



Comparison Of Effect Of Slow Deep Breathing Versus Gayatri Mantra Chanting On Attention, Memory And Visuo-Perceptuo Ability In School Going Children Of 13-14 Years Of Age.

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Abstract : Background and Aim of the present study was to compare the effect of slow deep breathing versus gayatri mantra chanting on attention, memory and visuo-perceptual ability in school going children of 13-14 years of age. **Methodology** The study was performed on the school 60 students of standard 9. All the students were given prior training for 10 days to learn the technique. One division was given SDB and the other was given GM chanting. Attention, memory and visuo-perceptual skills were assessed using Digit-letter substitution test and Rey-Osterreith complex figure test. Pre and post test scores were compared along with the post test scores of the both groups. **Results** showed significant improvement in the post test scores of the both groups concluding that both techniques are effective in increasing cognitive functions. Both no significant improvement was found when post test scores were compared concluding that neither of the technique is superior to the other.

IndexTerms - Breathing, Gayatri mantra chanting effect, attention, memory, visuo-perceptual skill

I. INTRODUCTION

‘Breathing’ in humans is an innate ability. The development of speech, attention and memory occurs simultaneously^{1,2}. Speech is associated with breathing. Though quiet breathing is done automatically, it also has cortical control. Slow deep breathing (SDB) is one of the techniques that is given as a part of physiotherapy. It enhances cardio-respiratory functions, cognition and behaviour through its influences on various systems of body.

Voluntary effect of breathing is subconscious but learned effect which changes with the change in the the state of arousal^{3,4}. Primary motor area (PMA- Area 4), pre-motor cortex (PMC) and supplementary motor area (SMA- area 6) controls the physiology of the breathing. Precision, planning and execution of the movement along with the attention required for the tasks is done by these areas along with cingulate gyri, inferior parietal gyri, right superior temporal gyrus (Wernicke’s areas) and right superior and middle frontal gyri. L. C. McKay et al in 2003 concluded that voluntary breathing is similar to other general voluntary movements which require integrated network of both cortical and subcortical structures. These cortical inputs from the cortex are carried by corticospinal pathways which functionally bypass medulla providing direct cortical control to the spinal respiratory motor neurons during voluntary breathing.

Breathing with frequency of the 6 breaths per minutes in adults elicits resonant and coherent features in neuro-mechanical interactions that optimize physiological function. This frequency maximizes heart rate variability which enhances cardiorespiratory synchronization where heart rate increases during inhalation and decreases during exhalation. This phenomenon is known as sinus respiratory arrhythmia (RSA) which is exaggerated at slower respiratory frequencies. RSA maximizes during sleep and thus it has intrinsic role in resting state of cardiorespiratory system. Respiratory and cardiovascular centers in medulla oblongata converge to generate cardiorespiratory rhythms (neural pacemaker). The pacemaker neurons are present in the nucleus of solitary tract (NTS) and nucleus ambiguus and they oscillate in phase with phrenic nerve. Literature about slow deep breathing in children does not mention the number of breaths per minute as mentioned for adults. Both sympathetic and parasympathetic activity of autonomous nervous system (ANS) is under the control of central respiratory centers^{5,6}. SDB induce functional state of alert relaxation^{7,8,9}, and, via nasal respiration-based actions on olfactory signaling, recruit hippocampal pathways to boost memory consolidation. Slow nasal respiration and slow cortical rhythms enhance memory. It is mediated via olfactory bulb-driven neural oscillations which travels to piriform cortex and then to hippocampus which entrains hippocampal oscillatory activity and enhances memory. SDB facilitates more oxygen intake which improves blood supply to brain which shows positive effect in concentration, emotions and induces relaxation while improving the academic performance as it also reduces anxiety levels. Slow breathing shows reductions in theta and increase in alpha activity on EEG which is associated with increased inwardly directed attention due to the self-regulated act of breathing. Slow deep breathing is also more accessible and easy technique to train and administer in children.

