Evaluation of Different Types of Stimuli in a ERP-Based Brain-Computer Interface Speller under RSVP

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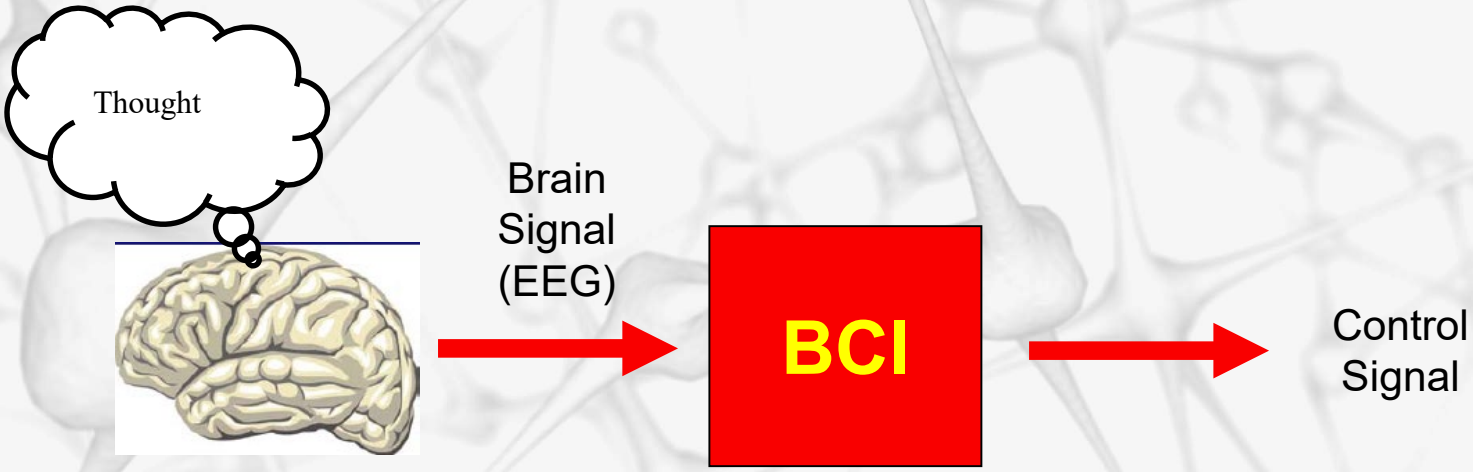
Dr. Ricardo Ron Angevin gained his M.S. in Telecommunication Engineering and Ph.D. degrees from the University of Málaga, Spain, in1994 and 2005, respectively. Since 1995, he has been lecturer at the Electronic Technology Department of the same university, where he is currently Associate Professor. He 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
- System description
- Experiments and Results
- Conclusions

What is a BCI?

