EFFECTIVENESS OF RETRIEVAL PRACTICE ON PROSPECTIVE MEMORY DEFICITS IN MILD TO MODERATE TRAMATIC BRAIN INJURY PATIENTS

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CHENNAI

CERTIFICATE

This is to certify that the research work entitled EFFECTIVENESS OF RETRIEVAL PRACTICE ON PROSPECTIVE MEMORY DEFICITS IN MILD TO MODERATE TBI PATIENTS was carried out by Reg. No.411514001 KMCH College of Occupational Therapy, towards partial fulfillment of the requirements of Master of Occupational Therapy (Advanced OT in neurology) of the Tamil Nadu Dr. M.G.R. Medical University, Chennai.

Guide

Mrs. Sujata Missal
M.Sc. (OT), PGDR. (OT)
KMCH College of
Occupational Therapy

Principal

Mrs. Sujata Missal
M.Sc. (OT), PGDR. (OT)
KMCH College of
Occupational Therapy

Clinical Guide

Dr.J.K.B.C.Parthiban

M.Ch(neuro).,FNS(Fujita.Japan)

Consultant Neuro surgeon

Kovai Medical Center and Hospital, Coimbatore

Internal examiner

External examiner

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OPERATIONAL DEFINITION

Traumatic Brain Injury

Traumatic Brain Injury is defined as any traumatically induced structural injury or physiological disruption of brain function as a result of an external force.

Prospective Memory

It is the deficit of old memory and daily memory skills after the accident. Prospective memory is a form of memory that involves remembering to perform a planned action or recall a planned intention at some future point in time.

Retrieval Practice

Retrieval practice helps to regain patient memory and their daily living skills. It is a new strategy to improve the learning skills and cognition.

ABSTRACT

Background: Impairment of prospective memory (PM) is common following traumatic brain injury (TBI) and negatively impacts on independent living, compensatory & Remedial approach to PM rehabilitation have been found to minimize the impact of PM impairment in adults with TBI ; however poor self- awareness after TBI poses a major barrier to the generalization of these strategies in daily life.

Objectives: The aims of the study is to find out the effectiveness of Retrieval practice of rehabilitation on prospective memory deficits for mild to moderate TBI patient.

Methods: 20 participants were recruited for the study. Of which 10 participants underwent Retrieval practice and 10 underwent compensatory training with traditional memory training. The participants were administered with Monstreal Cognitive Assessment (MOCA), Prospective and Retroceptive Memory Questionnaire (PRMQ), Cambridge prospective Memory test (CAMPROMT) and Cambridge prospective memory test (CAMPROMT) used as a outcome measure. The study period was for 2 weeks of 8 sessions given for the both the control group and experimental group.

Results: The pre test in experimental group had a mean of 17.7(N=10) and control group had a mean of 19.8(N=10 Comparison between the experimental and control group of CAMPROMT scores of various timeline is no significant difference ($p>0.05$) in the pretest and and post test of CAMPROMT of the experimental group and the pretest and post test of CAMPROMT of the control group. on comparison within pretest and posttest results of experimental group and control group on the scales of a CAMPROMT on 1st week and 2nd week showed statistical significance. the effect size of CAMPROMT of experimental group indicated that statically significance and greater effect size , $F(1.373,12.354) =45.466$, $P<.005$, and control group scores indicated that statically significance and medium effect size , $F(1.63,14.7) = 11.270$, $P<.005$.

Conclusion: Both the retrieval practice and the compensatory training were found to be effective in improving prospective memory in patients with TBI. Best clinical suggestion for intervention would be to alternate the use of both retrieval practice and compensatory techniques as intervention to achieve maximum benefits.

INTRODUCTION

Traumatic brain injury (TBI) is a form of acquired brain injury that causes damage to the brain as a result of sudden trauma.[1] It is regarded as "the most complex disease in the most complex organ", and distinguished by great heterogeneity in terms of etiology, mechanism, pathology, severity and treatment with highly varying outcomes. It may consist of diffuse damage, contusion brain damage or intracerebral hematoma. It is recognized that intrinsic pathophysiologic processes and systemic insults such as hypoxia and hypotension heightens the primary brain damage.[2] Sport, falls, motor vehicle accidents, assaults or blast injuries cause different types of injury.[3]

The incidence of TBI is rising as a sequel of transport related injuries in low and middle income countries.[3] Country-based incidence reported as 108 to 332 hospitalized new cases per 100,000 populations per year.[4] According to an estimate at the National Institute of Mental Health and Neuro Sciences, the incidence of TBI in India is 2,000,000.[5]

Traditionally, depending on the patient's presenting level of consciousness as expressed by the Glasgow Coma Scale (GCS) score TBI are classified into mild (GCS 13-15), moderate (GCS 9-12), or severe (GCS 3-8).[6] Interestingly, the highest incidence of mild TBI is seen between the ages 15 to 24 years. In addition to this age group, men and women above the age 65 years are observed to have similar incidence of mild TBI.[7]

More than 30% of mild TBI patients are reported to have difficulties returning to their previous work even at 3 to 6 months post-injury.[8] It has been suggested that the most severe symptoms are experienced within the first 72 hours and cognitive decrements can persist up to 1 to 3 months post MTBI. Memory impairment is one of the most frequent cognitive symptoms reported by patients, their family members, and clinicians after TBI ,and it has been shown to be associated with vocational instability.[9] Recent studies have demonstrated that the primary reason for difficulties in new learning and memory in people with TBI is difficulty in the initial acquisition of information rather than the retrieval of information from long term storage.[10]

Prospective memory is a form of **memory** that involves remembering to perform a planned action or recall a planned intention at some future point in time. **Prospective memory** tasks are common in daily life and range from the relatively simple to extreme life-or-death

situations. These intended actions should only include non-routine tasks and not highly practiced actions that are supported by environmental or physiological cues.[11] Prospective memory is pertinent to our everyday life as it affects our ability to perform many daily activities such as keeping appointments, paying bills and completing errands which are all necessary for independent living.

PM is a multidimensional process which makes demands on memory, attention and executive systems.[12] The prospective component of PM can be conceptualized as remembering that an action needs to be carried out, while the retrospective component involves remembering what action needs to be executed.[13,14] and when it must be executed.[15] It has been implicated as necessary for carrying out such actions to include, but not limited to, performing activities of daily living (ADL's).[16,17]

Retrieval practice (RP) (also known as the testing effect) as an effective mnemonic strategy . RP research demonstrates that the act of retrieving information also strengthens one's memory trace. That is, when persons are quizzed on information during learning (RP), they are better able to subsequently recall the information than if they restudied the information multiple times without testing. Numerous studies have demonstrated that retrieval from long term memory (LTM) can enhance subsequent memory performance, a phenomenon labelled the retrieval practice effect.[19] Varying explanations have been offered for how retrieval practice enhances memory performance. Some have focused on increased elaborative retrieval during testing[20] .whereas others have emphasized the narrowing of the retrieval search space via helpful contextual associations.[21]

An approach that may provide more traction for understanding the effect of retrieval practice on the quality of item-specific memory is to allow participants to report remembered information along a continuous response space. For example,[22] used a continuous response space in a task where subjects recalled the precise positions of different objects.

Retrieval practice resulted in a decrease in the average response error for retrieved locations relative to restudied locations. However, although a change in memory quality provides an intuitive explanation of these findings, a reduced guessing rate in the retrieval practice condition also would yield lower average response errors. Thus, the goal of the present work was to examine the retrieval practice effect using an analytic approach that can estimate both the probability of retrieval and the quality of the retrieved representations.

According to the inhibitory account of Retrieval induced forgetting , the repeated retrieval of some items in the presence of the category cue creates mental retrieval-competition between those items and the related, un-retrieved items. In order to overcome that interference during retrieval, the previously un-retrieved items are suppressed, or inhibited.[23,24] This reduced activation, or inhibition, of the un-retrieved items during retrieval practice leads to below baseline rates of final recall, recognition, and slower reaction times on implicit memory tests for those items, while memory performance for the retrieved items is enhanced.

Need of the Study:

Prospective memory deficits have been reported in a number of clinical syndromes including Parkinson's disease, dementia and traumatic head injury (Jones, Livner & Backman, 2006; Kliegel, Eschen & Thone-Otto, 2004; Kliegel, Phillips, Lemke & Kopp, 2005)Memory impairment is a typical characteristic of a TBI client. Kliegel & Martin (2003) have reported that up to 40% of patients in a memory clinic reports with prospective memory deficit.

Retrieval Practice was used in the conditions of depression, schizophrenia, Alzheimer disease, Parkinson disease and other cognitive related problems. Hicks and Starns (2004) have shown empirically that a retrieval practice effect can appear in item recognition. In addition, despite the predominant role of recollection in associative recognition, it is clear that people sometimes do use familiarity in this task.

Woods, Moran, Dawson, Carey, Grant et al., suggested that prospective memory plays a more integral role in these activities than other higher-level cognitive functions, such as retrospective episodic memory.[18] Prospective memory allows us to formulate and execute plans necessary for independent living, such as personal care and homemaking. Limited therapy protocols are present in reducing their prospective memory impairment.[8] There are few studies done on prospective memory remediation. Most of the study focused on compensatory training. Therefore the was a need to investigate on the effects of remedial training on prospective memory.

Research question

AIMS AND OBJECTIVES

Aim of the study

To find out the effectiveness of retrieval practice on prospective memory deficits for mild to moderate TBI patient.

Objectives

To find the effectiveness of retrieval practice on prospective memory in mild to moderate TBI patient.

To compare difference in performance between 1st week and 2nd week of intervention.

To compare the effectiveness of regular occupational therapy memory training and retrieval practice.

HYPOTHESIS

Alternate Hypothesis:

Retrieval practice is effective in improving prospective memory in patients with mild to moderate TBI

Null Hypothesis:

Retrieval practice is not effective in improving prospective memory in patients with mild to moderate TBI

RELATED LITERATURE

Definition of Traumatic Brain Injury

Traumatic Brain Injury (TBI) is defined as any traumatically induced structural injury or physiological disruption of brain function as a result of an external force. It is manifested by one or more clinical signs occurring immediately afterwards including a loss, decreased, or altered level of consciousness, amnesia, neurologic deficit, or intracranial lesion. External forces may include direct impact of the head with another object, indirect forces from acceleration/deceleration, or a blast injury. The Glasgow Coma Score (GCS) has traditionally been used to classify TBI as mild (GCS 13-15), moderate (GCS 9-12), or severe (GCS 3-8) Clinical Practice Guideline for Management of Concussion/ mTBI. [October, 2009].

