

A stylized, semi-transparent logo of a bird's head, likely a cardinal, in shades of red and yellow, positioned in the background. The bird's head is facing right, with a prominent yellow beak and a red body. The logo is rendered in a flat, graphic style with thick outlines.

A Collaborative Brain-Computer Interface (BCI)

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Outlines

- Introduction
- Methods
- Results
- Discussion
- Conclusions

Introduction

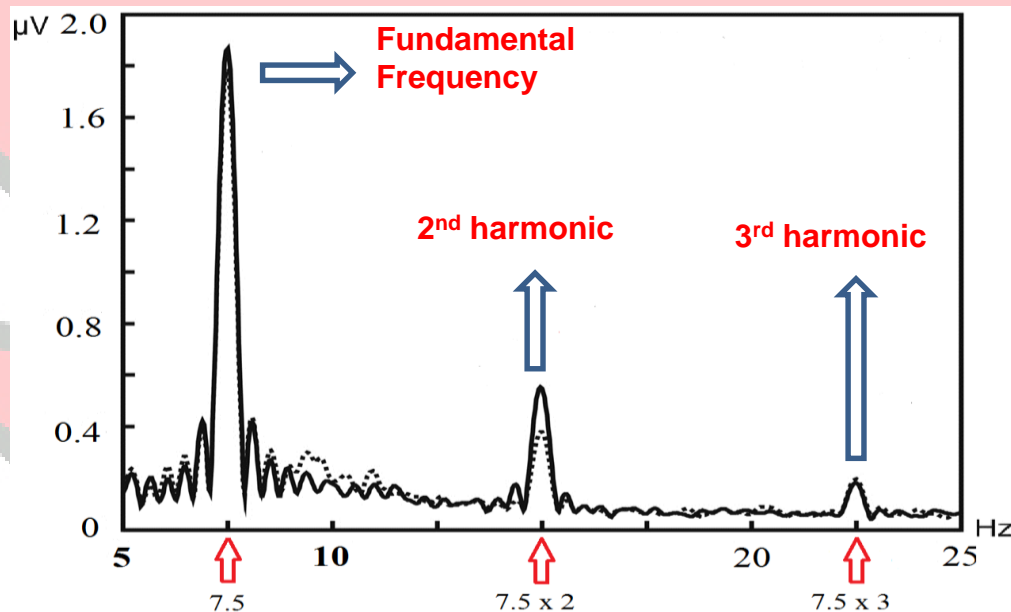


- What is BCI?

- BCI is a new system that allows users to communicate with the external world or control external equipment **without using normal pathways of peripheral nerves and muscles** (Wolpaw et al., 2002)
- It is an alternative communication medium for people with severe motor disabilities and for able-bodied people (Wolpaw et al., 2000).
- SSVEP: Steady-state visual evoked potential
- Advantage of SSVEP
 - ✓ No initial training is needed
 - ✓ SSVEP-based BCI offers higher ITR

