THE P300 AS A TYPING TOOL: TESTS OF BRAIN COMPUTER INTERFACE WITH AN ALS PATIENT

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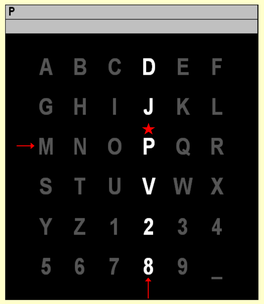
INTRODUCTION

The Display

- Matrix of 6 by 6 characters
- Every 125ms a row or a column are intensified ("flashed") for 100ms
- The 6 rows and 6 columns are flashed at random
- Subject focuses attention on one cell (P)

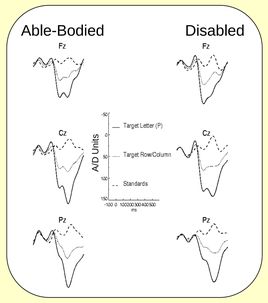


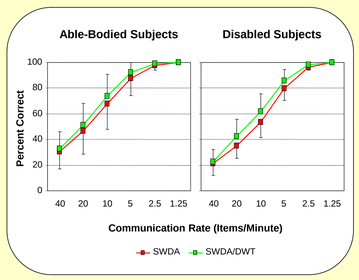
The Concept

•The flashes constitute an oddball sequence
•The row and the column containing the target character are the "rare category" and should elicit a P300
•Thus – by detecting which row and column elicited a P300 the program can identify the "typed" letter.

Previous Results

- Donchin et al. (2000) tested the system with wheelchair bound healthy adults and able-bodied adults
•Note that the targets indeed elicited a P300
•The challenge: reduce the number of trials needed for detection.





Off-line performance was approximately 80% at a rate of 8 characters per minute

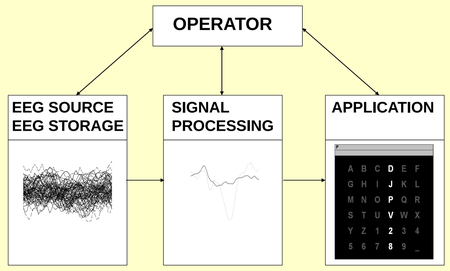
- On-line performance was 56% with column or row correct 92% of the time

CURRENT STUDY

- Summary of past studies
  - •P300 BCI was shown to perform well in young, able bodied, adults
  - •Communication rates achieved were between 5 and 8 char/min
  - •Need to test system with locked in patients
  - •Questions
    - •Is P300 elicited by oddballs in locked in patients?
    - •Can they perform the speller task?
    - •Will the target row and target column elicit P300?
    - •What are the communication rates for these patients?
- Will the P300 BCI work with ALS patients?
  - Three ALS patients were tested
  - (P1) A locked-in 70-year-old male ALS patient
  - Two mobile ALS patients
    - (P2) a 37-year-old male
    - (P3) a 44-year-old male
  - One able-bodied control subject is also presented for comparison (AB)

BCI2000 – Developed by the BCI Group at the Wadsworth Center, NYSDOH, Albany, NY

- Versatile BCI platform capable of functioning with different brain signals, e.g., sensorimotor rhythms, slow cortical potentials, and event-related potentials
- Composed of four modules that are independently executable programs.

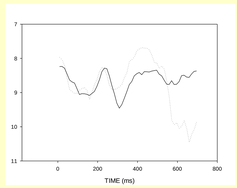


- **OPERATOR**
  Interface between human operator and the system
  Manipulate parameters, display, application, and data
- **EEG SOURCE**
  Acquires and stores data
  Passes specific data to signal processing
- **SIGNAL PROCESSING**
  Filtering/averaging/cascading operations passed to application module
- **APPLICATION**
  Controls the users task and display

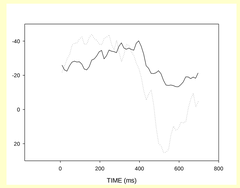
BCI2000 is available free of charge for research and educational purposes:
http://www.bci2000.org

X / O Visual Oddball Paradigm
200 trials – 20% "X" – ISI 1500 ms

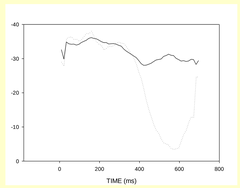
P1 (Cz)



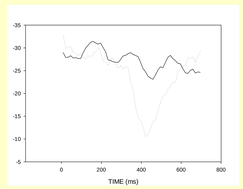
P2 (Pz)



P3 (Pz)

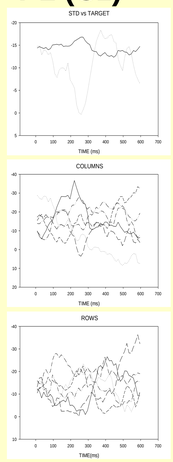


AB (Cz)

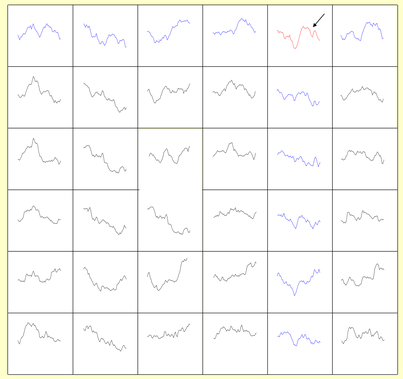


SPELLER DATA (100ms flash/500ms ISI)

