

## **Low Level Laser Therapy and Memory Enhancement: Effect of Different Energy Doses**

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**Abstract:-** Short-term memory is the information we are currently aware of or thinking about. The amount of information that can be stored in short-term memory can vary. An often cited figure is plus or minus seven items, based on the results of a famous experiment on short-term memory. Use of various new techniques to enhance the training module certainly help the learning in college age population, but doesnot provide any solution to the biologically retarding memory due to stress and inflammation of the neurons of the brain.

Our research aimed to study the effect different energy doses of Low Level Laser Therapy (LLLT) on memorizing capacity of the young population aged 20years to 30 years. For the purpose two equivalent tests of non-associated meaningful words were used. 106 subjects were divided into in Group A and Group B and each group took the “non-associated memory test” test, followed by Low Level Laser Therapytwice a week for four weeks. At the end of the 30<sup>th</sup>day an equivalent “non-associated memory test” post test was taken and the data was analyzed. The memory retention score of Group A was increase by 29.7% after 8 applications of LLLT. On the other hand group B showed 2% increase after 8 applications of LLLT.

In conclusion low level laser therapy, when used with the correct frequency, powered density and dose can be very effective in increasing the working memory of the test individuals.

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### **I. INTRODUCTION**

Use of concentrated light to treat various ailments of body is as old as the prerecorded time. It was first recognized and honored in 1903.The Nobel Prize for medicine was awarded to Dr. Niels Finsen, a Danish Physician who demonstrated the beneficial effects of various wavelengths in the treatment of various diseases especially Lupus Vulgaris and tuberculosis[ 1,2]. This same technology has proven to be effective in the fields of dermatology, neurology and physiotherapy [3-6]

In the 1960s in Europe it was noted that certain single wavelengths had excellent therapeutic effect on tissues through a process called photo-stimulation. One example is the practice of “light-treating” babies for jaundice, a common condition of newborns[7-9].

Early experiments on the effect of light on brain functions began in 1960s[10,11]. The first experimental proof and demonstration of neuron stimulation was in Aplysia ganglia using high power blue (488 nm) laser light done in 1971 by **Richard L Fork** at Bell Laboratories. Since then many other studies have been done on neuron stimulation and the effect of light in treating various brain disorders[12].

Demit et al 2006 reviewed the use of LLLT on different aspect of human health, LLLT has shown to produce beneficial cellular and physiological effects in a controlled trial to produce positive effects by stimulating various cellular activities[13]. It has been established that LLLT causes an increase in cellular respirationthat continues for much longer than the duration of exposure to the light by stimulating cytochrome c oxidase in the mitochondrial respiratory chain[14].

The number of studies on effect of LLLT on various diseases related to neuron denegation and neuron dysfunction is increasing. LLLT has shown to promote the axonal growth and nerve regeneration in both rat spinal cord [15, 16] and peripheral nerve injuries [17, 18, 19]. The efficacy of LLLT in the nervous system has been further established in animal studies showing improved neurological and functional outcomes in post-stroke [ 20,21], post-traumatic brain injury [22, 23], and in a mouse model of Alzheimer’s disease [24].It is thought this mechanism worked by suppressing the amyloid- $\beta$  peptide-induced oxidative and inflammatory responses in astrocytes.[25].Another study showed LLLT improves the emotional response and memory function in humans [26]. Somar AP 2013 concluded irradiation with moderate levels of 670-nm light and/or epigallocatechin gallate (EGCG) supplementation reducedamyloid-beta(A $\beta$ ) aggregates in SH-EP cells.Extracellular A $\beta$  can enter brain cells resulting in neurotoxicity which is thought to be involved in Alzheimer's[27].

Magical Number 7 is the concept of GA Miller also called Miller's law. It is often interpreted that the number of objects an average human can hold in working memory is  $7 \pm 2$ . [28]. One of highly sighted papers in psychology.[29,30,31,]along with the above studies prompted this research to determine the effects of

frequency, power density and total joules (dose) of LLLT may have on memory retention in healthy college age population.

## II. MATERIAL & METHOD

### Test Design

Two equivalent “non-associated memory tests” of twenty five meaningful non-associative three letter words were designed in Hindi, the local language. One of the tests was considered pre test and other a post test. All the words in both of the tests had a non-associative value of less than three. The words were tested for their association value in similar population (sample size 10) as a test population. Any word that was associated with a similar word by more than three out of sample population was discarded.

A powerpoint slide was prepared for each test which changes automatically after two seconds to standardize the time span given for each participant to visualize and memorize each of the words. After the slides were finished the participant was asked to write those words in the order of their memory in 5 minutes

### Sample Selection

The participants consisted of 106 subjects with minimum of a 10<sup>th</sup> grade education with similar cultural background. Depending on the type of laser applied the participants were divided into two groups. The Group A consisting of 56 (Mean±SD 23.7±4.8) subjects and Group B consisting of 50 subjects (Mean±SD 24.89±3.61).

### Inclusion criteria

- Age between 20 years to 30 years.
- A minimum education of 10<sup>th</sup> grade.
- Similar cultural background.
- Knowledge of the Hindi language as a primary language.
- No recorded history of mental illness or emotional instability.

