

Comparison Of Two Paradigms Based On Stimulation With Images In A Spelling Brain-Computer Interface

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Dr. Ricardo Ron Angevin gained his M.S. in Telecommunication Engineering and Ph.D. degrees from the University of Málaga, Spain, in 1994 and 2005, respectively. Since 1995, he has been lecturer at the Electronic Technology Department of the same university, where he is currently Associate Professor. He is a member of DIANA research group and manager of the UMA-BCI research group at the University of Málaga (www.umabci.uma.es). He has been the Principal Investigator of the Andalusian regional project BRAINS and the Spanish National project INCADI and LICOM. Currently is the Principal Investigator of the Spanish National project SICCAU. His research interests include the design of brain-computer interfaces and assistive technology.

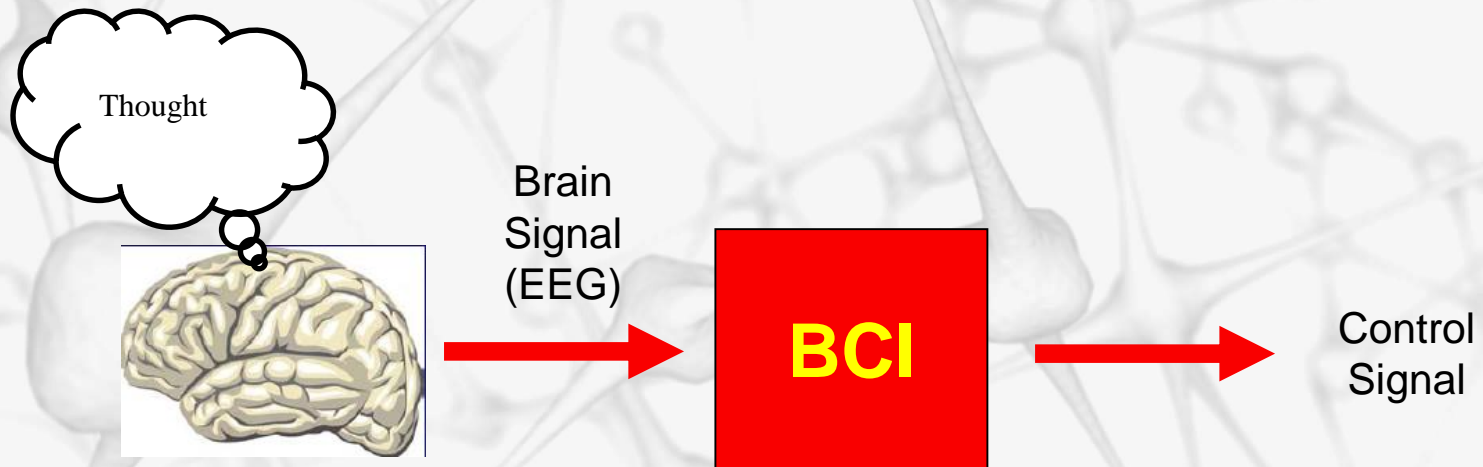


- Introduction
- Objective
- System description
- Experiments and Results
- Conclusions

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What is a BCI?

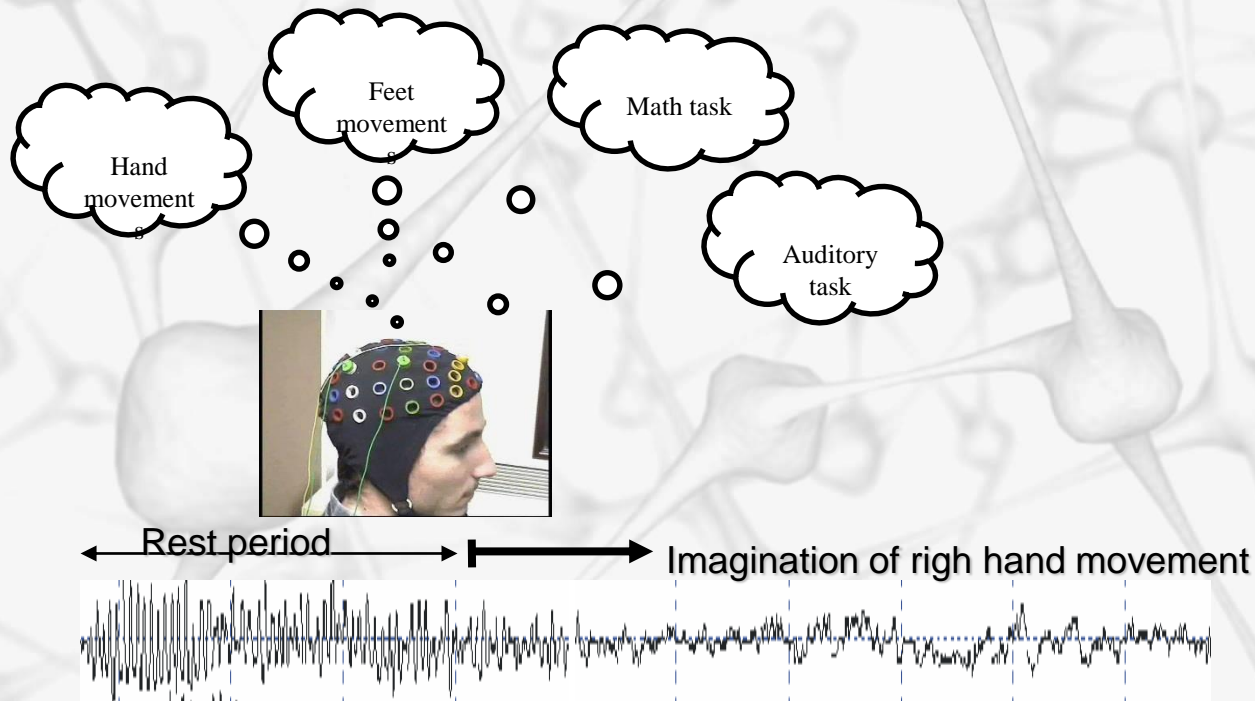
- *“A Brain-Computer Interface is a communication system that does not depend on the brain’s normal output pathways of peripheral nerves and muscles ”*



