

# EFFECT OF MENTAL FATIGUE ON MEMORY AND RETENTION: AN EXPERIMENTAL STUDY

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## **ABSTRACT:**

**Objective:** *The objective of this study was to find out the effect of mental fatigue on memory (Immediate and 24 hours memory) and retention.*

**Material and method:** *60 subjects were recruited. They were divided in two groups i.e. group A (30 subjects) and group B (30 subjects). Group A was administered with three tests (trail making test, 2n-back test, tower of London task). 5 exercises were taught immediately after the completion of these tasks. Subjects were asked to repeat the taught exercises after 1 hour with a video recording done. 2nd reading was taken after 24 hours. On the other end in group B a documentary was shown to the subjects in subgroup of 5-10. Same exercises were demonstrated and readings were taken after 1 hour and 24 hours.*

**Data analysis and results:** *In the present study Unrelated t-test was used to compare the scores between experimental and control group. Related t-test was used to compare the scores within the groups. From data analysis and results it was revealed that mental fatigue reduces memory and retention.*

**Conclusion:** *Fatigue results in greater loss of memory (immediate and 24 hours memory) and retention.*

**Key Words:** *Mental fatigue, memory and retention.*

## **INTRODUCTION**

The human brain is the most complex and interesting organ. [1] Brain consists of various parts and divided into three sections- cerebrum, cerebellum and the brainstem. The cerebrum comprises of four different lobes: the frontal, temporal, parietal, and occipital lobes. Some specific Structures are present in the temporal lobe which are associated with memory, understanding language, and maintaining emotional control such as limbic system, including the olfactory cortex, amygdala, and the hippocampus . Damage to this area of the brain can result in problems with memory, understanding language, and maintaining emotional control. [2]

Memory is the ability or mental capacity of a person to remember or recall past experiences or experiences which are stored in a person's mind involving mental processes such as encoding, storage and retrieval. [3] Encoding, storage and retrieval are the three primary stages of the human memory process. Encoding is the first step to create a new memory. It converts the information into a specialized neural code that can be stored within the brain and then recalled later from short term memory and long term memory. Storage is a process of retaining information in the brain. Retrieval refers to recalling of information from the past which have been previously encoded and stored in the brain. [4] There are four types of memory: Sensory Memory is of very short period (about three seconds) recall of a sensory experience like what we just saw or heard. Short-term memory is that brief period of time of retrieve or recall the information recall information that we were experienced. Short-Term is of 30 seconds to a few days. Working memory is defined as the capacity of brain to keep a limited Long-term memory comprises those memories that range from a few days to decades. [5]

Many factors can cause memory loss. These factors include: vitamin B-12 deficiency, sleep deprivation, lack of oxygen to the brain, certain types of seizures, infection (herpes simplex virus type 1), anxiety and depression, smoking, mental fatigue, thyroid dysfunction so on. [6] Fatigue refers to as tiredness, reduced energy, physical or mental exhaustion or lack of motivation. There are some causes of fatigue such as : (a) Psychological and psychosocial - e.g., stress or fatigue, anxiety and depression, (b) Physical - e.g., anemia, diabetes, glandular fever, and cancer and (c) Physiological - e.g., pregnancy, breastfeeding, inadequate rest or sleep, and excessive exercise. [7]

Mental fatigue is defined as a change in psycho-physiological state as the result of sustained performance. Mental fatigue can bring about feelings of stress, depression, insomnia, and low self-esteem. There are three major causes of Mental Fatigue and Memory lapses are: lack of proper rest, uncontrolled stress and improper nutrition. [8] Persistent stress or mental fatigue can lead to damage of hippocampus brain cells, sense-making boost attention, memory formation and recall of information. [9]

According to the study done at the University of British Columbia, regular aerobic exercise helps to boost the size of the hippocampus, the brain area involved in verbal memory and learning. Exercise helps memory and thinking through stimulating the release of growth factors i.e. chemicals in the brain that affect the health of brain cells, the growth of new blood vessels in the brain, and even the abundance and survival of

new brain cells. [10] Therefore, the present study has been done to find out the effect of mental fatigue on immediate memory and 24 hours later. To our knowledge, not much work has been done to find out the effect of mental fatigue on memory and retention.