Prior to using LLLT on day one, both, groups A and B took the “non-associated memory test” for 25 words, generated in local Language Hindi. The test sheet was formed on the basis of filtering non associated words to less than 3 associations in a sample of 10 subjects.

## III. LASER IRRADIATION

Two sets of different multi-diode lasers (Q10 & Q1000, 2035 PMA, USA) with same wavelengths (650, 808) and energy density (38.89mJscm<sup>2</sup>) but different energy output were applied for 3 minutes on the frontal and occipital region of the head of the participants simultaneously. The lasers were applied twice a week for 4 weeks. Q10 with energy output of 14mJ/s was applied by group A and Q1000 with energy output of 42mJ/s was applied by group B. At the end on the 8<sup>th</sup> application on day 30 the participants took another equivalent “non-associated memory test” and the results were analyzed.

### Observation

The data was interpreted according to Millers Law, considering 7 as the limiting number of words memorized. Out of the 106 participants, 56 in Group A and 50 in Group B all but two participants exceeded the millers limit of 7±2 (Fig. 1-7).

**Table: Demographic data and score of the pre-test and post test of the two groups of participants involved.**

Group	Age(Mean±SD)	Pre-Test	Post-test	P value
A	23.7±4.8	1.7±1.7	3.75±1.8	0.6090
B	24.89±3.61	2.14±1.5	2.22±1.04	0.0553

For Group A the mean ± standard deviation value score of pre-test was 1.7±1.7 and post test was 3.75±1.8, (p-value 0.6090). For Group B the mean value score of pre-test was 2.14±1.5, and the post test score was 2.22±1.04 (p-value 0.0553).

Using the score of 7 as 100% memory retention, the average percentage of the data was calculated. For group A pre test scored 23.9% and post test scored 53.6% while for group B the pretest scored 30.6% and post test scored 32.6%.

