Performance Across Multiple Calibrations using the Brain-Computer Interface RSVP Keyboard™ in People with Severe Speech and Physical Impairments

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Background

- RSVP Keyboard™ is a brain-computer interface (BCI) designed to restore communication by spelling
- The event related-potential (ERP) detects user intent
- ERPs are sensitive to the vigilance state (drowsiness levels) of the user

Research Questions

1. Do novel stimuli reduce sleepiness and boredom?
2. Do novel stimuli improve performance of the BCI system?

Methods and Procedures

Screening: Each participant passed a cognitive, sensory, and attention screening

Research Visit: Weekly visits (approximately 2-3 hours) occurred in the participant's home

Tasks and Equipment (see left): Participant's completed five consecutive calibrations of the RSVP Keyboard™ and self-rated measures of sleepiness and drowsiness. Each calibration was 100 trials.

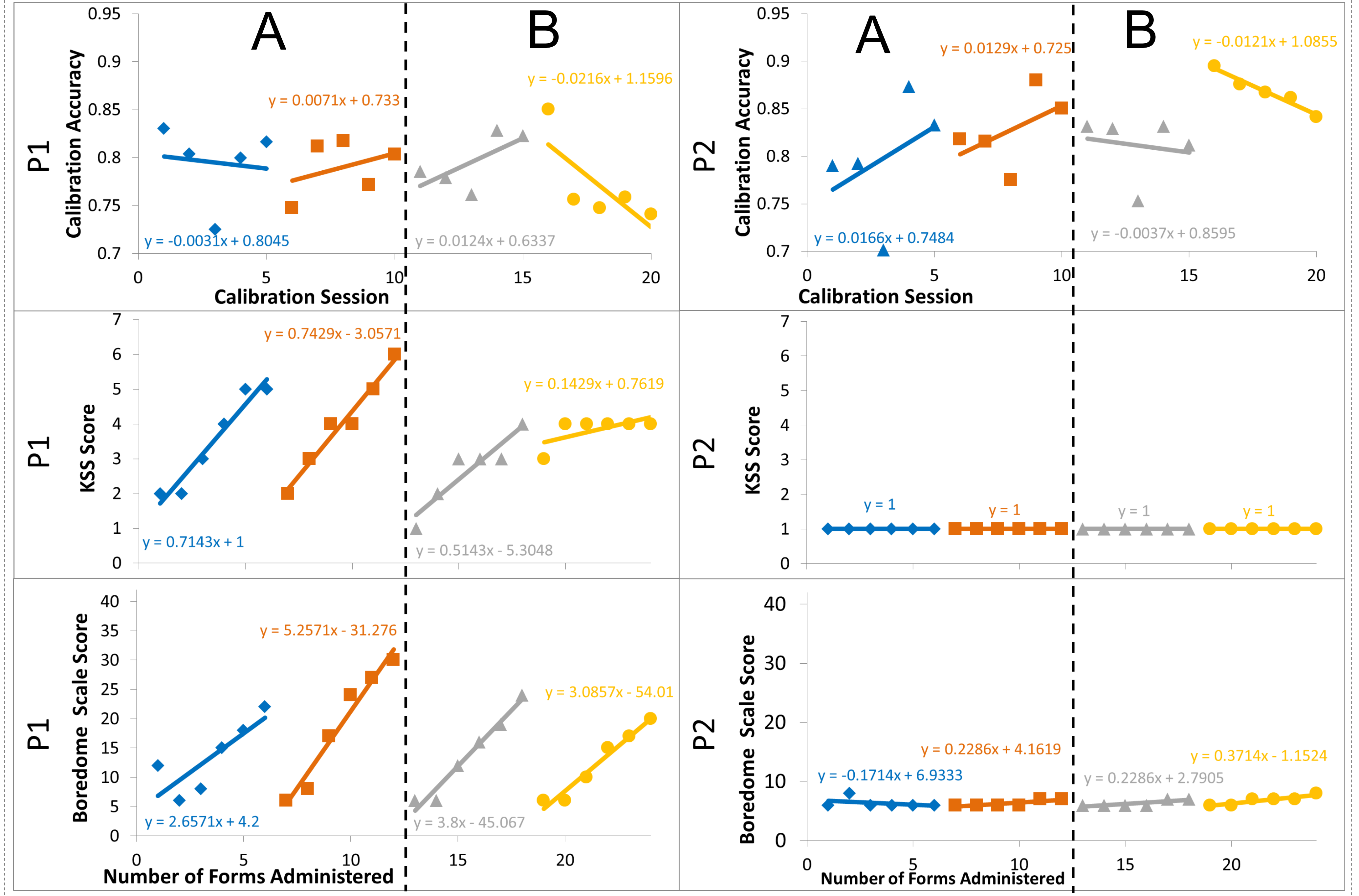**Design**: ABAB-withdrawal single-subject design

F + NTRKSPFLEA

A = Normal Calibration

Normal calibration occurred without tones

🔊 = VVWOOOOOP!! NEEEEYUUUU!!

B = Alert Tone Calibration

Alert tones included 5 different sounds, ~1 second long, which we presented along with target letters in 50% of trials.

Results

P1 — Calibration Accuracy vs Calibration Session
- A: $y = -0.0031x + 0.8045$; $y = 0.0071x + 0.733$
- B: $y = 0.0124x + 0.6337$; $y = -0.0216x + 1.1596$

P2 — Calibration Accuracy vs Calibration Session
- A: $y = 0.0166x + 0.7484$; $y = 0.0129x + 0.725$
- B: $y = -0.0037x + 0.8595$; $y = -0.0121x + 1.0855$

P1 — KSS Score
- $y = 0.7143x + 1$; $y = 0.7429x - 3.0571$
- $y = 0.5143x - 5.3048$; $y = 0.1429x + 0.7619$

P2 — KSS Score
- $y = 1$; $y = 1$; $y = 1$; $y = 1$

P1 — Boredome Scale Score vs Number of Forms Administered
- $y = 2.6571x + 4.2$; $y = 5.2571x - 31.276$
- $y = 3.8x - 45.067$; $y = 3.0857x - 54.01$

P2 — Boredome Scale Score vs Number of Forms Administered
- $y = -0.1714x + 6.9333$; $y = 0.2286x + 4.1619$
- $y = 0.2286x + 2.7905$; $y = 0.3714x - 1.1524$

Conclusions

- Participants did not demonstrate lower calibration accuracy scores across multiple calibrations.
- Participants did not self-report increased sleepiness or boredom.
- Auditory alert tones did not improve calibration performance in two adults with SSPI.
- Single day performance was comparable to individual level data in a previous experiment.
- Further research is necessary with adults with severe speech and physical impairments who demonstrate declines in performance at baseline.

Acknowledgements