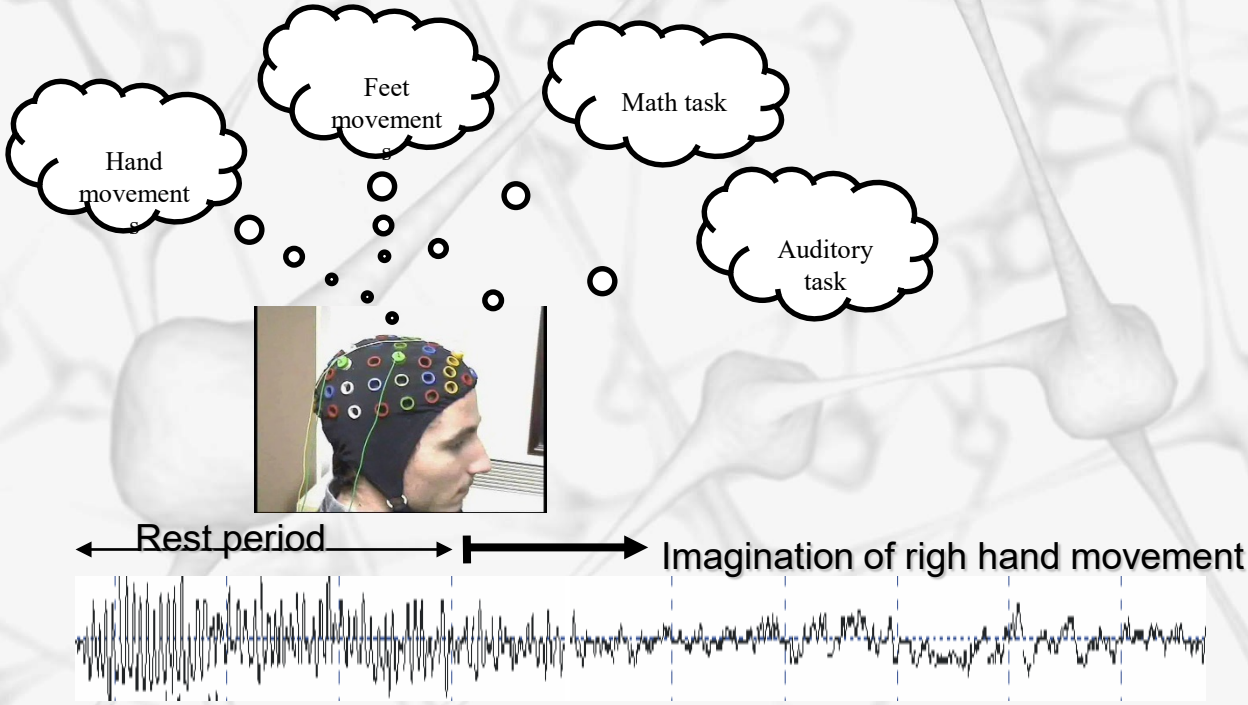
- *"A Brain-Computer Interface is a communication system that does not depend on the brain´s normal output pathways of peripheral nerves and muscles "*