Biomechanics

Traumatic injury results from the transfer of energy from the environment to tissue above the amount that can be absorbed without dysfunction. Traumatic insults generally occur over short periods of time and are referred to as dynamic loading. Dynamic loading includes both direct or impact loading, as well as impulsive loading where no physical contact occurs. The loads absorbed by the brain after trauma generally include linear and rotational components called angular loads. The rate and duration of the insult are important because loads applied at high rates tend to result in more damage LaPlaca MC, Simon CM, Prado GR, et al. CNS injury biomechanics and experimental models.Prog Brain Res 2007;161:13–26. [PubMed: 17618967]. Focal injury such as contusion results from direct loading and often occurs in the absence of widespread injury. In contrast, diffuse axonal injury (DAI) often occurs as a result of the rotational acceleration accompanying indirect loading. Gennarelli TA, Thibault LE, Adams JH, et al. Diffuse axonal injury and traumatic coma in the primate. Ann Neurol 1982;12(6):564–74. [PubMed: 7159060]. Humans are particularly susceptible given their large cranium connected to the trunk by relatively weak neck musculature. Rotational acceleration produces substantial and widespread strains within the brain resulting from both acceleration and deceleration. These diffuse strains lead to differential movement of the brain relative to the skull which can cause hemorrhage. Shear strain is most prominent after rotational injury, and brain tissue is particularly sensitive to this type of strain [16]. Holbourn AH. Mechanics of Head Injuries. Lancet 1943;242(6267):438–41

Pathophysiology

The initial traumatic insult results in mechanical damage including rupture of cellular and vascular membranes with release of intracellular contents, ultrastructural damage of axons, and changes in cerebral blood flow. [26] Subsequent metabolic derangement includes widespread release of excitatory neurotransmitters such as glutamate, severe dysregulation of calcium homeostasis, energy failure due to Adenosine triphosphate (ATP) depletion, free radical generation, and cell death by necrotic and apoptotic pathways.[27,28] More global consequences of the traumatic insult include increased intra-cranial pressure, decreased cerebral blood flow, tissue ischemia, cerebral edema, and functional blood brain barrier dysfunction.[29,30] Following the initial damage, repair and recovery processes begin through the removal of cellular debris, glial scar formation, and plastic changes in neural networks (IOM (Institute of Medicine). Gulf War and Health, Volume 7: Long-term Consequences of Traumatic Brain Injury. Washington, D.C.: The National Academies Press; 2009).

Putative Causes of Altered Consciousness in mild and moderate TBI

The definitive causes of altered consciousness are not known. Loss of consciousness requires either loss of the function of both cerebral hemispheres or of the reticular activating system. Several plausible hypothetical mechanisms have been proposed for the alteration of consciousness that occurs with mild TBI. These include the reticular, pontine-cholinergic system, centripetal, and convulsive hypotheses. The reticular activating system (RAS) resides in the brainstem reticular formation which extends from the top of the spinal column to the rostral midbrain with extensions into the thalamus and hypothalamus. The RAS is excited by input from surrounding sensory tracts and transmits this excitation to the cortex to induce generalized cortical and behavioral arousal. In the absence of input from the RAS, consciousness is impaired.

Under the reticular hypothesis of concussion, loss of consciousness after brain trauma results from a disturbance or depression of the activity of polysynaptic pathways within the RAS. It is not completely understood how a traumatic dysfunction of the RAS occurs however it is believed to result from shearing or tensile strains on RAS pathways at the cranio-cervical junction. Neuro pathological evidence for this is limited. The hypothesis also fails to address traumatic amnesia. A further difficulty is that Electroencephalogram (EEG) findings do not support depression of the RAS in concussion.

The pontine-cholinergic system hypothesis differs from the reticular activating system hypothesis in that RAS dysfunction is thought to occur as a consequence of trauma-induced activation of the inhibitory cholinergic system of the dorsal pontine tegmentum.[31] Furthermore, EEG studies show widespread neuronal discharge after concussion and elevated acetylcholine is found in the Cerebrospinal Fluid (CSF) of patients after TBI. However, it is not clear that activation of this system can produce loss of consciousness due to RAS suppression.

The centripetal hypothesis posits that sudden rotational forces cause shearing strains and stresses that result in functional decoupling of nerve fibers.[32] The depth of this functional decoupling is directly related to the extent of rotational acceleration delivered to the brain. Prospective Memory (PM) refers to the cognitive ability to form and remember to perform an intended action at a specific moment in the future. That cognitive ability is essential for many daily activities, such as remembering to pick up something at the market after work, send a gift for a birthday, or call a friend at a specific time. Although past researchers tended to characterize PM as a unitary process, it is very complex and comprised of various components. For example, consider the situation in which a principal asks a teacher to relay a message to a student. The teacher has committed him/herself to two memory tasks: one is to remember the content of the message, and the second is to deliver it as soon as he/she sees the student. Remembering the content of a PM task is essential to perform the PM task, which researchers refer to as the *content* of a PM task (*retrospective component*). However, remembering only the content of the PM task will not produce successful performance. The action must also be performed at the appropriate moment in the future. This is referred to as the *prospective component* of PM tasks. Thus, a critical aspect to success on PM tasks is not only recalling the content of the intended action, but also performing the action at the appropriate moment in the future.

PM assessment, a distinction has been made between three fundamental types of PM tasks: time-based, activity-based, and event-based (Kvavilashvili & Ellis, 1996).
A **time based** PM task requires that the intended action be performed at a specified time or following a specified time interval (e.g., medication must be taken at 10:00 a.m. every day).
Activity-based tasks require that the intended action be performed after the completion of another activity (e.g., turn off the computer after using it). **Event-based** PM tasks, the

intended action must be performed when presented with a specific external cue (e.g., give a message to a co-worker when seeing him/her at work).

A four stages model has been proposed to explain the functioning of PM :
1. *Intention formation* - the first phase consists on the formation of the delayed intention, which often involves forming a plan. Different degrees of motivation may influence the strength of encoding the delayed intention. In fact, the strength of an intention may reflect not only the personal importance, but also the potential benefits and costs of realizing the delayed intention.
2. *Intention retention* - the retention intervals describe the delay between the formation of and execution of the intended action. The retention interval, most of the time, is filled with an "ongoing task" . Some authors found lower performance after a long relative to a short delay , though others failed to find an association between delay length and decline or improvement in performance. In addition to the length of the delay interval, the cognitive load added during the delay interval (filled or un-filled intervals) may influence performance .
3. *Intention initiation* - the point in time at which execution of the intention is (or should be) initiated. Successful performance on PM tasks, not only required to accurately encode the intended action and maintain the intended action active during the interval delay, but also to recognize the cue, retrieve the action associated with that intention, and perform the action. People may fail on their performance not only because they fail to recall the intended action when the target occurs, but also because their cognitive resources were captured by the demands of the ongoing task.
4. *Intention execution* - where and when the intended action is executed. This may be considered the final stage with the execution of the delayed intention. However, successfully completing all previous phases, errors can occur and the delayed intention may not be performed. Distractions or failure to complete the task due to external circumstances may compromise performance. For example, the intention to phone a friend may fail because of interruption by the doorbell or the friend was not at home. When the delayed intention is not executed, it is necessary to re-establish the intended action and re-form the plan. A fifth phase, *Evaluation of outcome* was proposed and is concerned with monitoring the output of the execution of the intended action. The evaluation of outcome describes the process by which a person checks if the intended action has been accurately performed.

According to Einstein and McDaniel's model , there are two types of PM targets, event-based and time-based tasks1, that trigger the execution of our delayed intention. In conditions that require event-based PM, a person performs an action when a specific event occurs (i.e. 402 Traumatic Brain Injury passing a message when a friend calls); while in situations that require time-based PM, the action has to be performed at a specific time in the future (i.e. remembering the appointment with a friend at 4:00 p.m.) . Event-based PM tasks are considered to be less cognitively demanding than time-based PM tasks because they require less self-initiated retrieval and external cue(s) are available to help recall the task.

For individuals with TBI, frequent PM failures (e.g., forgetting to repay a loan to a friend, maintain an appointment, take medication, turn off the stove) can be frustrating, embarrassing and in some cases, life threatening.

These failures have the potential to limit the independence of these individuals, causing them to reply on a carer for prompting and completion of activities and instrumental activities of daily living. Moreover, these failures may affect their opportunity to return to work or start a new vocation. Impairment of PM in TBI patients would differ according to the complexity and requirement of the tasks ; moreover, when tested both on event- and time-based tasks, TBI patients are particularly impaired on time-based tasks consistent with the idea that those tasks require more self-initiation. Dysfunctions on time-based tasks may also be due to less strategic monitoring behaviour engaged by TBI patients . Adults with TBI and older adults performed more poorly than younger adults on short-term PM tasks, and TBI patients rated themselves more poorly than younger adults. Two PM tasks were used to assess PM performance: the first task involved telling the participants about a selfreport memory questionnaire at the beginning of an assessment session and instructing them to ask for the questionnaire at the end of the session (even-based task). The second task involved asking the participants to return (by mail) an evaluation form with the date written in the top corner (time-based task). Because of the small number of items used and the correct/incorrect nature of these items, the PM scores obtained with these tasks were limited in range and thus were unreliable .

To assess PM more reliably and accurately, it is necessary to increase either the number of items used or the number of responses required for each item. Recent studies considered these limitations and developed more appropriated tasks to investigate the effects

of TBI on event and time-based PM performance Among the studies identified, only one included patients with mild TBI . Some authors also manipulated the salience of the event cue in PM performance. The cue was either integrated (focal cue) or peripheral (no-focal cue) to the ongoing working memory task. TBI patients and controls showed no differences on the ongoing task, but PM performance was poorer in TBI patients in both focal and peripheral cue conditions. That finding suggested that even with highly salient cues, TBI patients exhibit PM failures. Moreover, both TBI and controls self-reported that greater monitoring effort was required for the peripheral, rather than for the focal-cue condition. Instead, when the cue is maintained in a focal condition, but is varied the number of distractions during the ongoing task, TBI patients performed more poorly both on one and four target conditions. Finally, some authors have varied the delay between encoding and task performance (10 vs 45 min) expecting lower performance in the longer delay condition. Researchers have also manipulated the functional link (semantic inter-item associative link) between intended actions with the expectation that performance would improve. Patients with TBI performed significantly lower than controls; however, there were no significant effects of delay interval or functional link of the intended actions retrieval practice (RP) (also known as the testing effect) as an effective mnemonic strategy among healthy college undergraduates.

Testing in educational and clinical settings is considered a tool for evaluation, but RP research demonstrates that the act of retrieving information also strengthens one's memory trace, when persons are quizzed on information during learning (RP), they are better able to subsequently recall the information than if they restudied the information multiple times without testing. Translating this mnemonic effect to clinical samples, RP has improved recall after a short delay (45min) in cross-sectional experiments with memory-impaired patients with multiple sclerosis and survivors of severe TBI, and these memory benefits of RP are maintained after a long delay (1wk) in memory-impaired patients with multiple sclerosis. Here, we investigate whether RP leads to better memory after short (30min) and long (1wk) delays among memory impaired survivors of severe TBI

Retrieval Practice to Simulate and Oppose Ruminative Memory Biases Categorically speaking, depressed people attend, interpret, and remember in somewhat biased ways[34] of these patterns, negative memory biases have received the earliest and most sustained attention. Attempts to explain depression-congruent memory biases were initially provided by schema theory and by network models that stressed the compatibility between the nature

of the memories and mood at encoding or retrieval.[35]Elements of both approaches can be found in recent frameworks that emphasize the habitual cognitive practices that characterize depression and are referred to by the phenomenological term rumination.[36,37,38,39,40] In designing the current experiment, our aim was to model one aspect of ruminative habit—repetitive thinking—by aligning it with the retrieval-practice paradigm.[41] The alignment of ruminative processes with retrieval practice rests on the observation that people who ruminate do not merely bring negative events to mind, as is suggested by some perspectives on mood-congruent recall. Instead, they focus repetitively on the same events, and in so doing they practice retrieval. Subsequent recall then benefits from retrieval practice as well as sometimes subtle changes in context and meaning as events is reconsidered anew each time. Our first goal for the current experiment was a straightforward simulation of rumination congruent recall by asking participants to study adjective-noun pairs, both positive and negative, varying whether they repeatedly practiced negative or positive pairs or had no opportunity for practice before they took a test over both types of pairs at the end of the session.

