Event Related Potentials during the Boston Naming Task, and their changes in ALS

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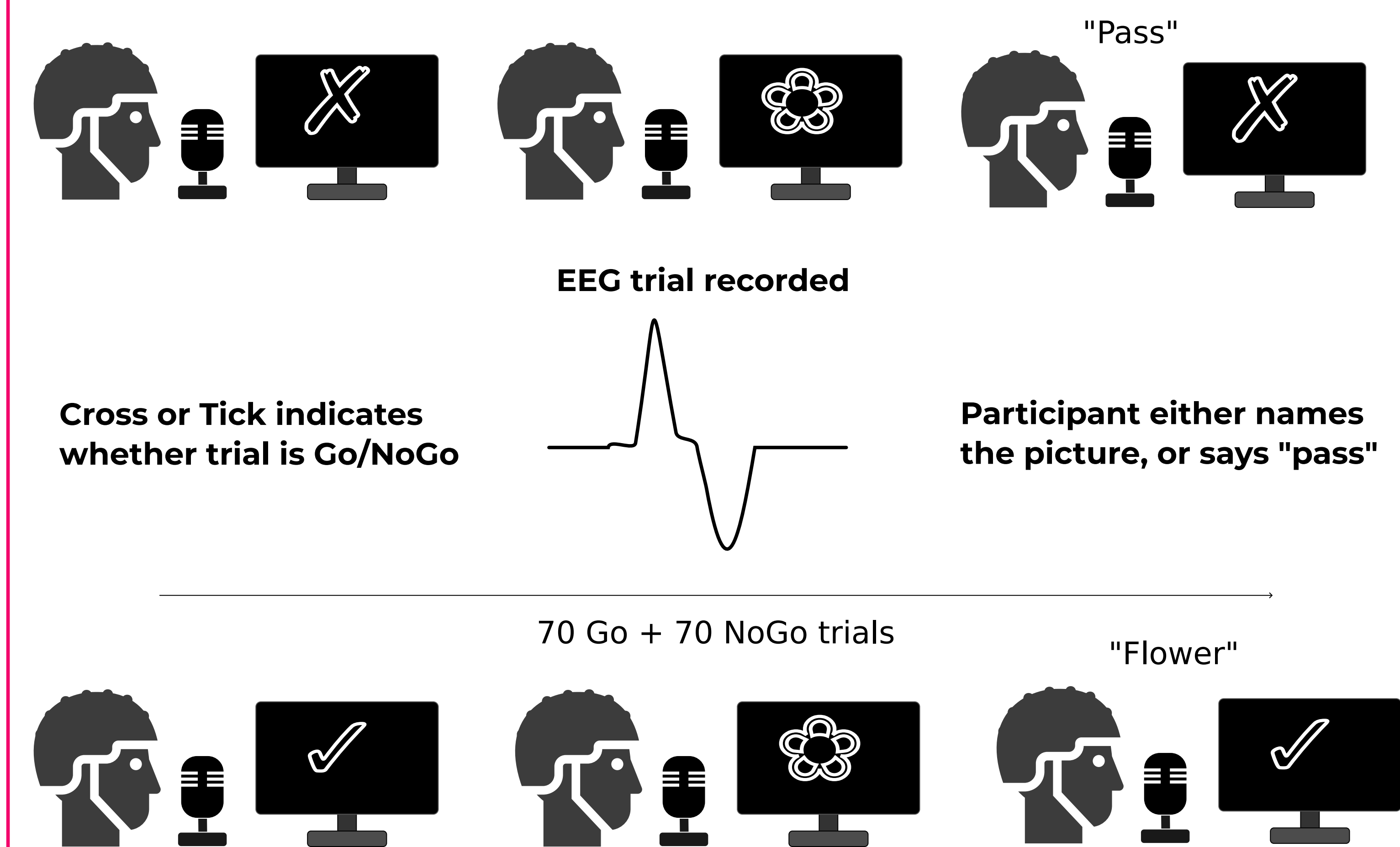## Introduction

Background:
- ALS: a chronic, terminal neurodegenerative disease, causing progressive paralysis and death within 3-5 years.
- Language impairment is common in ALS, and is associated with worse outcomes, e.g., shorter survival.
- The Boston Naming Test (BNT) is an picture naming test on which many people with ALS show impairments.
- Biomarkers for improved diagnosis, prognosis, and disease monitoring are needed for improved treatment/clinical trials
- We used electroencephalography (EEG) to record neural activity during a language task.
- Advantages over other measures (e.g., fMRI)
  - Directly measures neural activity
  - Low cost
  - High temporal resolution

Aims:
- To investigate whether event related potentials (ERPs) can be detected during the BNT.
- To see whether people with ALS display abnormalities in these ERPs, and whether this relates to language function.

