

Effect of light- sound stimulation on learning among adolescents

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■ **ABSTRACT** : Light, sound and light-sound stimulation could be very much effective for the adolescents to improve their learning abilities. Sample of 120 students were selected from teenage group *i.e.* 13 to 19 years of both sex belonging to middle socio-economic status by purposive random sampling technique. The experimental conditions was further divided into three experimental groups and were administered three different treatments *i.e.* sound, light and light-sound through mind power music and mind machines. Pre- and post-treatment tests were administered to all the subjects, using the Letter-digit-substitution-test (LDST) as the dependent variable. Independent 't' statistic at the 0.01 level revealed a significant difference in the mean pre and post- scores of the experimental and control groups. The results concluded that light, sound and light-sound entrainment technologies are very effective to improve the cognitive abilities in learning of an individual.

■ **KEY WORDS** : Mind machines, Light-sound stimulation, Audio-visual stimulation

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These days, in information technology age, the world has become more competitive. Information technology has improved the mechanism used to store, manipulate, distribute or create information. As the technology evolves, it brings about frequent changes in the tools it offers. To survive in today's lives, it is imperative that students continually learn in order to keep abreast with changing technologies. The physical fitness revolution in the last three decades has proven that the human body requires stimulation, challenge and exercise to remain healthy. Now a wealth of brain research is proving that the brain, like the body requires stimulation and challenge to function optimally that by exercising the brain and strengthening it, just as muscles grow stronger from physical exercise. Evidences suggest that the mind power techniques can provide the kind of stimulation, challenge and novelty that can strengthen the brain, increase the actual size and health of its neurons and produce peak performance, increased intelligence, and greater well-being (Hutchison, 1994). Human being has been living through a momentous revolution. The brain revolution scientists have discovered more about the human brain in the last few years than they had learned throughout the previous human history.

The human brain appears over endowed. It is often quoted statistic that we only use 10 per cent of potential brain power. The more psychologists have learned in the last twenty years, however, the less likely they dare attempt to quantify brain potential. The only consistent conclusion is that the proportion of potential brain power that humans use is probably nearer 4 per cent than 10 per cent (Smart and Smart, 1982).

Most of us, then, appear to let 96 per cent of mental potential lie unused. But it doesn't have to be so. Once an individual begins to understand how the brain and memory works, the way is opened to tap that vast unused potential. The result can be a quantum leap in learning speed and enrichment of every part of life. Scientists now believe a measurable increase in intelligence is possible whatever the age be.

Light - sound entrainment technologies :

Nowadays, light and/or sound entrainment technologies are very popular among teenagers in this globe. Every individual wants to improve mind potential. Light-sound (L-S) entrainment also known as audio-visual entrainment (AVE)

technology has been growing steadily in last twenty years. Many preliminary research studies in the applications of AVE in such areas as Attention Deficit Disorder (ADD), Premenstrual syndrome (PMS), alcoholism, and academic performance have shown encouraging results.

The light and/or sound-light (audio-visual) devices uses sound and light to directly affect the brain through a complex neural process called brainwave entrainment. Brainwave entrainment was first identified in 1934, although its effects had been noted as early as Ptolemy. Not long after the discovery of the Alpha brainwave by Hans Berger in 1929, researchers found that the strength of the wave could be driven beyond its natural frequency using flickering lights. This is called Photic Driving, which is another word for brainwave entrainment using photic (light) stimulation. In 1942 Dempsey and Morison discovered that repetitive tactile stimulation could also produce entrainment and in 1959, Dr. Chatrian observed auditory entrainment in response to clicks at a frequency of 15 per second (as cited in warrior mind coaching and training, 2012). When the brain is presented with a rhythmic stimulus, such as a drum beat for example, the rhythm is reproduced in the brain in the form of these electrical impulses. If the rhythm becomes fast and consistent enough, it can start to resemble the natural internal rhythms of the brain, called brainwaves. When this happens, the brain responds by synchronizing its own electric cycles to the same rhythm. This is commonly called the frequency following response (or FFR). FFR can be useful because brainwaves are very much related to mental state. For example, a 10 Hz brainwave is associated with learning, so a 10 Hz sound pattern would help reproduce the learning state in the brain. The same concept can be applied to many other mental states, including concentration, creativity and many others.