To our knowledge, investigations of retrieval-practice effects have not been extended to emotional materials (nor to a category-based subsets of studied materials), so evidence for this basic extension is interesting in its own right.[42]In addition, because retrieval-practice paradigms sometimes produce very large effects when recall is tested a week later,[43]similar findings with negative materials (studied amidst other materials) should constitute a successful simulation of rumination-congruent recall. Evidence for successful opposition could be established by naturally ruminative participants who practice retrieval of positive materials in the context of having studied negative materials as well. This evidence would augment current research on cognitive bias modification[44]. CBM research documents the modification of attentional and interpretive biases experienced by anxious and depressed people. A few attempts to modify depressive or ruminative memory biases have been reported, but most have succeeded in modifying memory indirectly by training biases in the interpretation of ambiguous events and observing memorial consequences of interpretation training.[45] In the current project,[46] we hoped to succeed with a more direct approach. Any attempt to oppose a ruminative bias presupposes evidence for that bias. In our experiment, however, it was not obvious whether and under what conditions such evidence should be found. First, evidence for negative bias is not consistently found in undiagnosed samples.[47] Moreover, we recruited participants according to their ruminative tendencies, not self-reported depression, although these measures are highly correlated. Therefore it seemed

merely possible that our ruminative sample of students would produce an unpracticed negative bias, given the right conditions. The second consideration, then, concerned the identification of those conditions. A reasonable hypothesis is that the bias could be produced by ruminators in a study-only condition who are exposed to all materials (a prediction compatible with network perspectives, on grounds that negative materials would be more elaborately or self-referentially encoded.) On the other hand, if self-initiated rehearsal is an important contributor to this study effect, recall in our study-only condition would not reveal the bias, because the intervals between study cycles were occupied by an attention-demanding task (digit/symbol substitution) to prevent that very possibility of rehearsal.

LITERATURE REVIEW

A phenomenon linked to competitive interference is the retrieval-induced forgetting observed in M. C. Anderson et al.'s (1994) retrieval practice paradigm. Subjects studied items belonging to a number of semantic categories. Following study, some of the items appeared again as targets in a cued recall test. This retrieval practice benefited recall of the items during a final recall test.

Prospective memory in TBI

- **Julie D. Henry, et.al, 2007**[48] investigated **Traumatic brain injury and prospective memory: Influence of task complexity** the evidence suggests that manipulations that increase demands on controlled attentional processes moderate the magnitude of observed deficits. A total of 16 TBI participants were compared with 15 matched controls on a task in which the number of prospective target events was manipulated. This manipulation was of interest because two competing models make different predictions as to its effect on controlled attentional processes. In the context of Smith and Bayen's (2004) preparatory attentional processes and memory processes (PAM) model increasing the number of target events should increase requirements for controlled attentional processing. In contrast, McDaniel and Einstein's (2000) multiprocess framework assumes that distinct target events presented in focal awareness of the processing activities required for the ongoing task are likely to depend on automatic processes. This latter model therefore leads to the prediction that increasing the number of target events should not increase demands upon controlled attentional processes. Consistent with McDaniel and Einstein's (2000) multiprocess framework, TBI patients were significantly and comparably impaired on the one and the four-target-event conditions relative to controls. Further, TBI deficits could not be attributed to increased difficulty with the retrospective component of the prospective memory task

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- **Joesph A. Mikels, 1998**[49] investigated **Prospective Memory: The Relation of Executive Function to Aging** In the present study two groups were examined in terms of their performance on four different prospective memory tasks. The two

groups included younger adults (ages 18-21) and older adults (ages 62-80). Both groups were asked to perform each of four prospective memory tasks webbed within a general knowledge quiz.. The results indicate that both groups performed significantly poorer on the TD task in comparison to the ED task. This finding suggests that a. deficit in internal cuing and attentional resources may be responsible for a PM performance deficit

- **Giovanni A. Carlesimo, 2013**[50] assessed the **Prospective Memory Impairment and Executive Dysfunction in Prefrontal Lobe Damaged Patients: Is There a Causal Relationship?** The prospective memory (PM) construct is aimed at capturing cognitive operations involved in the successful accomplishment of delayed intentions. To evaluate if there is a causal role of a deficit of executive abilities (failures of planning, set-shifting, selective attention, or working memory) over the PM impairment We report a detailed investigation of PM and executive abilities in two patients with posttraumatic damage to prefrontal lobes who complained from a reduced compliance with appointments and daily routines. Laboratory tests confirmed a difficulty in fulfilling delayed intentions in response to the occurrence of critical events and elapsed time. In one patient, PM impairment was associated with poor performance on tests investigating planning ,working memory, and mental shifting. The other patient performed in the normal range on all executive tests. Despite the frequent claim of a dependence of PM deficits from executive dysfunction, the reported cases demonstrate that this is not necessarily the case. The results are discussed in the light of current hypotheses relating PM impairment to other deficits that commonly occur as a result of damage to the prefrontal lobes.

- **Aiken, 2016**[51] explored **The effects of cognitive rehabilitation for improving prospective memory in acquired brain injury**. Individuals with ABI report that prospective memory (PM) deficits are the most detrimental cognitive impairment following injury, persistently and negatively impacting their ability to function properly in everyday life. Using neuropsychological assessments to produce patient deficit profiles, this study examines the effectiveness of individualized cognitive rehabilitation therapies: attention process training (APT) or PM training, for improving PM in ABI. Participants were randomly assigned to groups, completing 10 sessions of either cognitive rehabilitation (n=4) or educational programming (n=3).

Using the Memory for Intentions Screening Test (MIST), intra and inter treatment analyses examined the effectiveness of individualized cognitive rehabilitation for improving PM in ABI

Retrieval practice intervention used for other conditions

- **Malen Migueles and Elvira Garcı´a-Bajos, (2014)** investigated **The role of exemplar typicality and encoding strategies in category retrieval-induced forgetting** Selective retrieval practice of category exemplars often impairs the recall of related items, a phenomenon known as retrieval-induced forgetting (RIF). In Experiment 1 the role of item typicality (high, low) and presentation format of category exemplars (random, grouped) were analysed, while in Experiment 2 two encoding strategies (inter and intracategory) to modulate RIF were tested. Exemplar typicality was the critical factor underlying RIF. Competition during retrieval practice rendered RIF in the typical exemplars, but RIF did not appear when the exemplars were low typicality. The greater impairment of strong exemplars is in line with the inhibitory account of RIF and the notion of interference dependence. Inhibition appeared with random and grouped presentations suggesting that presentation format of the exemplars is not a critical factor in modulating RIF in a category-cued recall task. Distinctive processing instructions using sentences that connected items from different categories (intercategory strategy) and integration instructions by using size to organise the exemplars within categories (intracategory strategy) easily avoided competition and the need of inhibition processes in recall.

- **Jason C.K. Chan et.al, 2013**[52] investigated **Providing Corrective Feedback During Retrieval Practice Does Not Increase Retrieval-Induced Forgetting.** In two experiments, examined the influence of providing corrective feedback (no feedback, immediate feedback, delayed feedback) during retrieval practice on this retrieval-induced forgetting effect. Performance was assessed with category cued recall ,category-and-stem cued recall and recognition. A dissociation between the effects of feedback on memory of the tested materials and the nontested materials. Whereas providing immediate or delayed feedback (compared to no feedback) improved recall and recognition of the tested items, it had no influence on retrieval-induced forgetting. These results are consistent with the inhibition account of

retrieval-induced forgetting. From an applied perspective, this finding is encouraging for students and educators who use testing to foster learning.

- **Julia H.Coyne et al, December 2014**[53] has explored **Retrieval Practice as an Effective Memory Strategy in Children and Adolescents With Traumatic Brain Injury** Pediatric survivors of TBI (N=15) aged 8 to 16 years with below-average memory .During RP, participants were quizzed on to-be-learned information (VPAs and FNPs) shortly after it was presented, such that they practiced retrieval during the learning phase. MR consisted of repeated restudy (tantamount to cramming). SR consisted of restudy trials separated in time (ie, distributed learning).There was a large main effect of learning condition on delayed recall (P<.001; η_p^2=.84), with better mean recall of VPAs and FNPs studied through RP (6.23±1.39) relative to MR (3.60±1.53; P<.001) and SR (4.77±1.39; P<.001). Moreover, RP was the single best learning strategy for every participant. We identify RP as a promising and simple strategy to support learning and improve memory in children and adolescents with TBI. Our experimental findings were quite robust and set the stage for subsequent randomized controlled trials of RP in pediatric TBI.

- **Alice S. North a,et.al, 2002**[54] explored of **Retrieval-induced forgetting in Alzheimer's disease.** the evidence to date has been equivocal, because non-inhibitory mechanisms can account for the pattern of findings. Recently, however, a retrieval practice paradigm has been developed that is claimed to give a purer measure of inhibitory processing in episodic memory, the retrieval-induced forgetting (RIF) paradigm. As in previous work, inhibition was measured as the difference between final memory performance for unpractised items from practised categories, and unpractised items from unpractised categories. The results show that AD patients showed normal levels of inhibition with both tests of cued recall and category generation (CG).

