

Neuropsychological intervention of minimal cognitive impairment including language deficits

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Abstract. – OBJECTIVE: Mild Cognitive Impairment (MCI) is an early dementia or discrete memory loss. The cognitive deficit in MCI impedes people's daily activities, which influences multiple aspects of thinking and acting including attention, reading, writing, reasoning, language, and judgment. This review aims to assess the outcome of various neuropsychological interventions in treating MCI.

MATERIALS AND METHODS: MCI causes memory problems and is characterized by the cognitive damage that is disproportionate about individual education background and age.

RESULTS: Post-mortem biopsies performed on 134 patients diagnosed with MCI showed the presence of Alzheimer's disease AD in 54.4% of all the patients, mixed pathologies in 19.4% and gross microscopic infarcts in 39.1% patients. This review was done to assess the outcome of MCI and the various neuropsychological interventions, which are being used in the treatment of MCI. These techniques were studied individually followed by their roles in treating specific cognitive deficits.

CONCLUSIONS: The study focused on reviewing the literature for mainly three cognitive rehabilitation strategies: (1) rehearsal-based approaches (2) compensatory techniques (3) mnemonic strategies. In the present review, rehabilitation of language deficits in MCI is also included.

Key Words:

Minimal cognitive deficits, Attention deficits, Memory deficits, Mnemonic strategies, Compensatory techniques.

Introduction

Mild cognitive impairment (MCI), which is an early dementia or discrete memory loss, can cause detectable and measurable reduction in cognitive abilities, including memory and thinking. The cognitive deficit in MCI affects people's daily

activities including multiple aspects of thinking and acting, such as reading, writing, attention, reasoning, language and judgment. MCI causes memory problems and is characterized by cognitive damage that is disproportion to the education background and age of the patients¹. MCI is prevalent in older individuals, about 10% of people between the age of 70-79 years and 10% of people between the age of 80-89 years are affected by different degree of MCI. MCI is a transitional state between normal ageing and early dementia. People with MCI generally do not perform well in memory tests due to either forgetfulness or attention deficit. Cognitive impairment in MCI is progressive and one half of people with MCI will be diagnosed with Alzheimer's disease in the following 3 to 5 years. In this review, we will first discuss the progression of MCI. Also, various neuropsychological interventions used in the treatment of MCI will be discussed. We will discuss these treatments individually, followed by reviewing their roles in treating specific cognitive deficits. Three cognitive rehabilitation strategies including (1) rehearsal-based approaches, (2) compensatory techniques (3) mnemonic strategies, are the main focuses of this review.

Progression of Mild Cognitive Impairment

Post-mortem biopsies performed on 134 patients diagnosed with MCI showed the presence of AD in 54.4% of all the patients, mixed pathologies in 19.4% and gross microscopic infarcts in 39.1%. Hence it can be concluded that not all patients with MCI develop AD². Another study showed that a combination of different pathological processes, usually AD with macroscopic infarcts and neocortical Lewy body disease contributed to 45.8% of the 179 people with suspected AD.

