Usability Study of Different Platforms to Develop Communication Systems Based on P300-Brain-Computer Interface (BCI)

SICCAU Project
http://umabci.uma.es/siccau

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Dr. Ricardo Ron Angevin gained his M.S. in Telecommunication Engineering and Ph.D. degrees from the University de 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.

Outline

- Introduction
- Objective
- Experimental design
- Results
- Conclusions

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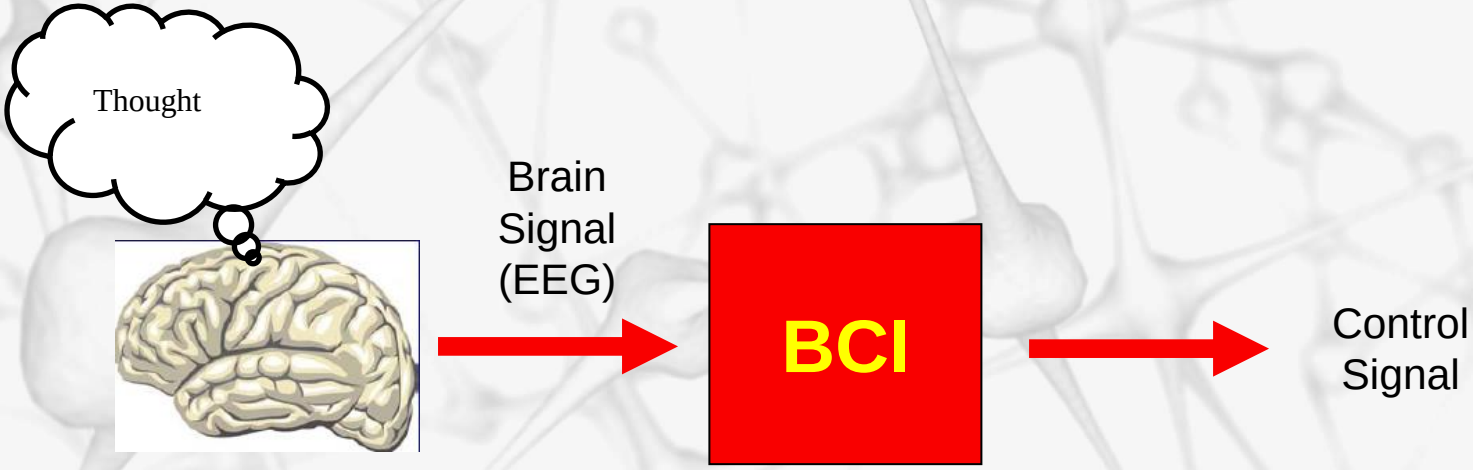
What is a BCI?

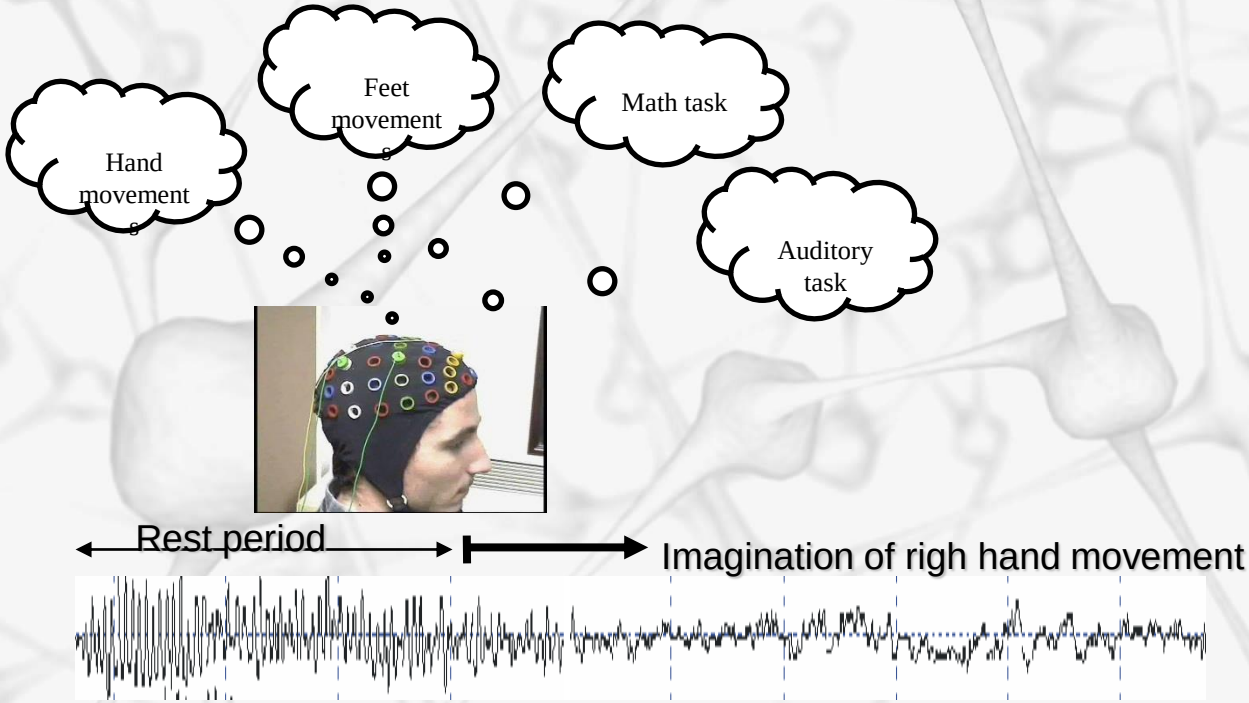
- *"A Brain-Computer Interface is a communication system that does not depend on the brain´s normal output pathways of peripheral nerves and muscles "*