- **Michael F. Verde et.al, 2004**[55] investigated **The retrieval practice effect in associative recognition**. In Experiment 1, subjects studied pairs of category exemplars. Retrieval practice followed, during which some pairs appeared in a cued recall test. A final test of associative recognition (with remember–know judgments) found lower accuracy and hit rate for nonpracticed pairs belonging to retrieval-practiced categories. In Experiment 2, subjects studied noun pairs from overlapping

sets, with study duration manipulated between subjects. Retrieval practice was manipulated by presenting some members of a set in a previous block during the recognition test. With long study duration, retrieval interference was evident in both recognition and remember judgments. With short study duration, it appeared only in remember judgments. These results support a dual-process account in which retrieval interference is specific to recollection and becomes evident in recognition performance only when recollection is sufficiently dominant

- **James F Sumowski et.al.,2013**[78] investigated the **Retrieval practice is a robust memory aid for memory-impaired patients with MS.** In a within-subjects experiment, 12 memory-impaired MS patients encoded verbal paired associates (VPAs) through massed restudy (MR), spaced restudy (SR), or retrieval practice (RP). Half of VPAs were tested after short delay (30 minutes) and half after long delay (one week). RP robustly improved memory more than restudy. Short delay: MR=15.6%, SR=27.1%, RP=72.9%. Long delay: MR=1.0%, SR=4.2%, RP=24.0%. RP was the best memory technique for nearly all patients after both short and long delays

- **Jeffrey J. Starns et.al, 2004**[56] explored the **Retrieval-induced forgetting occurs in tests of item recognition.** Using the retrieval-practice paradigm, In Experiment 1, retrieval practice on items from semantic categories depressed recognition of non practiced items from the same categories. Experiment 2 in a more stringent source test for practiced, non practiced, and new items. These results conceptually replicate those of previous retrieval induced forgetting studies done with cued recall (e.g., Anderson et al., 1994). findings are inconsistent with the hypothesis that item-specific cues during retrieval will eliminate retrieval interference in the retrieval-practice paradigm

- **Benjamin C. Storm et.al, 2010**[57] assessed the **Successful inhibition, unsuccessful retrieval: manipulating time and success during retrieval practice.** Experiments 1 and 2 replicated recent work suggesting that retrieval success is not a necessary condition for retrieval-induced forgetting to occur. Interfering items were forgotten even when retrieval practice was designed to be impossible. Experiments 3 and 4 employed the impossible retrieval practice procedure to examine the time-course of forgetting across a single retrieval practice trial. Results support the inhibitory account

of retrieval-induced forgetting and offer insight into the dynamics of how and when inhibition plays a role in retrieval\

Compensatory training for prospective memory

- **Edgecombe et.al**, **2012**[58] Determined the **Prospective Memory Following Moderate-to-Severe Traumatic Brain Injury: A Multinomial Modelling Approach** Seventeen participants with moderate to severe TBI and 17 age- and education matched control participants completed an event-based PM task that was embedded within an on going computer-based **color-matching** task. He MPT modelling approach revealed a significant group difference in the prospective component, indicating that the control participants allocated greater preparatory attentional resources to the PM task compared to the TBI participants. These findings indicated that the TBI participants had greater difficulty allocating the necessary preparatory attentional resources to the PM task and greater difficulty discriminating between PM targets and non-targets during task execution, despite demonstrating intact post-test recall and/or recognition of the PM tasks and targets.

- **Jonathan Evans et.al, 2002**[59] investigated **Prospective memory functioning in people with and without brain injury.** In this paper they were using, Cambridge Behaviour Prospective Memory Test (CBPMT) to assess prospective memory. The key findings were that (1) note-taking significantly benefited prospective memory performance, (2) significant relationships were found between scores on the prospective memory test and scores on tests of memory and executive functions, and (3) participants had more difficulty with the time-based than with the event-based prospective memory tasks. The results suggest that compensatory strategies improve prospective memory functioning; memory for content as well as attention and executive functioning processes are involved in prospective memory; and that time-based tasks are more difficult than event-based tasks because they place higher demands on inhibitory control mechanisms.

- **Jennifer Fleming et.al, 2015**[84] investigated **The efficacy of prospective memory rehabilitation plus metacognitive skills training for adults with traumatic brain injury: study protocol for a randomized controlled trial.** This randomized controlled trial has three treatment groups: compensatory training plus metacognitive

skills training (COMP-MST), compensatory training only (COMP), and waitlist control. Based on the sample size estimate, 90 participants with moderate to severe TBI will be randomized into the three groups using a stratified sampling approach. The primary outcomes include measures of PM performance in everyday life and level of psychosocial reintegration. Secondary outcomes include measures of PM function on psychometric testing, strategy use, self awareness, and level of support needs following TBI. Blinded assessments will be conducted pre and post intervention, and at 3-month and 6-month follow-ups. This study seeks to determine the efficacy of COMP-MST for improving and maintaining everyday PM performance and level of psychosocial integration in adults with moderate to severe TBI. The findings will advance theoretical understanding of the role of self-awareness in compensatory PM rehabilitation and skills generalization. COMP-MST has the potential to reduce the cost of rehabilitation and lifestyle support following TBI because the intervention could enhance generalization success and lifelong application of PM compensatory strategies.

- **Jennifer M. Fleming, 2005**[60] investigated **Prospective memory rehabilitation for adults with traumatic brain injury: A compensatory training programme**. In the study , result of all three participants improved on formal prospective memory assessment and demonstrated successful diary use after the programme. Self-report of prospective memory failure fluctuated and may reflect increased self-awareness. A compensatory approach may be useful in improving prospective memory performance following TBI.

- **Jennifer Fleming et.al, 2011**[61] investigated **a randomized controlled trial of prospective memory rehabilitation in adults with traumatic brain injury** In this study, Four groups of participants completed an 8-session individual intervention programme with pre- and post assessment by a blind assessor on a standardized test of prospective memory, actual strategy use, relatives' ratings of prospective memory failure, and level of psychosocial reintegration. Larger changes in prospective memory test score and strategy use were found in groups with compensatory prospective memory training compared with those groups without. The results provide evidence that prospective memory can be improved in patients with traumatic

brain injury using a compensatory approach in a relatively short duration and low intensity intervention.

- **Carlo Caltagironea et.al**, **2010**[62] investigated **Prospective memory in patients with severe closed-head injury: Role of concurrent activity and encoding instructions.** A group of patients with chronic squeal of severe closed-head injury and a group of matched normal controls were given an experimental procedure for the assessment of *time-based* and *event-based* prospective memory. Availability of attentional resources at the time of intention recall and encoding conditions at the time of giving instructions were varied across experimental sessions. The simultaneous execution of a concurrent task was more detrimental to accuracy in the spontaneous recall of the prospective intention in the post-traumatic than in the normal control group. Moreover, the instruction to encode more extensively by rehearsing aloud and mentally imaging the actions to be performed at the time of the study improved recall accuracy more in the post-traumatic than in the normal control group. Based on these data, we suggest that a prospective memory deficit in post-traumatic patients is due, among other things, to reduced availability of attentional resources and to poor encoding of actions to be performed

- **Julie D. Henry, Louise H. Phillips et.al, 2007**[63] investigated **Traumatic brain injury and prospective memory: Influence of task complexity.** In this study ,multi process framework assumes that distinct target events presented in focal awareness of the processing activities required for the on going task are likely to depend on automatic processes. This latter model therefore leads to the prediction that increasing the number of target events should not increase demands upon controlled attentional processes.

- **Daniela Wong Gonzale et.al, 2015**[63] has explored **Prospective Memory Following Traumatic Brain Injury: A Meta-Analysis.** In this paper the results revealed that the difference in prospective memory performance between TBI and control groups was large indicating that TBI patients have significantly lower prospective memory performance than matched controls. Subgroup analyses revealed that prospective memory was poorer when tasks were more demanding. In addition, prospective memory was significantly correlated with attention, retrospective memory and

executive functions. Prospective memory should be regularly assessed in individual with TBI, and task-related demands should be considered when deciding appropriate assessment measures and compensatory strategies.

- **Emily M. Aiken, 2016[64]** investigated **the Effects of Individualized Cognitive Rehabilitation for improving Prospective Memory in Acquired Brain Injury.** attention process training (APT) or PM training, for improving PM in ABI. Participants were randomly assigned to groups, completing 10 sessions of either cognitive rehabilitation or educational programming, Using the Memory for Intentions Screening Test (MIST), intra and inter treatment analyses examined the effectiveness of individualized cognitive rehabilitation for improving PM in ABI

- **Susan Petrie et. al, 2016[65]** investigated **Text messages reduce memory failures in adults with brain injury: A single-case experimental design.** Two single-case experimental designs with multiple baselines across activities are described. Participants presented moderate-to-severe cognitive impairments in one case and post-concussion syndrome in the other. Both reported memory problems in everyday activities. Target activities were selected using the Canadian Occupational Performance Measure. Participants were taught how to send reminders through Google Calendar to their mobile phones. The Canadian Occupational Performance Measure showed improved self-perception of performance and satisfaction levels. Using non-overlap of all pairs statistical analysis, most, but not all, target activities showed statistically significant improvement, with non-overlap ranging from 47% to 98%. Adjustments in the use of the reminders based on each participant's activities and cognitive abilities were required in order to maximise the benefits. The reminder system was effective in increasing the frequency of completion of routine activities of daily living. To increase the effectiveness of ubiquitous technology in supporting cognition after brain injury, several factors co-existing with cognitive problems should be taken into account

CONCEPTUAL FRAMEWORK

Like traditional RM rehabilitation, approaches to PM rehabilitation can be categorized as remedial or compensatory (Shum D fleming ,2002). Remedial training approaches to PM are based on a Skills remediation or bottom up approach which aims to restore or ameliorate the underlying impairment through repetitive practice of PM activities for example, remembering to perform time- and event-based PM tasks embedded within a filler activity that may be pen- and paper- or computer-based.

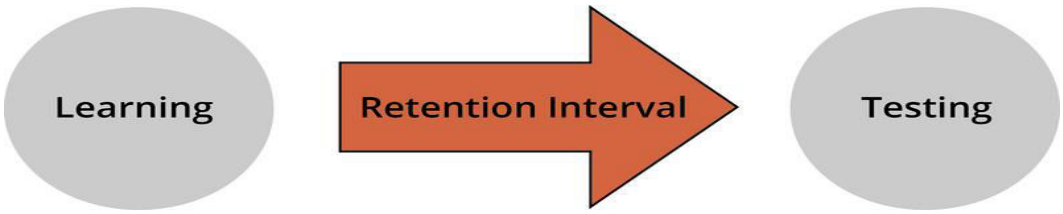
PM is a complex ability that involves multiple processes and components. According to Ellis there are five stages of PM: (1) formation and encoding of intention and action, (2) retention interval, (3) performance interval, (4) initiation and execution of intended action, and (5) evaluation of the outcomes. The first stage involves realizing that an action needs to be carried out in the future and encoding what the action is and when to execute it. In the second stage, the person stores the intended action and engages in one or more other activities. The action is initiated and executed in the third and fourth stages.

During the last stage, the person records and evaluates the outcome of the intended action. Therefore, PM involves a combination of RM (to encode and recall the action), executive function (to plan and initiate the action at the correct time), and metacognitive function (to monitor performance and evaluate the outcome). These functions are commonly impaired after TBI; the prefrontal lobes which are vulnerable to trauma are implicated in executive and metacognitive functions and are also considered the neural basis of PM (Stuss D Alexander,2000). In the present study a participant first learns several category examplar pairs from several categories (study phase) and then actively retrieves the studied examplars (retrieval-practice phase).The final phase (test phase). consists of a recall test involving all learned examplars.

