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Individual Case Study: Improved Memory Functioning following Neurocognitive Training in a Diagnosed TBI patient

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Introduction

Patients have been receiving neurocognitive training as part of their treatment at an outpatient mental health facility for the past ten years and findings are the result of an ongoing study completed over the past five years. The program consists of neuropsychological assessment, which is patient specific and related to the reason for evaluation. Based upon the individual neuropsychological evaluation, a specific treatment plan is created. The plan is patient specific. Evaluation is completed, using the same testing at the same time of day, following a general range of three to six months of treatment to ascertain changes and efficacy of the program.

Neurocognitive intervention has been gaining credence in recent research, along with the modifiable risk factors and exercise as an intervention to address dementia decline. There are commercial programs that have shown to have efficacy and large scale studies have been conducted revealing the benefit of cognitive training and stimulation [1,2]. Cognitive training intervention and cognitive enhancement have been found to have positive effects, as well as impacting cognitive decline in the aged population [3,4]. When cognitive training was compared to physical training, improvement was distinct revealing improved executive function with cognitive training and improved memory with physical training [5]. Only modest support was shown for the potential of videogame training to improve cognitive function in healthy older adults and another study revealed only specific effects [6]. The transfer of training to real life improvement was seen as offering mixed results [7-9]. Finally, another study revealed that an active lifestyle was more effective than the effect of short term training interventions as impacting cognitive change over time in a dementia risk group.

This is the case study of a 60 year old man was involved in a motor vehicle accident resulting in a brief loss of consciousness and diagnosis of traumatic brain injury by neuropsychological evaluation. He was in perfect health prior to the injury. Testing was completed over six month's post injury suggesting that this was past the well-known amount of time for spontaneous recovery. Therapy began eight month's post-injury. The man is from another country and an interpreter was present for all of the treatment sessions. He was provided with neurocognitive training twice per week for one hour per session for a period of seven months and re-evaluated on selected memory testing with the same examiner at the same time of day.

Based upon initial neuropsychological evaluation, a plan is completed to address specific neurocognitive difficulties and in this case, memory was agreed upon as the first area of brain function to treat. The plan is patient specific and developed based upon the results of neuropsychological evaluation. In this case, therapy targeted areas of memory (short term, learning, delayed recall, recognition) as well as the impact of executive reasoning deficits of sequential processing, integration and selective attention. There are over 200 games and activities to choose from; ranging from items that have been created as well as published games being used to address the specific deficits. He was seen twice per week for one hour each visit and he was given a carryover program for the home setting. Therapy begins with the use of specific games and activities designed to address these issues. The activities either increase in difficulty and/or there are additions of variables such as speed. This is an ongoing program, continually changed and altered by the therapist who is observing in the session the response of the patient.

Re-evaluation was completed with visual memory measures and an assessment used to track dementia through time, the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS). The verbal portions of this measure were translated into his own language. He was administered the visual memory tests from the following memory batteries; Memory Assessment System (MAS), Doors and People Test, Wide Range Assessment of Memory and Learning (WRAML-2) and Brief Visuospatial Memory Test-Revised (BVMT-R). Scoring is based upon age and normative data for each test. Results revealed significant improvement in memory functioning seven months from the beginning of treatment. He improved on every index, excluding two indices and one visual memory measure; there was a decline in delayed recall of a short story from the RBANS and on the visual recognition task from the Doors and People Test (performance declined from below average to well below average limits). He declined on the last version of the BVMT-R, it was initially administered twice, without and then with glasses. Glasses were not a variable for the remainder of the tests reported here that were re-administered.

Re-assessment on the RBANS resulted in a significantly improved overall score from well below average to the average range. He improved significantly on tasks of immediate memory from highly impaired to well below average limits. Delayed memory improved from well below average to the average range. Visuospatial/constructional processing improved from superior to very superior limits, suggesting likely rather high cognitive reserve seen elsewhere in this re-evaluation. Language improved from highly impaired limits to the below average range and attention improved slightly from low average to average limits.

Scaled scoring on the dementia assessment revealed significant improvement in the learning of a discrete list of words, delayed recall was similar although improved. Delayed recognition of the words (from distracter items) was significantly improved from impaired limits to a perfect score in the average range which contributed to his improved delayed recall index score. Learning of the short story improved only slightly for learning and declined from low average to

below average for delayed recall. Visual recall improved from below average to average limits. Naming of common items improved from impaired limits to the average range, while word retrieval remained within well below average limits. Short term recall of numbers remained within superior limits, while the speeded coding task improved slightly, although remaining within well below average limits.

He was re-assessed on a number of visual memory tests to address his progress in treatment. He improved on a measure of visual retrieval measure for five designs (presented one at a time) on the WRAML-2 from below average to high average limits. Another measure of visual retrieval (MAS) improved from average to above average limits for a total of two designs (presented one at a time). A task of immediate visual recognition for designs (MAS) improved from average to high average and delayed recognition improved from average to very superior limits. A short term visual task (MAS) dependent upon sequential processing improved from well below average to average limits.

A visual learning task (Doors and People Test) improved from average to above average limits and a perfect score in the recall of four shapes. Delayed recall of the shapes improved from below average to average limits, he only missed one detail. He continues to have more difficulty with the increased amount of visual stimuli which may be suggestive of the impact of executive reasoning (seen on prior assessment) and/or memory overload. On a visual learning task (BVMT-R) involving the learning and recall of six designs, his overall total recall score was declined from above average to the average range. Learning was improved from average to above average limits and delayed recall declined from high average to average limits. He struggled with the details of the designs (as well as the position on the page) and performance declined from the last learning trial to the delayed recall trial.

