

Central Fatigue in Cognitive and Motor Performance

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The Action Lab

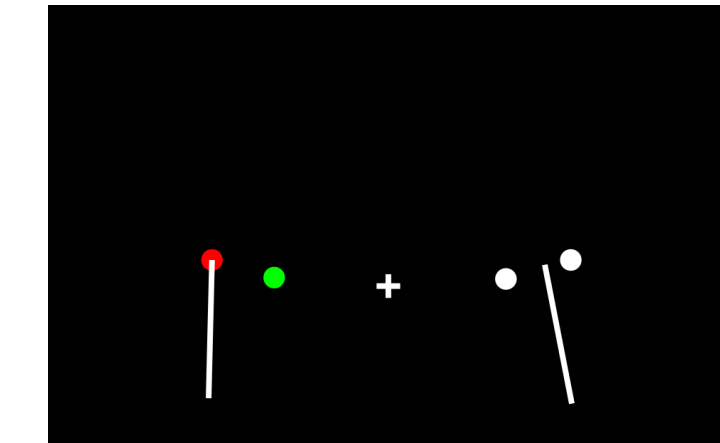
Abstract

Central fatigue is a complex and widespread phenomenon that negatively impacts human performance and refers to inability of the central nervous system to generate or maintain cognitive, motor, and sensory function. Despite its prevalence, etiology and characteristics of central fatigue are not well understood. Participants performed an asymmetric bimanual motor task, where one hand performed a triggered pointing movement while the other maintained continuous rhythmic movements. For the cognitive task participants listened to a letter sequence and verbally indicated whether each letter repeated the one two before. Session 1 consisted of 60 minutes motor task, preceded and succeeded by 20 minutes cognitive task; in session 2 the 60-minute cognitive task was bracketed by 20 minutes motor task. Session 1 and 2 order was randomized across participants. In session 3, both tasks were performed simultaneously for 60 minutes. Kinematic and electrocortical data (64-channel EEG) were recorded; pre- post-fatigue questionnaires and cognitive tests were administered. This study investigates interactions between motor and cognitive challenges. Preliminary EEG, error and reaction time, and self-report results showed that the 60-min sessions accrued fatigue. Consistent with increased reported fatigue, electrocortical activity decreased in the P300 event-related potential (ERP). Cognitive task fatigue led to pre- post-task increased motor reaction time. In contrast, the motor task did not result in pre-post task increased cognitive reaction time. These first results point to asymmetric interactions between motor and cognitive demands in their effect on central fatigue.

Method

Bimanual Motor Task:

Right hand: Oscillation between two targets at self-chosen frequency
Left hand: Cue-triggered pointing to target task as quickly as possible



Cognitive N-Back Task:

Subjects are given a random letter sequence and respond when a letter duplicates a letter 2 positions back. Responses are recorded with a microphone.

Pre- and Post-Task Evaluations:

Fatigue:

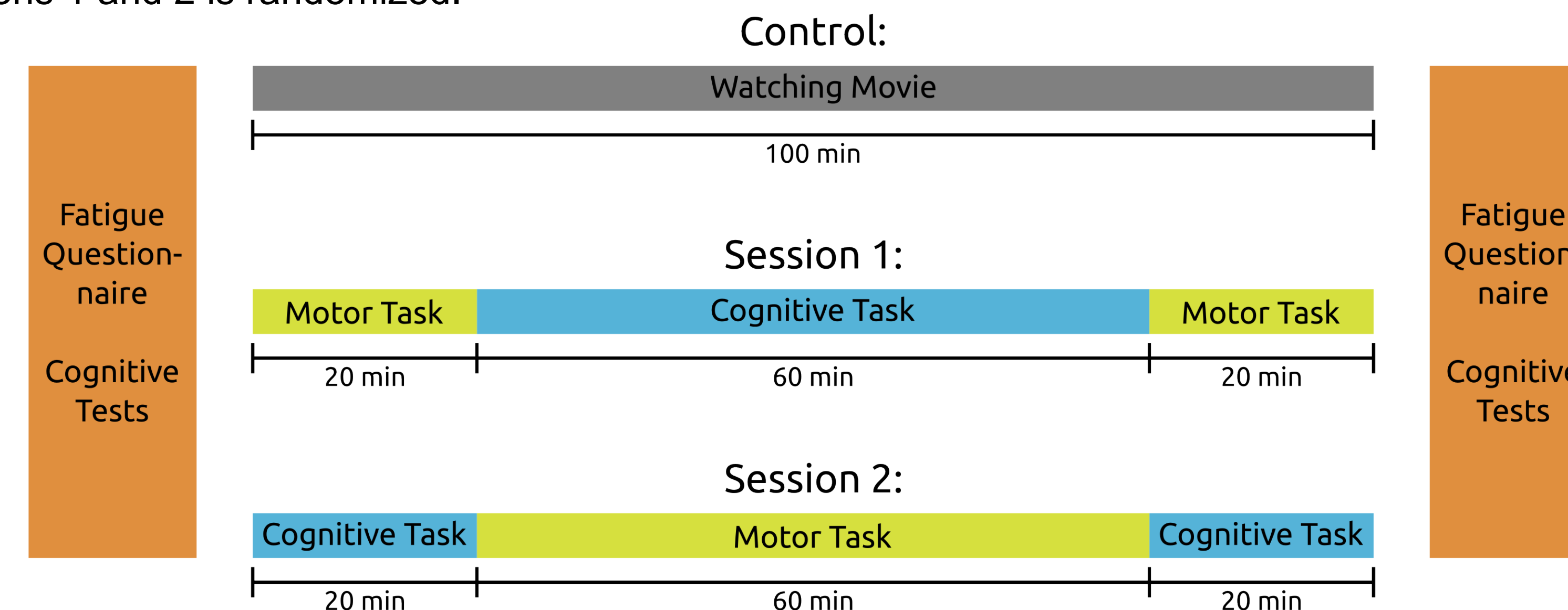
- Visual Analogue Scale for Fatigue: Subject rates fatigue regarding 18 parameters (e.g. "sleepy"; "energetic")
- Fatigue Severity Scale: Subject rates agreement with each of 9 statements reflecting impact of fatigue (e.g. "easily fatigued")

Cognitive Function:

- Nelson-Denny Reading Test: Reading Comprehension, Reading Rate

Protocol:

Subjects complete 3 sessions of the cognitive and motor tasks as outlined in the diagram. The order of sessions 1 and 2 is randomized.