In contrast, compensatory approaches focus on teaching the patient to use strategies to minimize the impact of PM impairment in everyday life; for example, training in diary or calendar use.(Shum D fleming ,2002)

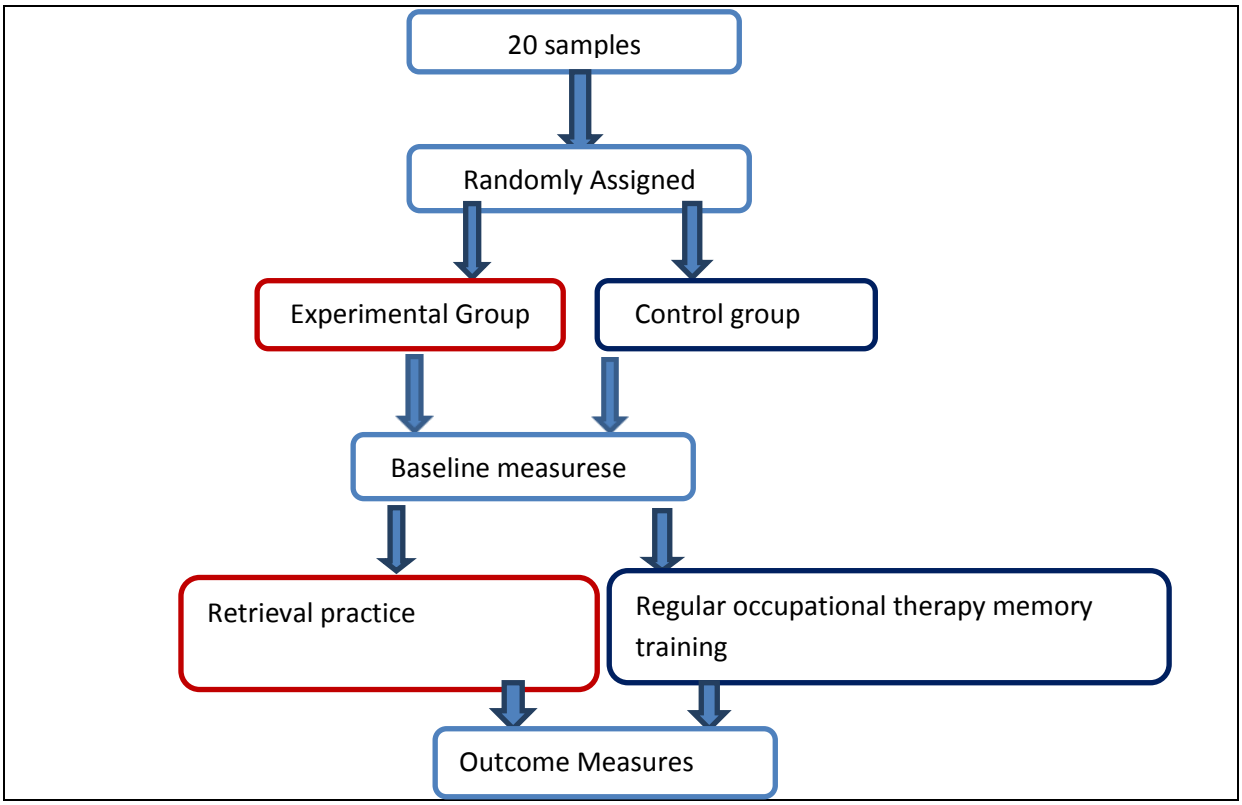
This is despite the common prescription of compensatory memory strategies in brain injury rehabilitation settings and the recommendation that training in external memory compensations should be standard practice (Cicerone KD Langenbahn,2011) . Such strategies include the use of a diary, note-taking, routines, checklists, alarms, and paging systems, and

are more relevant to everyday functioning, and may be more easily generalized to naturalistic settings compared to remedial activities. Furthermore, compensatory approaches to PM rehabilitation can assist patients with reduced cognitive capacity . Therefore in the present study we have memory aids , memory note book and computer and mobile games methods of compensatory strategies for control group.



METHODOLOGY:

Schematic representation of the research design:



Research design:

A Quantitative, two group pre-test post-test quasi experimental design was adopted for the study

Target population:

Mild to Moderate TBI patient.

Sample size:

20 (10 in experimental group and 10 in control group)

Sampling technique:

Convenient sampling with random grouping, assigning the first patient in experimental group and second patient in control group and so on for the 20 samples consecutively.

Place of study:

Outpatient and In patient unit of KMCH: a tertiary care hospital

Duration of Intervention:

The intervention for both the groups was for 14 days

Tools Used:

Baseline measure:

- Prospective-Retrospective Memory Questionnaire ([PRMQ]
- Montreal Cognitive Assessment(MOCA)
- Cambridge prospective memory test

Outcome measure:

- Cambridge prospective memory test

Prospective-Retrospective Memory Questionnaire ([PRMQ]

The PRMQ (Smith et al., 2000) is a rating scale, designed to assess the frequency of different types of memory failures. The 16-item PRMQ contains 2 items representing each of 8 categories: 8 items for prospective memory (both short-term and long term, self-cued and environmentally cued) and 8 items for retrospective memory (both short-term and long-term, self-cued and environmentally cued). Items are rated on a 5-point scale: 1 (never), 2 (rarely), 3 (sometimes), 4 (quite often), 5 (very often). Results can be derived for prospective or retrospective, short-term or long-term, self-cued or environmentally cued. Mean scores are used (range 1-5), and higher scores represent greater frequency of memory failures. Reliability of the Prospective and Retrospective scales were acceptable: .89, .84 and .76, respectively. Appropriate scale membership was indicated by item-total correlations for all items. The split-half reliability of the total scale was r = .87. The test-retest reliability of the PRMQ-S was r = .81, r = .78 for the prospective scale and r = .80 for the retrospective scale (n = 30). Total Score -80, above 31 is shown as impairement. (Pm Score – >18)(Rm Score->16)

Montreal Cognitive Assessment

The Montreal Cognitive Assessment (MoCA) was designed as a rapid screening instrument for mild cognitive dysfunction. It assesses different cognitive domains: attention and concentration, executive functions, memory, language, visuo constructional skills, conceptual thinking, calculations, and orientation. Time to administer the MoCA is approximately 10 minutes. MoCA's internal consistency coefficient (Cronbach's alpha) was

0.867. Test-retest reliability ICC value was 0.912 (P<0.01). MoCA score and MMSE were highly correlated (r = 0.912, P <0.01). Each item with total score correlation were 0.686-0.884. Factor analysis to extract two common factors that can explain the total variance of 71.882% The total possible score is 30 points; A score of 26 or above is considered normal.

Cambridge Prospective Memory Test

Three cued by time and Three cued by events .as the age of 16 and above Total Score Is 36 (18 from time based and 18 from event based). Points are from 0-6 and Test Time is 30 min. Total scores were then generated on time-based and event based subscales, each scoring a maximum of 18, with higher scores reflecting better prospective memory performance. The construct validity of the CAMPROMPT has also been supported by significant correlations between CAMPROMPT scores and scores on the Rivermead Behavioral Memory Test, which comprises retrospective and prospective memory tasks. (Wilson et al., 2005)

Selection Criteria:

***Inclusion criteria*:**

- Mild to moderate TBI
- Mild cognitive impairment. (MOCA 22 -26)
- RLA stage – 8 to 10
- Age 25 to 59.
- post injury ≤ 3 months
- Able to read Tamil or English.
- Both male and female

***Exclusion criteria*:**

- Perceptual deficits
- Major Psychological problem leading to affecting cognition
- History of non-TBI related neurological disorders.
- Reading and comprehension impairment.
- Visual impairment .(except Reflective Vision)

Variables in the Study:

Independent Variable:

- Retrieval practice for TBI patient

Dependent Variables:

- Mild and moderate TBI
- Prospective memory impairment

Extraneous Variables:

- Patient undergoing other memory training program

Procedure:

Ethical Consideration : First ethical approval was obtained from the KMCH Ethics Committee. Written consent was obtained each participant prior to the study.

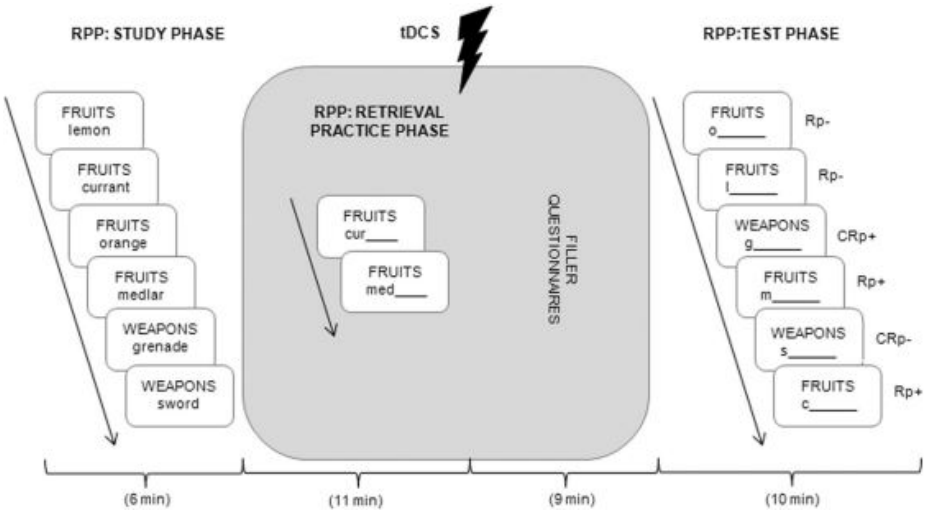
Those who matched the inclusion criteria were taken into the study & they were divided into two groups . At Pre test MOCA was used to screen out patients with mild cognitive impairment (score between 22- 26) and the Prospective-Retrospective Memory Questionnaire ([PRMQ] was used to identify patients with Prospective memory deficit (< 31 score) . The Cambridge behaviour prospective memory test was used to score level of prospective memory impairment .

Intervention

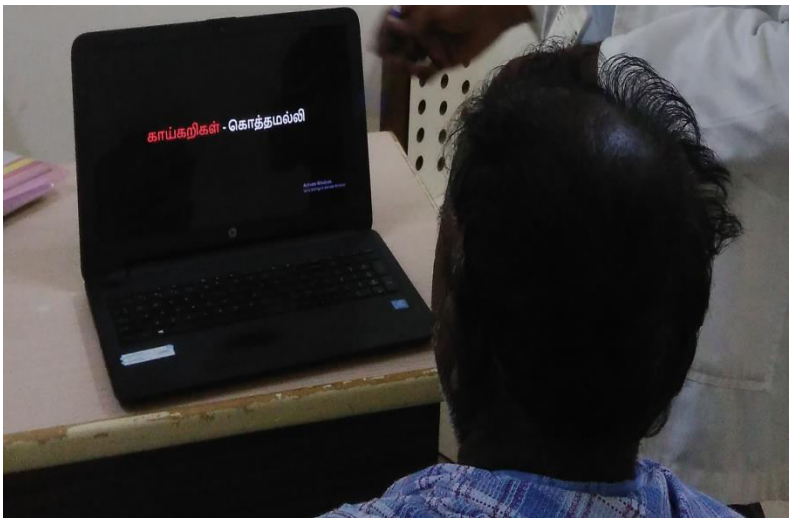
***Intervention for control group*:** Intervention for control group consisted of 8 session ,(30 mins) of regular occupational therapy memory program such as Text Message And Calendar, Memory Aid (diary and calendar) and Computer And Mobile Games Related To Memory. Training program might include in individual group