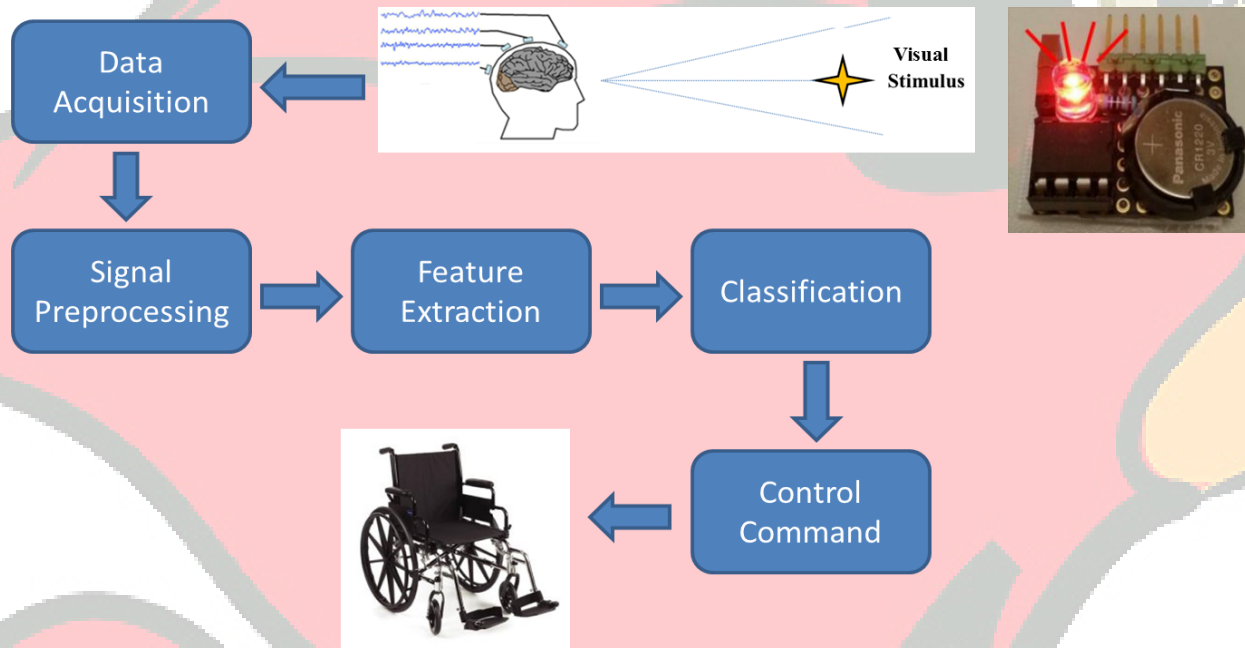
Introduction

- Example of SSVEP?
 - SSVEP evoked by a visual stimulus of 7.5 Hz with 2nd and 3rd harmonics



Introduction

- SSVEP-Based BCI



- Research Goal

- To evaluate effect of collaboration mode and motor disability on task performance

Method

- Participants
 - 10 ALS patients, 10 age-matched able-bodied participants
- Apparatus
 - Amplifier, EEG cap, LED lights, Robots



Method



- Independent Variables

- Collaboration Mode
 - ✓ Individual vs. simultaneous
- Motor Disability
 - ✓ ALS group vs. able-bodied group

- Dependent Variables

- Accuracy (%)
- Information Transfer Rate (bits/min)
- Completion Time (Sec)

