

Neurocognitive testing from the home: Statistical power of repeated, self-administered wireless dry EEG

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Motivation

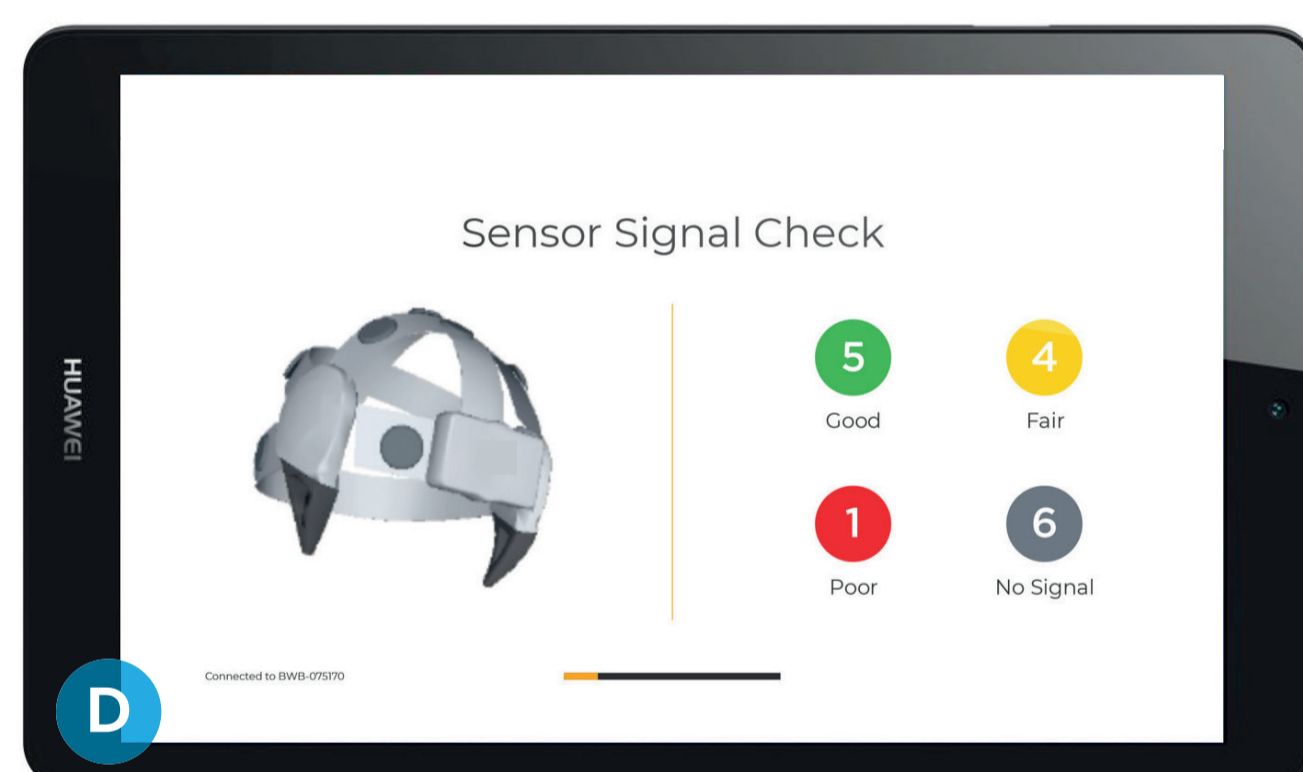
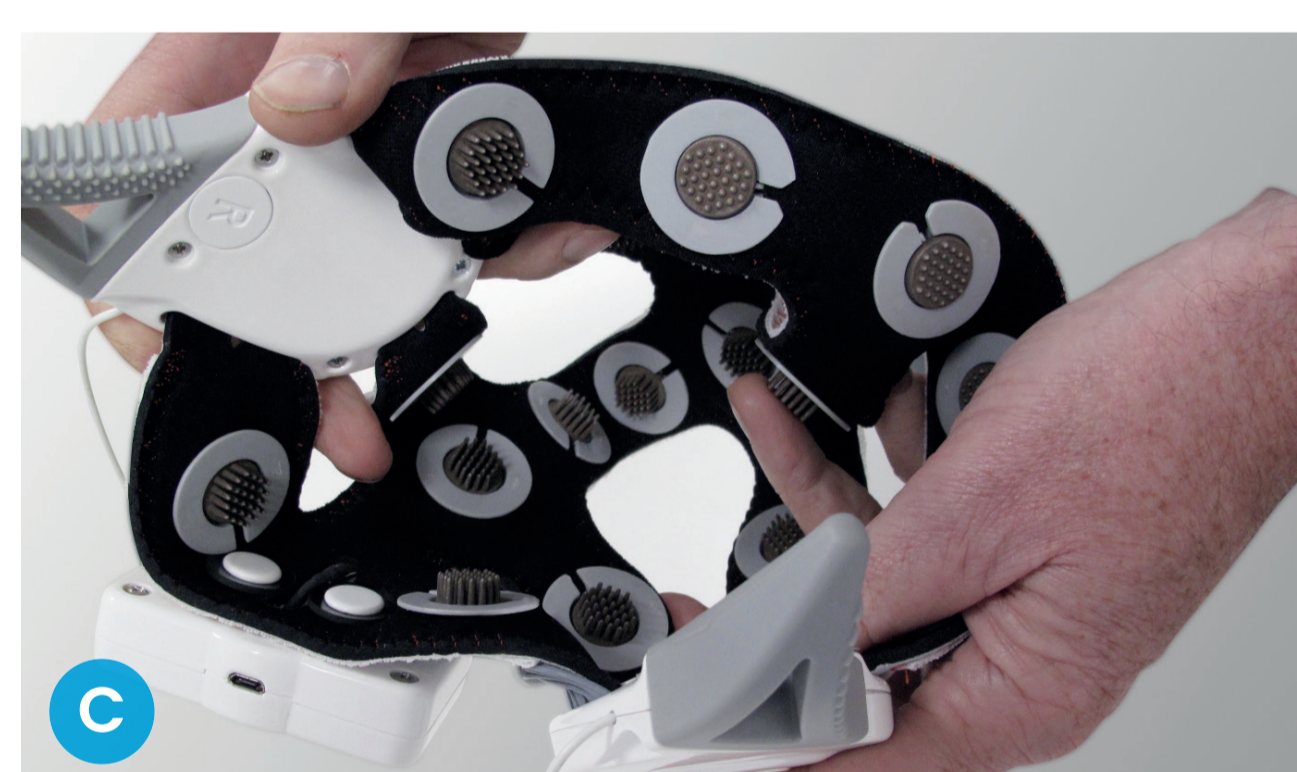
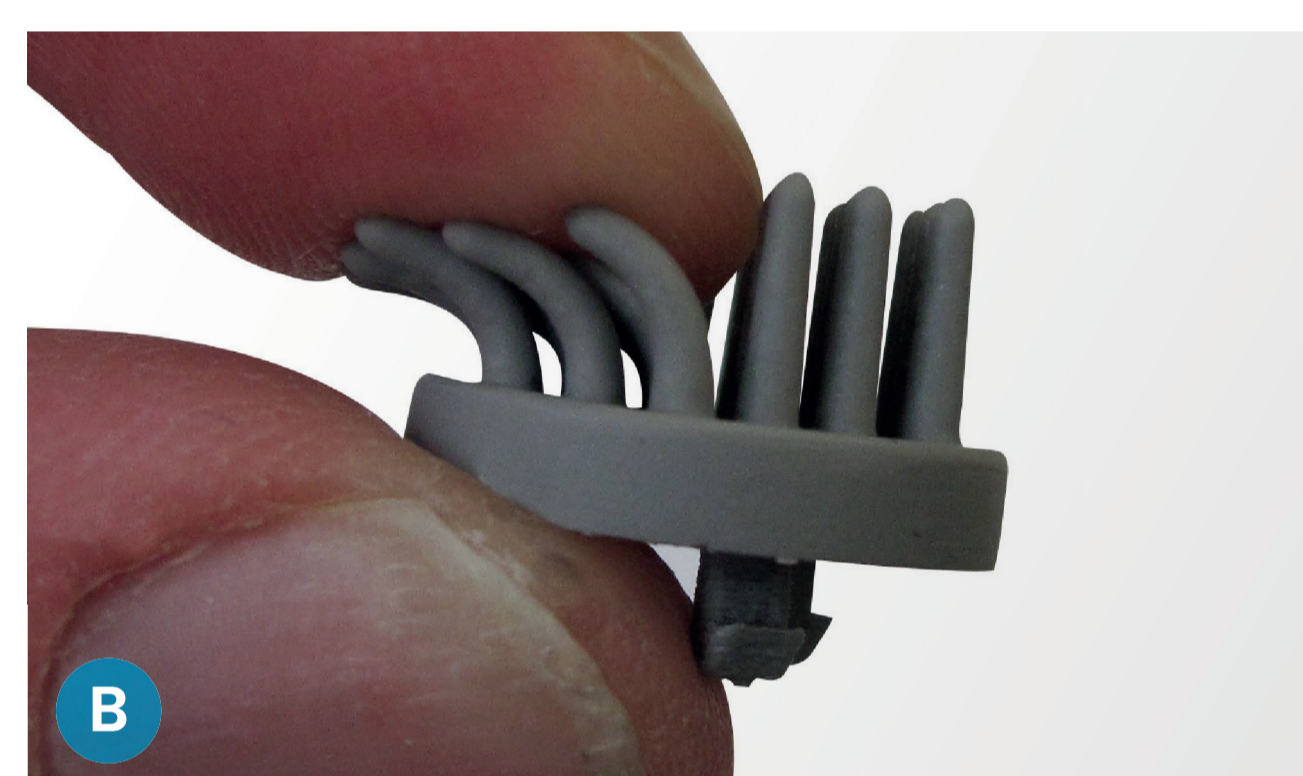
- Recent advances in sensor development, signal processing, and cloud-based technologies have led to the creation of wireless, dry EEG recording systems (1)
- Gamification of laboratory cognitive paradigms – adding game-like features (points, graphics, levels, storyline, etc.) – reduce attrition and increase participant engagement over extended periods (2, 3)
- These technologies combined allows the repeated collection of task-driven EEG data by research participants themselves over days, weeks, or months (4)
- The quality of remote self-administered gamified EEG needs to be investigated.