Speech comprises of delicate and rapid sequence of sensory and motor events requiring the coordinated activity of several parts such as oral-motor system and cognitive/semantic system¹⁰. Speech requires control of breathing according to the words and the sentences demands. We inhale enough air to vocalize a thought and exhale gradually during speech production. Laryngeal motor cortex (LMC) is essential in the control of voluntary laryngeal behaviors, both learned, such as speech and song, and innate, such as production on demand of laughter, coughing, breathing, etc. LMC is located in the primary motor area (area 4). The other areas required for phonation are premotor cortex, supplementary motor area (SMA), and lobule VI of the cerebellum. Primary auditory area include area 41, 42 and Wernicke's area. Area 41 & 42 are concerned with the perception of auditory impulses. Wernicke's area is responsible for interpretation of the auditory sensation along with understanding auditory information about any word and sending the information to the Broca's area¹¹.

Gayatri Mantra (GM) chanting: It is one of the oldest available divine hymns in ancient Vedic literature which is more than 10,000 years old. GM is the mantra of physical, emotional, mental healing and spiritual awakening or self-realization.¹²

“Om bhurbhuvahsvahatatsaviturvarenyambhargodevasyadhimahiDhiyohyonahpracodayat ||

GM consist 24 letters, with every letter providing subtle conscious energy field and magnetic field around body, it also stimulatesubliminal centers in the subtle body due to its specific syllables.^{12,13} GM has been translated by many authors; Swami Vivekananda translated GM as “We meditate on the glory of that Being who has produced this universe; may She enlighten our minds”

Vedic chanting enhances the attention and recallability^{14,15}. Chanting GM has also shown significant improvement in spatial and verbal memory. It has capacity to influence thinking compare to random thinking.¹² Vedic chanting generates specific frequencies and sympathetic activity which have their own certain vibrations which influence body's sympathetic and parasympathetic systems. The neuromotor response generated through it acts on cerebral hemispheres functions and improves cognitive¹³ and cardiovascular functions.

Attention is defined as directing of consciousness to a person, thing, perception or thought. At the age of 3 children develop ability to control their own behavior and emotions. Attention includes aspects such as obtaining and maintaining alert state, orienting to sensory stimuli and resolving conflict among competing responses¹⁰. Noisy distractions may impede focusing attention. There is the presence of complex developmental trajectory for selective auditory attention as well as in other cognitive functions in adolescence. The maturing of auditory cortex is complete till 12 years of age but the frontal cortex is still developing till mid-adolescence^{16,17}.

Memory is the set of processes used to encode, store and retrieve information over different period of time. Encoding involves the input of information into the memory system. Storage is the retention of encoded information. Retrieval is getting the information out of memory and into awareness.¹⁸

Perception is the way sensory information is organized, interpreted and consciously experienced. It involves Bottom-up processing were the perceptions are built from sensory input. How we interpret those sensations is influenced by our knowledge, experiences and thoughts. Attention affects the perception. It plays important role in determining what is perceived. Spatial relations develop optimally at the age of 7-9 years and improves till 10 years and further.^{19,20} Perceptual skills are enhanced with expanding cognitive skills in adolescence. They are important to manipulate visual information, planning and decision making.

2.1 Population and Sample- Students of 8th standard and studying in Gokhale Education, RM Bhatt school Parel, Mumbai in year 2022

2.2 Inclusion Criteria- Student and parent, willing to participate

2.3 Exclusion criteria – Student remaining absent for two days or more in three week period.

2.4 Data and source of Data-Prospective Interventional study

3.Theoretical framework

3.1 Outcome measures

Digit letter substitution test (DLST): uses letters and digits where digits are to be substituted with assigned letters²¹. It is the assessment of attention, neglect, psychomotor ability. It is speed dependant cognitive task used to also assess information processing speed also^{22,23}. It has been used for research in school children. Normative data for Indian children is also available. (Pradhan 2009)

