

How Many People are Able to Control a P300-Based Brain-Computer Interface (BCI)?

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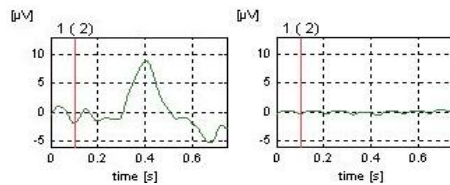
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BRAIN COMPUTER INTERFACE



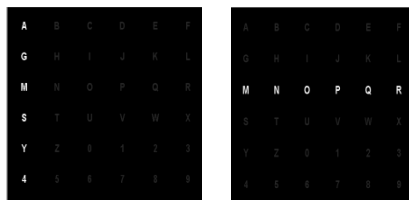
P300 based BCI systems are optimal for spelling characters with high speed and accuracy, as compared to other BCI paradigms such as motor imagery.

PHYSIOLOGICAL BACKGROUND



Specific symbols are presented on a computer monitor. The symbols are highlighted in a random order and the subject has the task to concentrate on a specific symbol. Whenever this specific symbol is highlighted, the P300 component is produced in the EEG data and can be analyzed.

ROW/COLUMN VERSUS SINGLE CHARACTER SPELLER

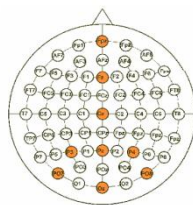


(i) the row/column speller (RC) flashes an entire column or row of characters

(ii) a single character speller (SC) flashes each character individually.

EXPERIMENTAL SETUP

100 subjects tested a P300 based BCI system to spell a 5 character word with only 5 minutes of training. EEG data were acquired while the subject looked at a 36 character matrix to spell the word WATER.



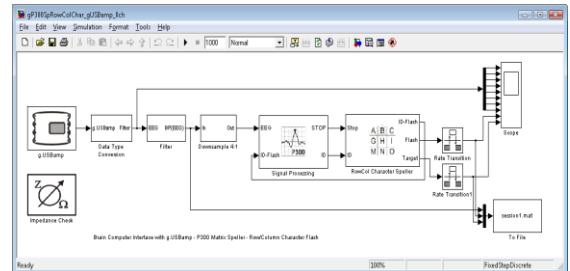
During the real-time phase of the experiment, the subjects spelled the word LUCAS, and were provided with the classifier selection accuracy after each of the five letters.

REFERENCES

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 Krusienski D., Sellers E., Cabestaing F., Bayouthe S., McFarland D., Vaughan M., Wolpaw J., "A comparison of classification techniques for the P300 Speller". Journal of Neural Engineering 2006;6:299-305.

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REAL-TIME MEASUREMENT



Simulink calculates the EP and performs LDA in real-time.

RESULTS

Classification Accuracy in %	Row-Column Speller: Percentage of Sessions (N=81)	Single Character Speller: Percentage in Sessions (N=38)
100	72.8	55.3
80-100	88.9	76.3
60-79	6.2	10.6
40-59	3.7	7.9
20-39	0.0	2.6
0-19	1.2	2.6
Average Accuracy of all subjects	91.0	82.0
Mean of subjects who participated in RC and SC (N=19)	85.3	77.9

- 72.8% (N=81) were able to spell with 100% accuracy in the RC paradigm and 55.3% (N=38) spelled with 100% accuracy in the SC paradigm.
- Less than 3% of the subjects did not spell any character correctly.
- Age, sex, education, working duration, and cigarette and coffee consumption were not statistically related to differences in accuracy.
- Disturbance of the flashing characters was rated as 1.5 on a scale from 1 to 5 (1- not disturbing, 5- highly disturbing).

DISCUSSION

- High spelling accuracy can be achieved with the P300 BCI system using approximately five minutes of training data for a large number of non-disabled subjects.
- RC paradigm is superior to the SC paradigm.
- 89 % of the 63 RC subjects were able to spell with accuracy 80% – 100%.

Classification Accuracy in %	RLS+BP Percentage of Sessions (N=99)
90-100	6.2
80-89	13.0
70-79	32.1
60-69	42.0
50-59	6.7

- A similar study using a motor imagery BCI with 99 subjects showed that only 19% of the subjects were able to achieve accuracy of 80% – 100%.