Method

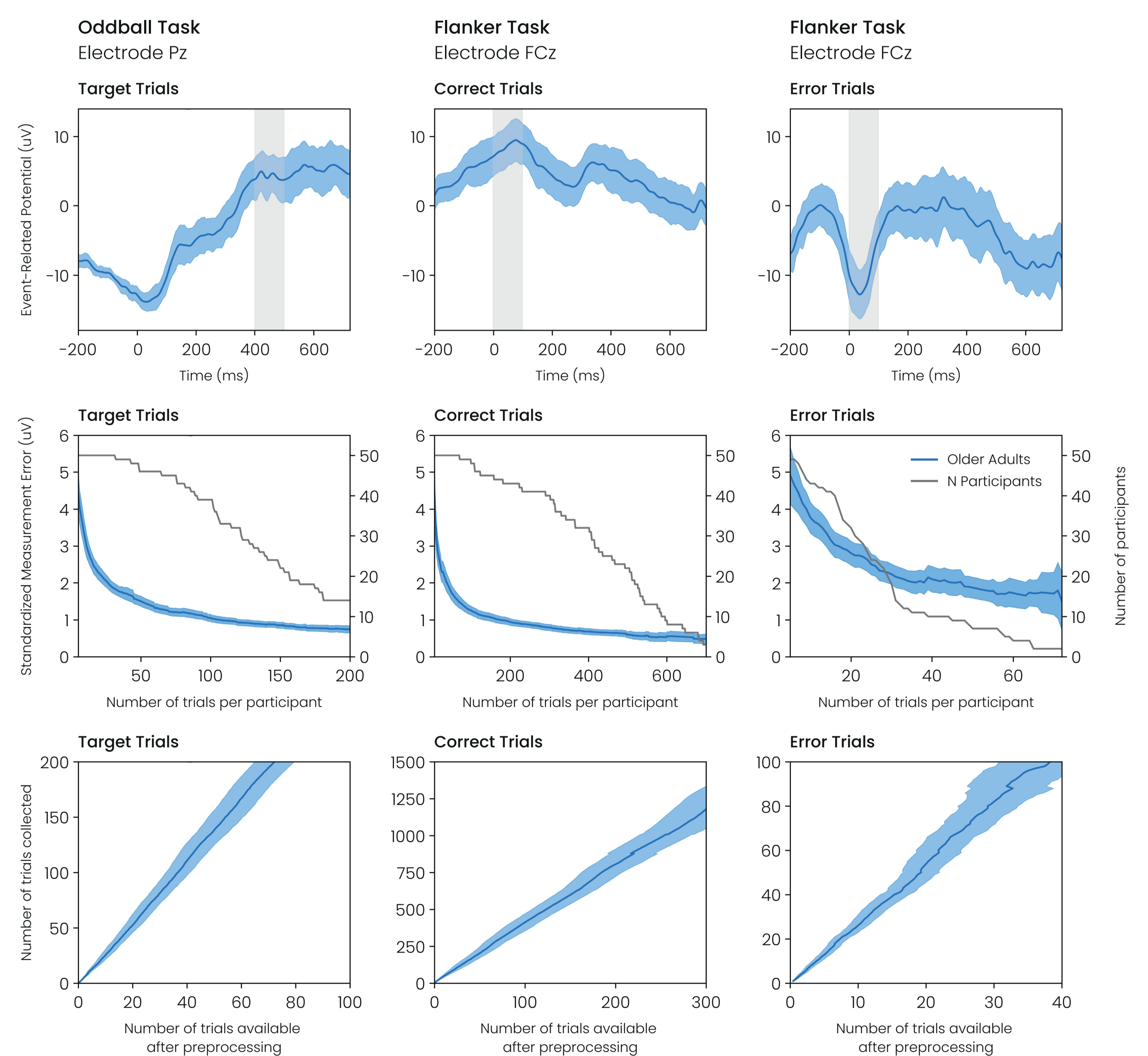
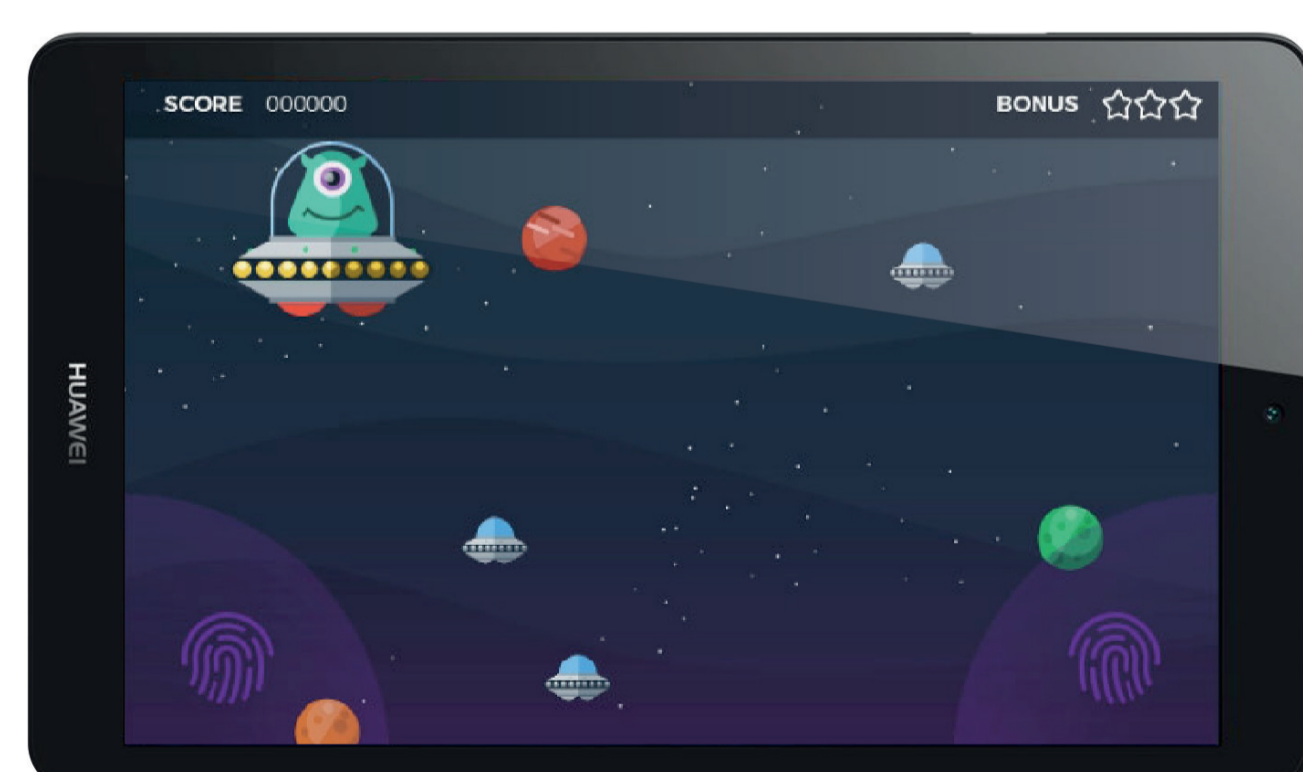
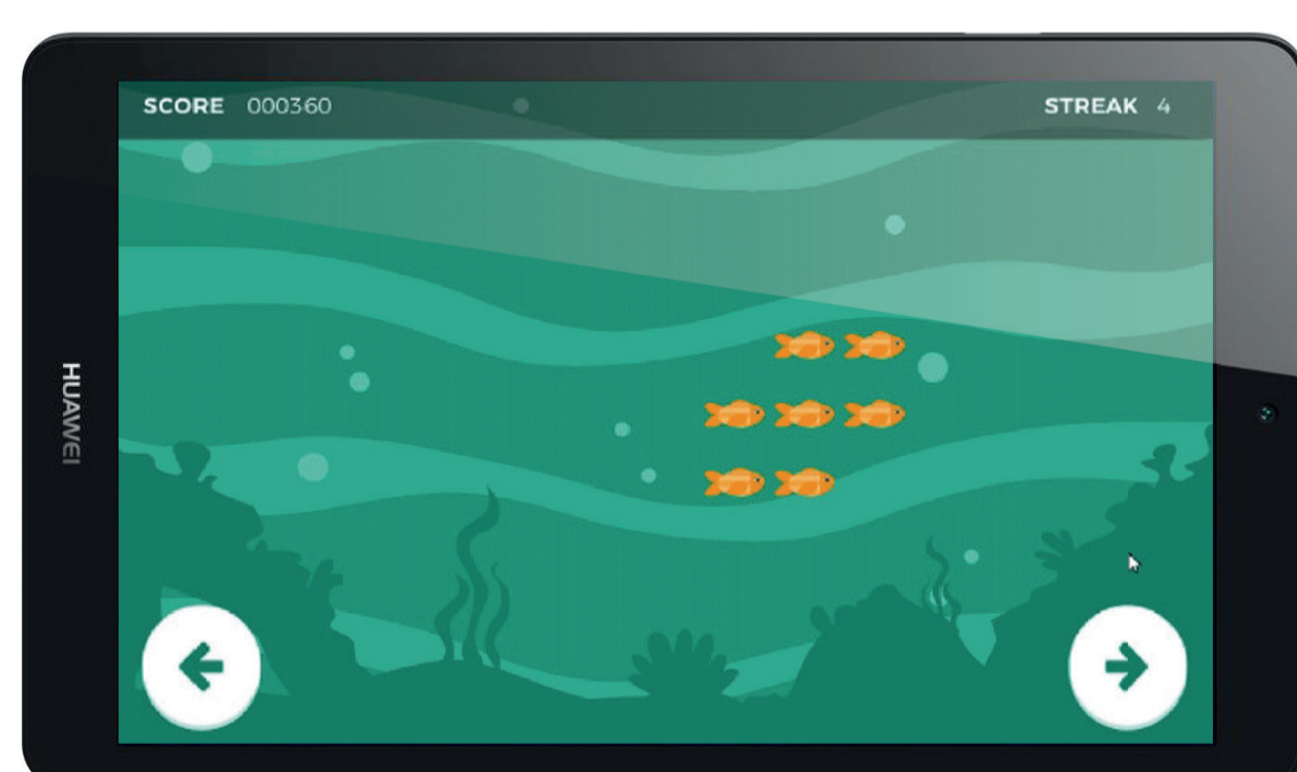
- 50 healthy older adults (55+ years; 25 female) completed 6 weeks of self-administered dry EEG at-home recordings (5 days/week)
- Gamified visual Oddball and Flanker tasks
- Usability was evaluated via participant adherence, percentage of sessions successfully completed, and quantitative feedback using the System Usability Scale
- EEG signals were preprocessed with frequency domain filtering and automatic artefact removal methods. Low quality epochs were removed using a conservative correlational approach

