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Outcomes of a Cognitive Management Program (CMP) for an Individual with Mild Neurocognitive Disorder at Risk of Developing Alzheimer

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Abstract

Individuals with mild neurocognitive disorder (mild-NCD) may suffer from one or a range of mild neurocognitive dysfunctions that disturb their daily life routines. This study tested the outcomes of an author-compiled cognitive management program (CMP) on a patient at the risk of developing Alzheimer. The CMP comprised a careful diagnostic procedure, a multi-dimensional cognitive assessment of the participant's cognitive functioning, and a series of cognitive rehabilitation procedures. A 59-year old woman (diagnosed based on DSM-5 and Addenbrooke's Cognitive Examination-Revised (ACE-R)) was included in the study. The participant's cognitive rehabilitation program consisted of a face-to-face training for twelve sessions and a daily homework-based training (35 days). The participant was tested at the baseline, at the end of the rehabilitation procedure, and 6- and 12-month follow-ups. To measure memory, attention, executive function, language, and reasoning abilities the following tests were administered: (a) Forward and Backward Digit Span Test; (b) Rey Complex Figure Test; (c) Continuous Performance Test; (d) Color-Word Interference; (e) Verbal Fluency; (f) Trial Making Test; (g) Symbol Digit Modality Test; and (h) The Twenty Questions Test and the Word Context Test. The Mean Percentage Improvement (MPI) index suggested improvements in the participant's scores for ACE-R subscales, memory, attention, language, executive functions, and reasoning and persistent improvements in the Word Context Test (55% at post-test and 63% at follow-up) and Rey Complex Figure Test (33% at the post-test and 47% at the follow-up). The results suggest that the CMP could improve the overall cognitive functioning of the participant.

Keywords: Mild Neurocognitive Disorder; Dementia; Alzheimer; Cognitive Rehabilitation reduction

Abbreviations: NCD: Neurocognitive Disorder, CMP: Cognitive Management Program, ACE-R: Addenbrooke's s Cognitive Examination-Revised, MPI: Mean Percentage Improvement, MCI: Mild Cognitive Impairment, MMSE: Mini-Mental State Examination, GDS: Geriatric Depression Scale, D-KEFS: Delis-Kaplan Executive Function System, TMT: Trial Making Test, MPI: Mean Percentage Improvement

Introduction

Mild cognitive impairment (MCI) is a common diagnosis among older adults **[1,2]**. Due to the importance of MCI, DSM-5 introduced a new diagnostic framework for screening mild neurocognitive disorders (mild-NCD) **[3]**. Mild-NCD is defined as a deficit in at least one cognitive function that has not been evident in the person's performance in the past. In addition, the deficit should not be a result of other forms of delirium and cannot be explained by other mental disorders **[4,5]**. The first subtype of mild-NCD is mild neurocognitive disorder caused by Alzheimer (mild-NCD due to Alzheimer), which is characterized by a progressive memory loss and learning inability. However, there are other subtypes that can describe cognitive dysfunction including mild vascular neurocognitive disorder or mild neurocognitive disorder due to HIV infection **[4]**.

Precise diagnosis is the first and the most important phase in the management of cognitive disorders in individuals with cognitive disorders like mild-NCD. To understand the nature of the disorder, it is necessary to manage its symptoms, alleviate its consequences, and prepare a multi-dimensional cognitive profile **[6]**. Moreover, a detailed cognitive neuropsychological assessment with a compressive emphasis on specific cognitive domains (i.e., memory, attention, language, executive functions, and reasoning) can provide a more inclusive evaluation prior to the rehabilitative intervention **[7]**. For instance, the diagnosis of attention deficit, which adversely affects memory **[8]**, is possible only through a multi-dimensional cognitive assessment.

Although multi-dimensional assessment and cognitive rehabilitation with a specific emphasis on real life performance can provide promising results **[9,10]**, there is not a general consensus over procedures through which cognitive rehabilitation can assist individuals with mild-NCD **[10]**. To develop a comprehensive model of cognitive rehabilitation for individuals with cognitive disorders, more evidence-based research is essential **[11]**. Thus, this study focuses on an evidence-based CMP that comprises three components: (a) diagnosis, (b) assessment, and (c) cognitive rehabilitation.

Case Illustration

The present study addresses issues regarding diagnosis, assessment, and cognitive rehabilitation procedures in a right-handed **[12]**, literate, 59-year-old woman who lived with her husband and daughter. Her medical records suggested that she had mild neurocognitive disorder (mild-NCD) caused by Alzheimer and was recruited from a daily Nursing Home in Mashhad-Iran. Her chief complains were related to memory problems, e.g., forgetting daily routines like taking medications. She had trouble remembering the name of people she had just met. She complained that she could not learn new things and had therefore withdrawn from her English language classes (a curriculum held by the Nursing Home). Likewise, she had trouble arranging her daily activities, and could not plan for participating in regular schedules organized by the Nursing Home. She reported that she does not care much about her diet or sleeping schedule. She suffered from mild knee arthritis and took medication to control urinary incontinence, which was interrupting her sleep. In addition, she took low-dose fluoxetine for years to manage her mood. However, she did not meet the criteria for depression disorder.

