

The self-reported motivation of three paraplegics does not influence the performance of the BCI_{FES} in a seated position*

Felipe Augusto Fiorin, Hygor Vinícius Pereira Martins,
Christiane Henriques Ferreira, Maurício Moreira, Daniel Prado de Campos and Eddy Krueger

Abstract—This work investigates whether there is a correlation between BCI performance and self-reported motivation in BCI_{FES} users with (dis)complete SCI in a sitting position. We found no statistical correlation between performance and motivation in BCI_{FES} users with (dis)complete SCI.

Keywords: Spinal cord injury, functional electrical stimulation (FES), neuroanatomy.

I. INTRODUCTION

Spinal cord injury (SCI) is a highly incapacitating condition compromising sensorimotor functions [1]. Assistive technologies (ATs) like the Brain-Computer Interface (BCI) have emerged to restore some functions. BCI, often combined with functional electrical stimulation (FES), creates a direct link between cortical commands and target nerves/muscles. An important factor is the user's learning curve and motivation, which can significantly influence performance [2]. This study investigates the relationship between self-reported motivation and BCI_{FES} performance in three individuals with (dis)complete SCI, hypothesizing a direct correlation.

II. MATERIALS AND METHODS

This quasi-experimental study involves individuals with SCI, approved by the Ethics Committee on Research Involving Human Beings of the State University of Londrina. Participants were ≥ 18 years old with SCI between C₄ and T₁₀, and > 12 months post-injury. Exclusion criteria included intolerance to electrical stimulation, infectious diseases, or pacemakers. We used a non-invasive BCI and a custom-designed FES device. The methodology for BCI acquisition, pre-processing, and processing, along with the use of a Common Spatial Pattern (CSP) combined with a Linear Discriminant Analysis (LDA) classifier, followed a previous study by our group [3]. Before each session, participants self-reported their motivation using a Likert scale (1-5). Given the small sample ($N = 3$), we used non-parametric Spearman's (ρ) test to correlate motivation with accuracy of CSP-LDA ($Ac_{CSP-LDA}$) values.

*This work was supported by Fundação Araucária (research scholarship) and the National Council for Scientific and Technological Development.

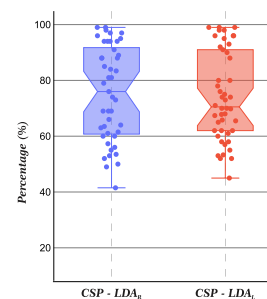
F. A. Fiorin, H. V. P. Martins, C. H. Ferreira and Eddy Krueger are with the Neural and Rehabilitation Engineering Laboratory (Anatomy department) at Universidade Estadual de Londrina, Londrina, Brazil ekrueger@uel.br

M. Moreira and D. P. Campos are with the Universidade Tecnológica Federal do Paraná, Apucarana, Brazil.

III. RESULTS

The study included three participants with (dis)complete SCI: P_A (T₆), P_B (C₄), and P_C (T₂). Participants reported high motivation, with a median (iqr) of 5 (0) on the Likert scale. Fig. 1 show that Median (iqr) $Ac_{CSP-LDA}$ was 76(33)% for right lower limb (RLL) and 70.5(29)% for left lower limb (LLL). Spearman's test found no significant correlation between motivation and performance. For $Ac_{CSP-LDA}$, ρ was 0.2 ($p=0.17$) for LLL and 0.13 ($p=0.36$) for RLL. This contradicts our initial hypothesis. The lack of correlation may be due to the subjective nature of self-reported motivation or other factors like mental fatigue and individual differences in mental imagery.

Fig. 1. Boxplot of $Ac_{CSP-LDA}$ to right and left (body) side.



IV. CONCLUSION

This preliminary study found no significant correlation between self-reported motivation Likert-scale and BCI_{FES} performance in individuals with (dis)complete SCI.

REFERENCES

- [1] B. Yang, F. Zhang, F. Cheng, *et al.*, "Strategies and prospects of effective neural circuits reconstruction after spinal cord injury," *Cell Death & Disease*, vol. 11, no. 6, pp. 1–14, 2020.
- [2] A. L. Behrman, M. G. Bowden, and P. M. Nair, "Neuroplasticity after spinal cord injury and training: An emerging paradigm shift in rehabilitation and walking recovery," *Physical therapy*, vol. 86, no. 10, pp. 1406–1425, 2006.
- [3] F. A. Fiorin, L. G. Sartori, M. V. G. Méndez, C. H. Ferreira, M. B. d. M. França, and E. Krueger, "The learning curve of people with complete spinal cord injury using a ness-fess interface in the sitting position: Pilot study," *Eng*, vol. 4, no. 2, pp. 1711–1722, 2023.