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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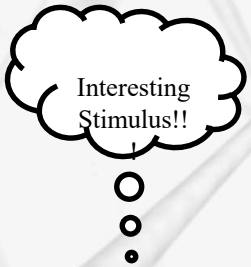
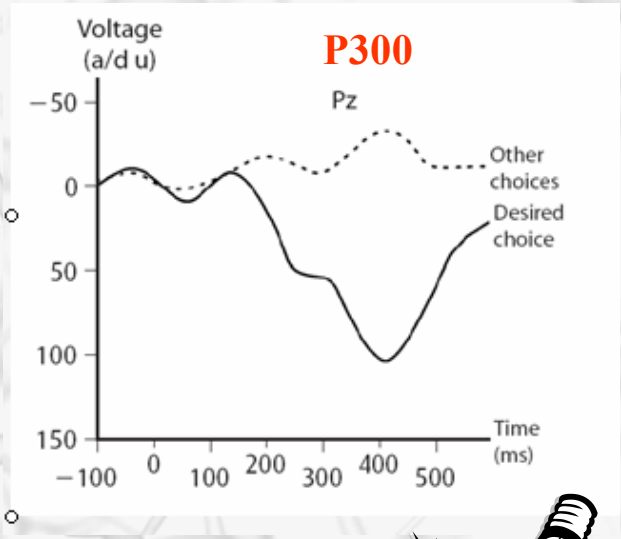
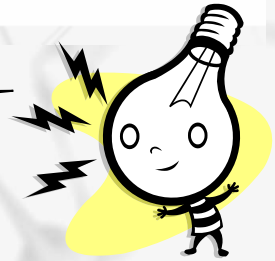
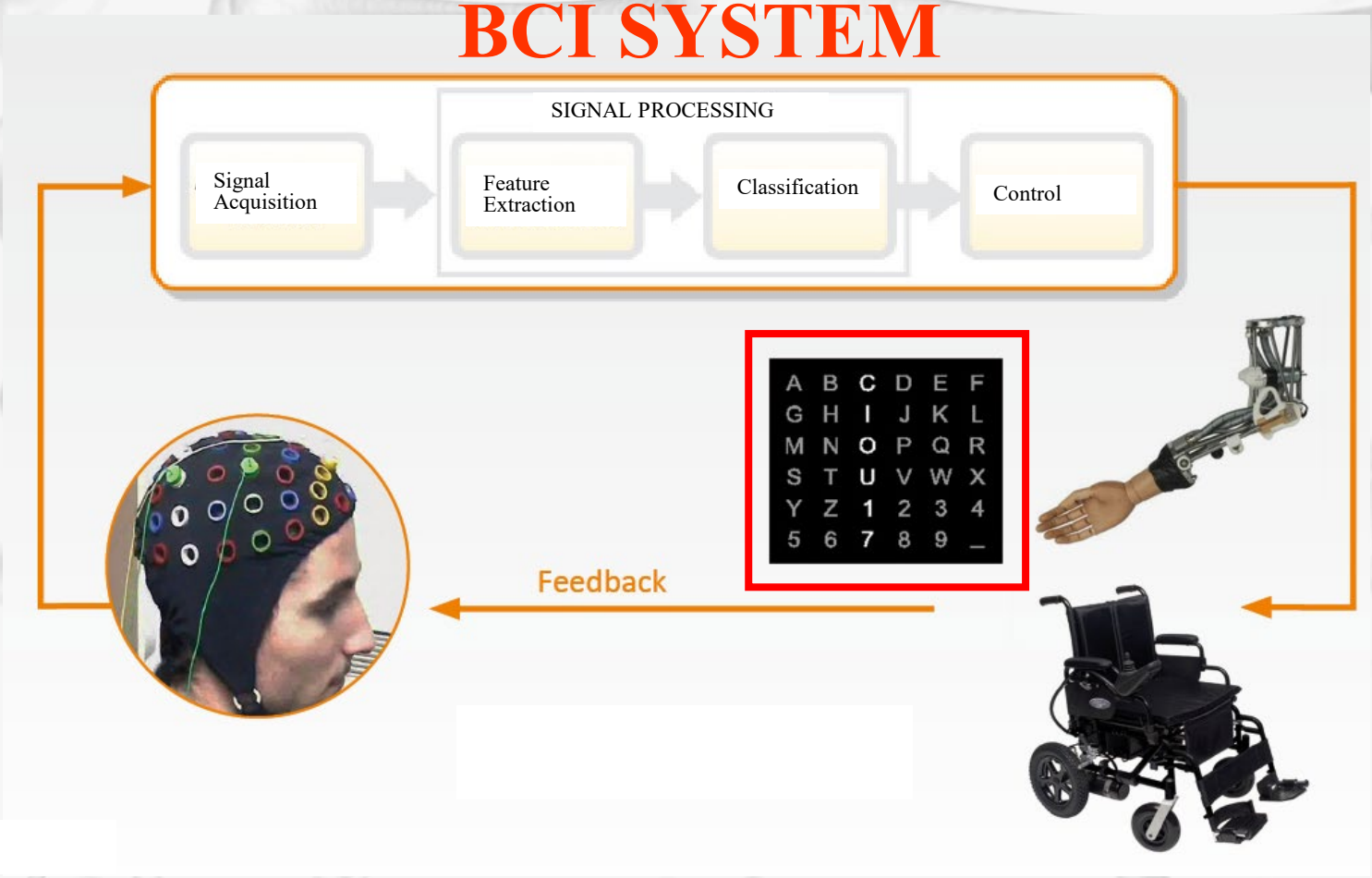






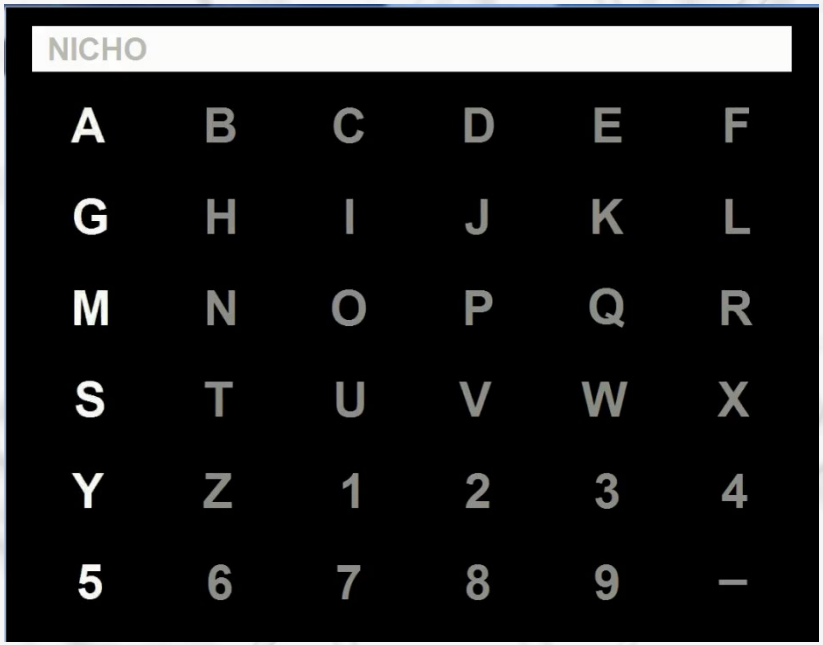
P300 amplitude depends on the stimulus interest for the subject