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

How does a BCI work?

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



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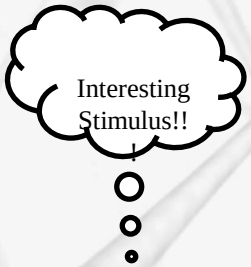
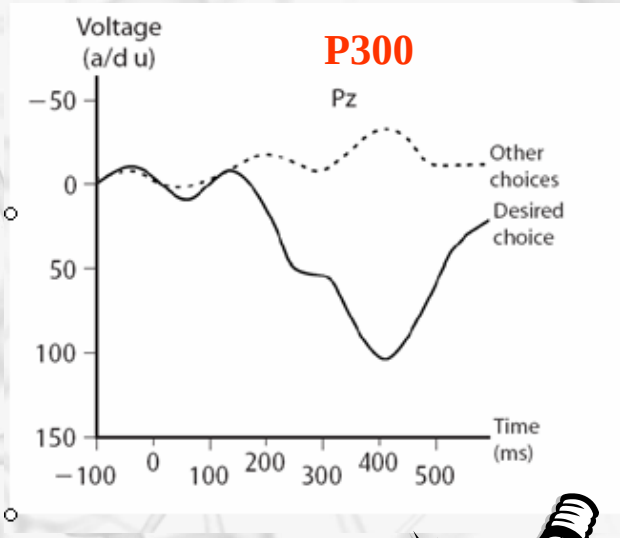
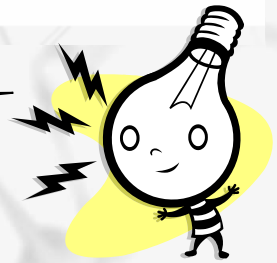
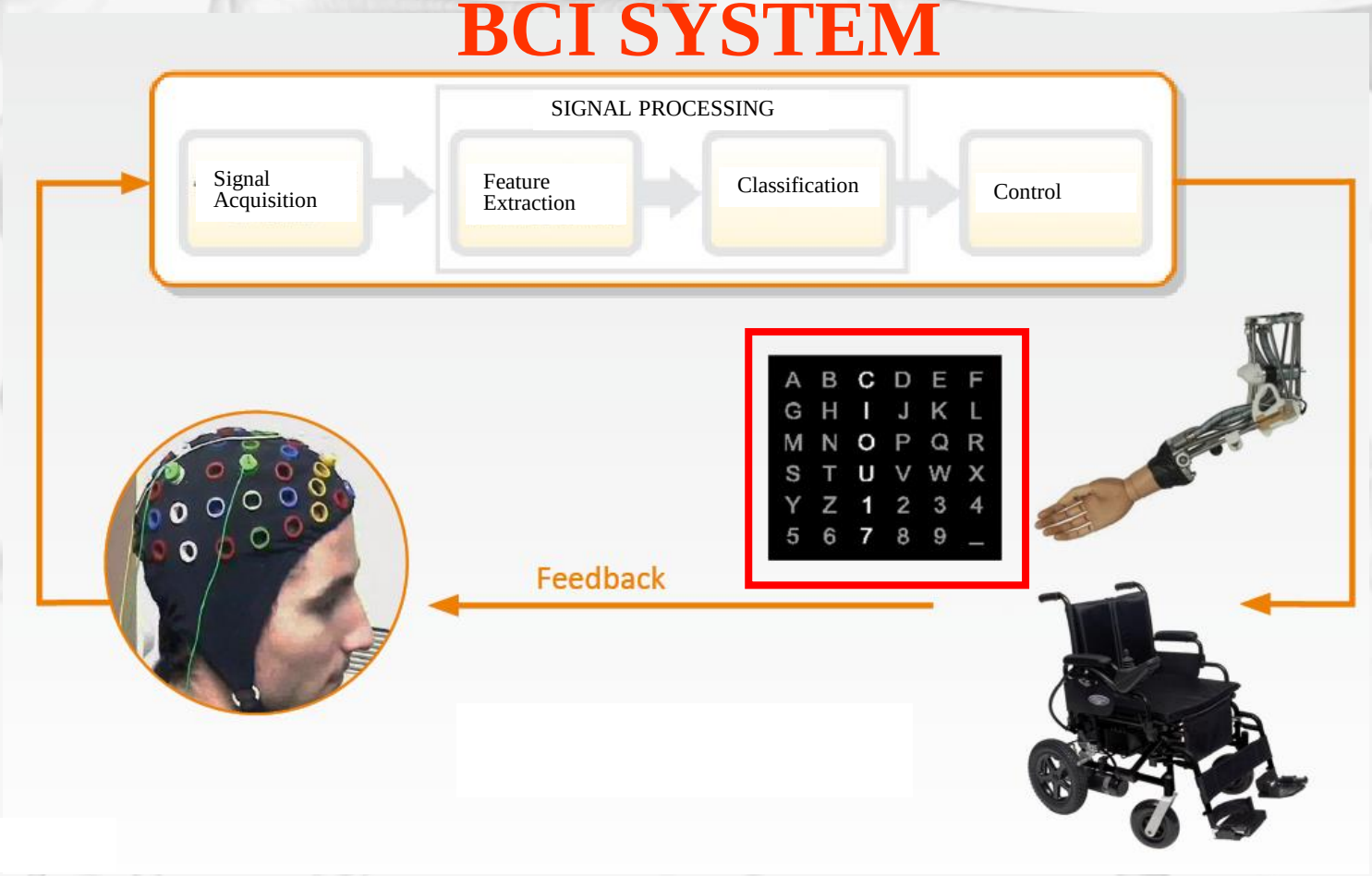






