Changes in brain network organization and brain-behaviour relationships following a 3-month intervention program for individuals with chronic TBI

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Introduction

- Objective measurement of neurological and neuroplastic changes are necessary to understand the effect of potential rehabilitation programs for chronic traumatic brain injuries.
- The purpose of this study was to assess the effectiveness of an intensive cognitive intervention program in individuals with chronic TBI and to evaluate the effects of this intervention on brain-behavioral relationships.

Objectives

- To evaluate the changes in brain function in individuals with chronic, mild traumatic brain injury (mTBI) following the 3-month intervention program.
- To evaluate changes in executive functioning, attention, related to mTBI following the 3 month intervention program

Methods

All measures were evaluated at baseline and post-intervention in participants with mTBI and in healthy controls.

Participants:

- Eight adults between the ages of 22 – 57 years with a history of mTBI (between 0.5-5 years post injury)
- Nine healthy age- and sex-matched controls

Intervention:

- ABI Wellness Four-Pillar Intervention program: 1) BrainEx cognitive training, 2) aerobic exercise, 3) meditation, and 4) bi-weekly counseling - 4.5 hours a day, 4 days a week.

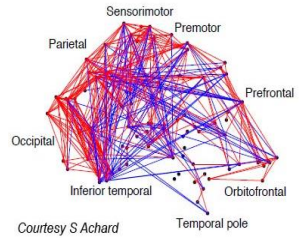
Electroencephalography (EEG) protocol:

- Resting state EEG data was collected for 5 minutes (with eyes closed) using a 64-channel Hydrocel Geodesic SensorNet (Philips Neuro (EGI), Eugene, OR).

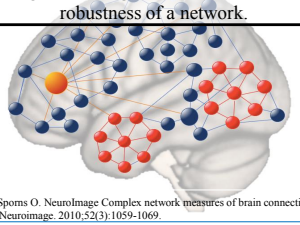
Neuro-Behavioural Testing:

- The NIH Toolbox Cognitive Battery and the Rey Auditory Verbal Learning Test (RAVLT) Trials 1-5 were administered to assess cognitive functioning.
- Anxiety and depression were measured through the Generalized Anxiety Disorder Scale (GAD) and the PHQ-9 Depression Scale (PHQ-9).

Graph Theory: the brain as a network



Clustering coefficient: Clustering coefficient measures the degree to which nodes cluster together in the brain - computed as the proportion of connections among a nodes neighbours. If a node and its neighbouring nodes are connected, they form a cluster [1]. High clustering is associated with the robustness of a network.



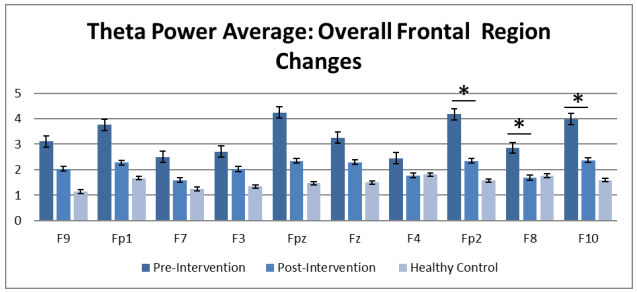
1. Rubinov M, Sporns O. NeuroImage Complex network measures of brain connectivity : Uses and interpretations. Neuroimage. 2010;52(3):1059-1069.

Results

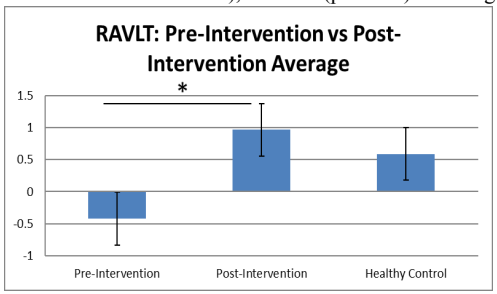
Demographics mTBI Subjects

Sex	Age	Time since last injury (in years)	Type of injury	Previous head trauma
F	49	2.47	hit on head	YES (3)
F	57	1.61	fall	YES (2)
F	35	4.00	MVA	YES (3)
M	22	0.98	fall	NO
F	34	1.81	biking fall	YES (2)
M	24	0.53	unknown sport	YES (2)
M	48	1.89	fall	NO
F	48	4.00	hit on head	YES (2)

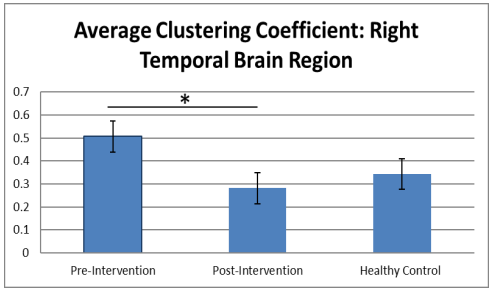
Results



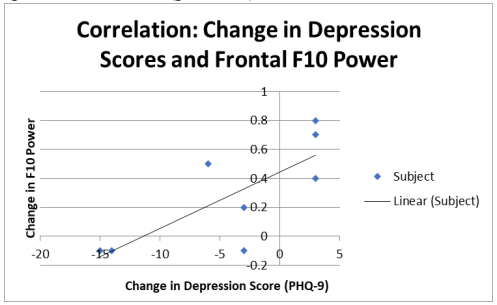
*Significant decrease in theta power over the Fp2 (p = .018), F8 (p = .018), and F10 (p = .025) brain regions.



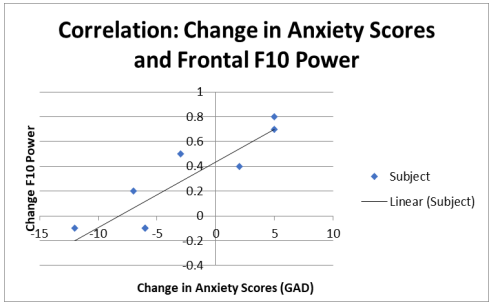
*Significant difference in RAVLT scores, pre- to post-intervention (p = .017).



*Significant difference in clustering coefficient from pre- to post-intervention (p = .025).



Significant correlation between change in PHQ-9 score and change in F10 theta power from pre- to post-intervention. r = .770, p = .025



Significant correlation between change in GAD score and change in F10 theta power from pre- to post-intervention. r = .887, p = .003

Conclusions

- This pilot study demonstrates evidence of change in EEG power, functional brain connectivity, and brain-behaviour relationships following an intensive intervention program in patients with chronic TBI suggesting that such individuals can benefit from targeted intervention.
- A major limitation of this study is the lack of a TBI control group.