Rey-Osterrieth complex figure test (**ROCF**): is devised by Rey 1941, standardised in 1944, but eventually several versions of figure and scoring systems are available now. It is neuro psychological assessment to assess visuo constructional ability and visual memory²⁴. In this the examinee is asked to reproduce a complicated line drawing on paper after seeing it. 2018 study by Josefina et al. added that ROCF test also provides information of executive performance linked to cognitive flexibility, organisation and working memory in children and adolescents.²⁵

3.2 Procedures

School authorities were contacted for pre IEC approval and consent for coordination in May 2021. After IEC approval (EC/84/2021) a MOU was made with Gokhale Education, RM Bhatt school, Parel, Mumbai. CTRI approval was sought in August 2021 (CTRI/2021/11/038251) and study began in September 2021. Teachers along with principal of this school helped coordinating with parents to explain nature of study. Then informed consent document was given to students to be carried at home for parent to read, understand and give written consent. Similarly consent was sought from all these children in form of assent since they were above 7 years. Once all consents were given three weeks were planned such that some class schedules were adjusted by teachers to allow pre intervention assessments, training, intervention and post intervention data collection. 8th standard had two divisions. Randomly by chit method division A was allotted SDB and division B was allotted Gayatri mantra chanting intervention. Thus,

1. SDB group (n=30) Group A
2. GM group (n=30) Group B

The interventions were carried out offline. Since it was just after pandemic, the students were made to sit with distancing in classroom and the investigator wore masks at all the time. The instructions were given along with the pictures of proper techniques. Intervention was given for 2 weeks.

INTERVENTION: SDB group –

The participants were seated comfortably. They were asked to place their palm on the belly. The instructions given were ‘Focus on taking more air in your belly. Feel your belly rise to the count of 3 given by the instructor during breathing in. Feel your belly falling during breathing out’ till the count of 6. Repetition of the above in the same way, for 10 mins. Daily for 5 days a week for 2 weeks, during the school hours.

GM group-

The investigator practiced GM chanting prescribed by think right.me, an emotional fitness mobile application run by Brahma Kumari. Participants were given GM chanting as the intervention. They were allowed to practice chanting GM for 10 days, prior the study They were asked to sit comfortably with eyes closed. Slight pause was made at the end of each sentence. They were asked to chant GM for 10 minutes continuously. Intervention was carried out for 5 days a week for 2 weeks.

DLST sheet have 8 rows and 12 columns (total 96 digits) which are to be substituted in 90 seconds. Digits are to be substituted row wise without skipping the digits. More than one skip is not allowed. If 2 or more skips are present simultaneously then further substitutions will not be counted. Three scores were recorded: attempted, wrong and net. Attempted score was calculated as total number of the digits substituted out of total 96 digits.

For ROCF test, the participants were given 3 blank sheets on which participants mentioned their names. The figure was presented on the projector. This figure is standardised Participants were given 5 minutes to copy the figure on the blank sheet. After that both original and copy was removed. 30 seconds later they were told to draw figure from the memory in 15 minutes and the sheet was collected. After 20 minutes participants were again asked to draw the figure from the memory as best as they could in 15 minutes and the sheet was collected.