Methods

Diagnosis

The participant met [at the baseline] the DSM-5 criteria for mild neurocognitive disorder caused by Alzheimer. On Addenbrooke's Cognitive Examination-Revised (ACE-R) test, she gained a score of 78 that was suggestive of a cognitive state between MCI and Alzheimer. In keeping with her complains and compared with her scores on attention and language tasks, she gained the lowest score on memory performance task (score = 14). **(Table 1)**.

To arrive at a valid diagnosis, other subtypes of mild-NCD were also evaluated based on DSM-5 criteria and the participant's medical records and laboratory findings. In addition, the participant's scores on the geriatric depression scale suggested that her scores on the cognitive tasks were not an artifact of depression at all assessment points.

To develop a satisfactory cognitive performance profile, a multi-dimensional battery of cognitive functioning (i.e., memory, attention, verbal fluency, executive functions, and

reasoning) was used in all assessment points **(Table 2)**.

Table 1: Shows attention-orientation, memory, fluency, language, visuospatial, total score, MIMSE, depression in each stage at pre-test, post-test, and at 6 and 12-month follow-ups.

Sub-scales	Pretest	Post test	post-test MPI	Follow-up (6 month)	Follow-up (6 month) MPI	Follow-up (12 month)	Follow-up (12 month) MPI
Attention orientation	18	18	0	18	0	18	0
memory	14	21	33%	18	22%	24	42%
Fluency	10	9	-11%	11	9%	10	0
Language	21	24	13%	23	9%	24	13%
Visuospatial	15	16	6%	15	0	15	0
Total	78	88	11%	85	8%	91	14%
MIMSE	27	28	4%	30	10%	30	10%
Depression	3	-	-	6	50%	5	40%

Note. Mean percentage improvement (MPI) was used to show the magnitude of the effect.

Table 2: Memory, Attention, executive function, language and reasoning subject's scores in the pre-test, post-test, and follow-up.

Instruments		Pretest	Post test	Post-test MPI	Follow-up (6 month)	Follow-up (6 month) MPI
Memory	Forward-digit span	7	8	12.5%	7	0
	Backward-digit span	5	6	17%	5	0
	Rey complex (ure test Copy	34	36	6%	36	6%
	Retrieval (3 minutes)	12	17	29%	15	20%
	Retrieval (20-30minutes)	8	12	33%	15	47%
Attention	continuous performance test	139	147	5%	148	6%
	Colour-Word Interference					
Language	Verbal fluency				0	
	Categorizing	6	7	14%	8	25%
	Switching	12	17	29%	15	20%
		11	11	0	22	50%
Executive Functions	Trial Making Test					
	Number-sequencing					
	Letter-number sequencing	9	12	14%	8	18%
	Symbol digit modality test	6	7	29%	15	33%
		36	42	0	22	-3%
Reasoning	Twenty Questions	9	12	25%	14	36%
	Word context	4	9	55%	11	63%

Note. mean percentage improvement (MPI) have been used to show magnitude of effect.

Intervention

A cognitive rehabilitation program was designed based on the diagnostic criteria and the outcomes of the multi-dimensional cognitive assessment with an emphasis on memory and tasks of executive functions **(Table 3)**. With some modifications, the rehabilitation program consisted of several practices adapted from previous studies **[13,14]**. Cognitive rehabilitation was divided into two types of training: (a) an in-person training (through face-to-face sessions); and (b) a home-based training (see **Table 3**). The former consisted of two to three sessions (90-min) per week (a total of twelve sessions), and the latter was performed every day by the participant; each session was monitored by the experimenter on the same day. The cognitive intervention lasted for 35 days. The rationale behind home-based training was that some tasks like diary training and executive function training strategies (e.g., planning skills) can best be promoted through daily practices by an individual at home **[15]**.

The participant was provided with sufficient, clear instructions on how to complete home-based training to improve her memory and manage her daily routines. The instructions covered four areas: (a) direction or orientation **[13]**, (b) a daily timetable, (c) diary writing, (d) writing of new items or a specific piece of information that she was expected to learn and remember in the next session **[14, 16-18].**

Daily face-to-face sessions were arranged with the participant to overview home-based training and to evaluate her progress with the previous session exercises. Different types of reasoning-based practices (categorization, summarization, and comprehension strategies) **(Table 3)** were scheduled for the initial phase of the intervention to enhance learning processes trailed by memory training **[19;21]**. There is evidence that improvements in memory can, in turn, enhance reasoning skills **[22-24]**. Additional trainings were included in the program to improve the participant's attention, executive functions, and language capabilities (i.e., fluency, switching, and categorization).

