MRI and Neuropsychological Outcomes following a Functional Medicine Intervention with Cognitive Training in Mild Cognitive Impairment (MCI): A Multiple Case Study

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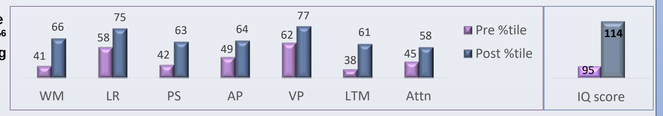
INTRODUCTION

Background: Neuro-inflammation is a prominent finding in Alzheimer's Disease (AD). Mild Cognitive Impairment (MCI) is a precursor to AD with up to 50% of individuals with MCI converting to AD within 1 to 3 years. Promising work has investigated MCI outcomes following a multi-faceted anti-neuro-inflammatory protocol. The current study examined MRI and cognitive outcomes for five cases with varying degrees of MCI following diet, exercise, optimized sleep, relaxation, and cognitive training protocol.

Research Problem: We have reported improvements in cognition and/or neural connectivity in multiple studies on LearningRx cognitive training programs[1-6] including the example below, but no studies using LearningRx for mild cognitive impairment (MCI) have examined neural correlates of cognitive change with this population, and we have not tested the intervention in combination with functional medicine protocols.

Results from a large observational study[6] on cognitive training with seniors (*n* = 262)



METHODS

Design: Using a multiple case study design, we examined neural connectivity, executive function, memory, attention, reasoning, everyday functioning, and overall IQ score for 5 clients with Mild Cognitive Impairment (MCI) before the intervention, after 12 weeks on functional medicine (FM) protocols without cognitive training, and again following completion of 72 hours of cognitive training.

Procedures: Participants spent the first 12 weeks following diet, supplements, and lifestyle protocols before beginning 12 weeks of cognitive training.

Functional Medicine (FM) Protocols: A physician and life coach monitored diet, nutritional supplements, and lifestyle changes, including the Institute for Functional Medicine (IFM) food plan with low/no sugar and low/no grains. Nutritional supplements included a multivitamin, Vitamin D, Omega 3 fatty acids, probiotics, Xymogen's Memorall and Brain Sustain shake. Participants were instructed to exercise aerobically for 30 minutes per day, to sleep at least 8 hours per night, and develop a habit of daily stress reduction using prayer, meditation, or other quiet time.

Cognitive Training: Then, participants attended three 90-minute cognitive training sessions each week for another 12 weeks. A psychologist monitored the delivery of the training. The cognitive training program, LearningRx Brain Booster, was delivered in person by a clinician—not on a computer—and targeted working memory, long-term memory, processing speed, visual processing, auditory processing, logic and reasoning, and attention skills.

Clinician delivering a cognitive training task

Assessments: Outcome measures included resting state fMRI, Montreal Cognitive Assessment (MoCA), Delis-Kaplan Executive Function System (DKEFS), Dementia Rating Scale-2 (DRS-2), Woodcock Johnson Tests of Cognitive Abilities, and Behavior Rating Inventory of Executive Function-Adult (BRIEF-A). MRI was performed on a Siemen's 3T MR scanner and included acquisition of a T1 weighted, high resolution anatomical image, and a 12-minute resting state EPI-BOLD functional acquisition (TR = 3 secs).

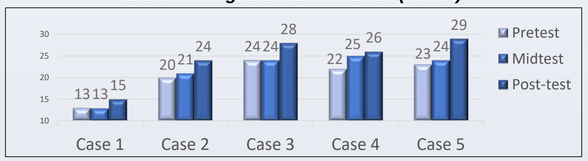
PARTICIPANTS

CASE 1: Age 71 Female with severe cognitive impairment
CASE 2: Age 68 Male with moderate cognitive impairment
CASE 3: Age 72 Male with non-clinical cognitive impairment
CASE 4: Age 71 Female with mild cognitive impairment
CASE 5: Age 56 Female with moderate cognitive impairment

**Severity graded based on DRS-2*

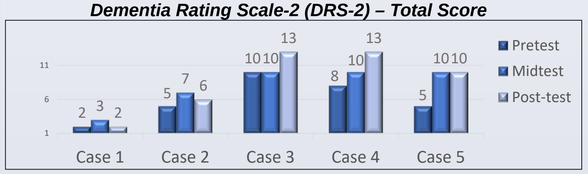
ASSESSMENT RESULTS

Montreal Cognitive Assessment (MoCA)