**METHODOLOGY**

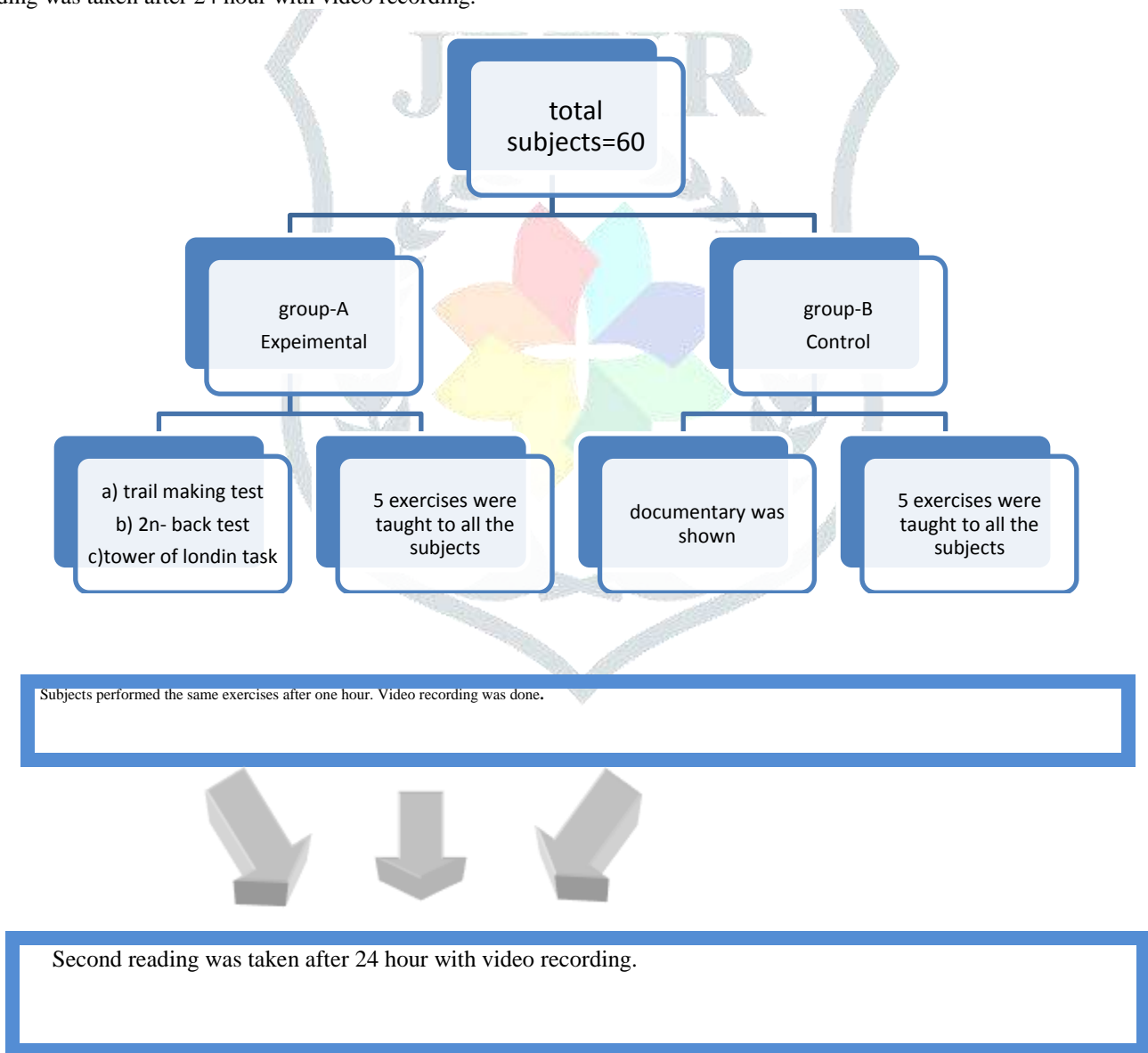
**PROCEDURE:**

Subjects fulfilling selection criteria were told about the study in detail. all these queries were answered and consent was taken. subjects were randomly allocated into two groups. demonstration of exercises were given to subjects. each exercises had four components. subjects in group A were asked to perform trail making test [11], 2n- back test [12] and tower of London task [13] to cause mental fatigue while subjects in group B were asked to relax, sit ideal and watch a documentary. After 1 hour, subjects were asked to perform the exercises. After 24 hours, subjects were again asked to perform the exercises . Scoring was done on the basis of components performed by subjects for each exercises.