A BCI system translates brain activities into output commands without carrying out any movements.

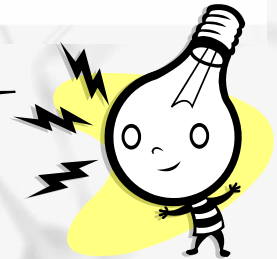
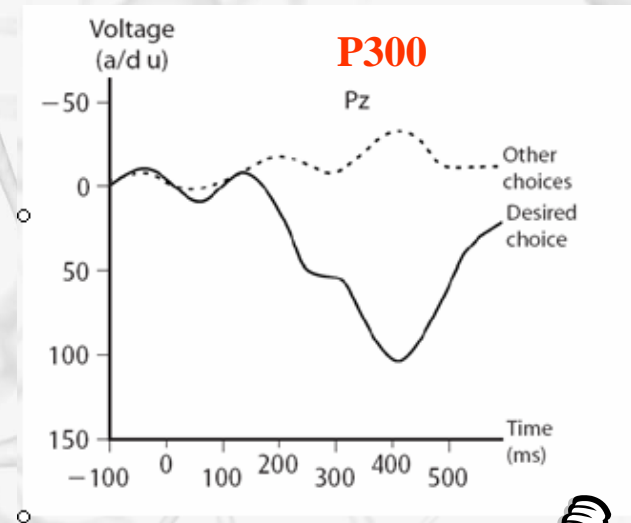
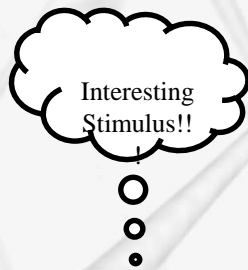
How does a BCI work?

- Different brain activities (thought) or external stimulus can produce changes in brain signals