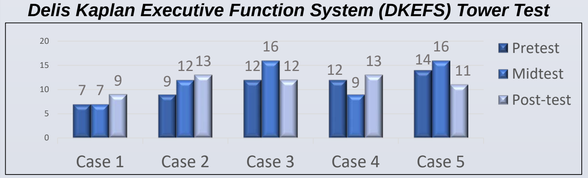
Score range: 0-30
26+ normal
18-25 mild impairment
10-17 moderate impairment
<10 severe impairment

Dementia Rating Scale-2 (DRS-2) – Total Score



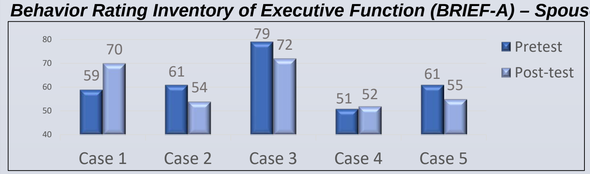
Score range: 2-18
2-3 Severe impairment
4-5 Moderate impairment
6-8 Mild impairment
9-18 Non-clinical

Delis Kaplan Executive Function System (DKEFS) Tower Test



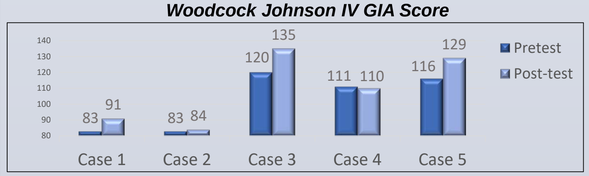
Score range: 0-20
0-3 Severe impairment
4-5 Moderate impairment
6-7 Mild impairment
8-12 Average for age
13+ Above average for age

Behavior Rating Inventory of Executive Function (BRIEF-A) – Spouse



T score range: <30 - 100
64 and below Non-clinical
65 and above Concern

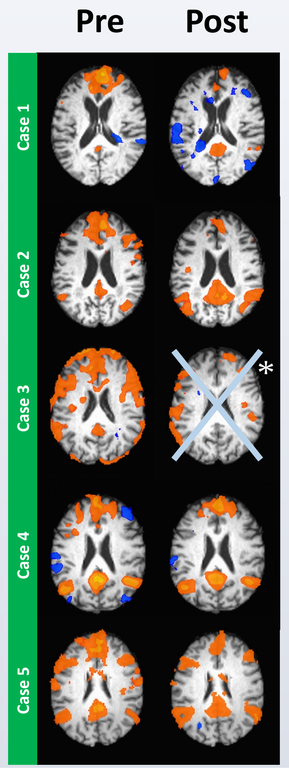
Woodcock Johnson IV GIA Score



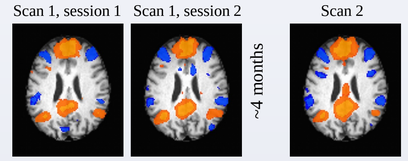
REAL LIFE CHANGES

- Case 1 reported improved social interactions and marital relationship
- Case 2 reported restored ability to write professionally and teach effectively
- Case 3 reported increased mental energy and launched a new business
- Case 4 reported increased energy, restoration of hope, and confidence to finish a doctorate
- Case 5 reported decreased depression and improved confidence

MRI RESULTS



Single Subject Control Scan of Default Mode Network



- Resting state fMRI data was processed using the CONN Toolbox
- Default mode network (DMN) integrity was assessed using the medial prefrontal cortex (MPFC) as the seed region of interest (ROI). MPFC connectivity with the posterior cingulate, and left and right parietal ROIs was then quantified.
- DMN integrity and cognitive impairment were inversely related on both pre and post scans.
- A trend toward normalization of the DMN was measured following the functional medicine and cognitive training protocol.

** Post scan for Case 3 was not included, subject fell asleep during the scan but incident was not reported until follow-up interview.*

CONCLUSIONS

- In all five cases, improvement in both cognitive and life skills was achieved with a functional medicine protocol that included cognitive training.
- Participants exhibited modest training-induced changes in neural connectivity.
- Normalization of the Default Mode Network (DMN) was evident along with the appearance of anti-correlations and decreased hyperconnectivity.
- A multidisciplinary approach to slowing or reversing cognitive decline appears to be promising.

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