



HAL
open science

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

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

► **To cite this version:**

Camille Jeunet, Fabien Lotte, Martin Hachet, Bernard N’Kaoua. Impact of Cognitive And Personality Profiles On Motor-Imagery Based Brain-Computer Interface-Controlling Performance. 17th World Congress of Psychophysiology (IOP2014), Sep 2014, Hiroshima, Japan. hal-01088811v2

HAL Id: hal-01088811

<https://inria.hal.science/hal-01088811v2>

Submitted on 1 Dec 2014

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

IMPACT OF COGNITIVE AND PERSONALITY PROFILES ON MENTAL-IMAGERY BASED BRAIN-COMPUTER INTERFACES CONTROLLING PERFORMANCE

Camille JEUNET¹, Fabien LOTTE², Martin HACHET² & Bernard N'KAOUA¹

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.

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) | $\alpha_0 = 46.783$ | 2.472 | | 18.928 | .000 |
| Tension | $\alpha_1 = -1.320$ | .227 | -.733 | -5.816 | .000 |
| Imagination | $\alpha_2 = .863$ | .227 | .458 | 3.806 | .003 |
| Active learner | $\alpha_3 = .723$ | .175 | .527 | 4.172 | .001 |
| Autonomy | $\alpha_4 = .853$ | .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.

REFERENCES

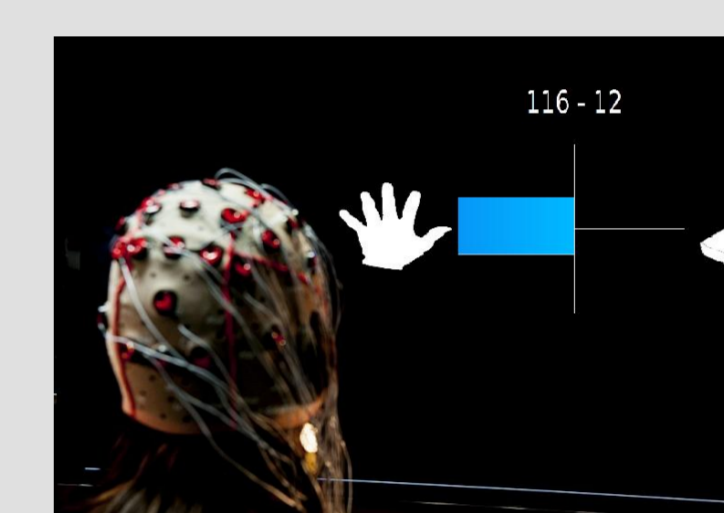
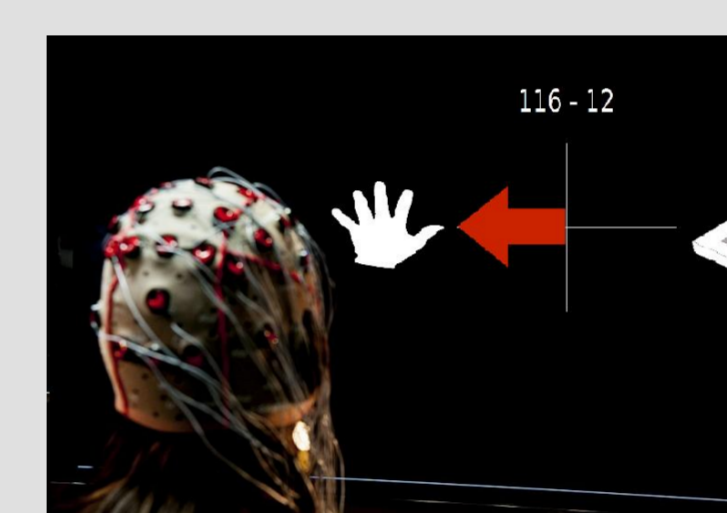
- [1] Allison, B. & Neuper, C., *Springer London* (2010)
- [2] Lotte, F. et al., *FNHUM* (2013)
- [3] Friedrich, E. et al., *PloS one* (2013)
- [4] Cattell, R. B. et al., *Tea* (2000)
- [5] Kolb, D. A., *McBer and Company* (1999)

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.

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/>