MCI is a transitional phase that connects physiological ageing and dementia; therefore, the understanding of MCI is crucial for the implementation of secondary interference on dementia. Currently emphasis is laid on the identification and utilization of both pharmacological and non-pharmacological tools to impede or attenuate the transition from MCI to AD. Several previous studies have carried out to investigate the progression of MCI to dementia as well as many other cognitive disorders. Different rates of progression were reported in different studies; the average conversion rate of MCI to dementia is 10% per year, indicating a linear progression in the transition to dementia over time¹⁻⁴. A random population cohort study conducted over a period of 6 years reported that approximately 80% of the MCI patients developed dementia. A community based study conducted over a period of 1 year⁵ showed that 0-3% of the MCI patients developed CDR (Clinical Dementia Rating), and > 1 but ≤ 20% of the patients experienced serious cognitive damage, 6-53% showed improvement or complete recovery, and 29-92% showed no progression. Studies conducted on single and multi-domain executive MCI suggest that single-domain executive MCI possesses a prognosis superior to amnesic MCI. Also, executive pathology in multiple-domain MCI is insufficient to enhance the likelihood of transition to dementia⁶. It's reported that hypothyroidism, normal pressure hydrocephalus, vitamin B12 deficiency, and subdural hematoma caused by MCI, can be cured in one-third of the subjects. At the same time, neurodegenerative disorders like lewy body disease developed in subjects with MCI⁷. Subjects having subcortical microvascular disease, mild parkinsonian signs, non-amnesic MCI, multi-cognitive deficit MCI, vascular comorbidity, signs of vascular disease on brain imaging, mood disorders and behavioral indications, are more likely to develop vascular dementia⁸⁻¹⁰. A meta analysis of 41 robust inception cohorts¹¹ reported that the conversion rate of MCI to dementia was 9.6% in specialist clinical settings, to Alzheimer's dementia was 8.1 % and to vascular dementia was 1.9%, whereas in community settings it was 4.9%, 6.8%, and 1.6%, respectively. Hence it is unlikely that most patients will develop dementia during the following ten years¹². Improvement or complete recovery has been reported in up to 33-55% of all the patients and factors related to the reversion have also been studied¹². The factors which can improve the disease include complicated mental activity, more readiness to experien-

ce, superior vision, superior olfactory potential, bigger combined volume of the left hippocampus HC and left amygdala, and a steeper decline in diastolic blood pressure between baseline and follow-up. Poor prognostic markers for MCI were associated with the existence of multiple-domain MCI, a damaged cognitive domain or an informant-founded memory complaint. These results were based on data derived from a prospective, population-founded Sydney Memory and Ageing Study. Hence controlling vascular factors like fall in diastolic blood pressure and incorporating cognitively enriching experiences are promising interventions for MCI.

Neuropsychological Intervention Approaches

Rehearsal-Based Approaches

Rehearsal based approaches are to ask patients repeating information over time. The characteristic of the repetitions varies across techniques. Two examples of such approach include spaced retrieval approach and subtracting cues approach. In the former one, the patient is required to remember targeted message over gradually increased time lapses. In the latter one, the deletion of parts of the target message (e.g., the spelling of a noun) was applied. Both techniques have been proved to be effective in treating patients having AD^{13,14}, thus proving the conclusion that rehearsal may be most suitable for late MCI patients. Those approaches are useful in teaching specific message like names of new persons in a known societal circle (e.g. church members)^{15,16}. However, it is important to keep in mind that these effects are stimulus-specific or information-specific that cannot be generalized across different cross sections of the society (e.g., to other church members or new comers of a hospital), making it imperative to train the individual every time he/she gets new piece of learning information. The new piece of information could be a new church member's name, the site of certain household items, or a certain road to a new doctor's office. Hence, no matter how efficient they are, the application of these techniques is not only situation-dependent and stimulation-specific but also limited by the length and complicity of the treatment. Many of the available computerized training programs are designed with the purpose of improving cognitive abilities and one study reported increased hippocampal activation after training¹⁷. However, when it comes to generalization of standardized

neuropsychological tests^{18,19} or daily management across patient populations^{20,21} evidence on such approaches are conflicting. This limitation consolidates the necessity for training to be geared towards outcomes.

Compensatory Methods

Techniques employing compensatory aids aim to alter or augment memory processes and hence altering the manner of learning, retention and information retrieval of patients. Such even techniques can even benefit cognitively intact individuals to improve their daily life quality. For instance, external compensatory aids like grocery lists or smart-phones are perhaps most efficient for potential tasks like memorizing assignments. Memory note-books conventionally play an important role in treating patients with rehabilitation of traumatic brain injury (TBI) or stroke patients to re-establish their impaired memories²². The Cognitive Rehabilitation Manual released by the American Congress of Rehabilitation Medicine²³ describes well-documented approaches that can achieve that effect. In their attempt to modify the traditional notebook approach, Greenaway et al²⁴ have demonstrated that a disciplined training program can be helpful for improvements in the daily activities and memory self-effectiveness in people having MCI and reduction of the caregivers' distress. These external compensatory approaches also have limitations. Aid-dependency is the main limitation, and failure in task will happen without aid. Another limitation is the occasional/frequent inappropriate use of these aids. For instance, the aid could prove cumbersome and awkward in situations such as recalling an individual's name, a task with social norms is expected to be recalled promptly. Likewise, with the outside help in mind, an individual tends to accumulate pages (electronic or physical), notes, or bookmarks and as a result, the retrieval of specific information could prove challenging with the passage of time. Although patients can refer to key events (e.g., holidays) to retrieve information, studies indicate that temporal referencing²⁵ and associative referencing²⁶ will be particularly difficult for patients with MCI.

