

# P300-based brain-computer interface (BCI) performance: effects of matrix size and presentation rate

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## Introduction

### A Brain-Computer Interface (BCI):

Records electrical activity from the brain and use the signals to convey intent

Does not use peripheral nerves or muscles

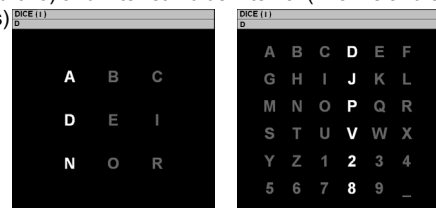
### P300 BCI:

Rows and columns of the matrix randomly intensify

The attended item elicits a P300, and the system operates by detecting which cell elicited the response (Farwell & Donchin, 1988)

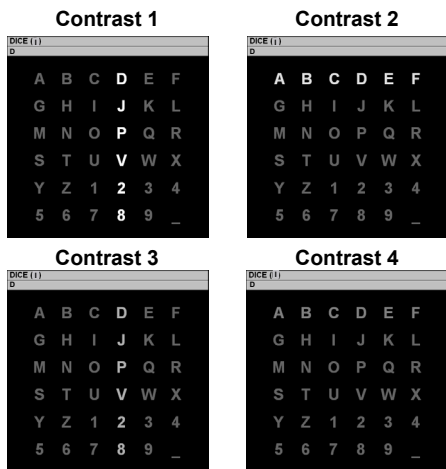
### Study 1:

Examines the stimulus properties of matrix size (3x3 and 6x6) and inter-stimulus interval (175 ms and 350 ms)



### Study 2:

Examines 4 intensification contrast values



### Classification method:

Step-Wise Discriminant Analysis (Draper & Smith, 1981)

### Pre-processing parameters:

Decimation and moving average  
 Study 1 = 4 or 16: Study 2 = 12

### Reference:

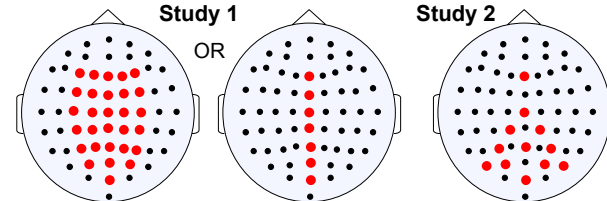
Common average or earlobe – Study 1  
 earlobe only – Study 2

### Channel set:

Study 1

OR

Study 2



## General Methodology

Each user completed 5 experimental sessions of 36 characters

Each of the 36 characters intensified 30 times (15 column and 15 row intensifications)

Online feedback provided in sessions 2 – 5

## Study 1

Design: 4 Conditions

Matrix ISI Num of Sequences

3x3	175	40
3x3	350	20
6x6	175	20
6x6	350	10

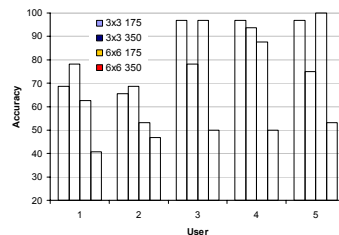
- Each character attended for 42 s

### Hypotheses:

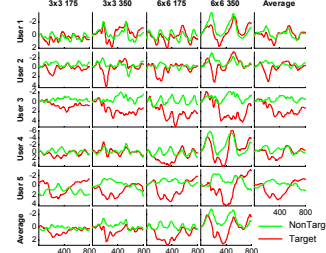
- Adjustable matrix size will allow for a more flexible BCI
- Optimal presentation rate may be user specific

## Results

### Classification



### Pz Waveforms



## Discussion

Accuracy higher in 3x3 matrix condition

Changing matrix size should not compromise BCI performance

Accuracy higher in 175 ms ISI condition

Shorter ISI provides faster communication

## Study 2

Design:

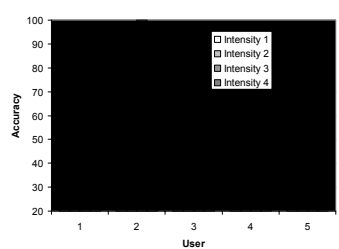
- 4 intensification contrast values
- 6x6 matrix 175 ms ISI
- Counter-balanced presentation order
- Each character attended for 31.5 s
- 15 Sequences

### Hypotheses:

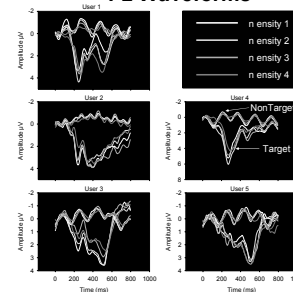
- May allow prolonged use by reducing fatigue
- May allow for less distracting stand-by mode
- Optimal intensification contrast may be user-specific

## Results

### Classification



### Pz Waveforms



## Discussion

Low contrast stimuli produce accuracy levels similar to high contrast stimuli

Users report less fatigue in reduced contrast conditions

Individual differences should be considered to optimize performance

**Conclusions** • Various matrix size/ISI combinations and multiple intensification contrast conditions produce high accuracy levels • To meet the user's individual needs, matrix size, ISI, and contrast should be considered, and optimized • The current results suggest a P300-based BCI can operate with multiple menu sizes and at low intensities • Accuracy is stable across five sessions

### Acknowledgements

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