Methods

- Record EEG during the Boston Naming Test (object naming).
- Epoch EEG recording from 200ms before picture to 1000ms after.
- Find Go/NoGo difference.

"Pass"

EEG trial recorded

Cross or Tick indicates whether trial is Go/NoGo

Participant either names the picture, or says "pass"

70 Go + 70 NoGo trials

"Flower"

Figure 1: Illustration of the experimental protocol: a version of the BNT compatible with EEG recording. On Go trials, participants named the picture, on NoGo trials, participants said "Pass".

Participant Characteristics:
- n = 45, 19 controls (11 female), 26 people with ALS (6 female).
- All participants were over the age of 40, to match ages of ALS cohort.
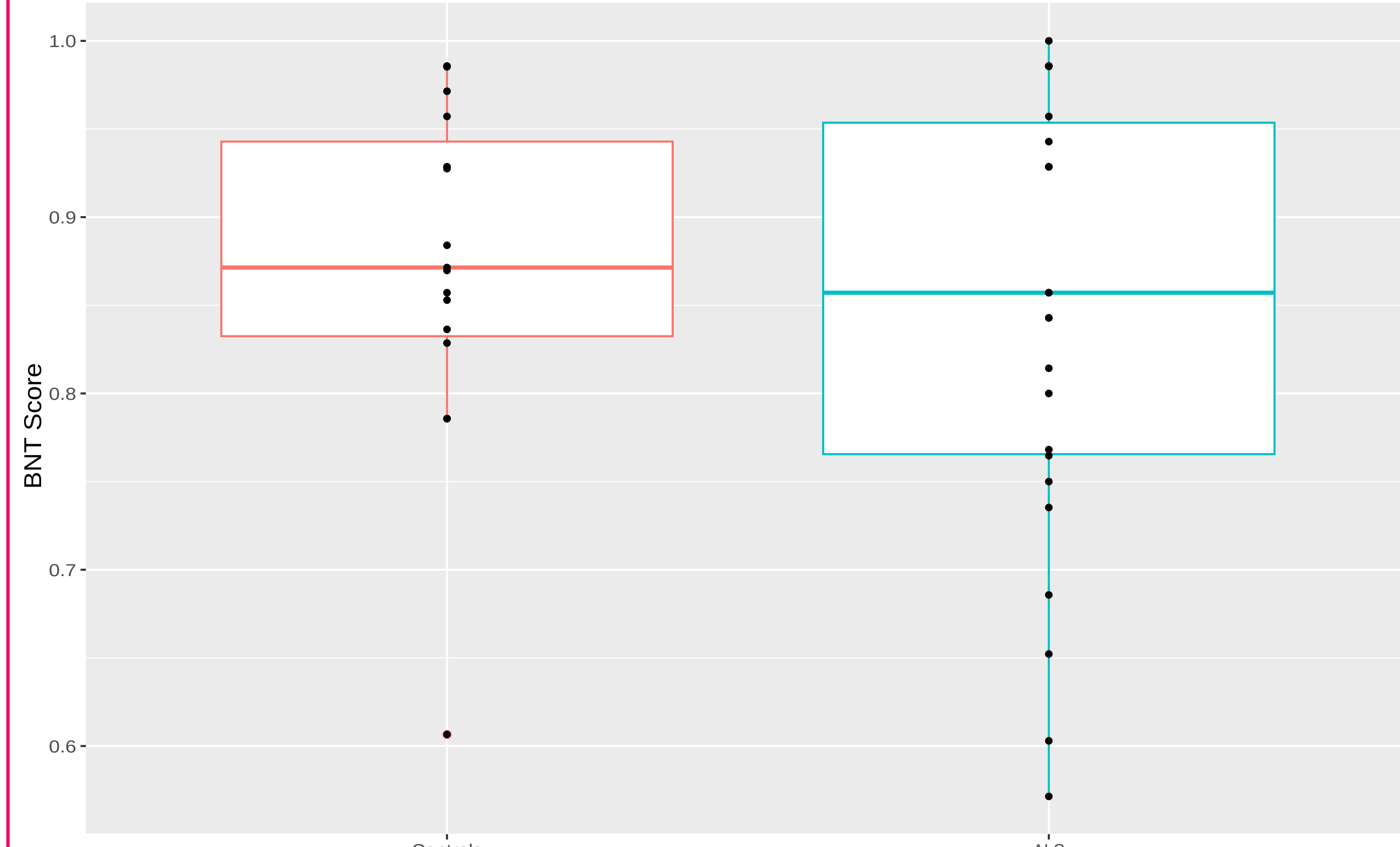
Results

Figure 2: Boxplots showing median and interquartile range of scores in people with ALS and controls. Score is calculated using the formula (correct answers)/(correct answers + incorrect answers). No significant difference in medians was found (Mann Whitney U test, n = 41, p = 0.74).