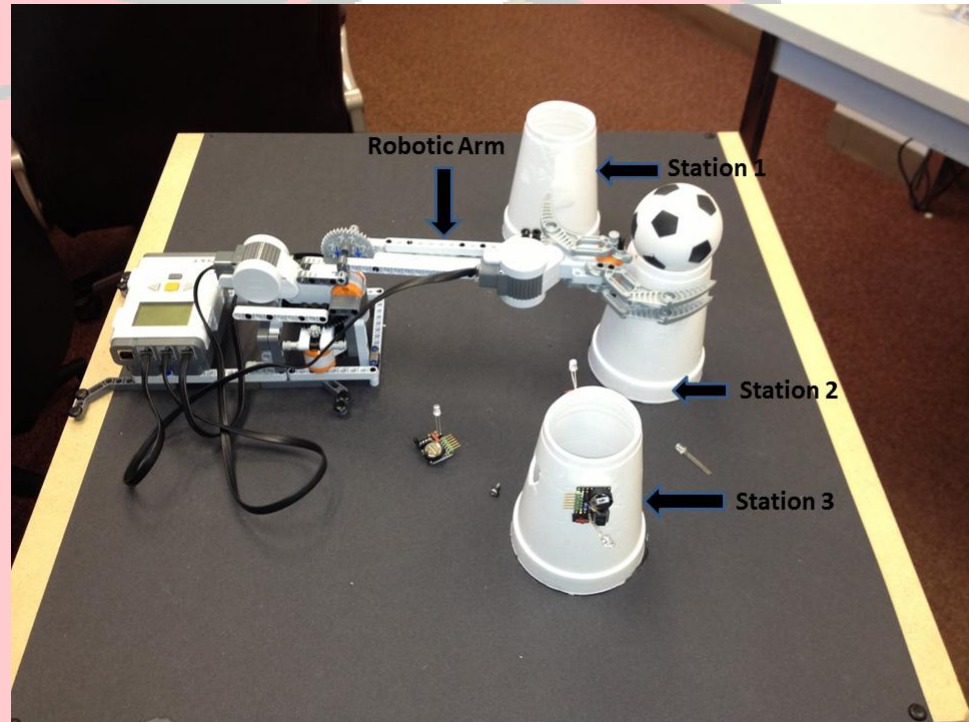
Method

- Experimental Task

- Perform the sequence of movement:

G → St3 → R → G → St1 → R

- Grab at Station 2
- Move to Station 3
- Release at Station 3
- Grab at Station 3
- Move to Station 1
- Release at Station 1



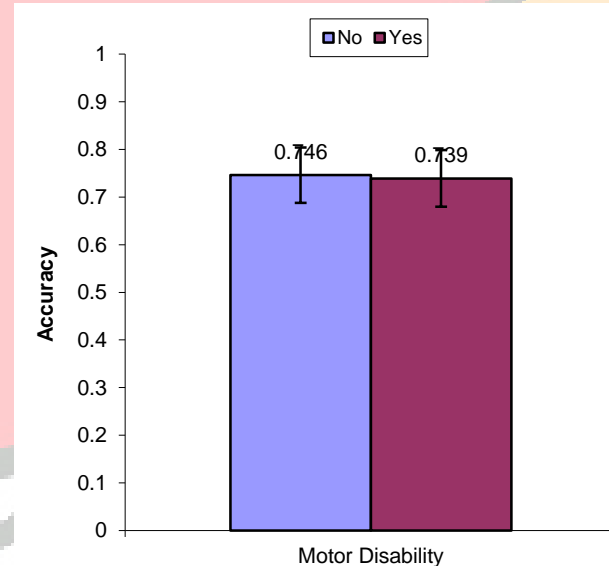
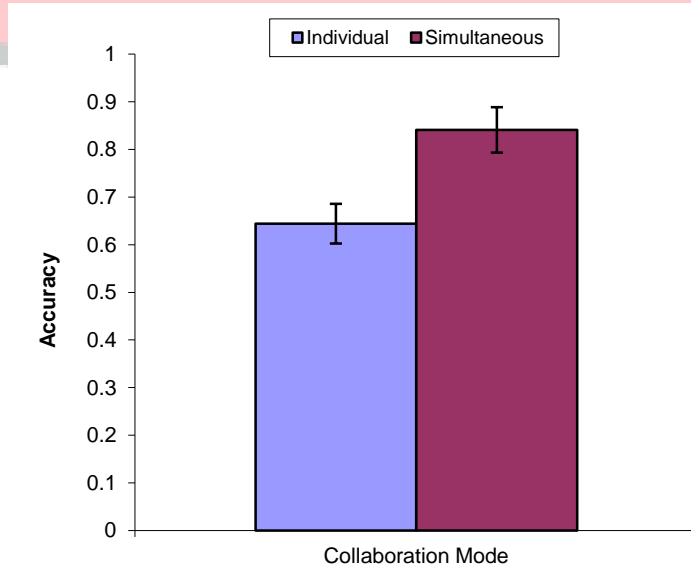
- Balanced 2 X 2 mixed design

- 4 trials with 2 trials in each condition

Results

➤ Accuracy (%)

