Impact of Cognitive And Personality Profiles On Motor-Imagery Based Brain-Computer Interface-Controlling Performance

Camille Jeunet, Fabien Lotte, Martin Hachet, Bernard N'Kaoua

Impact Of Cognitive And Personality Profiles On Mental-Imagery Based Brain-Computer Interfaces Controlling Performance

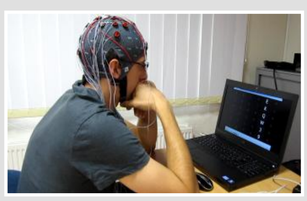
Camille JEUNET[1], Fabien LOTTE[2], Martin HACHET[2] & Bernard N'KAOUA[1]

[1] University of Bordeaux, [2] Inria Bordeaux Sud-Ouest, FRANCE

Introduction

- Mental-Imagery based Brain Computer Interfaces (MI-BCIs) are very promising to improve living standards of patients with motor disabilities...





- ... However, they remain barely used outside laboratories [1].

WHY?

- Controlling a MI-BCI-based system requires the acquisition of specific skills: generate stable and distinct brain activity patterns when performing the mental tasks.
- Some people seem unable to acquire these skills using standard training protocols [2].

Long term Objective

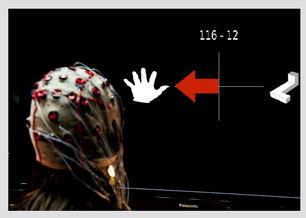
- Propose MI-BCI training protocols adapted to users' profiles in order to increase MI-BCI reliability.

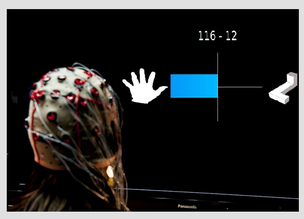
Contribution

- Proposing a model allowing to **predict MI-BCI users' performance** according to their personality and cognitive profile.

Methods

- 18 participants (9 women, aged 21.5 ±1.2)
- 6 two-hour long sessions per participant
- **Part 1 - Learn to perform 3 Mental-Imagery (MI) tasks** [3]
  - Left hand motor imagery
  - Mental subtraction
  - Mental rotation





- **Part 2 - Complete questionnaires assessing:**
  - *Personality*: locus of control, anxiety, autonomy, imagination, self-confidence, sensibility, etc.
  - *Cognitive profile*: learning style, working memory, visual retention, etc.
  - *The ability to perform the MI tasks*: motricity, arithmetic and mental rotation tests.

Results & Discussion

- This model, generated by a Stepwise Linear Regression, allows to predict MI-BCI users' performance (i.e. the rate of good classification of the MI tasks) with 80.9% accuracy:

$$\text{Predicted\_Performance} = \alpha_0 - \alpha_1 * \text{Tension} + \alpha_2 * \text{Imagination} + \alpha_3 * \text{Active\_Learner} + \alpha_4 * \text{Autonomy}$$

- With:
  - *Tension*, *Imagination* & *Autonomy*: 3 dimensions assessed by the 16 PF-5 test [4].
  - *Active Learner* (by opposition to Reflective Learner): one dimension measured by the Learning Style Inventory test [5].

- These results are very interesting because the 4 dimensions are:
  - independent from the performed mental tasks.
  - consistent with psychology and instructional design literature.

R	R^2	R^2 adjusted	Standard Error
0.925	0.857	**0.809**	1.919

	Non Stand. coefficients		Stand. Coefficients	t	Sign.
	A	Standard Error	β		
(Constant)	α_0 = 46.783	2.472		18.928	.000
Tension	α_1 = -1.320	.227	-.733	-5.816	.000
Imagination	α_2 = .863	.227	.458	3.806	.003
Active learner	α_3 = .723	.175	.527	4.172	.001
Autonomy	α_4 = .853	.340	.330	2.250	.027

Conclusion

- This model predicts MI-BCI performance with 80.9% accuracy and informs about cognitive and personality aspects that influence this performance.

Future work

- Designing new MI-BCI training approaches adapted to the users' profiles.
- Include these protocols in an Intelligent Tutorial System which also allows to adapt the protocol during the training according to users' state, and make this training more pleasant and efficient.

Contact: camille.jeunet@inria.fr

To know more about our work: https://team.inria.fr/potioc/

References

[1] Allison, B. & Neuper, C., *Springer London* (2010)
[2] Lotte, F. et al., *FNHUM* (2013)
[3] Friedrich, E. et al., *PloS one* (2013)
[4] Cattell, R. B. et al., Tea (2000)
[5] Kolb, D. A., *McBer and Company* (1999)