Title of the PhD project
Decrease of individual responses to stress: neuroplasticity elicited by cognitive and brain stimulations

Disciplines: Sports Sciences and Behavioral Neurosciences

Laboratory: Laboratoire Interuniversitaire de Biologie de la Motricité – Director: Pr. Christian Collet – Research team name: Mental processes, sensorimotor processes and motor performance - Pr. Aymeric Guillot

Doctoral school: Interdisciplinary Doctoral program in health-sciences (EDISS) - ED 205

Scientific background and rationale: Stress-related disorders are likely to substantially harm the quality of life by interfering with social life and physical health. Stress in its severe forms can even be a major health problem associated with multiple causes of death including heart disease, cancer, and stroke, as well as mental health problems including depression, PTSD and anorexia. Besides its multidimensional nature, the concept of “stress” remains ambiguous and not well-defined in the scientific literature. Stress is linked to a cascade of modulations in central and peripheral physiology which impact both motor and cognitive performances. Acute and chronic changes appear in neurochemical systems and specific brain regions. Notably, stress exposure weakens the dorsolateral prefrontal cortex, strengthens the response of the amygdala and striatum, and increases tonic firing of the locus coeruleus. Due to such detrimental effects, counteracting acute and chronic stress requires further attention, particularly through a multimodal approach and the use of a biofeedback paradigm. There is therefore a current need to find a non-invasive and cost-effective method likely to manage stress responses. Spurred by the importance of preventing stress disorders, the aim of this PhD project is twofold: (1) to better characterize the concept of stress using multimodal methodologies, and (2) to investigate a relevant approach designed to significantly decrease the individual response to stress when facing to both declarative and procedural tasks.

Description of the project methodology: Experiment 1 seeks to determine the best approach that might prevent the effect of acute stress on both declarative and procedural tasks. To address this question, three groups of healthy participants will be subjected either to 15min of biofeedback, brain stimulation [by means of transcranial direct current stimulation, tDCS over the dorsolateral cortex], or both methods simultaneously. Acute stress will be induced and maintained using the Trier Social Stress Test. Neurophysiological data (salivary cortisol samples, heart rate and variability, electrodermal activity), psychological data (questionnaires and Likert scales), as well as results on the experimental tasks, will be collected. Experiment 2 aims at investigating whether multi-sessions of the most efficient approach tested in Exp. 1 may promote brain plasticity and limit dendritic reductions when facing to chronic stress condition. Stressed and non-stressed participants selected by means of questionnaires will undergo a functional magnetic resonance imaging (fMRI) before and after six sessions of stress mediation including mental and physical practice. Plasma and salivary cortisol levels, as well as psychological assessments and autonomic nervous system responses, will be collected. Same behavioral tasks as used in Exp. 1 will be completed to assess the effect of the stress management intervention.

Expected results: Exp. 1 should reveal that applying tDCS while performing the biofeedback task is the optimal method to decrease the impact of stress on both declarative and procedural performances. Exp. 2 should reveal an increase of the hippocampus volume as well as in the frontal cortex after the stress mediation intervention. Mediation of chronic stress should further demonstrate beneficial impacts on behavioral performance.

Perspectives: The present PhD project is designed to determine how decreasing the individual response to stress. Practical applications of stress prevention programs might therefore be tailored for persons facing to different types of stress (i.e. medical students and lecturers, employees suffering from intense stress at work in large companies). Based on scientifically proven concepts of stress reduction, our intervention is expected to help persons to more positively react to stressful conditions by modifying the situation, adapting their judgement mechanisms, or developing their acceptance when facing to a stressful situation.

Skills required: Computer programming and data processing, assessment and analysis of autonomic nervous system activity, plasma and cortisol levels, tDCS recordings.


Key-words: Acute and chronic stress, biofeedback, tDCS, psychophysiology, fMRI

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Application should include: CV, application letter, Names and addresses of two references.
The application file should be sent before May 14, 2017 to: Christian Collet - Christian.collet@univ-lyon1.fr.
The open competitive recruitment process is in two steps: 1. Internal laboratory procedure. 2. Interdisciplinary jury of EDISS.