**EXERCISE PROTOCOL:**

- a) Bilateral scapular retraction or both arm “W” shoulder blade squeeze.( 4 points)
- b) One arm elbow straightening ( 4 points)
- c) One arm “ full” soda can exercises ( 4 points)
- d) “ Shoulder clocks” ( 4 points)
- e) Double arm “V” exercise(4 points)

Subjects performed the same exercises after one hour. Video recording was done.  
Second reading was taken after 24 hour with video recording.



**DATA ANALYSIS AND RESULTS**

Data consisted of immediate and 24 hours memory and retention of 60 subjects ( 35 males and 25 females).

**Table 1.1-** Descriptive analysis of data for both the groups of immediate memory and retention on of both the groups.

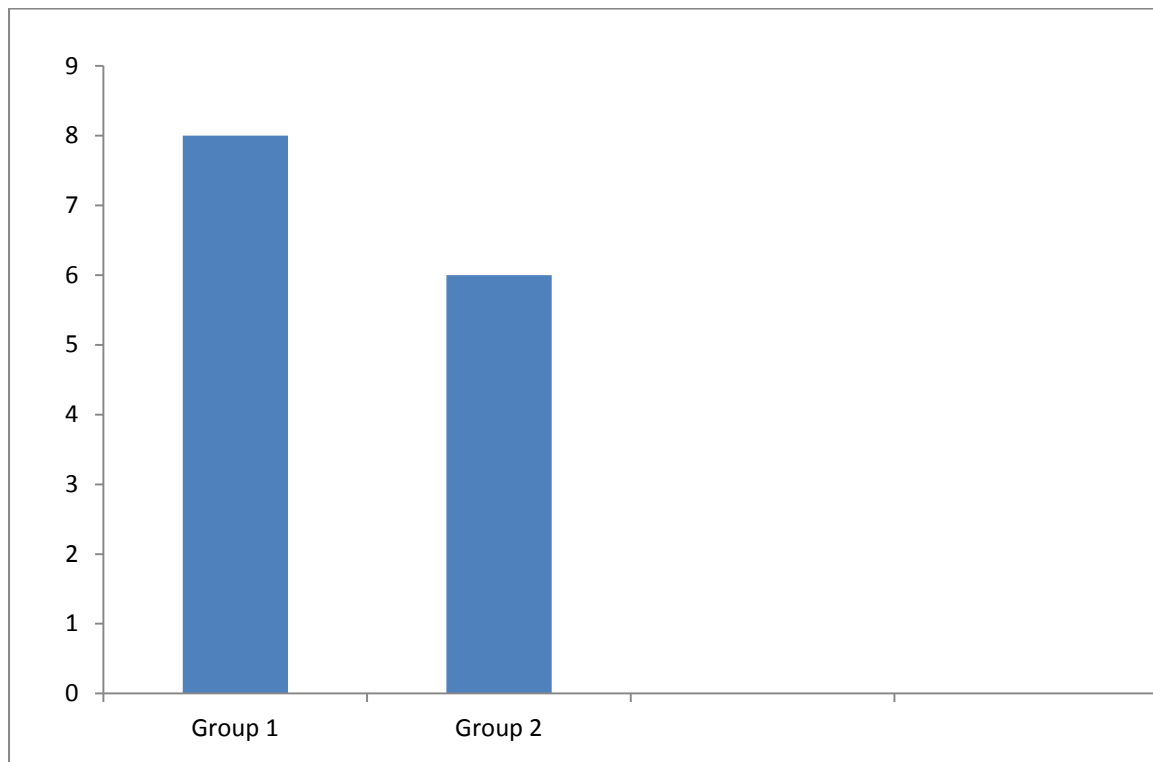
Group	Mean	Standard Daviation
Group 1	8.7	2.42331
Group 2	6	2.30442

**Table 1.2** Data for immediate retention was evaluated for normal distribution by Shapiro –wilk test. Result showed that data was not normally distributed

Test of normality			
	Shapiro-wilk test		
	Statistics	df	Sig
Mean gp1	.933	30	.60
Mean gp2	.927	30	.40

**Table 1.3** Data was analyzed with Mann-whitney U test for statistical significance. Result showed statistically significant difference between groups.

Test Statistics	
	PRE- IR
Maan- Whitney Utest	186
Exact 2 tailed hypothesis	0



**Graph 1.1** showing the mean values decreased for both the groups of immediate memory and retention of both the groups.