Sound-light (audio-visual) stimulation can be effective only when it produces changes in the brain wave pattern. When the energy of light and sound is transduced by the appropriate receptors of the body into electrical waveforms that represent the frequencies present in the light and sound stimulus, entrainment is achieved. This change in brainwave pattern may be observed with an electro-encephalograph (EEG) machine. The sound and light energy is also converted into chemical energy.

Binaural beat :

When two sounds having different frequencies, say 500 Hz and 510 Hz, are presented to the brain simultaneously but separately through each ear, for example with the use of stereo-headphones, the two hemispheres of the brain process the two sound signals in such a way that the brain is aware of only the sound represented by the difference in the two frequencies. In this example, the brain hears a sound that has a frequency of 10 Hz (500-510). This 10 Hz sound is called a binaural beat. Human brain consists of tremendous amount

of neuron and glial cells. Two kind of brain electrical activity can be recorded by electrophysiological method: evoked cortical potential and spontaneous electrical activity is called electroencephalogram (EEG) (as in cited Yang, 2012)

The EEG can be divided into four sections to the frequency: Alpha-wave (8-13Hz, 20-100uV) is the main waveform when an adult is under resting condition. Beta-wave (14-30Hz, 5-20vV) can be obvious when an adult opens his eyes or is under stress, this waveform can be observed at frontal and parietal. Theta-wave (4-7Hz, 100-150uV) is a mark of tiredness, when an adult is getting tired, theta wave can be recorded at frontal and parietal clearly. Delta-wave (0.5-3 Hz, 20-200uV) can hardly be observed when an adult is in consciousness. It appears when a person is asleep or given anesthesia (as in cited Yang *et al.*, 2012). According to the information above, it is seen that alpha-wave and beta-wave can reflect a person's mental state. Some former experimental results show that irritation of signals with rhythm on eyes and/or ears have impact on EEG signal in specific frequency. This is the fundamental of light and sound stimulation. Actually, they are many ways to exert simulation on sensory organs, such as optical, audio and somatosensory.

Effect of audio-visual stimulation (AVS) (synchronized pulsed tones and flickering lights set at an alpha or theta frequency) to entrain neural activity on three key cognitive functions (verbal learning, memory, and attention) was tested following a regimen of training with the MC square® (GEOMC Co, Ltd., Seoul, Korea) AVS device (Tracy *et al.*, 2007). A double blind, placebo controlled (sham device), and crossover design was utilised with pre- and post-testing on the cognitive measures occurring during each phase of the crossover. The primary hypothesis was that after training with the MC square there would be improvement in verbal memory, associative learning, working memory and attention/concentration (Tracy *et al.*, 2007). Tracy *et al.* (2007) suggested a statistically reliable improvement on the measure of attention/concentration, the digit span forwards test, following MC square training and the data suggest the MC square device provides modest enhancement in the ability to focus, attend and report information over the short term.

Statement of the problem :

The importance of mind power techniques (Light -sound entrainment technologies) developed by electronic engineers to facilitate memorisation, sensation, and perception. IQ and learning abilities is of prime concern for the psychologists to go into details and find out how it works to facilitate cognitions and also to modify certain maladaptive behavioural symptoms for mental well-being in this competitive world of open economy or universalization.

Everybody is interested to go for high profile areas. Nobody is thinking of their own potentials, specially the teenagers who are already in strain and stresses are suffering

more in deciding their future plans. In the present research investigation, efforts were made to find out the impact of mind power techniques on learning psychological variable.

Light and sound stimulations of 1-min duration were presented to 10 newborn infants on each of their first 5 days of life. Differential stimulus effects on frequency of sucking bursts were observed. No differential effects were found on time spent sucking during periods of stimulation. An inverted U-shaped relation was found between level of light intensity and number of sucking bursts. Sound stimulation decreased burst frequency. No additive effects of combined light and sound stimulation were found. Stimulus change affected sucking bursts but did not inhibit sucking. Reliable individual differences were found for average number of sucking bursts per minute, burst length, inter-burst interval length, and seconds of sucking per minute (Sameroff, 1967).