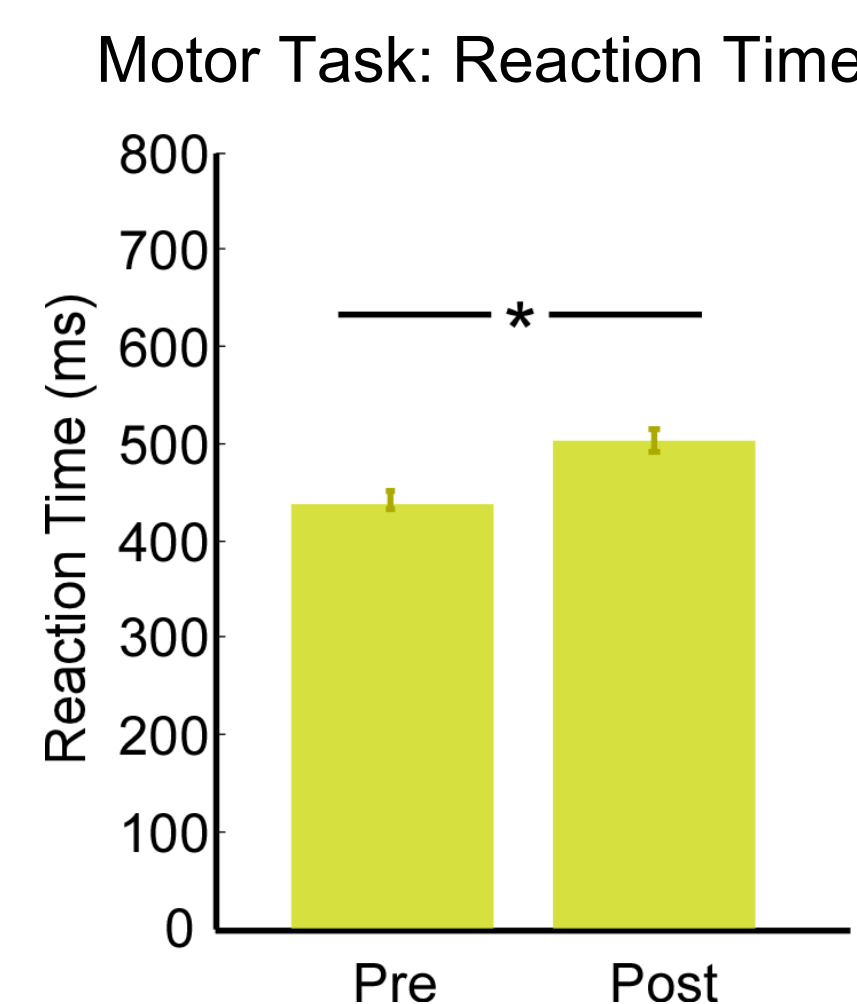
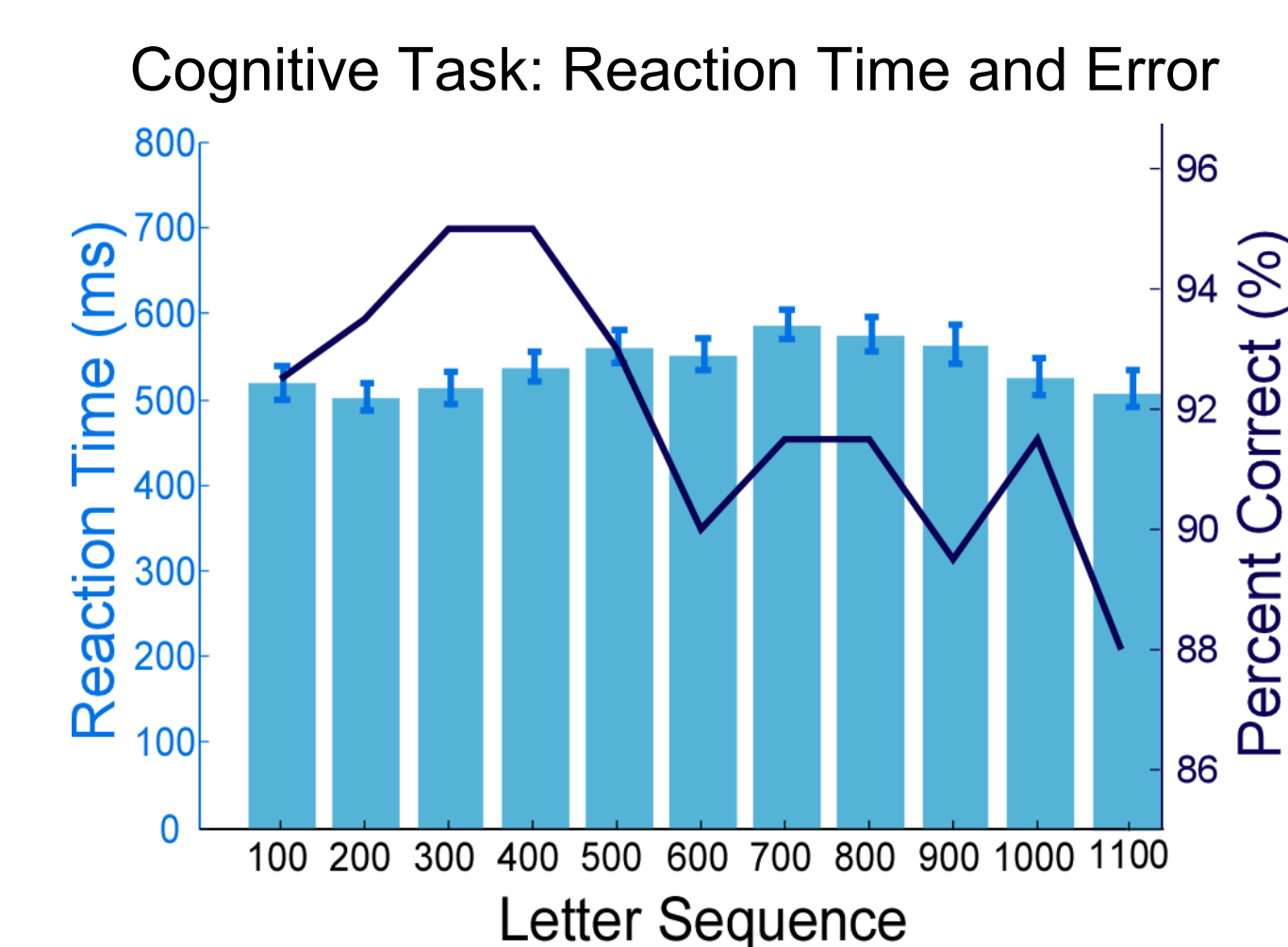
Introduction

Tasks that result in central fatigue are common in modern society, in areas such as the military and aviation, as well as in everyday tasks. Central fatigue is a change in central nervous function that differs from peripheral fatigue in muscle function. Although the phenomenon is common, central fatigue is not well understood. This study aims to investigate the development of central fatigue during a motor and a cognitive task, performed separately or in combination.

