 DOI:10.3217/978-3-85125-260-6-79

Investigation of the Utility of Mind-Body Awareness Training in the Early Learning of a 1D Sensorimotor Rhythm Based Brain-Computer Interface

A. Doud[1,2], K. Cassady[1], K. Lafleur[1], B. He[1,3]
[1]*Department of Biomedical Engineering, University of Minnesota, Minneapolis, USA;*
[2]*University of Minnesota Medical School, Minneapolis, USA;*
[3]*Institute for Engineering in Medicine, University of Minnesota, Minneapolis, USA*

Correspondence: A. Doud, Nils Hasselmo Hall, 312 Church Street SE Room 7-105 , Minneapolis, Minnesota. E-mail: alexdoud@umn.edu

Abstract. In the present study we present the initial BCI training period of a cohort of 5 subjects with regular exposure to yoga, meditation, or a combination of both practices. The investigation of these mind-body awareness training practices may provide insight into valuable strategies for reducing barriers to BCI fluency that limit the use of these systems by some individuals. The investigated subjects showed rapid training times, and were able to achieve competence in the use of two differentiable control signals, left hand vs right hand and both hands vs rest. Subjects were able to achieve ≥ 80% accuracies in these traditional BCI cursor tasks using standard electrode configurations and with as little as 33 minutes of training time.

Keywords: EEG, Motor Imagery, Yoga, Meditation, Training, Rehabilitation

1. Introduction

Mind-body awareness and the capacity to focus for a prolonged period of time are intuitively important skills that may help to bridge the gap between users who struggle with brain-computer interface control and those to whom it comes naturally. Here we investigate if experience with yoga and/or meditation, examples of formalized mind-body awareness training (MBAT) can accelerate the initial learning of a 1D sensorimotor rhythm (SMR) based BCI. Five practitioners of MBAT were taught to control the movement of a cursor in the left-right and up-down dimensions using SMR and were seen to adopt these systems fluently with very little training when compared to the published literature.

2. Materials and Methods

Five subjects (ages 22–30, 1 male, 4 females) attended three sessions of ten 3-minute experimental trials. Subjects were recruited based on their regular exposure yoga, meditation or a combination of both, having practiced regularly for at least a year. Task competency required four consecutive 3-minute trials with accuracies ≥ 80% or an overall session accuracy ≥ 80%. Subjects imagined each hand to move the cursor left or right, then progressed to an up-down control task, imagining both hands together vs. a volitional rest state. A 64-channel Neuroscan EEG cap using the international 10-20 system was used to acquire the EEG signal. The amplitudes of the 12 Hz components of the C3 and C4 electrodes were used to control the cursor. C3 minus C4 produced the left-right control signal, while C3 plus C4 controlled up-down.

3. Results

The number of 3-minute trials that each subject needed to achieve competency in both tasks is reported in Fig. 1. The subjects required an average of 16.25 3-minute trials to pass the established criteria for competency in both tasks. The theoretical minimum training time to pass the competency criteria in each individual task was 12 minutes (achieved by one of the experimental subjects for right-left and by a separate subject for up-down). The minimum time that a subject required to achieve competence in both tasks was 33 minutes of training.

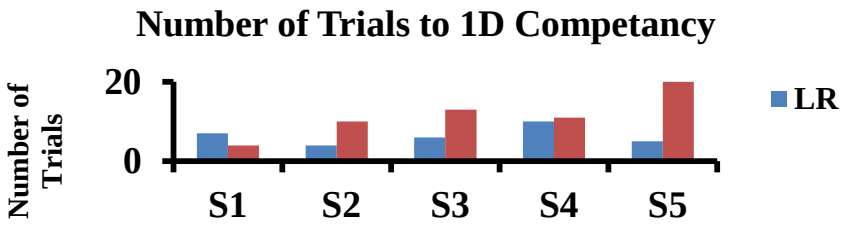

Figure 1. *The number of 3-minute trials for each subject to pass the competency criteria for LR and UD control are reported.*

4. Discussion

Subjects identified the practices of meditation, Yoga-nidra, and Reiki as most helpful to BCI training. These sub-disciplines are aimed at learning to direct focused attention to specific regions of the body. Table 1 provides some of the published literature on SMR BCI training in the general population. In comparison, the dramatic drop in training time, and the ability of all the presented MBAT subjects to achieve high accuracy suggests that MBAT may promote the self-awareness needed to intentionally modulate SMR activity before BCI training has begun. There is an exciting potential to further refine these practices to provide accelerated training times, and enhanced control of SMR modulation for paralyzed patient populations.

Table 1. *1D classification accuracies and training times for contemporary publications in 1D SMR BCI*

Journal, Author, Year	*Number of Subjects*	*1D Accuracies*	*Total Training Time*
Royer, J. Neural Eng., 2011	20 healthy	60-80% (group mean range)	240 minutes
Pichiorri, J. Neural Eng., 2011	10 healthy	75-96% (subject range)	240-320 minutes
Neuper, Clinical Neurophysiology, 2009	20 healthy	77% (group mean)	~75 minutes
McFarland, Clinical Neurophysiology, 2005	5 healthy -2 SCI	48-100% (subject range)	240 minutes

Acknowledgements

The team thanks the Your Yoga studio and Gregory Arenson for recruiting yoga practitioners, and Arman Shahriar for experimental assistance. This work was supported in part by NSF CBET-0933067, NSF DGE-1069104, and ONR N000141110690.

References

Royer AS, Rose ML, He B. Goal selection versus process control while learning to use a brain-computer interface, *J Neural Eng*, 8(3):036012, 2011.

Pichiorri F, De Vico Fallani F, Cincotti F, Babiloni F, Molinari M, Kleih SC, Neuper C, Kübler A, Mattia D. Sensorimotor rhythm-based brain–computer interface training: the impact on motor cortical responsiveness. *J Neural Eng*, 8(2):025020, 2011.

Neuper C, Scherer R, Wriessnegger S, Pfurtscheller G. Motor imagery and action observation: Modulation of sensorimotor brain rhythms during mental control of a brain–computer interface, *Clin Neurophysiol*, 120(2):239–247, 2009.

McFarland DJ, Sarnacki WA, Vaughan TM, Wolpaw JR. Brain-computer interface (BCI) operation: signal and noise during early training sessions, *Clin Neurophysiol*, 116(1):56–62, 2005.