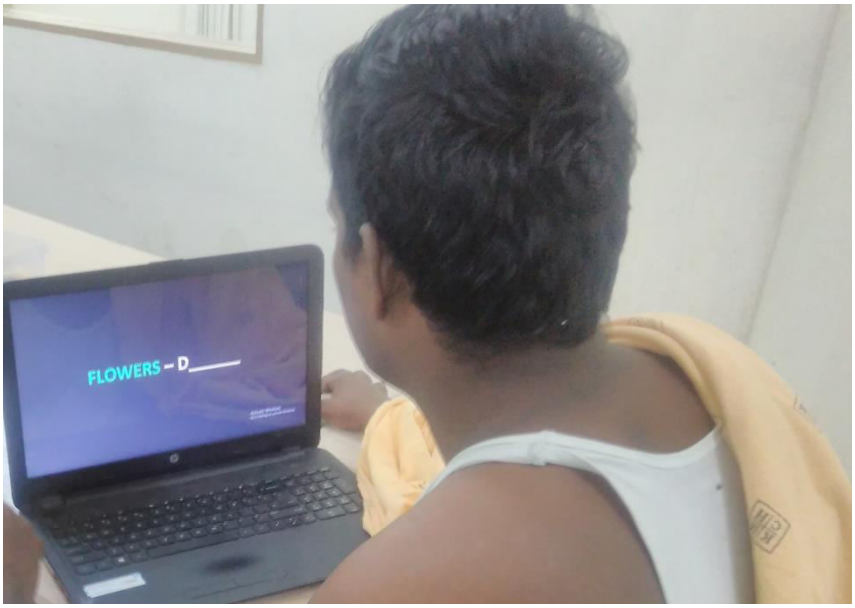
***Intervention for experimental group*:** Intervention for experimental group consisted of 8 sessions ,(30 mins) of Retrieval Practice Program which is a computer – based training of using the power point slides of word –pairs in Tamil or English nouns of exemplars belonging to eight semantic categories selected from the categorical production norms (Boccardi and Cappa, 1997). 96 verbal –pair words from the categories of animals, plants ,fruits, vegetables , colors, birds, shape ,flowers. During the 1st week 48 words and the 2nd week next 48 words . Each item had a unique first letter. In all categories, **7 items were strong exemplars** , whereas the other **five items were weak exemplars** .(Anderson et al., 1994). **First phase** of the paradigm (study phase), participants studied the 48 category word associated pairs.Fixation cross for 0.5 s, blank lasting 0.5 s, and a category–word pair for 5 s. (6 mins) In the **second phase** (retrieval-practice phase), Only weak exemplars and four times each, in the form category-plus-three-letter-stem.fixation cross for 1 s, followed by a blank lasting 1 s, and an item for 4 s. (11 mins) and next Filler Questionnaire. In the **third phase**

(test phase)- category-plus- one letter stem,Each trial started with a fixation cross lasting 0.5 s, followed by a blank screen lasting 0.5 s, and an item for 4 s. (20 Mins)




SHAPES - TRAPEZOID


காய்கறிகள் - கொத்தமல்லி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DATA ANALYSIS AND RESULTS

This chapter discusses the analyses of the collected data. The aim of this study was to find out the effectiveness of retrieval practice on prospective memory deficits for Mild to Moderate TBI patient.

Statistical description of the variables

For this study analyses were done using SPSS for windows (version 20.0). Descriptive analyses was performed to characterize the groups and inferential analyses to compare the performance of the groups (Mann Whitney U , Wilcoxon, Repeated measures ANOVA) were used.

- Pretest scores of experimental group and control group analyzed through the Mann Whitney U test.
- Posttest scores of experimental group and control group analyzed through the Mann Whitney U test.
- Pretest and posttest and both experimental group and control group separately were analyzed using the Wilcoxon signed rank test.
- To compare the means of experimental group and control pre and post and to find out the effect size with the help of the repeated measures ANOVA

  Effect size: $n_p^2 = F \times df_{effect} / F \times df_{effect} + df_{error}$

An effect size of <0.4 is considered to be a small effect

An effect size of >0.5 is considered to be a medium effect

An effect size of >0.8 is considered to be a greater effect

Table 1: Demographic details of the participants

	Group	N	Mean	S.D	Minimum	Maximum
AGE	Experimental Group	10	43.4	9.58	31.00	57.0
	Control group	10	41.8	12.6	25.0	60.0

	Group	Female	Male
GENDER	Experimental Group	1	9
	Control Group	2	8

	Group	Mild TBI	Moderate TBI
DIAGNOSIS	Experimental Group	5	5
	Control Group	5	5

Table 2: Comparison of CAMPROMT between the experimental and control group at the various timelines.

Scale	Group	N	Mean rank	Sum rank	Mann-Whitney U	P value
CAMPROMT	Experimental group	10	9.50	95.00	40.0	.481
	Control group	10	11.50	115.00		
CAMPROMT 1ST WEEK	Experimental group	10	10.95	109.5	45.5	.739
	Control group	10	10.05	100.5		
CAMPROMT 2ND WEEK	Experimental group	10	11.15	111.5	43.5	.631
	Control group	10	9.85	9.8		

Graph 1:

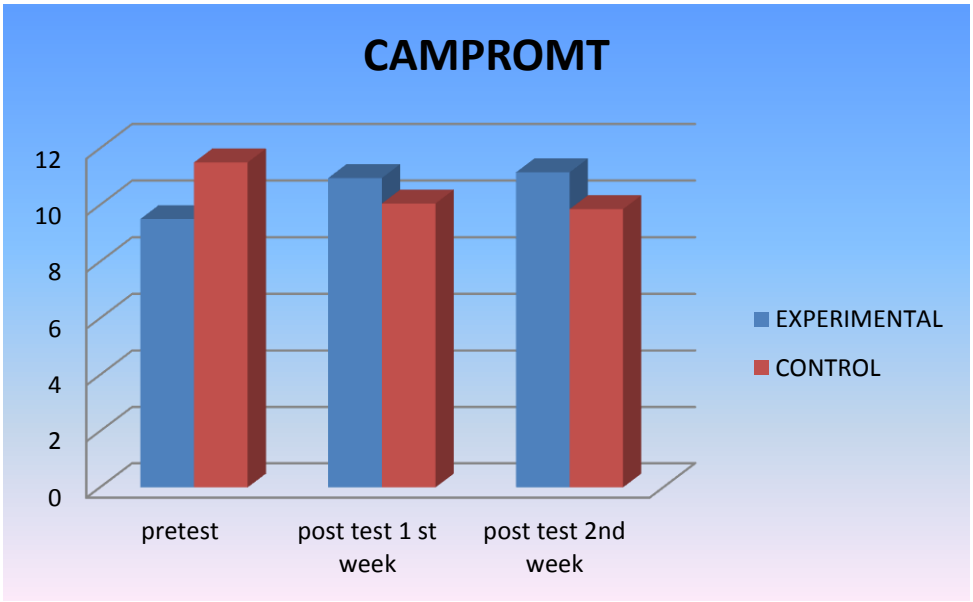

Table 2. Graph 1 shows that there is no significant difference ($p>0.05$) in the pretest and and post test 1st week and 2nd week scores of CAMPROMT of the experimental group and control group

Table 3: Comparison of pretest and posttest results of experimental group- on wilcoxon between 1st and 2nd week .

Scale	Test	N	Mean	S.D	Z value	P value
CAMPROMT 1ST Week- CAMPROMT	Pre test	10	17.7	4.32	-2.877	.004
	Post test	10	20.6	3.65		
CAMPROMT 2ND Week- CAMPROMT	Pre test	10	17.7	4.32	-2.842	.004
	Post test	10	22.2	5.7		

Graph 3:

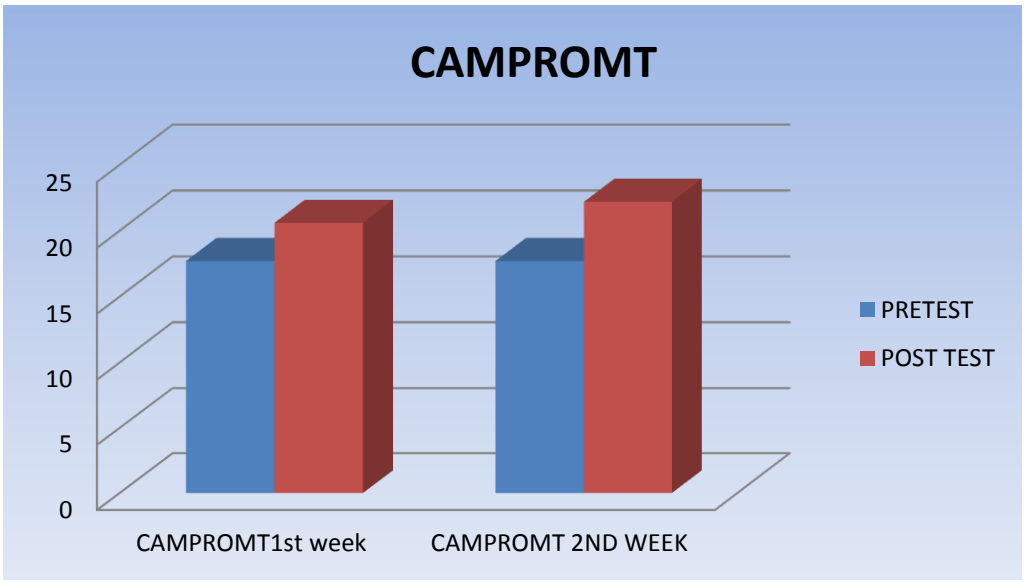

Table 3. Graph 3 Shows the pretest and posttest scores within the experimental group on the CAMPROMT during 1st week and 2nd week showed a statistical significance

Table 4: comparison of pretest and posttest results of control group- on wilcoxon between 1st and 2nd week

Scale	Test	N	Mean	S.D	Z value	P value
CAMPROMT 1ST Week- CAMPROMT	Pre test	10	19.8	5.99	-1.342	.180
	Post test	10	20.1	5.62		
CAMPROMT 2ND Week- CAMPROMT	Pre test	10	19.8	5.99	-2.530	.011
	Post test	10	21.1	5.7		

Graph 4:

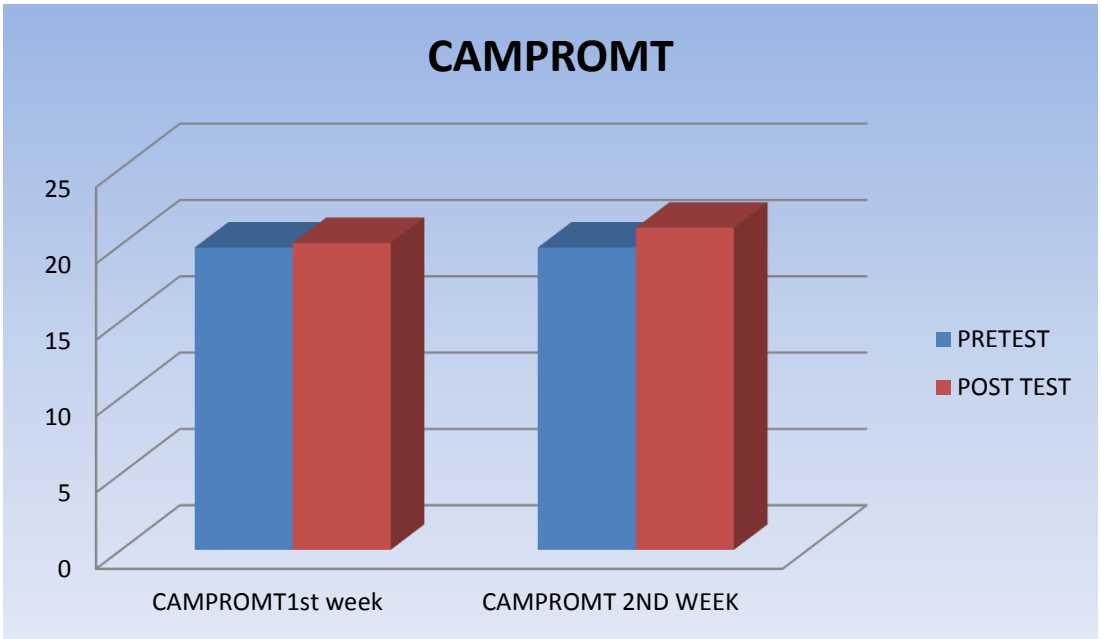

Table 4, Graph 4 Shows the comparision between pretest and posttest scores within the control group on CAMPROMT during 1st week and 2nd week showed a statistical significance

Table 5: Repeated measure ANOVA and effect size of CAMPROMT of experimental group and control group

SCALE	Mean square	Df	F	Effect size	Sig.
CAMPROMT(exp)	75.816	(1.373) (12.354)	45.466	.835	.000
CAMPROMT (con)	5.657	(1.63) (14.7)	11.270	.556	.002

Graph 5:

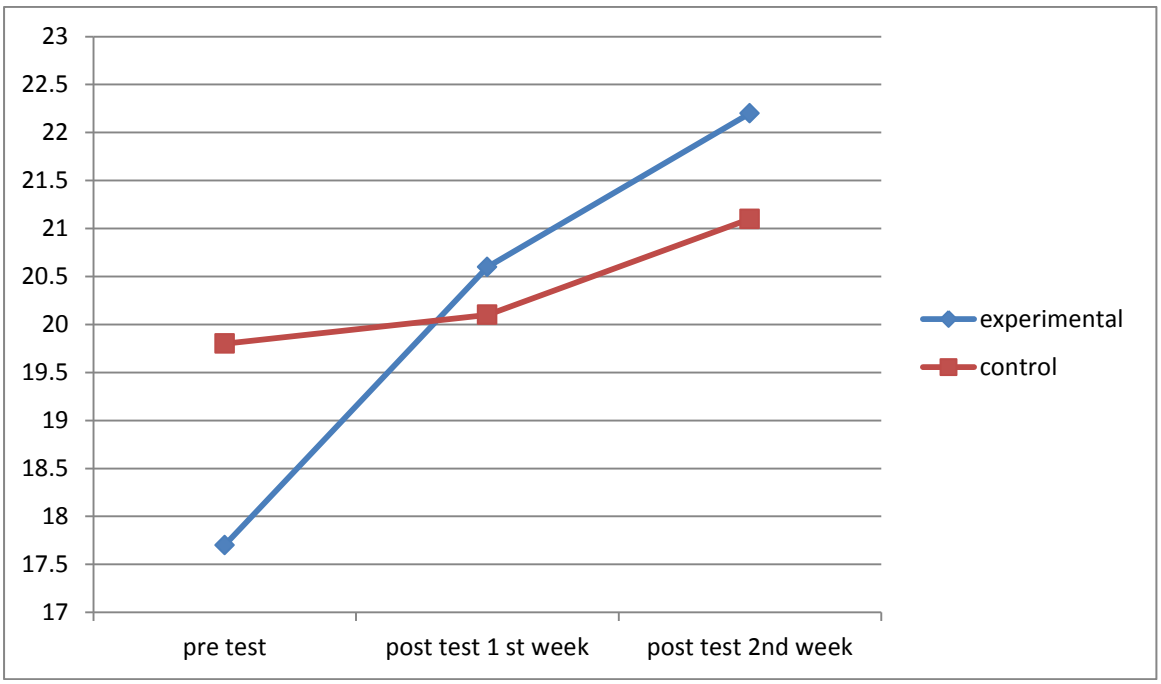

Table 5, graph 5 the repeated measure ANOVA and effect size of CAMPROMT of the experimental group shows the greater effect size and control group shows the medium effect size

DISCUSSION

This study was conducted in Coimbatore, Kovai Medical Centre and Hospital. 10 participants were allotted in the control group who received compensatory techniques based on standardized protocol for prospective memory along with traditional memory training.10 participants received retrieval practice of the standardized protocol.

With the acceleration and deceleration forces acting on the brain during a mild Tramatic brain injury, regions of the temporal lobes and frontolimbic systems are especially vulnerable to diffuse damage (Saunders, J., & MacLeod,2002)

Impairment of Prospective Memory is common following TBI and may have serious repercussions for an individual's independent living, social engagement, and employability.(Raskin,2004) Retrieval practice is the act of retrieving information also strengthens one's memory trace.(Meyer, A. N. D., & Logan, 2013)Retrieval Practice has improved recall after a short delay in cross-sectional experiments with memory-impaired patients with multiple sclerosis and survivors of severe TBI.(Sumowski JF et.al.,2010)

The age of the selected subjects ranged from 25 to 39 of the mild and moderate TBI patient with 9 male and 1 female in experimental group (mean age 43.4 years) and 8 male and 2 female in control group (mean age 41.8 years). The diagnosis of the TBI patient with mild and moderate TBI in the experimental group (mean 1.5) and the control group(mean 1.5).(table 1).

The subject underwent an intervention program which took place for 8 session within 2 weeks for both the experimental group and control group

On comparison between both the groups at the pre-test , 1st and 2nd week of post intervention there was no statistical significant ($p<.05$), difference at baseline at both the time points . (Table 2).This could be because prospective memory is influenced by other factors like information processing, visuoperception, visuospatial, and language functioning .

On comparison within pre-test and the post-test of Ist and 2nd week of post intervention for the experimental group there was statistically significant ($p<.05$), difference at both the time points . This shows that the remedial training was effective for the experimental group in improving the prospective memory .(Table 3).

These findings are supported by the study done by Sumowski J F,et.al., RP improved memory much more than restudy strategies in MS patients with severe memory impairment, even after a week-long delay.[80] In another study done by Sumowski J F,et.al., on TBI they found that RP was the most effective memory strategy for every patient after a short delay, and RP was essentially the only strategy that supported recall after a long delay (1wk).[83]

On comparison within pretest and posttest scores of control group in 1st week and 2nd week there was a statically significance difference .($P < .05$)(table 4). According to the proposed study by Jennifer Fleming, whilst research shows that compensatory approaches to PM rehabilitation minimize the impact of PM impairments in adults with TBI, integrating metacognitive skills training (MST) with compensatory approaches to PM rehabilitation will improve every day PM performance. [73]

The study further revealed that participants who went through remedial training performed better in PM with a greater effect size , $F(1.373,12.354) = 45.466, n_p^2 = .835$, $P < .005$.(Table7) Similarly the participants who practised compensatory strategies also performed significantly in PM with a medium effect size , $F(1.63,14.7) = 11.270$, $n_p^2 = .556$ $P < .005$. (Table8)

CONCLUSION

Both the retrieval practice and the compensatory training were found to be effective in improving prospective memory in patients with TBI. Best clinical suggestion for intervention would be to alternate the use of both retrieval practice and regular occupational therapy memory training as intervention to achieve maximum benefits.

LIMITATIONS AND RECOMMENDATION

Limitations:

- Results of this study could not be generalized due to small sample size.
- The evaluation of the prospective memory task as provided by the scale may not sufficient to analyze the performance of TBI patient.
- The duration of the intervention is very short.

Recommendations:

- Can be continued for a larger sample size.
- Requires longer duration of intervention to be more effective.
- Specifically investigate the generalization of prospective memory.

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APPENDICES

CAMPROPMT Record form

Name :

Age/ sex :

Date of test :

	Time	Event
1) Book		_____
2) Change task/Pen	_____	
3) Take keys	_____	
4) Give message		_____
5) Objects and locations		_____
6) Ring garage	_____	

Score conversion
score A = 6
score B = 4
score C = 2
score D =4
score E =2
score F =1
score G =1
score H =0

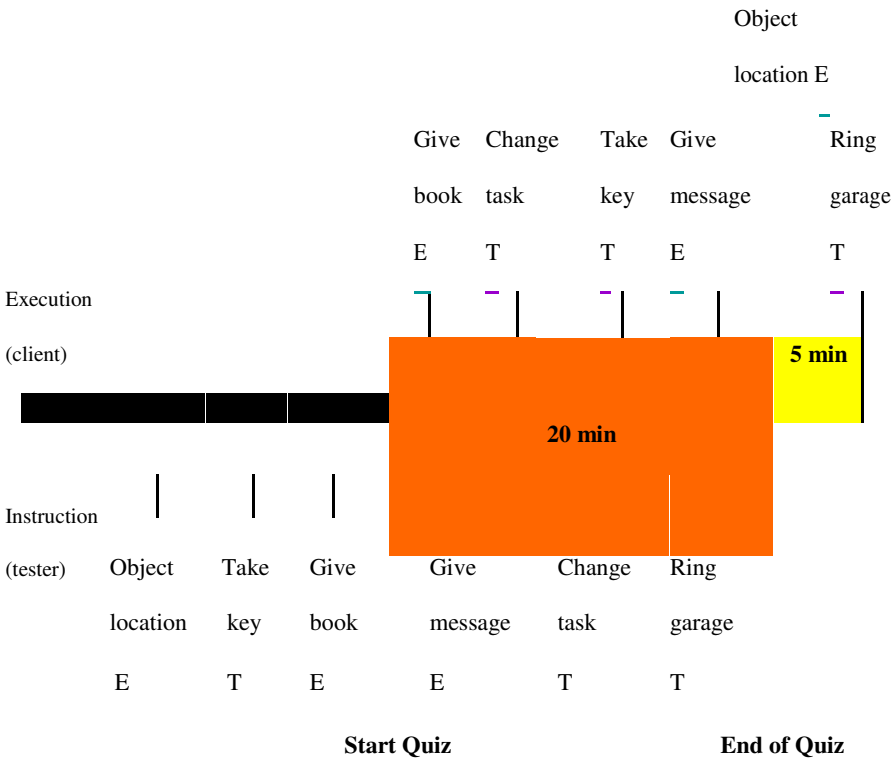
Total Time based = _____

Total Event based =

_____

Over all total score = [ ]

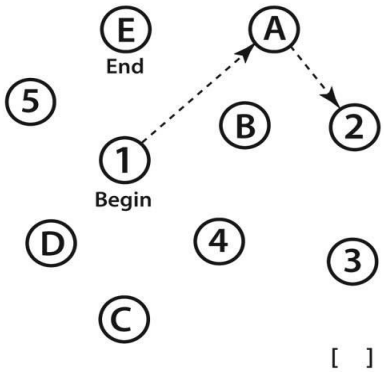
score: 36 (event-based + time based)
Scoring criteria Score
Client spontaneously carries out some tasks
Correct task Score A= 6
Wrong task- Prompt-Correct task Score B= 4
Wrong task- Prompt- Wrong task Score C= 2
No response
Prompt- Correct task Score D= 4
Prompt-Wrong task- Prompt-Correct task Score E= 2
Prompt- Wrong task-Prompt- Wrong task Score F= 1
No response
Prompt-No –Prompt- Correct task Score G= 1
Prompt- No- Prompt-'No'/ Wrong task Score H= 0