Fatigue is assessed in terms of reaction time and accuracy on the tasks, as well as in electroencephalographic (EEG) data. Event-Related Potentials were extracted from data, which is an accepted measure of central fatigue (Uetake & Murata 2005).

Results

Session 1:



Over 60 minutes of the cognitive task, reaction time was unchanged, while the percentage of correct responses decreased. Pre- to post- task comparison revealed an increase in reaction time in the motor task.

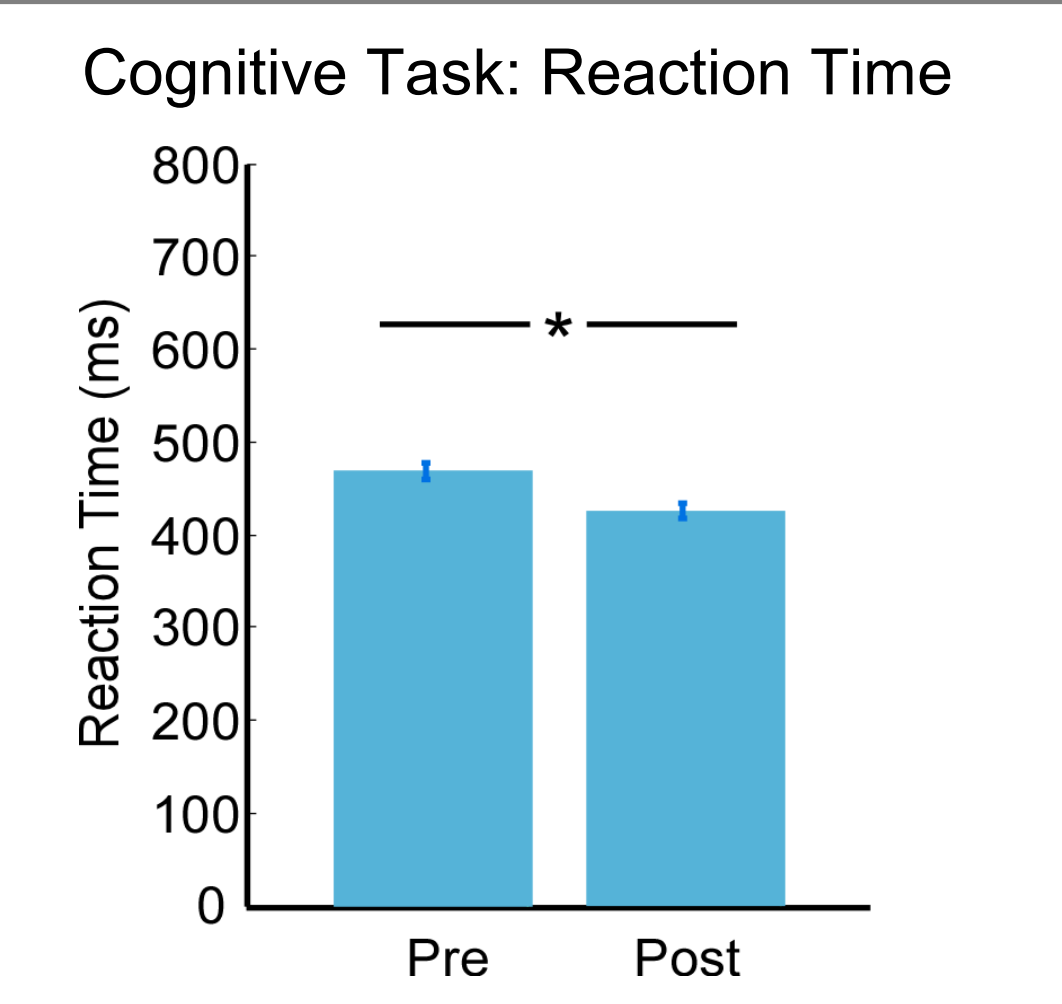
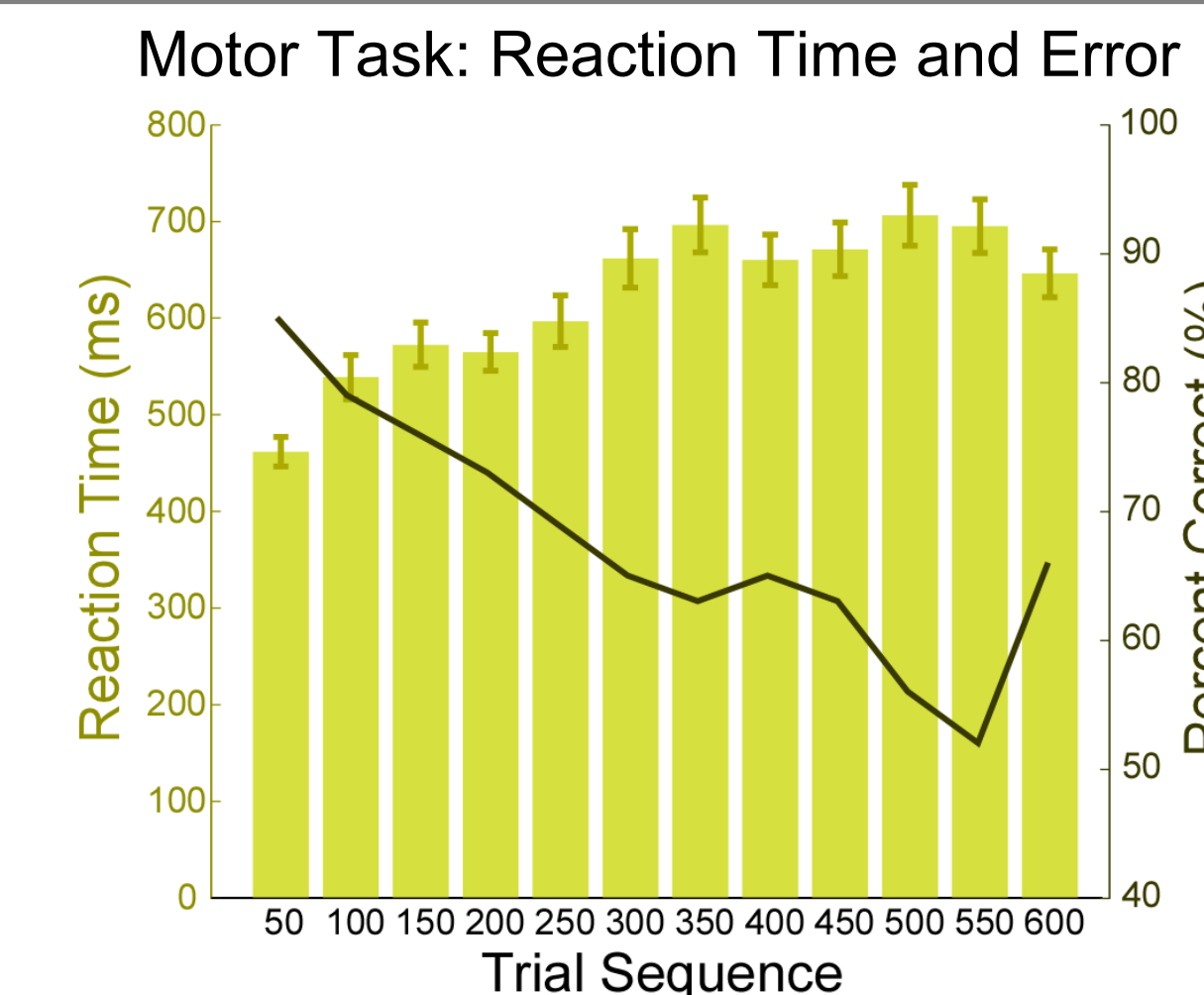
Questionnaires indicated a significant increase in fatigue, reading rate decreased significantly.