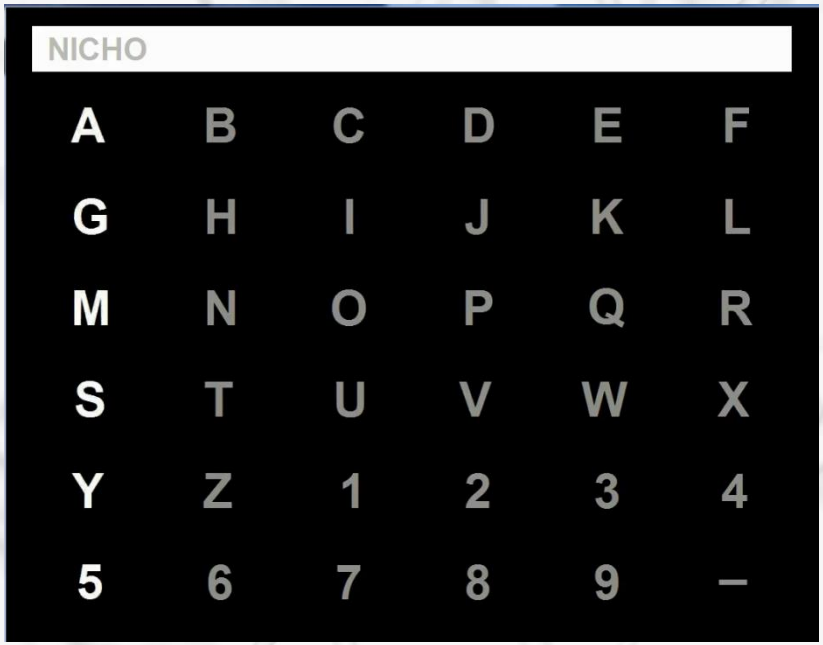
P300 amplitude depends on the stimulus interest for the subject

BCI Applications



P300-Based BCI Speller

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



- 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.**

P300-Based BCI Speller

- The layout speller should be adapt to each patient
  - Configuring the different elements of the speller
    - Size, color, characters, images,…

- Platforms to develop P300 speller

BCI 2000

Most popular

Open Vibe

UMA BCI

New platform developped by UMA-BCI research group

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- Introduction
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- System description
- Experiments and Results
- Conclusions

Objectives

- To evaluate the usability of the 3 proposed platforms
  - Study focused on the feasiblity to change the speller layout
  - Usability:
    - Effectivenes, efficiency and satisfaction

- The obtained results will allow researchers to select the most appropriate platform to develop communication system based on P300 spellers