Re-assessment revealed the most robust improvement on memory evaluation for the visual memory measures. He improved significantly on a task of recalling discrete words and declined for the delayed story recall. He continues to struggle with word retrieval seen on the RBANS. The pattern of the test results suggests ongoing greater difficulty when overwhelmed by too much stimuli presented at one time. This may be the result of executive reasoning processes which were not assessed in this evaluation. Results point to improvement that is significant from the intervention of neurocognitive training received two times per week. As a result of re-evaluation, the focus of neurocognitive intervention/training will shift to executive reasoning, as well as attention and re-evaluation will be completed in three months' time. He reports that he feels that he can rely more upon his memory for daily life tasks. This case study is commensurate with ongoing research and improvement seen over the course of the last ten years, shown in abstracts presented at area conferences since 2012 by this facility [10-18].

Limitations

While it is well-known and documented that six months' time is the period of spontaneous recovery from a brain injury, this does not totally rule out the impact of time upon the natural process of recovery. From a clinical perspective, the recovery process is greatest within the first six months of injury and declines after that time and would not reveal the robust effect that has been seen with the introduction of neurocognitive training.

Specific Test Findings

Scaled Scores: Average=10, Standard Deviation=3. This means that a score of 13 would be above average and a score of 7 would be below average. Standard Scores, IQ Quotient or Quotient Scores: Average=100, Standard Deviation=15. This means that a score of 115 would be above average and a score of 85 would be below average.

Dementia Assessment

Index scores on the RBANS

Index scores are based upon standard scoring whereby 100 is average and 15 is the standard deviation, meaning that 85 would be below average and 115 above average. Normative data based upon age (Tables 1a-1d).

Index	Immediate Memory	Visuospatial Visuoconstructional	Language	Attention	Delayed Memory	Total Scale
SS	53	121	57	91	71	73
%tile	0.10%	92%	0.20%	27%	3%	4%

Table 1a: Normative data: April 2016.

Index	Immediate Memory	Visuospatial Visuoconstructional	Language	Attention	Delayed Memory	Total Scale
SS	78	131	94	94	100	95
%tile	7%	98%	34%	34%	50%	37%

Table 1b: Normative data: January 2017.

Subtest	Scaled Score	Percentile
List Learning	2	
Story Memory	3	
Figure Copy	14	
Line Orientation		51-75%tile
Picture Naming		Below 2nd %tile
Semantic Fluency	3	
Digit Span	15	
Coding	2	
List Recall		26-50%tile
List Recognition		Below 2nd %tile
Story Recall	8	
Figure Recall	7	

Table 1c: April 2016 specific subtest scores.

Subtest	Scaled Score	Percentile
List Learning	8	
Story Memory	4	
Figure Copy	14	
Line Orientation		Above 75% tile
Picture Naming		17-25% tile
Semantic Fluency	3	
Digit Span	15	
Coding	3	
List Recall		51-75% tile
List Recognition		51-75% tile
Story Recall	5	
Figure Recall	11	

Table 1d: January 2017 specific subtest scores.

Learning and Memory Evaluation

Brief visuospatial memory test-revised

Presented in T score formulations whereby 50 represent the average and 10 is the standard deviation. Normative data based upon age (Tables 2a-2c).

Trial	T score	%tile	Trial	T score	%tile
Trial 1	42	21st	Total Recall	28	1st
Trial 2	30	2nd	Delayed Recall	37	10th
Trial 3	<20	<1st	Learning Score	35	7th

Table 2a: Normative data based upon age- April 2016.

Trial	T score	%tile	Trial	T score	%tile
Trial 1	58	79th	Total Recall	60	84th
Trial 2	60	84th	Delayed Recall	57	76th
Trial 3	60	84th	Learning Score	52	58th

Table 2b: Normative data based upon age- May 2016.

Trial	T score	%tile	Trial	T score	%tile
Trial 1	43	24th	Total Recall	47	38th
Trial 2	45	31st	Delayed Recall	47	38th
Trial 3	55	69th	Learning Score	63	90th

Table 2c: Normative data based upon age- January 2017.

The doors and people test

Scores are represented by scaled scores whereby 10 is average and 3 is the standard deviation. Normative data based upon age (Tables 3a and 3b).

Doors	7	Shapes	11

Table 3a: Normative data based upon age- April 2016.

Doors	4	Shapes	14

Table 3b: Normative data based upon age- January 2017.

The following scores provide further information regarding his performance by comparing the various variables in this memory measure (Tables 4-6).

SUBTEST	SS	SUBTEST	SS
Visual Memory	9	Visual Forgetting	7

Table 4a: April 2016.

SUBTEST	SS	SUBTEST	SS
Visual Memory	9	Visual Forgetting	9

Table 4b: January 2017.

The memory assessment system (MAS)

Index Score	Visual Memory
May 2016 Standard Score	99 (47th %tile)
January 2017 Standard Score	120 (91st %tile)

Table 5a: Normative data based upon age, 100 is average and 15 is the standard deviation.

SUBTEST	SS	SUBTEST	SS
Visual Span	4	Visual Reproduction	9
Delayed Visual Recognition	9	Immediate Visual Recognition	10

Table 5b: May 2016 Scaled scored.

SUBTEST	SS	SUBTEST	SS
Visual Span	9	Visual Reproduction	12
Delayed Visual Recognition	14	Immediate Visual Recognition	17

Table 5c: January 2017 Scaled scored.

Wide range assessment of memory and learning (WRAML 2)

Date Tested	Index	SS
May 2016	Design Memory	5
January 2017	Design Memory	12

Table 6: Scaled score based upon age.

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