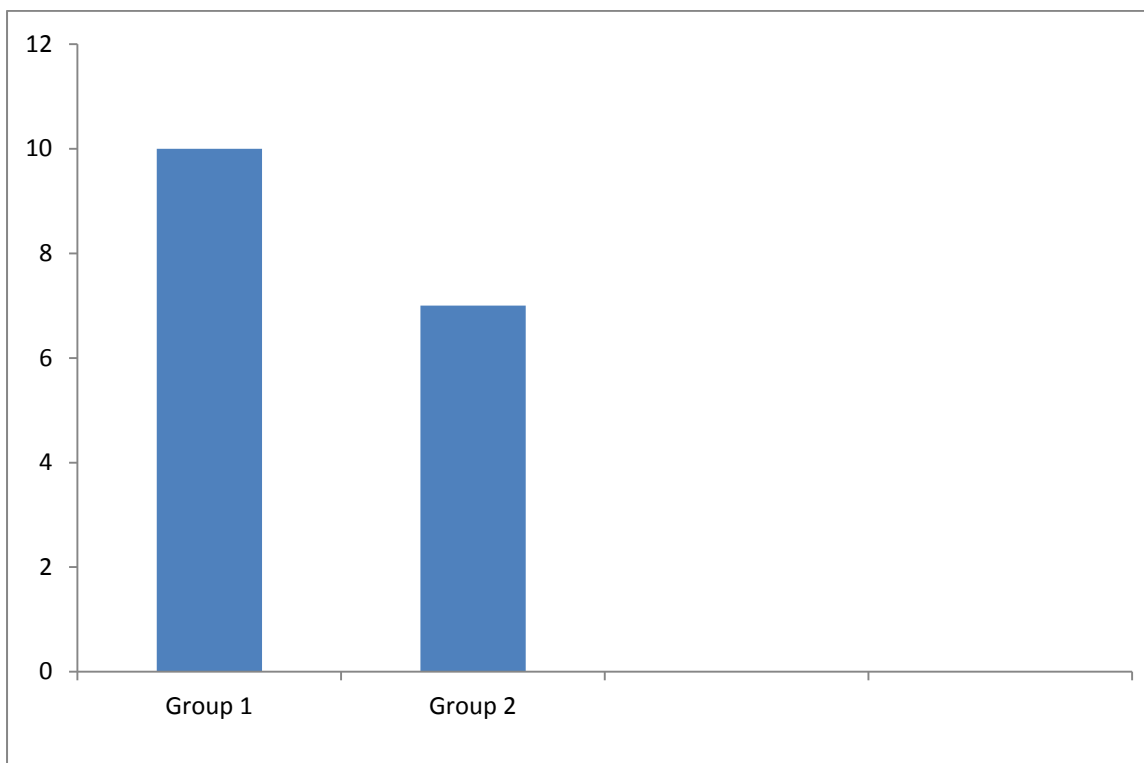
**Table 1.4** - Descriptive analysis of changes in memory and retention after 24 hours is given.

Group	Mean	Standard deviation
Group 1	10.1667	1.94906
Group 2	7.6333	2.20475

Data was analyzed for normal distribution using Shapiro-wilk test. Result showed that data was not normally distributed. Data was analyzed for stastically significance using Mann- whitney test. Result showed that statistically significant difference between groups( **table 1.5**)

**Table 1.5 (Test Statistics)**

	PRE- IR
Maan- Whitney Utest	173.5
Exact 2 tailed hypothesis	0



**Graph 1.2** showing the mean values decreased for both the groups of memory and retention after 24 hours of both the groups.

## DISCUSSION

Present study was done to find out the effects of mental fatigue on memory and retention. Results suggest that may result in decreasing in memory and retention.

According to a study done by Maarten A.S. Boksem, Theo F. Meijman, Monique M. Lorist et al in 2005 subjects developed increasing difficulties in staying alert and sustain attention during performing a visual attention task. Reaction times and number of false alarms and missed targets increased during task performance [14]. Lorist et al (2000) examined the effects of mental fatigue on planning and preparation for future actions using time on task and observed a deterioration in performance [15]. According to Holding and Hockey (2005) aversion to invest further effort into task performance is the most reliable characterization of mental fatigue, therefore increase in fatigue may be associated with a clear decrement in performance [16].