Mnemonic Strategies

Cognitive 'instruments' that help organize and connect new messages through internal compensatory aids fall under the category of mnemonic strategies. By facilitating new information processing, they facilitate a more in-depth proces-

sing. Procedures such as semantic organization, semantic articulation, and mental imagery are included in mnemonic techniques. 'Internal' means that these cognitive tools can be used by the patients almost everywhere. Mnemonic strategies are considered as normal treatments of patients with insignificant memory deficits after traumatic brain injury²² and hence support the earlier reports that these methods might be most helpful for patients with early MCI^{27,28}. Mnemonic strategies are believed to be able to improve studying and memory in old adults as revealed by meta-analysis studies²⁹ and several large scale studies employing these techniques within larger programs³⁰⁻³². These techniques can re-establish the use of "normal" brain parts (or networks) and/or engage other compensatory parts (or networks) to improve patients' behavior, given that these methods engage multiple cognitive procedures. Researchers²⁶ have indeed shown enhanced fMRI-based activation and connection between numerous crucial prefrontal and parietal regions. The authors also showed incomplete reestablishment of hippocampal activation in patients having MCI²⁸. A compensatory role by the right parietal temporal junction, when applied strategically in MCI patients, has also been suggested by some other researchers³³. These findings together with the associated behavioral improvements support the theory that mnemonic methods adaptively alter the way patients deal with messages. Therefore, generalizing them to other scenarios and daily life could be promising because their universal "rules" can be applied across settings once learned. Limitations of those approaches are not lacking. They are time consuming and effortful in nature needed to be considered in outcome within restricted exposure time (e.g., one word every second as in most word lists) or bulky information beyond the handling capacity of attentional/working memory. In addition, this approach with its cognitive demands may be too complicated for more cognitively compromised people²⁸.

Cognitive Rehabilitation Techniques for Specific Cognitive Impairments

A thorough scrutiny of the available data from patients diagnosed with cognitive impairment showed that attention parameter gets affected in the early part of the disease. The selective attention deficit has often been associated with impairment of implicit memory³⁴. The ability to concentrate on a specific stimulus by eliminating unwanted or harmful stimuli is called selective attention.

Selective attention also encompasses detailed attention and response to the stimulus³⁵. From patients' data, the pattern of cognitive impairment is shown to have started gradually during the early adulthood. Age-related changes in the brain have also been responsible for cognitive impairment. Although brain can develop newer synapses as a part of the compensatory mechanism, lack of specific skills further contributes to cognitive weakness. Therefore, reinforcement of specific skills by cognitive training intervention should be able to arrest progressive worsening of cognition, in which cognitive rehabilitation plays a pivotal role. It includes a wide array of therapeutic techniques, most common being the one in which the therapist evaluates ratio of right responses and the rate of cognitive tasks performed by their patients. The degree of difficulty is heightened by the therapist once the patient masters the given task³⁶. The impact of cognitive rehabilitation on various parameters like mood and memory has been extensively studied by Barekatin et al³⁷. Schmitter-Edgecombe et al³⁸ showed beneficial results in people suffering from moderate cognitive impairment regarding behavior management. Stavros et al³⁹ reported that attention disability and memory related impairment can be rectified with cognitive rehabilitation techniques. However, Huckans et al⁴⁰ have suggested the need for a remedial approach in conjunction with rehabilitation techniques to develop a hypothetical model for developing and evaluating the therapeutic concerns. Abundant data on the evaluation of cognitive function, quality of life and severity of neural symptoms are available. Yet, hardly any studies concentrate on evaluating the effect of rehabilitation on mild cognitive damage⁴⁰. The present has been carried out to examine the efficacy of cognitive rehabilitation in improving the discriminating attention deficit of patients having cognitive damage.