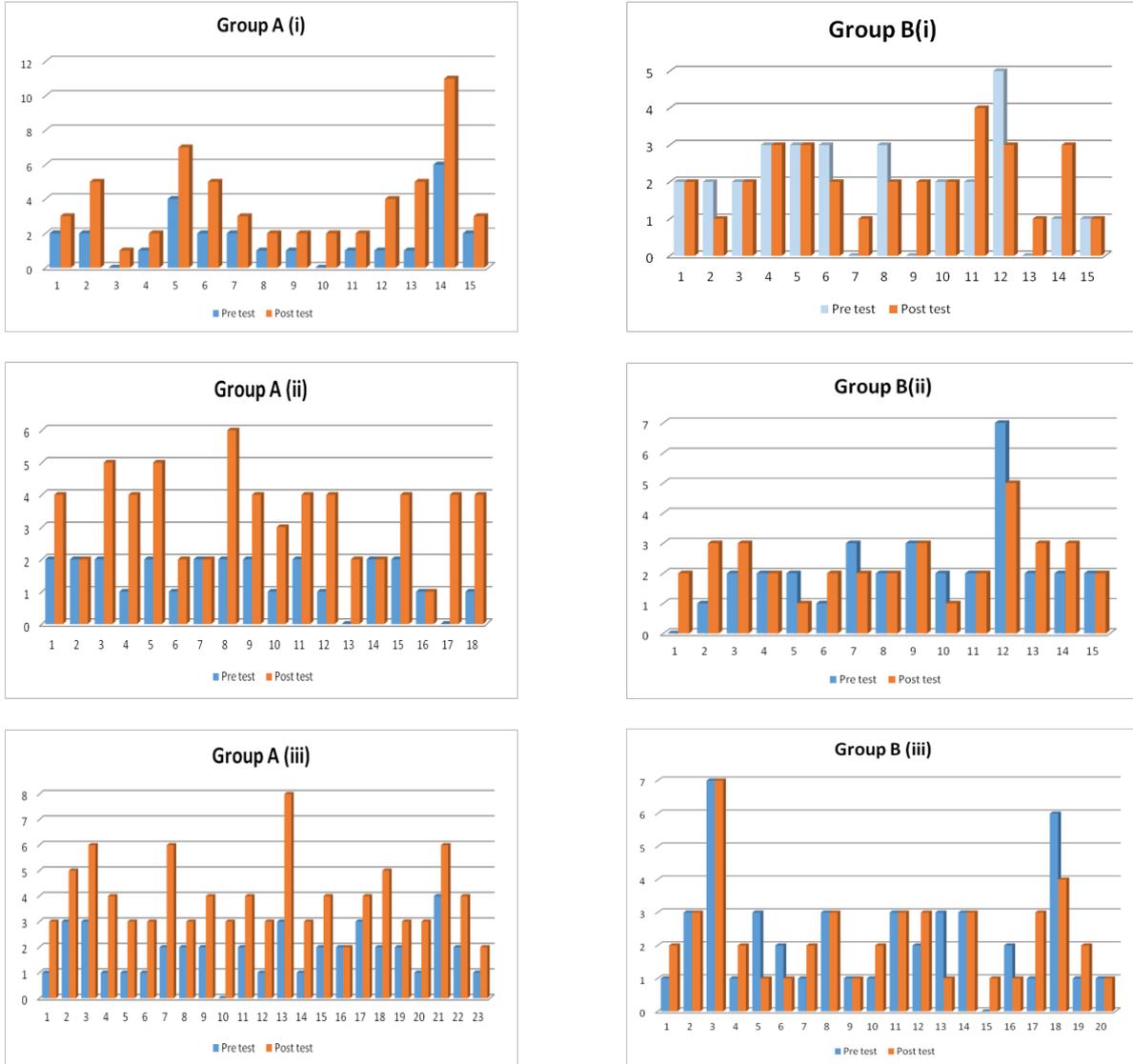


Figure 1-6:. Graphical representation of pre and post test of Group A & Group B

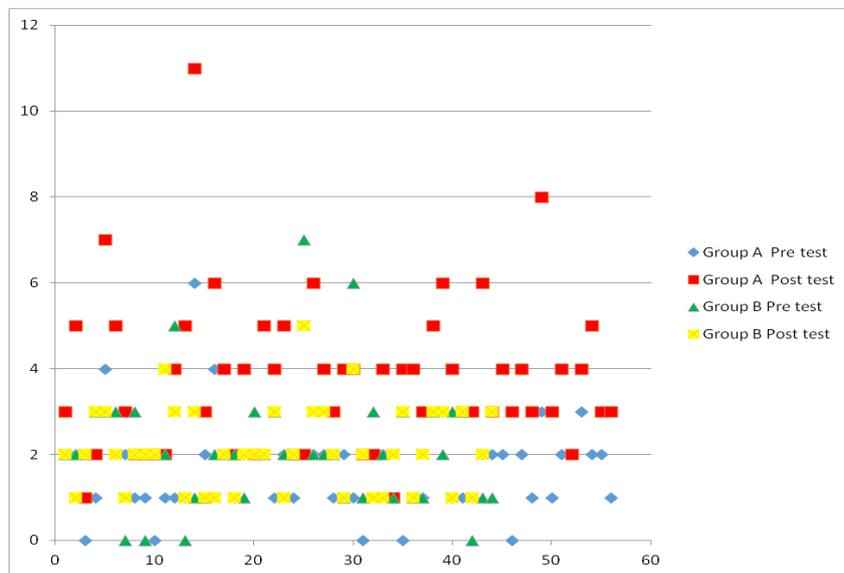


Figure 7: Scatter Diagram showing distribution of scores in pre and post test of Group A and B respectively. Group A post test shows distribution of scores on higher side.

#### IV. CONCLUSION

This study concludes that “more is not better!”. Low doses of Low level Laser therapy works far better than high energy doses with same wavelength and energy density on memory retention and learning capacity. Further research is needed to explain the exact mechanism.

#### V. RESULTS & DISCUSSION

The memory retention score of Group A was increased to  $3.75 \pm 18$  (29.7% of 7 word count) words from  $1.7 \pm 1.7$  (P-value 0.6090) words after 8 applications of the LLLT twice per week over a period of four weeks. While Group B showed a minor increase after the LLLT over the same time period. The results suggest that aiming a beam at a beam to the frontal and posterior region of the head at the same time consisting of two 650nm and two 808nm diodes emitting an output of 14mJ/s with a dosage of 2.5J and power density of 38.89 mW/cm<sup>2</sup> for a 3 minute cycle are statistically effective in improving memory retention than higher dose with lasers of same wavelength and energy density.

The exact mechanism of the action of LLLT is not clearly known but the studies have shown that LLLT activates cytochrome c oxidase in mitochondria to increase ATP[31]. An increase in ATP following LLLT treatments in participants would have beneficial effects, including an increase in cellular respiration and oxygenation. There may have been an increase in regional cerebral blood flow (rCBF) specific to the frontal lobes. **Naeser MA 2011** suggested improved function in prefrontal cortex and anterior cingulate gyrus regions on application of LLLT. Significant improvement for subject, on “inhibition and inhibition accuracy” on the Stroop test particularly, suggests improved function of the medial prefrontal cortex, anterior cingulate gyrus area[22]. The reduction in inflammation and increase in ATP production in the regions of brain following LLLT must have affected the cognitive behavior and thus memory is the study group.

Weijun Xuan in 2013 experimentally showed effect of low level laser on improvement of various parameters of traumatic brain injury brain and concluded that transcranial laser is a promising treatment for TBI in mice. However, selecting a proper LLLT regimen has shown to be a key factor for optimal therapeutic effect. They also demonstrated that the effect is time dependent application for greater duration does not show significant improvement<sup>33</sup>. Its similar with the dose of the lasers. Our research reported that higher energy dose with same wavelengths were less effective as compared to lower energy doses. Thus the energy medicine must have the optimum time and dose on which it works at maximum efficiency and activate the healing mechanism of cells. Higher doses must dilute this effect. Further studies are needed to explain further.

**Declaration:** The study was done according to Helsinki Guideline for clinical studies

**Discloser:**

"The author(s) declare(s) that there is no conflict of interests regarding the publication of this article."

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