Research has shown that music directly stimulates right brain functioning. Therefore, it can be used effectively in the class room to stimulate children to express unconscious feeling and thoughts Bony (1973).

Budzynski (1976) concluded that subjects who could learn to get into a state of synchrony experienced dramatic changes: increase in IQ and grade in school, improvements in performance by executives and athletes and, repeatedly, the subjects who learned to produce brain wave synchrony reported extraordinary experiences of highline states of consciousness emotional breakthroughs, feelings of oneness with cosmos and ecstasy (Budzynski, 1976).

Eceles and John intrigued by the fact that the theta state seemed to increase learning and also seemed to produce frequent vivid memories, began investigating relationship between theta and memory (Eceles and John, 1977). They found that for memories to be formed, the brain must undergo a process called Long Term Potentiation (LTP), which involves electrical and chemical changes in the neurons involved in storing memory. When LTP does not happen, information that enters the brain is not stored by totally forgotten. Significantly, the theta rhythm is what Lynch callas the natural indigenous rhythm of a part of the brain called the hippocampus, which is essential for the formation and storage of new memories and the calling up of old memories.

Swanson (1988) compared learning disabled and non-disabled children in problem solving task of picture arrangement. The study revealed that although both the groups were comparable in overall performance, learning disable children had difficulty with specific mental process related to procedural knowledge or problem execution. Swanson (1988) argued on the basis of findings that, learning-disabled children general methods of problem solving allow them to perform in the average range of intelligence, but their problem solving performance reflects an inefficient coordination of specific mental process.

Working independently, biofeedback researcher and

psychologist, Thomas Budzynski also sensed something magic about the theta state (Budzynski, 1992). He conducted extensive research into the properties of theta, which he dubbed the 'twilight state. People in theta, he found, were hyper-suggestible; they were also able to learn enormous amounts very quickly. He suggested that theta, is the state in which super learning takes place - when in theta, people are able to learn new languages, accept suggestions for changes in behaviour and attitudes, memorize vast amounts of information.

Janice (2001) studied the effect of audio, visual and audio-visual performance on perception of musical content. This investigation was designed to examine the amount of musical information fourth-graders, junior high students, high school students, or university students perceive when presented with videotaped musical performances and to compare amounts of information received under visual, audio or audio-visual conditions. Results indicated a significant difference among viewing conditions with audio-only achieving the highest music comment ratio (musical comments /total comments) and visual-only achieving the lowest. There were significant differences among specific style conditions during Audio-visual and visual-only conditions (Janice, 2001).

Light and/or sound neurotherapy (LSN) is an evidence-based treatment with over 75 years of basic and applied research. This review study summarizes the findings from 26 studies involving approximately 1,200 patients. These studies document that LSN is a robust treatment that often results in sustained improvement for a wide variety of difficult to treat conditions (Pigott *et al.*, 2009).

A kind of stimulation device aiming at alleviating brain fag was designed. Meanwhile, the specific stereo signal which is expected to induce alpha-wave of human brain was programmed and encoded into audio files. To evaluating the effectiveness of this system, a comparison test was conducted. Volunteers are divided into control group and experimental group. Via power spectral analyzing, we can find the difference of EEG signals between control group and experimental group in alpha band (8~13Hz). It can be noted that the intensity of alpha-wave and beta-wave of experimental group is larger than that of control group obviously (Yang *et al.*, 2012).

■ RESEARCH METHODS

The locale of the study was confined to the schools of Udaipur and Jhunjhunu districts of Rajasthan state in India as these schools are motivated for quality teaching and inspire their students for such mind empowering technology. The locale was selected according to the availability of sample, convenience and mobility of the investigator.

Instruments :

A light and sound instrument is a mind entrainment tool.