Procedure

A written informed consent was obtained from the participant prior to the study. The present study lasted from January 2019 until March 2020 (follow-up). One of the present coauthors was responsible for the administration of the study. She was granted access to all medical records of the participant in the Nursing Home. The diagnostic procedure was carried out by the experimenter who holds a degree in psychology and a gerontologist at the Nursing Home. All testing and intervention sessions were conducted in a silent room at the Nursing Home. The room was furnished with comfortable seats and an office desk. The second 12-month follow-up partly coincided with the outbreak of COVID-19 pandemic and we were not able to administer all post-test measures due to the pandemic. Therefore, only tests of diagnostic criteria (i.e., ACE-R and GDS) for the participant's cognitive abilities are reported at the 12-month follow-up.

Instruments

Diagnostic tests

Addenbrooke's Cognitive Examination Revised (ACE-R)

First, the Persian version of Addenbrooke's Cognitive Examination-Revised (ACE-R) was administered with the participant. The ACE-R is an extension of the Mini-Mental State Examination (MMSE) **[25]** and has good reliability and validity **[26,27]**. The participant scored 78 on the ACE-R. A score of 78 and lower is suggestive of Alzheimer's disease whereas scores between 78-85 are suggestive of MCI.

Geriatric Depression Scale (GDS)

The participants' depression symptoms were assessed using the validated and reliable Persian version of GDS **[28-30]**. A score of ≥ 8 indicates clinically relevant depression, which was not met by the present participant.

Cognitive Battery Tests

Table 3. Personal (face to face) and home-based training.

General Cognitive Domain	Specific cognitive domain	practice	Home-based	In person
Memory	Visual short memory	Memorizing list of purchasing		*
		Memorizing list of numbers		*
	Auditory short memory	Memorizing list of purchasing		*
		Memorizing list of numbers		*
	Visual working memory	List of numbers		*
	Auditory working memory	List of numbers		*
	Spatial working memory	Sequences of doing activities		*
		Address finding		*
	Face recognition	Matching faces with names		*
	Long term memory	Writing everyday diary	*	*
		Learning piece of information	*	
		Remembering past session		*
Attention	Orientation and direction	Writing every day's date	*	
	Sustained attention			*
	Inhibition	Looking at pictures for a while and then answer the questions		*
		Listening to given information focusing on important one and ignore other things		
Executive function	Planning	Writing every day's program in schedule	*	
		Planning some vacation, tour, accommodation and etc.		*
Language		Talking about given topic		*
		Writing about given topic	*	
		Interview with experimenter and keep the conversation in certain way		*
		Try to use descriptive sentence in writing and talking	*	*
Reasoning	Categorizing	Classify reading text	*	
	Comprehension	Link various part of reading together	*	
		Who/where/ when/why strategy	*	
		Summarizing text	*	

Note. * shows the types of cognitive rehabilitation

Memory

Tests of short-term, long-term, and working memory, forward and backward digit span (adapted from the Wechsler Memory Scale) **[31]** and Rey-Osterrieth Complex Figure Test (i.e., copy, immediate recall, and delayed recall) **[32]** were administered with the participant, respectively.

Attention

Computer-based Continuous Performance Test **[33]** was used to measure sustained attention. Color-Word Interference Test was administered to measure inhibition and switching **[34]**. This test was extracted from the Persian version of the Delis-Kaplan Executive Function System (D-KEFS) **[35]**.

Executive function

The executive functions were measured using Symbol-Digit Modality Test (S-DMT) (36) and Trial

Making Test (TMT) **[35,36]**.

Language

D-KEFS subtests of verbal fluency, categorization, and switching standardized for Persian language were administered with the participant to measure her language abilities **[35,36]**.

Reasoning

D-KEFS subtest of Twenty-Question Tests and Word Context were used to measure the participant's reasoning skills **[35,36]**.

Data analysis

To analyze data on diagnosis and assessments, we used Trend Change Chart and Mean Percentage Improvement (MPI) index. The MPI index is a measure of clinical significance that is used to show the mean improvement percent, which is calculated from the following equation:

MPI = [(baseline mean – treatment phase mean) / treatment phase mean] × 100

Results

The following presents the study results for diagnostic criteria and cognitive performance. In terms of diagnostic criteria, the results for the ACE-R sub-scales indicated improvements in scores for language, memory, and visuospatial skills from pre-test to post-test and to the 6- and 12-month follow-ups **(Table 1)**. The total ACE-R score increased to the normal range (88-100) at the post-test, with a minor decrease at the 6-month follow-up (85), and again a major spike at 12-month follow-up (91)

(Table 1).