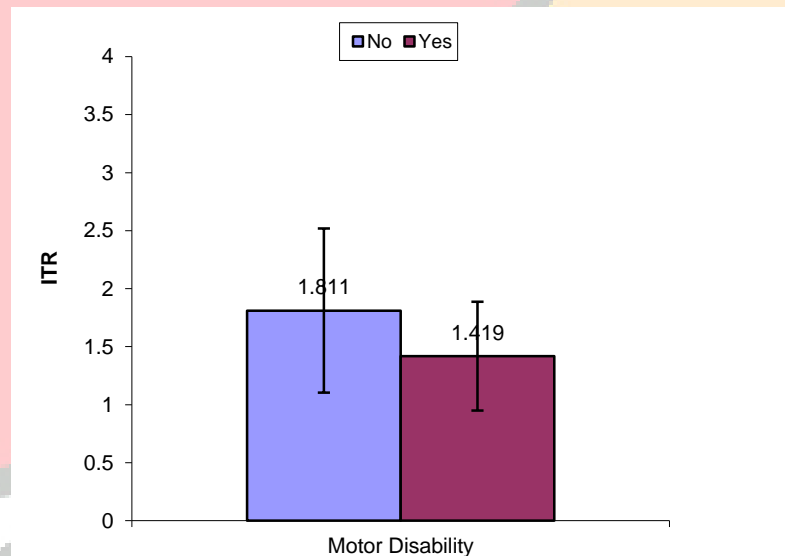
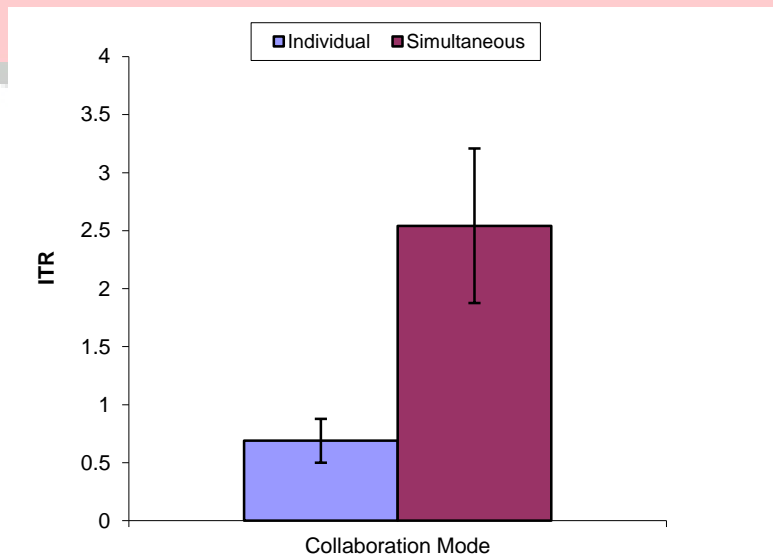
- ❖ Significant effect of collaboration mode ($F_{1,8} = 51.12, p < 0.0001$)
- ❖ Individual ($M=0.644$) < Simultaneous ($M=0.841$)
- ❖ No main effect of motor disability ($F_{1,8} = 0.03, p = 0.8680$)



Results

➤ ITR (bits/min)