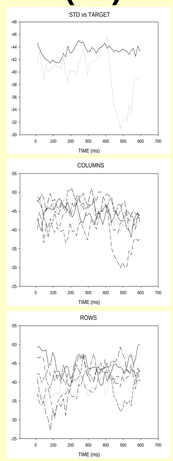
P1 (Cz)

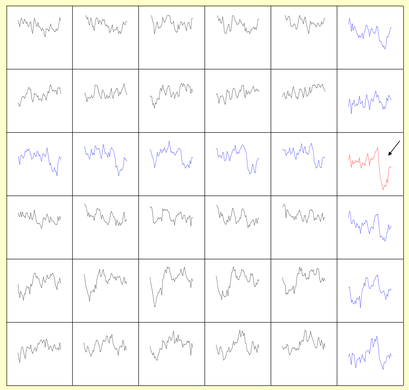


ERPs for each cell of the 6x6 matrix
Red=attended cell Blue=attended row/column
Black=unattended

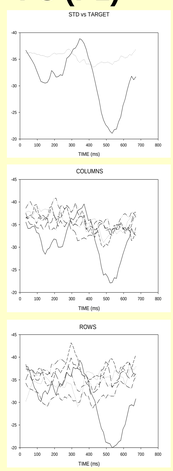


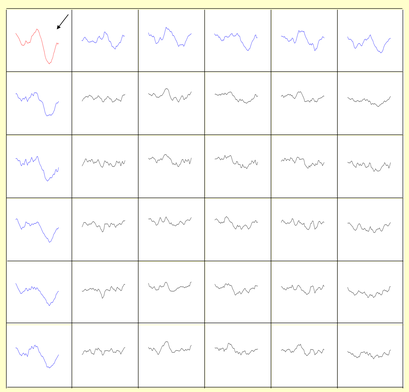
P2 (Cz)





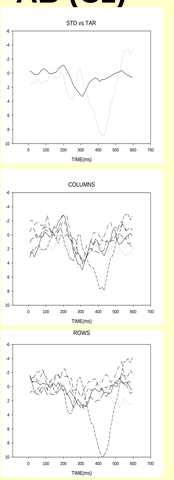
P3 (Pz)

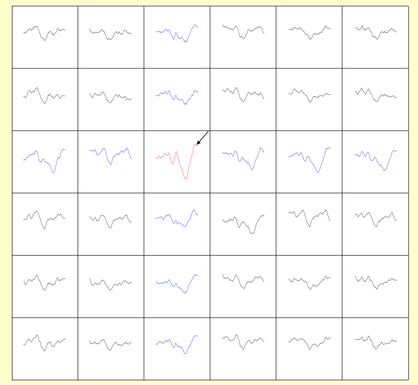




SPELLER DATA – Cont.

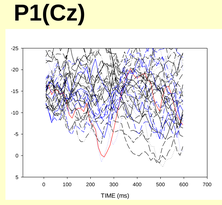
AB (Cz)



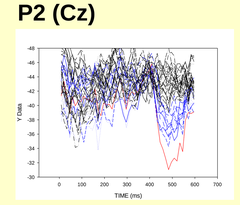


36 Cell Overlay for Each Subject

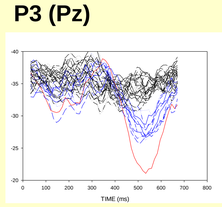
P1(Cz)



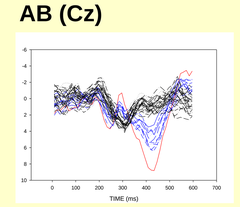
P2 (Cz)



P3 (Pz)



AB (Cz)



CONCLUSIONS

- Even in a severely paralyzed ALS patient it is possible to record P300 in response to odd ball stimuli.
- The data from ALS patients in early stages of the disease are similar to the data obtained from able bodied subjects.
- The environment of a paralyzed ALS patients presents challenges to the recording due to the presence of a respirator and other electrical devices. These technical challenges can be overcome.
- It may be necessary to shift from a 6 by 6 matrix to a 2 by 2 matrix with a fully paralyzed subject due to difficulties in maintaining focus of attention on the characters.
- In general, the system appears to have a potential for serving the needs of the locked in patient.
- We are beginning to examine in detail the effectiveness of different detection algorithms in providing increased communication speed.

References

Donchin, E., Spencer, K.M., & Wijesinghe, R. (2000). The mental prosthesis: Assessing the speed of a P300-based brain-computer interface. *IEEE Transactions on Rehabilitation Engineering*, *8*, 174-179.

Farwell, L. A., & Donchin, E. (1988). Talking off the top of your head: Toward a mental prosthesis utilizing event-related brain potentials. *Electroencephalography & Clinical Neurophysiology*, *70*, 510-523.

See also Proceedings of 2nd International Conference on brain-computer interfaces: *IEEE Transactions on Rehabilitation Engineering, Vol 8*(2), June 2000.