- No significant group differences in task performance.
- Distribution appears more uniform in ALS.
- No significant correlations between score and ERP amplitude.
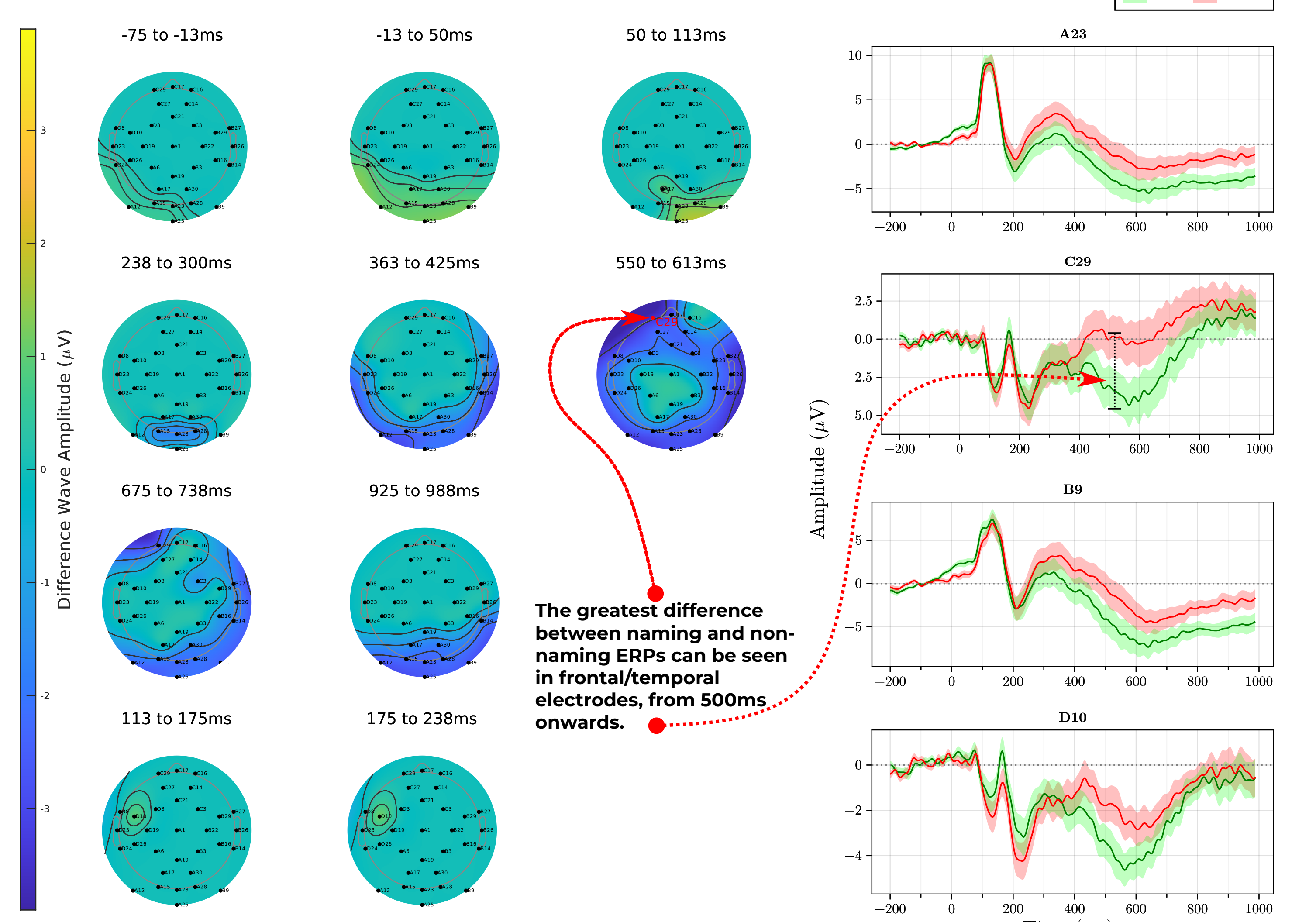
Results

Figure 3 (left): Sample topographic plots (topoplots) displaying the mean "difference wave" (Go - NoGo) across all controls. Only differences which were significant after FDR correction at a rate of 10% are shown.

The greatest difference between naming and non-naming ERPs can be seen in frontal/temporal electrodes, from 500ms onwards.

Figure 3 (right): Grand mean ERPs from electrodes at which maximal difference wave was found. Go trials (green) and NoGo trials (red), are shown. Error bars indicate SEM.