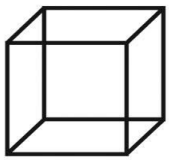


MONTREAL COGNITIVE ASSESSMENT (MOCA)
Version 7.1 Original Version

NAME :
Education : Date of birth :
Sex : DATE :

VISUOSPATIAL / EXECUTIVE





Copy cube

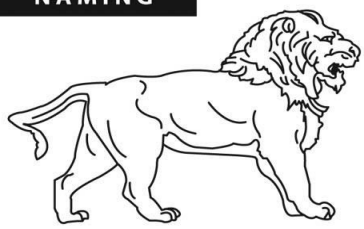
[ ] [ ]

Draw CLOCK (Ten past eleven)
(3 points)

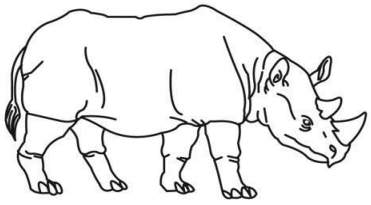
[ ] Contour [ ] Numbers [ ] Hands

POINTS ___/5

NAMING



[ ]



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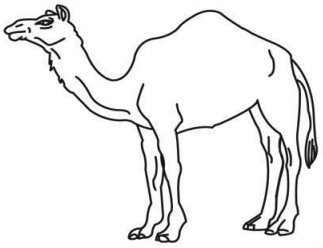

[ ]

___/3

MEMORY

Read list of words, subject must repeat them. Do 2 trials, even if 1st trial is successful. Do a recall after 5 minutes.

	FACE	VELVET	CHURCH	DAISY	RED
1st trial					
2nd trial					

No points

ATTENTION

Read list of digits (1 digit/ sec.).
Subject has to repeat them in the forward order [ ] 2 1 8 5 4
Subject has to repeat them in the backward order [ ] 7 4 2

___/2

Read list of letters. The subject must tap with his hand at each letter A. No points if ≥ 2 errors
[ ] F B A C M N A A J K L B A F A K D E A A A J A M O F A A B

___/1

Serial 7 subtraction starting at 100 [ ] 93 [ ] 86 [ ] 79 [ ] 72 [ ] 65
4 or 5 correct subtractions: **3 pts**, 2 or 3 correct: **2 pts**, 1 correct: **1 pt**, 0 correct: **0 pt**

___/3

LANGUAGE

Repeat : I only know that John is the one to help today. [ ]
The cat always hid under the couch when dogs were in the room. [ ]

___/2

Fluency / Name maximum number of words in one minute that begin with the letter F [ ] _____ (N ≥ 11 words)

___/1

ABSTRACTION

Similarity between e.g. banana - orange = fruit [ ] train – bicycle [ ] watch - ruler

___/2

DELAYED RECALL

	Has to recall words **WITH NO CUE**	FACE [ ]	VELVET [ ]	CHURCH [ ]	DAISY [ ]	RED [ ]	Points for UNCUED recall only
Optional	Category cue						
	Multiple choice cue						

___/5

ORIENTATION

[ ] Date [ ] Month [ ] Year [ ] Day [ ] Place [ ] City

___/6

www.mocatest.org

Normal ≥ 26 / 30

TOTAL ___/30

Add 1 point if ≤ 12 yr edu

Administered by: _____

REMEMBERING TO DO THINGS

Prospective-Retrospective Memory Questionnaire as described in:

Smith, G., Della Sala, S., Logie, R.H. & Maylor, E.A. (2000). Prospective and Retrospective Memory in Normal Aging and Dementia: A Questionnaire Study. *Memory*, 8, 311-321.

In order to understand why people make memory mistakes, we need to find out about the kinds of mistakes people make, and how often they are made in normal everyday life. We would like you to tell us how often these kind of things happen to you. Please indicate by ticking the appropriate box.

Please make sure you answer all of the questions on both sides of the sheet even if they don't seem entirely applicable to your situation.

Please provide the following details about yourself. Age _____ Male/Female _____

How many year of formal education have you had? _____

Have you suffered from brain or head injury resulting in hospitalisation (Y/N) _____

Please give brief details

Please answer all of the questions as accurately as possible.

	Very Often	Quite Often	Sometimes	Rarely	Never
Do you decide to do something in a few minutes' time and then forget to do it?	☐	☐	☐	☐	☐
Do you fail to recognise a place you have visited before?	☐	☐	☐	☐	☐
Do you fail to do something you were supposed to do a few minutes later even though it's there in front of you, like take a pill or turn off the kettle?	☐	☐	☐	☐	☐

	Very Often	Quite Often	Sometimes	Rarely	Never
Do you forget something that you were told a few minutes before?	☐	☐	☐	☐	☐
Do you forget appointments if you are not prompted by someone else or by a reminder such as a calendar or diary?	☐	☐	☐	☐	☐
Do you fail to recognise a character in a radio or television show from scene to scene?	☐	☐	☐	☐	☐
Do you forget to buy something you planned to buy, like a birthday card, even when you see the shop?	☐	☐	☐	☐	☐
Do you fail to recall things that have happened to you in the last few days?	☐	☐	☐	☐	☐
Do you repeat the same story to the same person on different occasions?	☐	☐	☐	☐	☐
Do you intend to take something with you, before leaving a room or going out, but minutes later leave it behind, even though it's there in front of you?	☐	☐	☐	☐	☐
Do you mislay something that you have just put down, like a magazine or glasses?	☐	☐	☐	☐	☐
Do you fail to mention or give something to a visitor that you were asked to pass on?	☐	☐	☐	☐	☐
Do you look at something without realising you have seen it moments before?	☐	☐	☐	☐	☐
If you tried to contact a friend or relative who was out, would you forget to try again later?	☐	☐	☐	☐	☐
Do you forget what you watched on television the previous day?	☐	☐	☐	☐	☐
Do you forget to tell someone something you had meant to mention a few minutes ago?	☐	☐	☐	☐	☐

PATIENT CONSENT FORM

I Mr / Mrs/ Miss _____accept to become a participant in the research study: "Effectiveness of retrieval practice on prospective memory deficits in mild to moderate TBI patients ". The researcher has explained me the content of his research in brief, what he needs to interview from, what treatment program he is providing and has answered the questions related to the research to my satisfaction.

Date :

Signature of the Patient/Guardian: Signature of the Researcher:

MASTER CHART

1.CAMPROMT FOR EXPERIMENTAL GROUP

S.No	CAMPROMT (pre test)	CAMPROMT 1st week (post test)	CAMPROMT 2nd week (post test)
1	26.0	28.0	28.0
2	20.0	22.0	22.0
3	20.0	24.0	24.0
4	20.0	22.0	24.0
5	20.0	22.0	24.0
6	16.0	18.0	20.0
7	16.0	18.0	20.0
8	14.0	18.0	20.0
9	11.0	16.0	18.0
10	14.0	18.0	22.0

2.CAMPROMT FOR CONTROL GROUP

S.No	CAMPROMT (pre test)	CAMPROMT1ST week	CAMPROMT 2ND week
1	26.0	26.0	28.0
2	26.0	26.0	26.0
3	28.0	28.0	28.0
4	24.0	24.0	26.0
5	10.0	11.0	11.0
6	16.0	16.0	18.0
7	20.0	20.0	22.0
8	18.0	18.0	18.0
9	14.0	16.0	16.0
10	16.0	16.0	18.0

KMCH ETHICS COMMITTEE
KOVAI MEDICAL CENTER AND HOSPITAL LIMITED

Post Box No. 3209, Avanashi Road, Coimbatore - 641 014. INDIA
✆ : (0422) 4323800, 4323619 Fax : (0422) 4270805
E-mail : ethics@kmchhospitals.com
EC Reg. No : ECR / 112 / Inst / TN / 2013

Ref: EC/AP/551/07/2017
24.07.2017

APPROVED

To

Dr.J.K.B.C.Parthiban,
Senior Consultant – Neuro and Spine Surgeon,
Kovai Medical Center and Hospital,
Coimbatore-641 014,
Tamilnadu, India.

Dear Dr.J.K.B.C.Parthiban.

The proposal entitled **"Effectiveness of Retrieval Practice on Prospective Memory deficits in Mild and Moderate TBI Patient"** submitted by **Mr. Selva Srinivasan** under your supervision was reviewed by the Ethics Committee in its meeting held on **22.07.2017** and permission is granted to carry out the study at **Kovai Medical Center and Hospital Ltd, Coimbatore, India.**

Thanking you,

Yours faithfully,

Dr. P. R. Muthuswamy 24/7/17
Chairman, KMCH Ethics Committee

Dr. P. R. MUTHUSWAMY,
MA.,MLA (EDM(IIM-A)Ph.D.,
Chairman
Ethics Committee
Kovai Medical Center and Hospital
Avanashi Road,
COIMBATORE-641 014

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KMCH ETHICS COMMITTEE MEMBERS LIST

S. NO	MEMBER NAME	DESIGNATION	REPRESENTATION	DESIGNATION TO THE INSTITUTION	GENDER
1.	Dr.P.R.Muthuswamy	Principal, Dr.N.G.P Arts & Science College	Chairperson	Chairperson, KMCH Ethics Committee	M
2	Dr. Devdas Madhavan	Consultant Urologist	Member Secretary	Consultant Urologist	M
3	Dr. V.Rajamani	Consultant Rheumatologist & Physician	Clinician	Consultant Rheumatologist & Physician	M
4	Dr.K.Senthilkumar	MD-Pharmacology Pharmacologist	Basic Medical Scientist	None	M
5	Dr. A.N.Murugan	Medical Director	Clinician	Medical Director	M
6	Dr. Sangita S.Mehta	Consultant Pathologist	Clinician	Consultant Pathologist	F
7	Dr. S.Madhavi	Principal	Member	Principal, KMCH college of Nursing	F
8	Dr. K.S.G.Arul Kumaran	Professor	Basic Medical Scientist	Professor, KMCH college of Pharmacy	M
9	Dr. S.Thamil Selvi	Social Worker	Social worker	None	F
10	Mr. C.Tamil Selvan	VP-Materials	convener	VP-Materials	M
11	Mr. T.C.Dinamani	Advocate	Legal Expert	Personnel Manager	M
12	Mr.R.Krishnamoorthy	Priest	Theologist	Priest	M
13	Mr. D.Ramanathan	Office Assistant	Lay person	Office Assistant	M

Dr. P. R. Muthuswamy
Chairman, Ethics Committee

Dr. P. R. MUTHUSWAMY,
MA.,MEA. FDFM(IIM-A)Ph.D.,
Chairman
Ethics Committee
Kovai Medical Center and Hospital
Avanashi Road,
COIMBATORE-641 014.