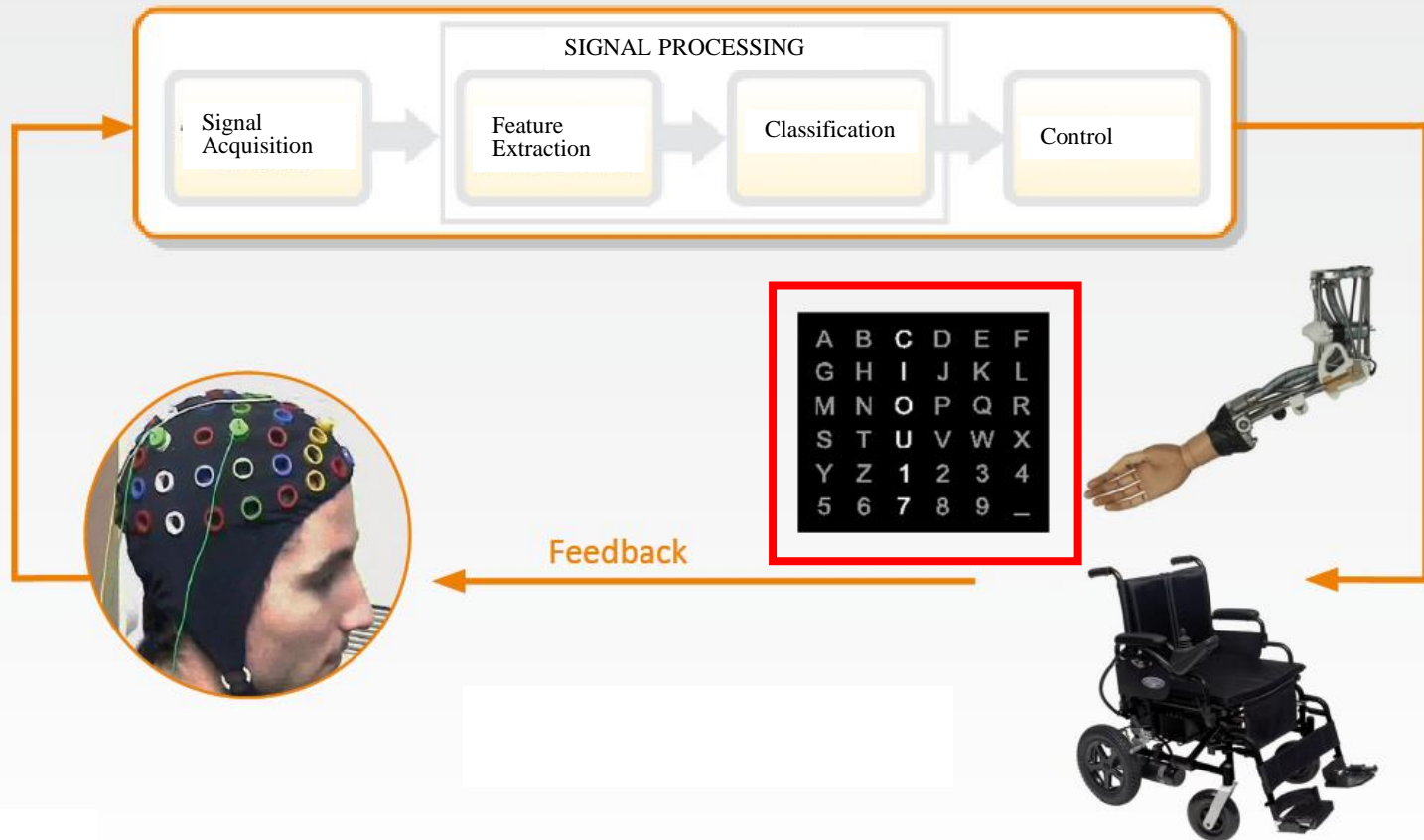
How does a BCI work?

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P300 amplitude depends on the stimulus interest for the subject

BCI SYSTEM



P300-Based BCI Speller

- Based on the **Row-Column Presentation (RCP)** paradigm

NICH0					
A	B	C	D	E	F
G	H	I	J	K	L
M	N	O	P	Q	R
S	T	U	V	W	X
Y	Z	1	2	3	4
5	6	7	8	9	—

- Each row and column **flash** (stimulus)
- Subject **count** the number of times a symbol flash
- For **each flash**, a **P300** is produced
- After **some flashes**, the P300 is detected and the **symbol detected**.
- Performance** depends on the **user's ability to gaze** the different symbols.

P300-Based BCI Speller

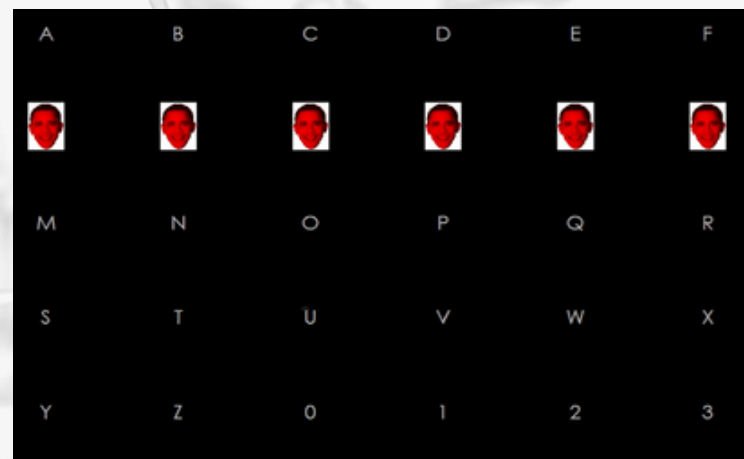
- To increase BCI performance, different stimulus presentation based on familiar faces have been proposed

Green familiar faces (2015)



Q. Li, S. Liu, J. Li, and O. Bai, "Use of a green familiar faces paradigm improves P300-speller brain-computer interface performance," PLoS One. 10, pp. 1–15, 2015.

Red familiar faces with white rectangle (2021)



X. Zhang, J. Jin, S. Li, X. Wang, and A. Cichocki, "Evaluation of color modulation in visual P300-speller using new stimulus patterns," Cognitive Neurodynamics, pp. 1–14, 2021.