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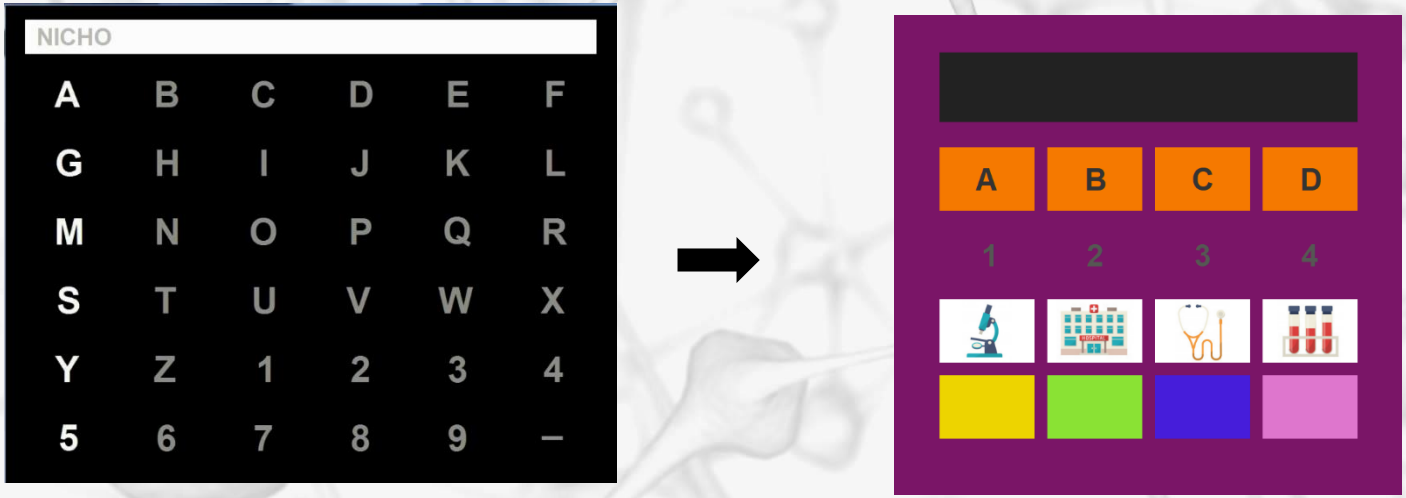
Experimental design

- With each platform, users has to transform the speller of reference into a proposed speller



Changes:

i) the matrix size (to 4x4),
ii) the color of the background (to purple),
iii) the inclusion of some images,
iv) the configuration of some characters (“A”, “B”, “C”, “D”, “1”, “2”, “3”, “4”)
v) the color of some cells

Experimental design

- A manual for each platform was provide to the user
  - The manuals should be read before the experiments.
  - The users could consult the manual during the experiment.
- For each platform, the time available was 60 minutes.
- Once finishing the task, the users were asked to complete different questionnaire to evaluate usability

Effectiveness
- % of correct changes

Efficiency
- Time required
- Subjective workload (NASAT-TLX)

Satisfaction
- 5 statements

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Results

Participants: 3 users

- Effectiveness

	User 1	User 2	User 3
UMA-BCI Speller	100	100	100
OpenVibe	80	100	100
BCI2000	100	100	100

Percentage of correct changes (in %)

- Efficiency

		User 1	User 2	User 3	**Mean**
UMA-BCI Speller	Workload	14,3	28,6	23	**21,9**
	time	5	4	6	**5**
OpenVibe	Workload	64,6	72	96	**77,5**
	time	60	38	45	**47,6**
BCI2000	Workload	51,6	52,6	68	**57,4**
	time	20	18	22	**20**

Total workload and time (in min) required

Results

- Satisfaction

	User	Statements (S)					Mean
		Complex	Help required	Tedious	Knowledge necessary	Easy	
UMA-BCI Speller	1	1	1	1	1	1	1,13
	2	1	1	1	2	1	
	3	1	1	1	2	1	
OpenVibe	1	2	4	5	5	5	4,13
	2	4	4	2	4	5	
	3	4	4	5	4	5	
BCI2000	1	2	2	2	3	3	3
	2	3	3	3	4	3	
	3	3	4	4	4	2	

1- The most favourable
5- The least favourable

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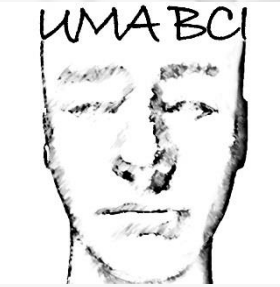
Conclusion

- The present work has **studied the usability** of the three most popular platforms to develop P300 speller: **BCI2000, OpenViBE and UMA-BCI Speller**.

- The **UMA-BCI Speller** offered the best scores in all dimensions, being the platform with the **highest level of usability.**
  - Most effectiveness
  - Most efficiency
  - Most satisfactory



Questions?

Thanks for your attention

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