Moreover, the highest improvement was observed in the memory subscale at the post-test (33%), at the 6-month follow-up (22%), and at the 12-month follow-up (42%). It was followed by improvements in the language subscale at the post-test (13%), at the 6-month follow-up (9%), and at the 12-month follow-up (13%) **(Table 1)**.

In terms of multi-dimensional cognitive functioning **(Table 2)**, there was a 55% increase at the post-test and a 63% increase at the 6-month follow-up scores for Word Context Test. Memory in the Rey-Osterrieth Complex Figure Test's delayed recall subscale was the next variable with 33% and 47% improvements at the post-test and the 6-month follow-up, respectively. Further increases were observed at the post-test for the 3-min immediate recall (29%) and for the categorization of language (29%); the increase in both indices was smaller at the follow-up assessment (i.e., 20% of increase compared with the pre-test assessment). All language subscales except improved substantially at the post-test and follow-ups. Among attention subscales, only switching and Continuous Performance Test showed an improvement. All subscales of executive functions improved at the post-test **(Table 2)**. No complications or undesired side effects were reported by the participant, the experimenters or the nursing home team members.

Discussion

The present study aimed to diagnose, assess, and intervene in the process of mild neurocognitive disorder (mild-NCD) caused by Alzheimer. Our findings suggest substantial improvements in the cognitive performance of an individual with mild-NCD, as evident from increases in her scores from pre-test to post-test and the follow-up assessments for the following indices: short-term and working memory, visual memory, sustained attention, switching, verbal fluency, categorization, number-sequencing, letter-number sequencing, symbol digit modality, twenty questions, and word context.

Considering the need for categorization, comprehension, summarization, and structuring information, reasoning improved smoothly during the training and reached a high level for both auditory and visual tasks. In reciprocity, memory training would help improve reasoning and language abilities. Accordingly, there is evidence supporting the strong relationship among language, memory, and reasoning **[22-24, 37-40]**. Each of the above can have a positive effect on one another, which should be considered in a rehabilitation model. In addition, the participant reported that when she intended to participate in the Nursing Home's book club, she tried to categorize information by taking notes and remembering them later. The participant reported a similar improvement in the same way (i.e., categorization, preparation, and finalization) by drawing a picture in the Rey test.

Likewise, the participant's ability to plan her daily activities improved, and she was able to manage training, which called for a satisfactory level of planning (e.g. planning a travel for tour members by considering limitations such as the timetable of activities, traveler's preferences, and several such factors). Consistent with her progress in planning, her scores improved in the subscales of executive functions (see **Table 2**).

Our findings provide support for the view that cognitive-based therapies may improve cognitive functions **[41]**. However, the extent of improvement may vary in various cognitive domains. In the present study, the highest improvements were observed in the participants' language capabilities (except for verbal fluency), working memory, and visuospatial skills which further support findings reported by Spector et al **[42]** and Hall et al. **[42]**.

The main assumption underlying cognitive-based interventions is that cognitive rehabilitation can reverse cognitive decline in individuals at risk of Alzheimer **[43]**. the rehabilitation can exerts its impact through neurocognitive mechanisms, including (a) adaptation; (b) cognitive control; and (c) categorization through organization **[44]**. Another explanation is that adhering to a home-based training (i.e., directions questions, diary writing, and checking a timetable on a daily basis) reduces stress, and improves learning and memory **[45-47]**.

Likewise, reasoning training (e.g., categorization) and language practices (speaking for a limited time) can expedite the cognitive rehabilitation process **[48]**. Most of the changes (i.e., restorations and improvements) appear to be the outcomes of effective and organized behavioral adaptive coding in the prefrontal cortex and reciprocal, network-related cortico-cortical and cortico-subcortical connectivity and activities **[44,49]**.

Although the present study focused on a real-life training **(Table 3)**, there are some limitations associated with ecological rehabilitation and the generalization of the skills to other real-world situations **[50]**. The limitation seems to be due to the complex relationship between everyday activities and cognitive domains that they engage **[16]**. Therefore, future studies can explore these relationships to develop more comprehensive real-life training programs, which could involve using computerized technologies.

To conclude, memory, language, and reasoning appear to play a substantial role in the success of cognitive management program in individuals at risk of developing dementia caused by Alzheimer's disease. Careful diagnosis of mild-NCD, followed by a multi-dimensional assessment of the clients' cognitive functioning, could promote evidence-based findings that are necessary to develop effective cognitive-based intervention **[51]**.

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The Ethics Committee of Mashhad University of Mashhad approved the study. participant gave informed consent before participating.

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