BCI Applications



P300-Based BCI Speller

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

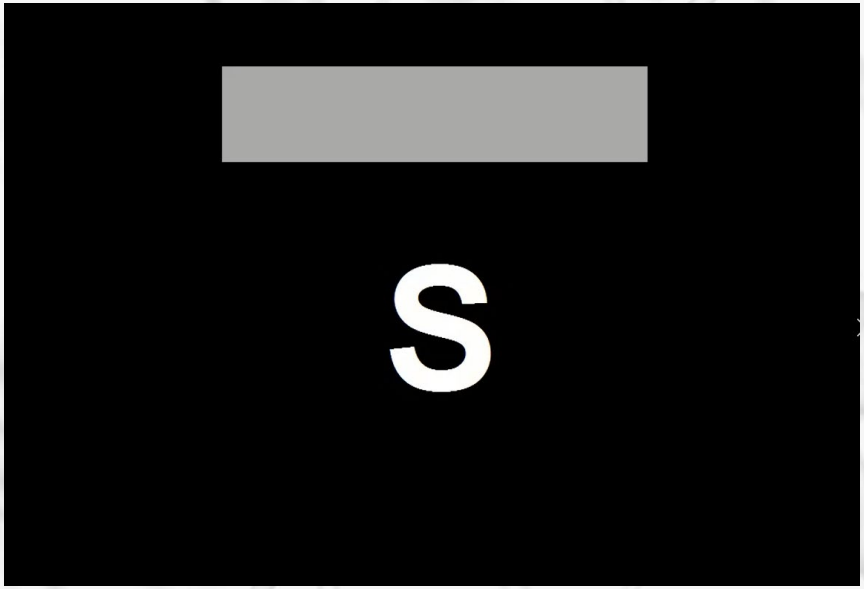


- Each row and column **flash** (stimulus)
- Subject **count** the number of times a symbol flash
- For **each flash, a P300** is produced
- After **some flashes,** the P300 is detected and the **symbol detected.**

•**Performance** depends on the **user´s ability to gaze** the different symbols.