Concentrated Restorative Cognitive Training Intervention - Single Domain, Attention/Information Processing

Barnes et al⁴¹ has shown a significant improvement in selective attention deficit through auditory attention and discrimination rehabilitation technique. In that study, the possibility of a downstream effect on memory with auditory attention rehabilitation technique was discussed. In that study, a focused computerized cognitive training intervention (100 mins/day, 5 days/week for 6 weeks) against a control group, which was given robust computer activities, was developed. The

results showed that the test group performed well in a spatial span task, but performed poorly in the rest of the tasks. The work design had lacunae regarding the possibilities of having given less cognitively stimulating tasks to the control group. Besides, the study did not evaluate the long term usefulness of the rehabilitation technique in converting MCI to normalized cognition or preventing its progression to dementia. Another paper that was reviewed was a quasi-experimental study conducted by Oskoei et al⁴². The subjects in that research consisted of 40 patients from neurology clinic in Tehran in 2012. All patients in the test group had mild cognitive impairment assessed by a medical psychologist (MMSE score lower than 25 and Wechsler memory test). All the patients were above 55 years old with minimum education at degree level and no comorbid neurological or psychiatric illnesses was found from their medical records. The entire group was randomly divided into test group and control group, 20 patients in each group. The test group was administered with 12 sessions (two hours each section) of cognitive rehabilitation using Neurocognitive Joyful Attentive Training Intervention (NEJATI). The control group was exempted from these trial sessions. The parameters like discriminating attention of both sets were studied before and after the test using a Strop computer program. We analyzed the data using the covariance statistical test, MANCOVA. The outcome showed a significant improvement in discriminating attention scores of the test group against the control group. Thus, it can be deduced that cognitive rehabilitation helps improving discriminating attention deficits.

Concentrate Compensatory Cognitive Training Intervention - Single Domain, Memory

Greenaway et al²⁴ concentrated on improving memory with a compensatory cognitive training tool. It consisted of maintaining calendars and notebooks 2 hours/week for 6 weeks, like arranging appointments, including "to do" items, and journaling. They showed a significant improvement in memory self-efficiency and daily performance compared to the control group. It also showed that improvement in daily functioning lasted for 6 months post intervention. Some of the parameters such as objective global cognition, QOL, or neuropsychiatric sign seriousness which are used as therapeutic evaluation tools were not significantly improved because these parameters were not the targets of the rehabili-

tation design. The drawback of this study was that conversion rate of MCI to normalized cognition or dementia was not calculated. A literature review showed two exclusive reports which studied the impact of cognitive rehabilitation on memory alone⁴³⁻⁴⁵. The rehabilitation in both studies mainly consisted of reinforcing and neither of them had contact control cohorts. Rapp et al⁴³ performed rehabilitation programs included six 2-hour sessions arranged across six weeks of training in compensatory memory skills as well as psycho education and easing (breathing) practice. The subjects showed significant improvement in memory tests during the first 6 months after intervention. They also demonstrated better usage of pneumonic methods at follow-up. The work of Troyer et al⁴⁴ consisted of ten 120-minute sessions arranged across 6 months, one hour dedicated mainly to compensatory memory practice, and the other hour dedicated to focused lifestyle training along with psychotherapeutic therapeutic methods. Their study design was worthy of appreciation in multiple terms like recruiting dieticians for lifestyle management, providing participants with more resources so that they could heighten their activeness, arrange sessions of intervention over long period so that potential benefits could be achieved for a longer period. However, their study results in terms of objective memory behavior, subjective memory complaints, or everyday performance, were not remarkable. Nevertheless, the experimental group reported a certain element of wellness in their lifestyle with increased usage of compensatory memory strategies and this belief was sustained for three months post intervention.

Conclusions

The possibility of ineffective intervention and inadequate measures cannot be ruled out for the occurrence of non-significant results. Again both the studies failed to examine the conversion rate to normalization of cognition or dementia. Yet, the experimental set did not present considerable enhancement on measurement of the scale.

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Conflict of interest

The authors declare no conflicts of interest.

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