Using fMRI to Investigate the Effect of Neurorehabilitation Treatment on HIV Associated Cognitive Symptoms: Preliminary Results

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Background:

Cognitive symptoms (e.g., impairment in complex attention, working memory and speed of processing) are common in individuals living with HIV/AIDS even after treatment with antiretroviral medication. The direct effects of the virus (e.g., apoptosis) and deleterious effects from the resulting inflammation and neurochemical changes secondary to immune response (e.g., production of neurotoxic proteins) compromise the integrity and efficiency of the fronto-striatal white matter, the basal ganglia and the prefrontal cortex. HIV cognitive syndromes are categorized as Atypical (some complaints, but no neuropsychological test findings), Minor Cognitive Motor Disorder (MSMD) and HIV Associated Dementia Complex (HADC). Neurorehabilitation techniques may offer a means of treating the cognitive sequelae of HIV-infection. The NeuroRESTORE program at St. Michael's Hospital is a 10-week cognitive rehabilitation study that involves 30-40 hours of a cognitive rehabilitation treatment that targets complex attention and speed of processing.

The goal of this ongoing project is to evaluate Functional Magnetic Resonance Imaging (*f*MRI) as a means of evaluating the impact of neurorehabilitation on the brain function of people living with HIV/AIDS. We chose *f*MRI because it is a more sensitive means of detecting change in brain function than neuropsychological tests and will allow us to address the following questions:
(1) *What is the effect of neurorehabilitation at the neural level in people living with HIV?*
(2) *How do functional changes in cognitive symptoms relate to changes in underlying functional brain organization in people living with HIV?*

Method:

6 participants were scanned using a 3-T Signa MR scanner with a standard coil one week before beginning and one week after finishing the neurorehabilitation treatment. During the scan they performed the *n-back* task of continuous working memory (2-back and 0-back). Functional scans were acquired by using a single shot T2*-weighted pulse sequence with spiral readout (TR = 2000 ms, TE = 30 ms, flip angle 70°, effective acquisition matrix = 64 × 64 x 26, voxel size = 3.125 x 3.125 x 5 cm, slice spacing = 0 mm, FOV = 20 x 20 cm), including off-line gridding and reconstruction of raw data (Glover, 1998). For each participant, 184 functional volumes were collected per run, the experiment having 4 runs in total. Participants also completed a comprehensive neuropsychological assessment. Results from 3 people living with HIV (one Atypical, one MCMD and one HADC) and 3 controls will be presented.

Results:

Preliminary findings indicate the NeuroRESTORE intervention results in a significant reduction in self-reported cognitive symptoms and in problems in everyday functioning goal areas, (see figure 1). Neuroimaging results are very preliminary but two findings are relevant: (1) At baseline, people with HIV show a significantly greater intensity and volume of brain activation compared to controls, and (2) After NeuroRESTORE treatment, intensity and volume of activation were significantly decreased in the 3 participants with HIV, relative to baseline levels (see Figure 2 for a representative example). Overall, this suggests that neurorehabilitation is a promising treatment for HIV related cognitive problems, and that fMRI is a useful technology for evaluating treatment effects at the neural level. Results differed depending on diagnosis of HIV syndrome (e.g., MCMD v. HADC). The relationship between functional brain reorganization and changes in the ability to perform activities of daily living will be discussed.

Figure 1: Improvement in Self Reported Cognitive Symptoms

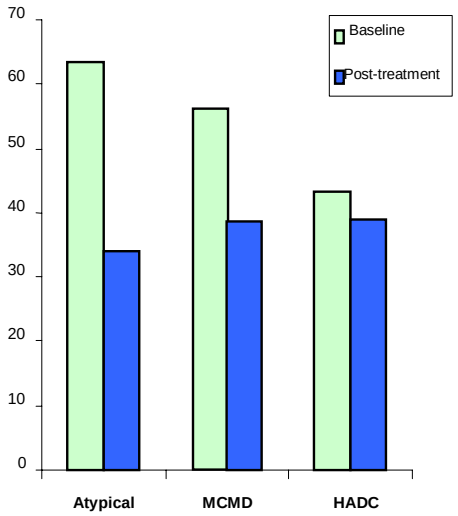

Figure 2: Time 1 and Time 2 fMRI maps showing 2-back v. 0-back activation

Time 1 Time 2