P300-Based BCI Speller

- Based on the **Rapid Serial Visual Presentation (RSVP)** paradigm

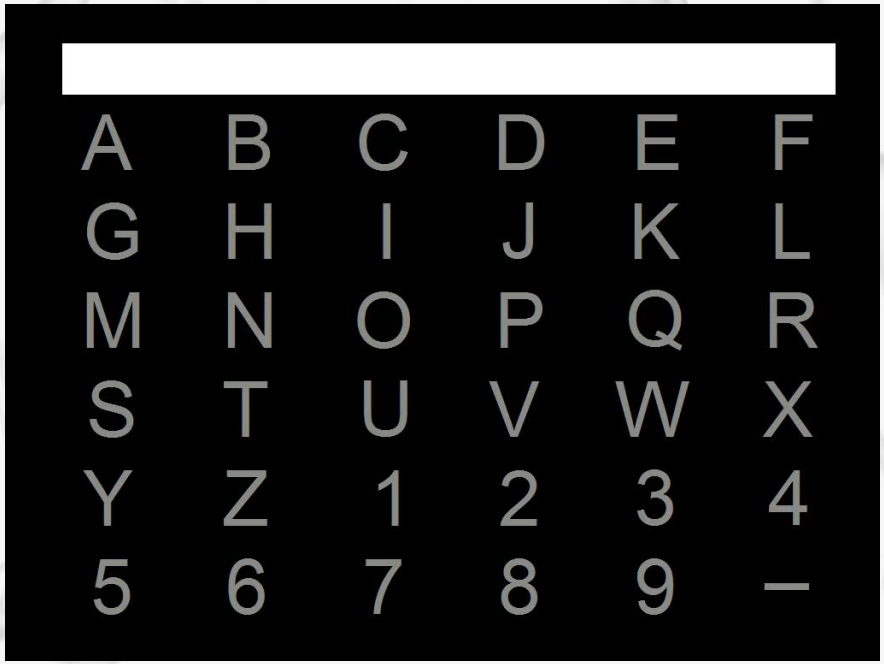


- **Does not depend on eye movement**

- The different **symbols** are presented, one by one, in the **center of the screen**
- Subject **count** the number of times the **chosen symbol appears**
- For **each symbol, a P300** is produced
- After **some symbol,** the P300 is detected and the **symbol detected.**

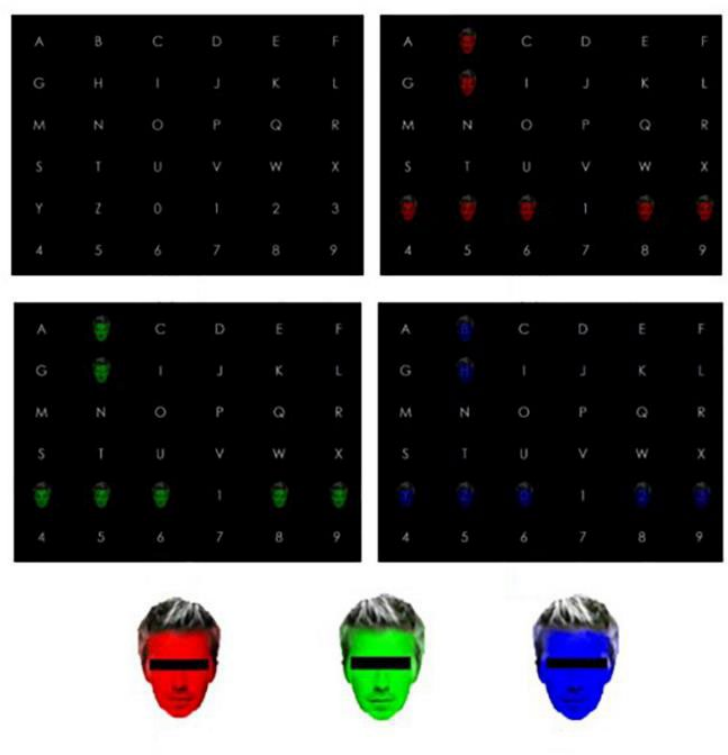
P300-Speller

- **Option to improve** P300 Speller effectiveness in **RCP** paradigm
  - To replace conventional flashes (highlighted from grey to white) by semitransparent famous faces in green
    - Higher P300 amplitud: **Reduced the number of flash required to detect the symbol**



P300-Speller

- A recent study in RCP paradigm shows that **red famous face performed better** than green and blue faces



No study have been carried out with RSVP paradigm

Objective

- To study if similar stimuli (semi transparent red famous face) can improve the performance of a P300-speller based on RSVP paradigm
- It may be interesting to ask whether this effect on face color performance could also be obtained under RSVP.

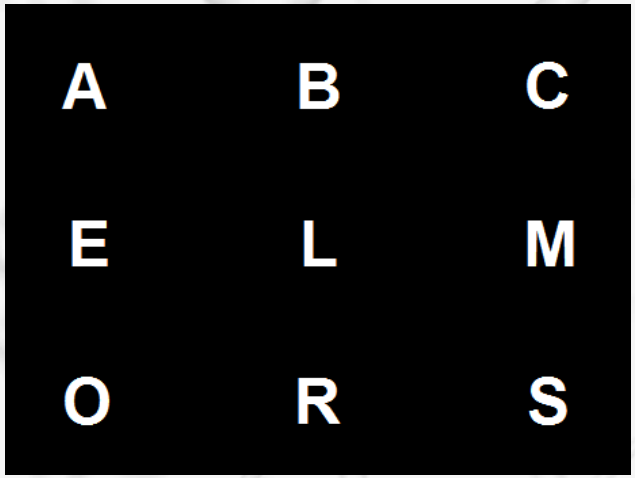
- Four different stimulus configurations