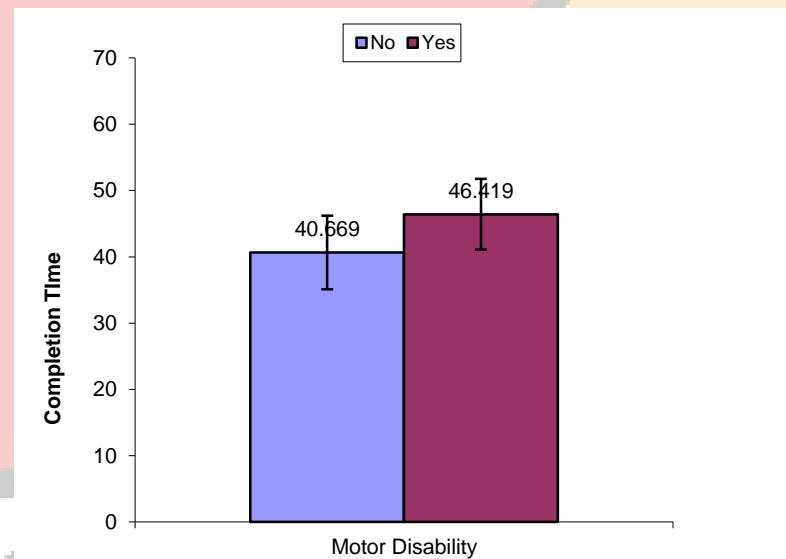
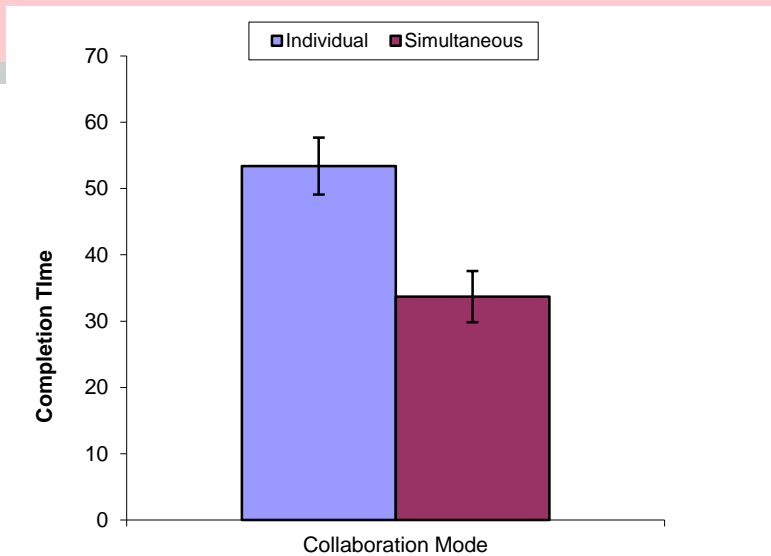
- ❖ Significant effect of collaboration mode ($F_{1,8} = 42.59, p = 0.0002$)
- ❖ Individual ($M=0.69$) < Simultaneous ($M=2.54$)
- ❖ No main effect of motor disability ($F_{1,8} = 1.13, p = 0.3180$)



Results

➤ Completion Time (Sec)

- ❖ Significant effect of collaboration mode ($F_{1,8} = 77.66, p < 0.0001$)
- ❖ Individual ($M=53.4$) > Simultaneous ($M=33.7$)
- ❖ No main effect of motor disability ($F_{1,8} = 2.08, p = 0.1868$)



Discussion



- Effect of Collaboration Mode
 - Significant effect on task performance (completion time, accuracy and ITR): → **Significantly better performance in simultaneous mode than individual mode**
 - The result confirms previous research (Wang & Jung, 2011; Eckstein et al., 2012).
 - Simultaneous mode is more efficient because of the error cancellation property of team work (Baron, Kerr, & Miller, 2012; Brown, 2000).
 - The presence of teammates elevated individual performance (Aiello & Douthitt, 2001).

Discussion



- **Effect of Motor Disability**
 - No significant effect on task performance.
 - Different from Li et al. (2011) and Li et al. (2014), Sellers & Donchin (2006). Same as Volosyak et al. (2009) on ITR.
 - It showed that ALS patients can use BCI as efficient as able-bodied people.
 - Impact of fatigue may appear if task is much more complex.
 - However, the layout of the visual stimuli should be further investigated for ALS patients when there are more visual stimuli.

Conclusions



- Both groups can finish the robot control task within time limit with satisfactory accuracy.
- Collaborative modes were more efficient than individual mode.
- Pioneered the design and evaluation of collaborative BCI.
- Demonstrated that people with motor disabilities could use collaborative BCI as efficient as able-bodied people,
- It proves the potential of BCI to help those with severe motor disabilities.



Thank you!