The method by which this entrainment occurs is known as the Frequency Following Response (FFR). Through the use of audio (headphones) and visual (eye frames with LEDs) stimulation, listeners are gently guided into specific states of mind. Each audio beat and light pulse is a specific frequency. Minds think in terms of frequency. Brainwaves change frequencies based on neural activity within the brain, be it by hearing, touch, smell, vision and/or taste. These senses respond to activity from the environment and transmit that information to the brain via electrical signals. Hearing and vision are considered the favourable senses for affecting brainwaves safely. By presenting these beats and pulses to the brain, within a few minutes, the brain begins to mimic or follow the same frequencies as the stimuli (the beats and pulses). This process is referred to as entrainment (Michael, 2012).

The investigators used commercially available cassette and mind machines for this study. These devices were based on sound, light and light-sound stimulations.

Instrument I :

Sound stimulation was given by "Dr. Anil Bapna's Mind Power Music"TM cassette. These cassettes uses relaxing music based on raga AnilTM. Raga Anil is the culmination of Indian music. It is defined as nature's music. It means any music that gives you the feeling of being in a park or being in natural surroundings like near a river in the forest or near a seashore etc. is Raga Anil (Bapna, 1991 and 1992). Mind power music (Bapna, 1991 and Dhaka, 2000) contains subliminal messages. It means that there are messages, which are hidden from conscious mind. But, sub-conscious mind can hear these messages and accept them. Since conscious mind cannot hear them, it does not interfere with these messages. They simply go to the sub-conscious mind and programs or control the mind to change the behaviour in the desired way. The cassette is of 30 minutes and both the sides are same.

Instrument-II :

Light stimulation was given by "Universal's Mind Machine (Model Faster Learning)"TM. The device is portable. It generates 10 Hz frequency (the scientific term for flashes or cycles per second) flashing light in both closed eyes simultaneously with variable intensity, which can be varied accordingly. The stimulation was given through special eye glasses which consisted by small red light emitting diodes (LED's) two per eyes are mounted in a black plastic frames of the folding sunglasses style.

Instrument-III :

Light-sound stimulation was given by "Universal's Mind Machine (Model super IQ)"TM. It combines rhythmic light and sound stimulation. The stimulation is given by special cassettes through special eyeglasses with flashing lights in

both closed eyes simultaneously with variable intensity and stereophonic headphones. The cassette is of 30 minutes and both the sides are same. The lights flash in certain pattern and there are certain sound signals containing subliminal messages. As a result, it has the ability to change brain waves to alpha, beta, theta, or delta. This device has been used to explore consciousness, to relax, to enhance intelligence and performance, for learning, for sleep and energy.

Letter-digit-substitution-test :

All the three treatments *i.e.* sound, light and light-sound were considered as independent variables of the study. Learning by substitution was used to analyse the level of learning of the subjects. In this the alertness of the mind is measured. The result is concluded on the basis of substitution done by an individual.

Substitution tests are generally used as clinical and research tools in neuropsychology and these tests are sensitive to brain dysfunction in a nonspecific way because their performance draws on many different processes: the simple responses generated in substitution tests depend on the integration of complex neuropsychological processes, including visual scanning, mental flexibility, sustained attention, psychomotor speed, and speed of information processing (Lezak, 1995). This nonspecific sensitivity to brain dysfunction, combined with the possibility of group administration and the short test time, makes substitution tests highly suitable as screening instruments.

The LDST is an adaptation of earlier substitution tests, notably the Digit Symbol Substitution Test (DSST) (Wechsler, 1981) and the Symbol Digit Modalities Test (Smith, 1968).

In the DSST, digits are presented and the test participant has to respond by writing the corresponding symbol in a blank space, according to a key, while this relation is reversed in the SDMT. The SDMT has an advantage over the DSST because the response can be given in writing or verbally, which makes it possible to compare a participant's written and spoken performance (Lezak, 1995).

The Letter-Digit-Substitution-Test (LDST) is related to the Symbol-Digit Modalities Test developed by Smith (1968), which originates from the Digit Symbol Test developed by Wechsler (1958). The LDST was used to measure the efficiency of operations in working memory. At the top of the test sheet, a box is presented with nine numbers coupled with nine letters in a random order. On the rest of the page, boxes are presented with just letters. Subjects were asked to fill in as many corresponding numbers as possible within 1 min. The number of correctly filled in numbers in 60 seconds was recorded.