1- Stimulus based on letters (comparative results)
2- Stimulus based on red famous faces
3- Stimulus based on green famous faces
4- Stimulus based on blue famous faces

Developed System

- BCI system implemented through UMA-BCI Speller platform
- 2x3 matrix size ➡ 6 symbols

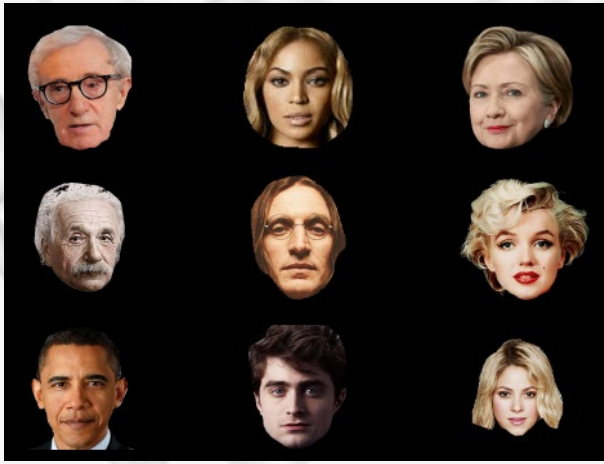
Gray Letters (GL)



Gray letters with
Red Famous Face (RFF)

Gray letters with
Green Famous Face (GFF)

Gray letters with
Blue Famous Face (BFF)



Experiments and results

- Experiment description
  - Participants: **6 healthy subjects (preliminary study)**
  - 1 sesión: to **test the 4 paradigms**
  - Electrodes positions: **P3, P4, PO8, Fz, Cz, Pz, PO7, Oz**

  - Each test consisted on:

1- **Calibration phase**

- **16 letters** (“ASIE”, “REIN”, “NIER”, “SAIN”)
- **Each “letter” was intensified 10 times:** (16,7s)

2- **Copy spelling phase**

- **12 letters** (“ANIS”, “RIEN”, “SERA”)
- **The number of intensification depended** of the calibration accuracies
- **Criterium**: minimin number or trials to obtain 100% accuracy in the calibration phase

Experiments and results

- Results: Copy-spelling phase

TABLE I. MEAN ± STANDARD DEVIATION (SD) OF NUMBER OF SEQUENCES USED, ACCURACY AND INFORMATION TRANSFER RATE (ITR) FOR THE DIFFERENT CONDITIONS IN THE ONLINE TASK: WL, BFF, GFF, RFF.

Participant	Number of sequences				Accuracy (%)				ITR (bit/min)			
	GL	BFF	GFF	RFF	GL	BFF	GFF	RFF	GL	BFF	GFF	RFF
P01	3	3	3	6	91.67	100	100	100	23.44	30.63	30.63	15.32
P02	4	5	4	4	50	91.67	83.33	75	3.77	14.06	13.76	10.61
P03	4	3	5	4	83.33	83.33	100	100	13.76	18.35	18.38	22.98
P04	3	5	5	4	100	100	100	83.33	30.63	18.38	18.38	13.76
P05	4	4	3	4	100	100	100	100	22.98	22.98	30.63	22.98
P06	5	9	8	4	100	58.33	100	83.33	18.38	2.52	11.49	13.76
Mean	3.83	4.83	4.67	4.33	87.50	88.89	97.22	90.28	18.83	17.82	20.55	16.57
SD	0.75	2.23	1.86	0.82	19.54	16.39	6.8	11.08	9.28	9.38	8.26	5.2

GL +

GFF +

GFF +

The ANOVA analyse showed NO significant results

Conclusion

- The results obtained in the present work differs with those obtain by other proposals:
  - **In RCP paradigm**, stimuli based on **Red Famous Face** improve the performance
  - **In RSVP paradigm,** stimuli based on **Green Famous Face** seems to improve the performance, but **NO significant** results were obtained
- It is necessary to consider the peculiarities of each paradigm: RSVP and RCP
  - It is necessary o increase the number of participants

diana
Grupo de investigación

Questions?

Thanks for your attention

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