Neurofeedback treatment to enhance cognitive performance in Schizophrenia

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1. Objective

Neurofeedback is the instrumental conditioning of different EEG parameters, which can be done by rewarding or inhibiting certain features of the brain activity. Research has shown (Gevensleben et al., 2010; Kayiran et al., 2010; Kouijzer et al., 2010; Markovska-Simoska et al., 2008; Ros et al., 2009; Sterman, 2000; Trudeau, 2005; Vernon et al., 2003) that a variety of neurofeedback protocols have been used successfully in the treatment of several disorders (e.g., attention deficit disorder, autism, epilepsy, post-traumatic stress disorder, addiction, depression, fibromyalgia…) and in the optimization of human performance in healthy individuals (e.g., cognitive enhancement, optimal performance in sports and artistry, improvement of microsurgical skills…). Neurofeedback may be a promising method of treatment for people with Schizophrenia, although little is known about it. The enhancement of cognition plays a key role in the modern treatment of Schizophrenia, relying on the evidence that neurocognitive deficits are core features of the illness and significant determinants of functional outcome (Green et al., 2000, 2004). Given that neurofeedback has been shown to be effective improving attention, memory, executive functioning, motivation and self-control in other neuropsychiatric disorders, we hypothesize that neurofeedback constitute a good candidate for the cognitive enhancement of people with Schizophrenia and with related disorders. This exploratory study examined the feasibility of using neurofeedback as a bio-behavioural method to enhance neurocognitive performance in schizophrenia.

2. Material and Methods

Participants

Three patients with Schizophrenia, maintained on current antipsychotic medication, from the Hospital S. João Psychiatry Day-Hospital. ***Patient 1:*** Male, 52 years old, single, 9th grade of educational attainment, diagnosed with Schizophrenia since 1992. ***Patient 2:*** Male, 35 years old, single, 12th grade of educational attainment, diagnosed with Schizophrenia since 2007. ***Patient 3:*** male, 39 years old, divorced. 10th grade of educational attainment, diagnosed with Schizophrenia since 1989.

Instruments

All patients completed pre and post-treatment assessments of social and neurocognition based on the MATRICS Consensus Cognitive Battery:

Continuous Performance Test – Identical Pairs (measures sustained attention or vigilance): the participant is required to focus on a computer screen that presents various numbers and to press a button whenever two matching stimuli appear on consecutive trials.

NAB Mazes (measures executive functioning and problem solving): consists of seven timed paper-and-pencil mazes of increasing difficulty.

BACS Symbol Coding (measures processing speed): paper-and-pencil test in which the respondent uses a code to write digits (1-9) that matches to nonsense symbols, as quickly as possible.

Letter-Number Sequencing (measures verbal working memory): the respondent memorizes random numbers and letters and then is asked to first recall the numbers in order (from smallest to largest) and then the letters (in alphabetical order), with increasing trial length.

MSCEIT-Managing Emotions (measures social cognition): the respondent chooses actions that are most effective in obtaining a specified motional outcome for an individual in a story.

Intervention

From October 2010 to January 2011, patients were assigned to a neurofeedback operant conditioning training of the 10-13hz band and the 13-15Hz band initially at C4 (reference at A1) and then at FCz (reference at A2), while inhibiting theta and high beta. The reward of 12 or13-15Hz (SMR) band at C4 while inhibiting theta(4-7Hz, which is consistently augmented in schizophrenia) is a standard protocol effective to increase attentional skills and executive functioning. Thompson and Thompson (2009) encourages the reward of the SMR band between Cz and Fz (FCz) in adults, which was done in the last sessions. The recent discover of mirror neurons in humans and their possible dysfunction in Schizophrenia was taken into account when deciding the protocol of EEG/biofeedback (Pineda, et al., 2008). Considering that mu rhythm (8-13hz) suppression is a reliable measure of mirror neuron activity, its training by biofeedback may improve behavior and social cognition in Schizophrenia, which was done in every sessions, in the beginning of the session. A portable NeXus-10 amplifier and recording system (Mindmedia) was used for neurofeedback training. The stimuli used for feedback were music (e.g., pop music), videos (e.g., movies, cartoons) and games.

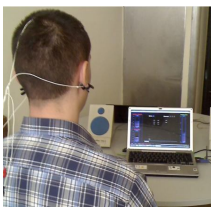
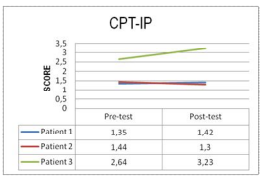


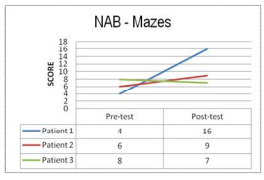
Fig 1. Patient during the training

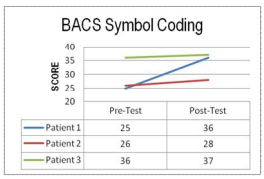
Fig 2. The therapist master screen

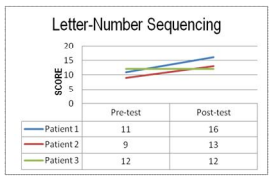
Fig 3. The filtered EEG signal is presented to the patient as a significant stimulus

3. Results and conclusions









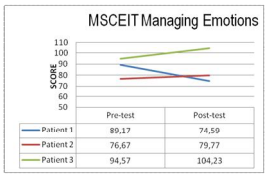


Fig 4, 5, 6 7 and 8. Pre and post treatment results in the Continuous Performance Test - Identical Pairs (vigilance), NAB Mazes (executive functioning and problem solving), BACS Symbol Coding (processing speed), Letter-Number Sequencing (working memory) and MCSEIT Managing Emotions branch (social cognition)

Following treatment, patients showed evidence of improved performance in different cognitive measures. The most important and consistent increases were observed in attention/vigilance, working memory and processing speed. We also observed changes in the EEG patterns during the treatment, suggesting a learning effect. Patients were very collaborative during the treatment sessions and showed increased interest in their performance. Results from this exploratory study support the feasibility of using neurofeedback to enhance cognition in schizophrenia, but this method should not be considered alone for this purpose. This results also provides precursor findings to support a complete controlled trial.

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