P300-Based BCI Speller

- The use of images as flashing stimuli can also improve the performance of a BCI speller (UMA-BCI group-2019)



Advantages:

- Different images were used for each symbol of the matrix
- The use of different images allows to develop BCI speller based on pictograms or commands, increasing the options of communications and control

A. Fernández-Rodríguez, F. Velasco-Álvarez, M.T. Medina-Juliá, and R. Ron-Angevin, "Evaluation of emotional and neutral pictures as flashing stimuli using a P300 brain– computer interface speller," Journal of Neural Engineering, vol. 16, pp. 1-11, 2019.

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Objective

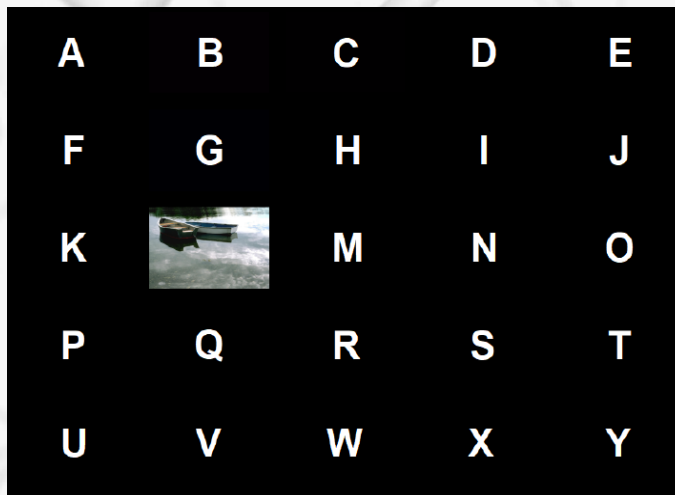
- Due to the **advantage of using different images** to stimulate the different symbols, the main **objective** of this preliminary study was **to study** if the **performance** of a BCI-P300 speller based on **pictures** stimulus presentation **was similar to those based on red famous face with a white rectangle**.

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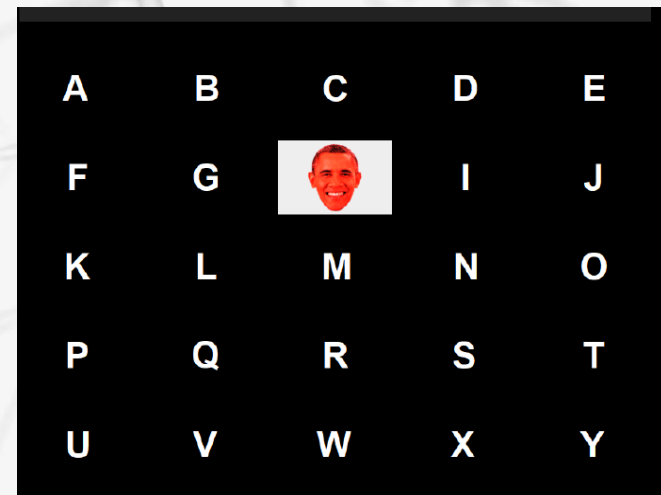
Developed System

- BCI system implemented through UMA-BCI Speller platform
- 5x5 matrix size → 25 symbols

Images



Red Familiar faces with white rectangle



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Experiments and results

- Experiment description
 - Participants: **4 healthy subjects (preliminary results)**
 - 1 session: to **test the 2 paradigms**
 - Electrodes positions: **P3, P4, PO8, Fz, Cz, Pz, PO7, Oz**
 - Each test consisted on:

1- Calibration phase

- **12 letters** (“FEUX”, “CHAT”, “PURE”)
- **Each “letter” was intensified 20 times: (30,4s)**

2- Copy spelling phase

- **16 letters** (“ABRI”, “LUNE”, “YOGA”, “CHEFF”)
- **The number of intensification depended** of the calibration accuracies
- **Criterium:** minimum number of trials to obtain 100% accuracy in the calibration phase

Experiments and results

- Results: Copy-spelling phase

Subject	Condition	N° flashes on-line	Accuracy (%)	ITR (bits/min)
S1	Faces	3	100	30,55
	Images	3	93,75	26,44
S2	Faces	3	100	30,55
	Images	4	100	22,91
S3	Faces	3	100	30,55
	Images	2	75	26,50
S4	Faces	3	75	17,67
	T2	3	100	30,55
Mean	Faces	3	93,75±6,25	27,33±3,21
	Images	3	92,18±5,91	26,6±1,56

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Conclusions

- Preliminary **results** very **promising**
- This study suggests that the use of **Images does not make worse the performance** compare to the one of the BCI-speller most effective proposed in the literatura: red familiar faces with rectangle.
- **The use of different images must be convenient to develop BCI speller based on pictograms or commands**, increasing the options of communications and control

Conclusions

Questions?



Thanks for your attention

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