Boksem et al in 2005 reported that fatigued subjects were less able to prepare themselves for responding and had increasing difficulties in sustaining attention and ignoring irrelevant information that is increased distractibility. This therefore can result in reduced capacity to memorize. Benjamin pageaux, Samuele M. Marcora and Romuald lepers in 2013 in a study stated that The changes during development of mental fatigue include various biochemical and neurophysiological alterations [17]. According to Carmen Sandi et al et al (2011) the great sensitivity of the hippocampus to the disrupting effects of extrinsic stress in cognition is revealed by the profound suppression of hippocampal synaptic plasticity after acute exposure to stressors. A crucial role for the medial temporal lobe mediate these stress-induced retrieval impairments is also supported by human neuroimaging studies. There is also evidence that acute stress-induced memory has adverse effects which can also be mediated by activation of dopaminergic transmissions in other structures, such as the prefrontal cortex.

The biochemical changes included raised vanillylmandelic acid levels of urine and decreased plasma valine levels after mental fatigue inducing sessions as compared to their levels after relaxation sessions[18].

According to AO' Meara (1994) there was significant increase in dopamine metabolite homovanillic acid (HVA) and the noradrenaline metabolite 4-hydroxy-3-methoxyphenyl glycol (HMPG) in urine samples of healthy students facing mental stress. Another reason for reduced memory and retention can be the individual differences in intelligence quotient of subjects included in the study. This therefore results in reduced capacity to memorize [19].

An interesting point observed in the study was the better performance of experimental subjects as compared to the control subjects. The mean scores of the control group were less as compared to the experimental group. This can be due to the games administered in the experimental group. Sara Prot Craig A, Anderson in 2010 conducted a study to determine the effects of video games on cognitive performance. Result suggested that participants who did not play video game had no change in their cognitive performance, while those who played either a violent or non-violent video game had an improvement in their cognitive performance [20]. Similarly Douglas A. Gentile and J. Ronald Gentile in 2008 also supported the same fact that students who play video games should be more likely to learn aggressive cognitions and behaviors than those who play fewer [21].

## CLINICAL IMPLICATIONS -

- The study indicate that after a specific time limit (30 minutes in this study) there is a decrement in the memory and retention.
- Live demonstration is a better method to teach exercise protocol in home regimens given to the patients.

An interesting observation of the present study was the variations in the scores of Trail making test, 2-back test and Tower of London task. The scores were calculated on the basis of time elapsed in completing trail making test and points scored in the remaining two tests. Comparative analysis of these scores can be done in the future study.

Memory and retention are an important key skill for individuals. It is relevant to students as well as working profession. Implications of mental fatigue on memory and retention may help individuals to avoid mental fatigue.

## CONCLUSION

Fatigue results in greater loss of memory (immediate and 24 hours memory) and retention.

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## DECLARATION OF INTEREST

There was no declaration of interest. There was no conflict to interest among any of the authors whatsoever. The information contained in the manuscript and related files is not submitted to any other journal in any form, by any of the authors and is absolutely new and confidential in terms of scientific values.

## APPENDIX

### TRAIL MAKING TEST

This test comes from the Army Individual Test Battery (1944). It is a popular and easily administered test of visual and mental tracking capabilities. It is given in two parts, A and B. Both parts of the Trail Making Test consist of 25 circles distributed over a sheet of paper. In Part A, the circles are numbered 1 – 25, and the subject draw lines to connect the numbers in ascending order. In Part B, the circles include both numbers (1 – 13) and letter (A – L); as in Part A, the subject draws lines to connect the circles in an ascending pattern, but with the added task of alternating between the numbers and letters (i.e., 1-A-2-B-3-C, etc.). The subject is instructed to connect the circles as quickly as possible, without lifting the pen or pencil from the paper. Time the subject as he or she connects the "trail." If the subject makes an error, point it out immediately and allow the subject to correct it. Time is being noted at the end of task.

### 2N- BACK TEST

This is a working memory task. It was originally introduced by Kirchner (1958). Gevins et al(1990) introduced it to the field of neuroscience by using it as a "visuomotor memory task". In the 2n-back task participants are presented with a stream of stimuli and the task is to decide for each stimulus whether it matches the one presented 2 items before. Decision, selection, inhibition and interference resolution processes are involved. Scores are available at the end of test in percentages.

### TOWER OF LONDON TASK

The Tower of London task was originally developed by Shallice (1982) to investigate problem solving skills in subjects with damage to frontal lobes. Subjects are required to move the coloured beads in the window on the bottom (working area) until they achieve the arrangement in the win down on the top (goal position). Subjects are instructed to try to achieve the goal arrangement in as few moves as possible. The test can contain trials with 3 beads and 3 pegs, 4 beads and 4 pegs and 5 beads and 5 pegs. There can be 3, 4, and 5 beads problems with varying number of moves required for the optimal solution. Scoring is done automatically through computer at the end of task.

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