Acknowledgements:

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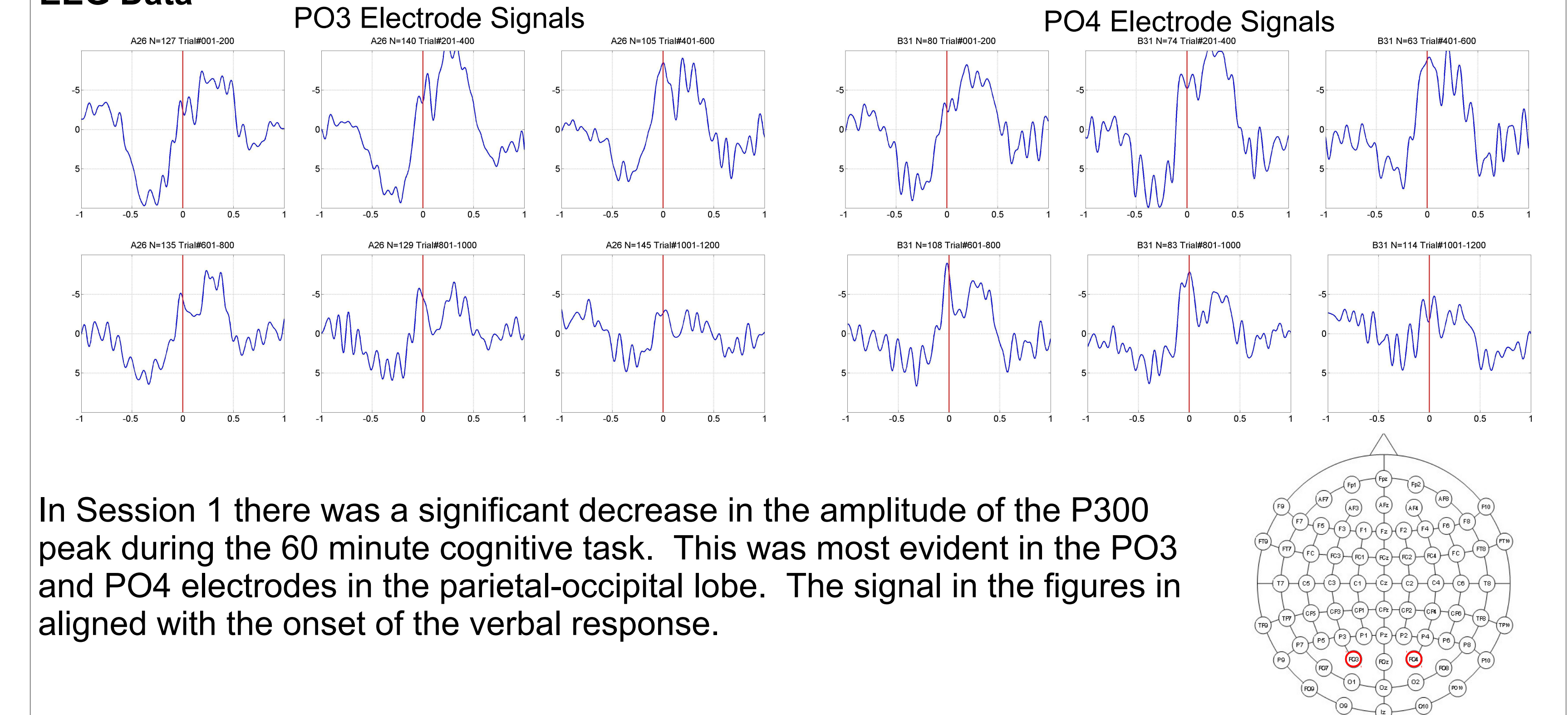
Results

Session 2:



Motor Reaction time increased over 60 minutes of the bimanual task, while percent correct decreased. Interestingly, cognitive task reaction time decreased significantly from pre- to post test. Questionnaires indicated an increase in fatigue and a decrease in reading rate.

EEG Data



In Session 1 there was a significant decrease in the amplitude of the P300 peak during the 60 minute cognitive task. This was most evident in the PO3 and PO4 electrodes in the parietal-occipital lobe. The signal in the figures is aligned with the onset of the verbal response.

Conclusion

The cognitive function tests and fatigue measures indicate that central fatigue developed in both sessions. The decreased amplitude of the P300 ERP in the EEG data confirms that fatigue developed over the course of the cognitive task. However, while the extended cognitive task resulted in decreased motor performance, the motor task did not appear to decrease cognitive performance. This indicates an asymmetrical relationship between the two tasks that warrants further investigation.

However, only the data of one subject has been analyzed. Future plans for this research include analysis of dual task (Session 3) data to determine the effect of simultaneous tasks on central fatigue, as well as completing further analysis of the EEG data and confirming the results with more subjects.

The preliminary results of the research indicate an interesting relationship between the tasks and fatigue: although the cognitive task seems to clearly cause central fatigue, it does not appear that a motor task has the same effect. If such findings hold, this has implications for planning activities involving both types of tasks, such as military tasks.

References

A. Uetake & A. Murata. (2000). Assessment of Mental Fatigue during VDT Task using Event-related Potential (P300). Proceedings of the 2000 IEEE International Workshop on Robot and Human Interactive Communication. Osaka, Japan. 27-29 September 2009.