- Positive deflection in first 100ms, in occipital electrodes
- Widespread negative deflection from ~250ms to 1000ms.
  - Strongest in frontal/temporal lobes, from 550-600ms
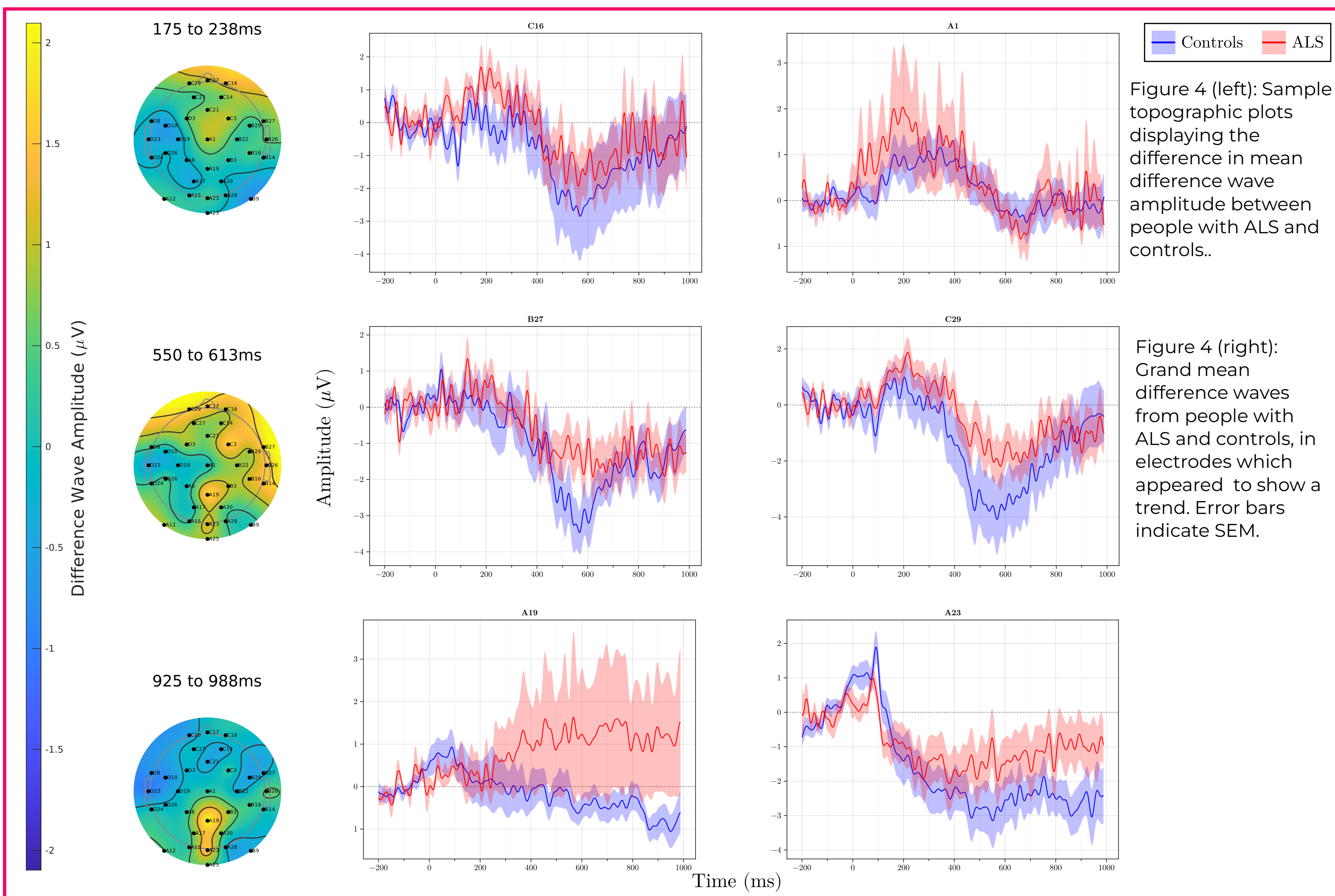- P100 in temporal/parietal lobes

Figure 4 (left): Sample topographic plots displaying the difference in mean difference wave amplitude between people with ALS and controls..

Figure 4 (right): Grand mean difference waves from people with ALS and controls, in electrodes which appeared to show a trend. Error bars indicate SEM.

- No significant differences found
- Some interesting trends
  - Increased activity in ALS in A19, A23 from 500ms to end
  - Mildly increased difference wave amplitude in A1 at 200ms in ALS.

Summary of Results:
- A significant event related potential (ERP) was found in controls.
- No significant differences in difference wave amplitude or cognitive score between ALS and controls.
- No significant correlations between task performance and EEG measures.

Conclusions

- The Boston Naming Test can be used to study language using event related potentials.
- These results are inconclusive as to whether the networks underlying these ERPs are impaired in ALS.
- The cognitive processes underlying the identified ERP may not relate to task performance.

Future Directions:
- Use time-frequency analysis to determine whether rhythmic activity differs between ALS and controls.
- Application of source analysis, to characterise brain areas involved in BNT.
- Perform this experiment in people with ALS with stronger cognitive impairment.