Procedure :

In this method, the subjects are provided with a sheet, in which they have to fill up the basic information. The key

gives the numbers 1 to 9 each paired with a different letter; the test items are printed beneath the key. Then a key is in the sheet in which for each letter there is a number (digit). The subjects were instructed to write under each letter the corresponding number (digit) in one minute. This process is repeated for several times like 5 or 10. Then the average for substitution is noted and the scoring is done by calculating mean. Average time taken for administration is 5 minutes.

Sample and its selection :

A sample of 120 students were selected from teenage group *i.e.* 13 to 19 years of both sex belonging to middle socio-economic status by purposive random sampling technique from Udaipur and Jhunjhunu districts of Rajasthan state. Out of which 90 subjects were selected as experimental group and remaining 30 were kept in controlled group.

The experimental condition was further divided into three experimental groups and were administered three different treatments of mind power techniques *i.e.* sound, light and light-sound through mind power music and mind machines (Universal's Mind Machine User's Guide, 1997). The sample was also divided on the basis of gender *i.e.* male and female and further by having early teenage (13-15 years) and later teenage (16-19 years) group of respondents to see the difference of mind power techniques among these group of respondents.

The data for present research were collected in different stages. A pilot study was conducted with 20 samples prior to the main data collection. For each treatment, 5 samples were selected and given each treatment *i.e.* sound, light and light-sound. Pre test, post test design was used by giving interventions of three type of experimental conditions. Each group was administered a group of pre test. In the experimental group each of the subject were given their treatment as selected by investigator and were instructed to use it for six days a

week for 7 weeks (42 treatments) under the guidance of the experimenter. After 42 days, post testing was done immediately after the sound, light and light-sound treatment to the respondents for the variable under study that is learning.

■ RESEARCH FINDINGS AND DISCUSSION

The scoring was done as per the procedure laid down in the manual of the test. The difference of pre and post scores were then computed and analysed with suitable statistics, mainly the mean, standard deviation, 't' value and F-ratio were applied to find out the significance of difference among the gender, stages of teenage and experimental and control group.

All the three treatments *i.e.* sound, light and light sound were considered as independent variables. The data for the present research work have been collected from 120 teenagers of Rajasthan state, to study the effect of three independent variable on learning dependent variables of the research investigation. The mean, standard deviation and 't' values were calculated for each dependent variable and difference between male and female, early and later teenagers and pre and post scores. To see the difference between independent variables *viz.*, sound, light and sound-light stimulation's, analysis of variance was done.

The results of various parameters are as follows:

The mean value for both males and females at pre-testing and post-testing stage were at par. The results reveals that the score of learning for later teenager was more at pre-testing stage post testing stage but the difference was non-significant (Table 1). From Table 2, it is observed that there was a significant difference between post test scores of learning in different stimulations.

Table 3 indicates significant difference between the post test scores of all the three treatments and the post test score of control group. Further, it shows that post -test scores of

Table 1 : Showing mean, standard deviation and 't' value for learning

Testing stage	Pre-test			Post-test		
Gender	Male	Female	't' value	Male	Female	't' value
Mean	26.5	26.8	0.26	33.9	33.6	0.26
S.D.	2.9	3.7		3.1	3.4	
't' value	34.8	28.2		42.4	37.7	
Stages of teenagers	Early teenagers	Later teenagers		Early teenagers	Later teenagers	
Mean	26.0	27.3	1.08	33.2	34.3	0.90
S.D.	2.3	4.0		3.3	3.2	
't' value	43.3	26.5		39.4	41.4	

Table 2 : Mean squares of pre test and post test score for learning

Source of variations	Degree of freedom	Pre -test	Post -test
Effect between treatments	3	8.34	595.94**
Error (with in)	116	32.19	27.48

Indicate significance of value at P=0.01

super IQ and faster learning were at par but significant than the post test scores of music. The significant gain in these three treatments were 29.27, 32.42 and 17.62 per cent in Super IQ, Faster Learning and music, respectively as shown in Fig.1.

