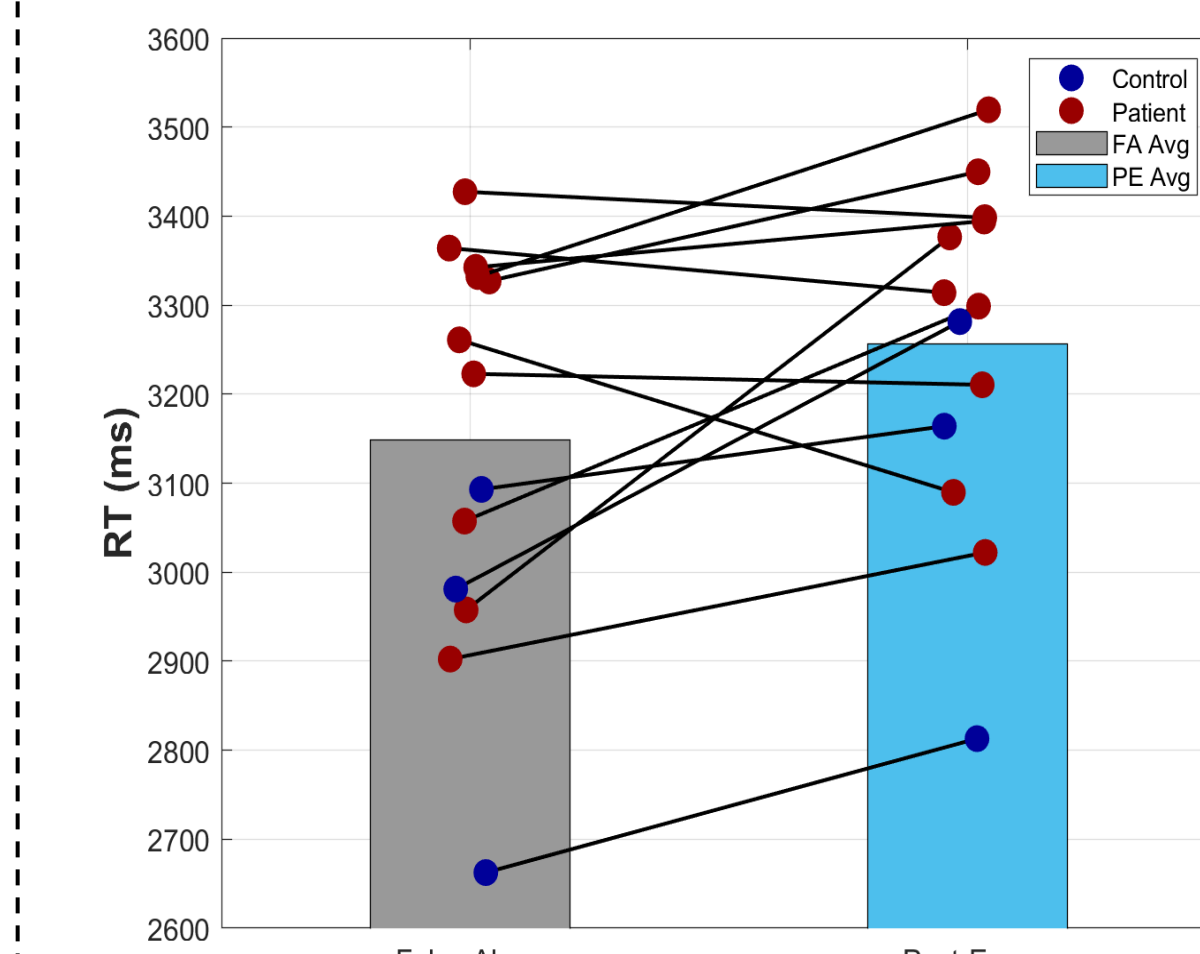


Figure 9. RTs following an error were significantly slower than false alarms ($t_{12}=2.46$, $p=.03$).

SUA across Task Conditions:

Examples of Heterogeneous Response Patterns

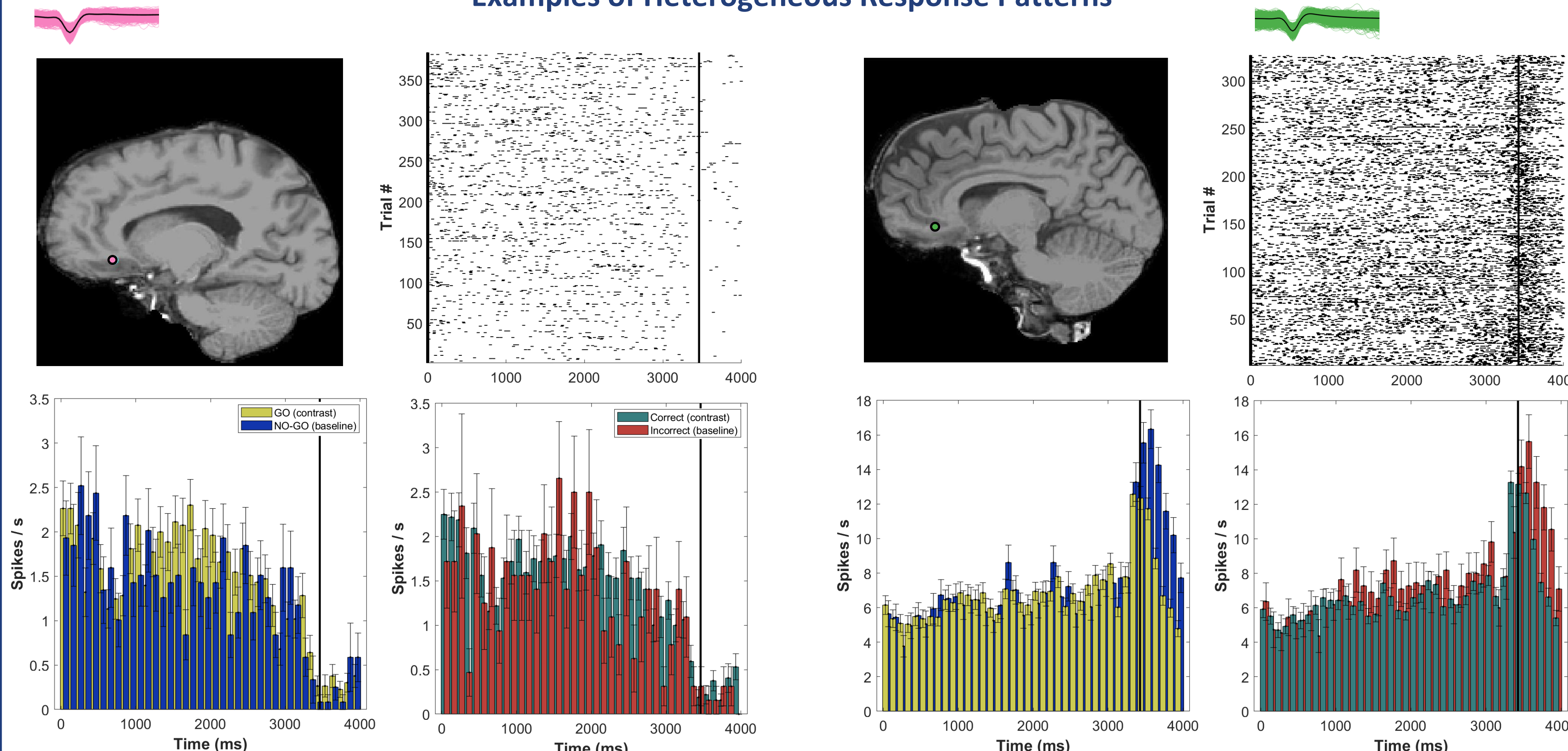


Figure 10. Example unit N1 recorded from the left OFC of patient YFP.

- A generalized linear model analysis revealed significantly **higher** firing rates during **go trials** ($\beta=0.07$, $p<.001$) and **correct** trials ($\beta=0.08$, $p<.001$).
- A sharp **decrease** in firing rate was observed around the RT, aligning with the temporal pattern observed in the raster plot.

Figure 11. Example unit N2 recorded from the right OFC of patient YFN.

- Significantly **lower** firing rates during **go trials** ($\beta=-0.08$, $p<.001$), especially visible after the average RT, and **correct** trials ($\beta=-0.1$, $p<.001$).
- A sharp **increase** in firing rate was observed around the RT, aligning with the temporal pattern observed in the raster plot.