- Signal variability was quantified by computing the Standardized Measurement Error (SME) (5) over repeated sessions and multiple trials. Event-related potentials (ERPs) from the Oddball task were extracted from stimulus locked Target trials at Pz. SMEs were calculated across the 400–500 ms time window. ERPs from the Flanker task were extracted from response locked Correct and Error trials at FCz. SMEs were calculated across the 0–100ms time window. The shaded areas correspond to the 95% confidence intervals.

Cumulus Headset



Flanker and Oddball Gamified Tasks



ERPs analyses

Top Row: Event-related potentials. Middle row: Standardized Measurement Errors per number of trials. The grey continuous lines correspond to the number of participants remaining in the SME calculation after trial rejection. Bottom Row: Mean numbers of trials available after preprocessing.

Results

- 1,499 EEG sessions were collected. On average, participants completed 28.9 sessions of 29 sessions requested (std=7.6)
- Older adults successfully completed 93% of the sessions attempted and reported a mean usability score of 84.5
- The SME can be seen to decrease with the inverse of the root mean square of numbers of trials
- The average SME for one Oddball session (extracted from Target trials) was of 2.50uV. For the Flanker task, average SME for one session were of 2.27uV and 3.98uV for Correct and Error trials, respectively.

Conclusions

Wireless EEG technology is a suitable tool for cognitive neuroscience investigations, and has the potential to provide objective, frequent and patient-centered tracking of biomarkers of functional neurophysiology. This approach has potential to facilitate large scale longitudinal studies of brain disorders that manifest on different time scales.

Bibliography

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