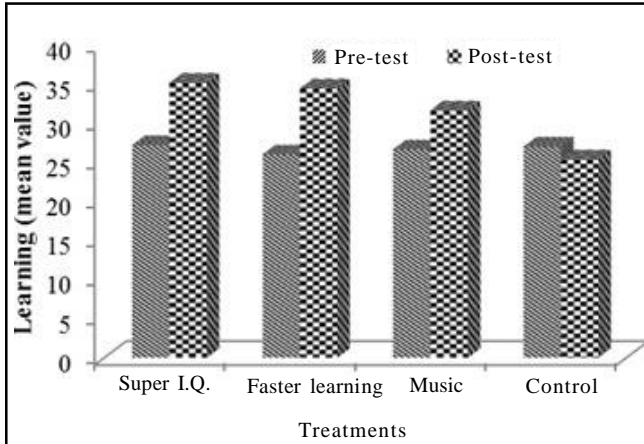


Fig.1: Effect of different stimulation methods on learning

Learning is a more or less permanent change in the behaviour as a result of experience. Learning depends on the experiences given to an individual. So, in present study, both boys and girls are equally exposed to the environment and this interaction with the environment effects the learning of the individual. When neuro-scientists make a new discovery about the brain, we are enthralled, not so much for the contribution the new discovery makes to the field of brain science, but for the light it casts into over own depths, for the insights it offers into own emotions, memories, thoughts and intelligence. When the scientists discover something new about the brain, we discover something new about ourselves.

Scientists have since long assumed that the physical size of the brain - weight, number of brain cells, thickness of cortex - is determined by heredity. But a series of studies has now proven that certain external stimulation's of the brain, or enriched environments, actually cause a pronounced increased in brain size, including the size of the neurons and the number of certain brain cells. Studies indicate that the human brain is

capable of far greater feats of bearing, remembering and creating under proper conditions; normal humans can absorb, store, process, and recall vast amounts of information.

In normal condition, the two hemispheres of the brain - which ordinarily generate brain waves of different frequencies and amplitudes - become synchronized. Both hemispheres generate the same brain waves, which is called synchronization. So when the brain hemispheres operate in synchrony, the amplitude of the wave pattern throughout the entire cortex is powerfully increased. This represents forceful whole brain fluctuations, with the resulting potential for brain reorganisation at a higher order. Later, Fehmi (1980) found that by giving L/s stimulation synchronization is produced which is effective for learning, increased intelligence etc., (Fehmi and Selzer, 1980). The present research also reveals the same (Table 3 and Fig.1) that after giving a proper type of stimulation there is increased in scores of learning.

In a related series of investigation, Robert Cosgrove noted that the audio-visual integrator (AVI) was very powerful in its ability to cause deep relaxation (Cosgrove, 1988). Although there is considerable evidence that light and sound entrainment is a replicable physical phenomenon, there have been no quantitative studies on the possible effects on behaviour and brain functioning of sustained light and sound entertainment.

Conclusion :

The scores for learning showed that there was a significant difference between experimental groups and Control group at post testing stage. It was found that Super IQ (L-S Stimulation) and Faster Learning (Light stimulation) models were at par, but significant than the post test score of Music. Further it was observed that there was no significant difference before and after giving the stimulation's between both the groups *i.e.* gender and stages of teenage.

On the basis of these conclusions, it has become clear that mind power techniques are very effective to improve cognitive abilities in learning of an individual. These techniques could be very much effective for the teenagers to achieve their goals in the life. So this path of light-sound stimulation seems to be the best for the adolescents .

Table 3 : Mean, standard deviation and 't' value of pre test and post test scores for learning

Treatments	Pre-test		Post -test		't' value	Gain (%)
	Mean	S.D.	Mean	S.D.		
Super I.Q.	27.23	6.17	35.20	6.57	4.84**	29.27
Faster learning	26.03	5.63	34.47	5.08	6.09**	32.42
Music	26.67	6.42	31.67	5.38	3.27**	17.62
Control	27.03	4.22	25.40	3.45	1.64	-
S.E.±	1.04		0.96			
C.D. (0.05)	NS		2.69			

** Indicate significance of value at P=0.01,

NS= Non- significate

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Year
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