RESULTS

OFC Population Neural Trajectories for Go vs. No-Go Trials

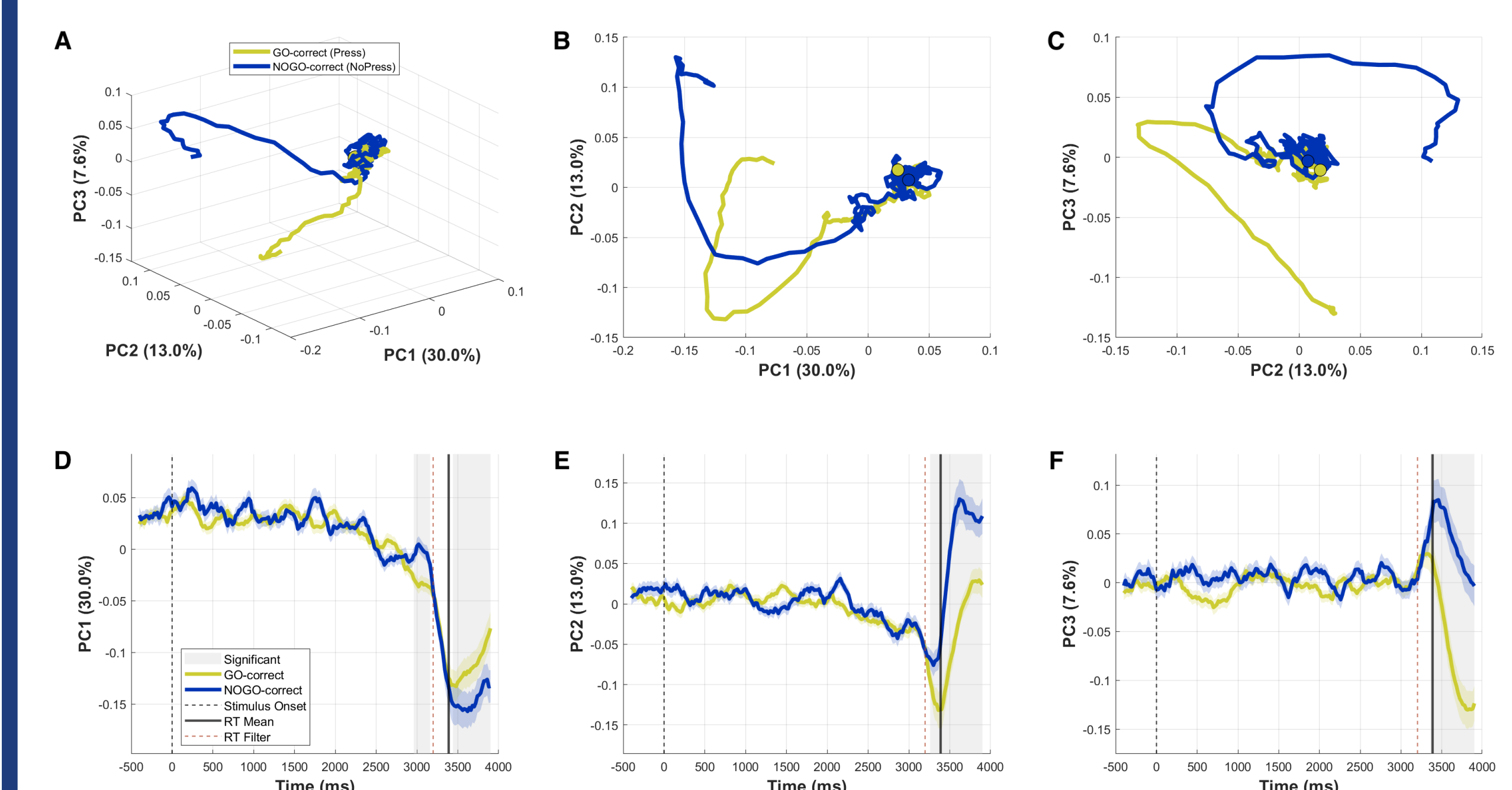


Figure 12. OFC population neural trajectories using PCA (Principal Component Analysis).

- 93 OFC units across 7 participants were included in the analysis.
- Neural trajectories for go correct and no-go correct trials initially overlap at trial onset but diverge later during the response period.
- Significant separation was observed across all three principal components during the response period.
- PC1 shows a significant go/no-go difference **before any movement** (trials with RT < 3200 ms were excluded from the analysis) and then later, **after the average RT**.
- PC2 shows sustained divergence starting just before the average RT.
- PC3 peaks at the average RT and remains separated afterward.

DISCUSSION

1. Behavior

- Effectively captured key behavioral patterns seen in traditional GNG paradigms:
 - ☐ **Faster reaction times during false alarms.**
 - ☐ **Slower responses with increasing task difficulty.**
 - ☐ **Post-error slowing.**

2. SUA Patterns

- OFC units show **task-related modulations** of their firing rates.
- The **patterns are heterogeneous**, spanning increase and decrease of activity at different moments throughout the trial.

3. Neuronal State-Space Trajectories

- Each dimension captured different patterns of OFC activity.
- Neural trajectories for go and no-go trials overlapped at the start of the trial and diverged just before and around the response time.
- These neural results complement the behavioral findings, indicating that the Anticipation Task elicits OFC dynamics that differentiate go and no-go trials.
- This is in line with previous findings of inhibitory control activity in OFC^[3], and its broader role in regulating actions^[4] and monitoring their outcomes^[5].

CONCLUSIONS

- The Anticipation Task could potentially be used to measure inhibitory control dynamics in a more engaging and naturalistic way.

We plan to:

- Extend our preliminary findings** by analyzing data from a larger cohort of patients and across multiple brain regions.
- Test** for the effect of other task variables (difficulty, lives remaining, etc.).
- Compare** neural responses recorded during the Anticipation Task to those recorded during a traditional GNG tasks in the same participants.

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