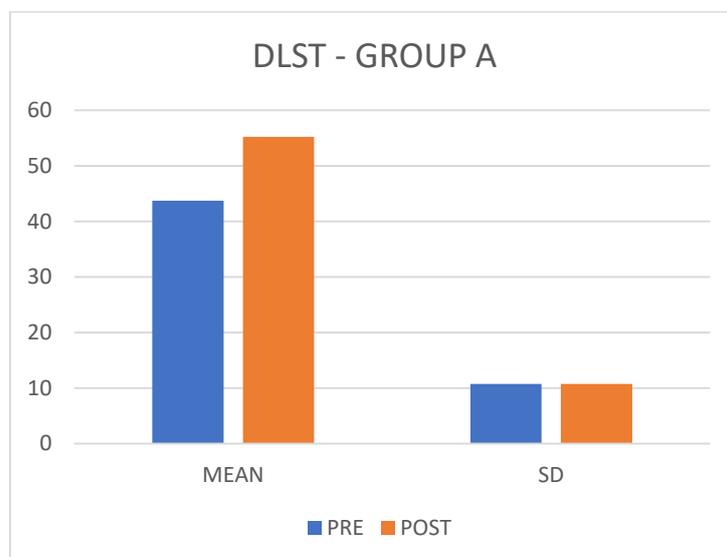
4.Statistics and data analysis-

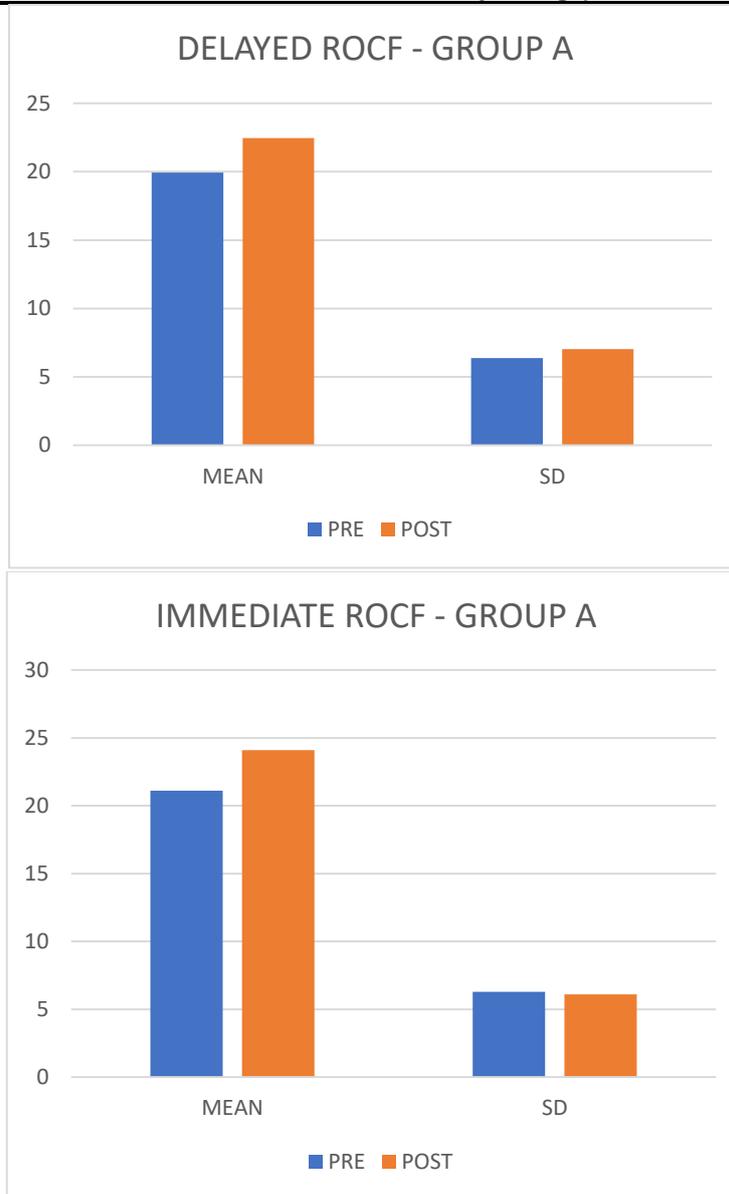
The data was entered using Microsoft Excel and analysed using SPSS statistical software. Kolmogorov-Smirnov test was used to check the normality of the data. The data was normally distributed across the pre groups. Inter group analysis was done using Wilcoxon rank sum test. Intra group analysis was done using Mann-Whitney U test.

5.Results

GROUP A – SDB Pre post analysis using Wilcoxon rank sum test

TEST	MEAN	SD	SIGNIFICANCE (p-value)
DLST			<0.001
PRE	43.76	10.7	
POST	55.26	10.73	
IMMEDIATE ROCF			0.009
PRE	21.11	6.28	
POST	24.10	6.10	
DELAYED ROCF			0.022
PRE	19.93	6.36	
POST	22.46	7.03	

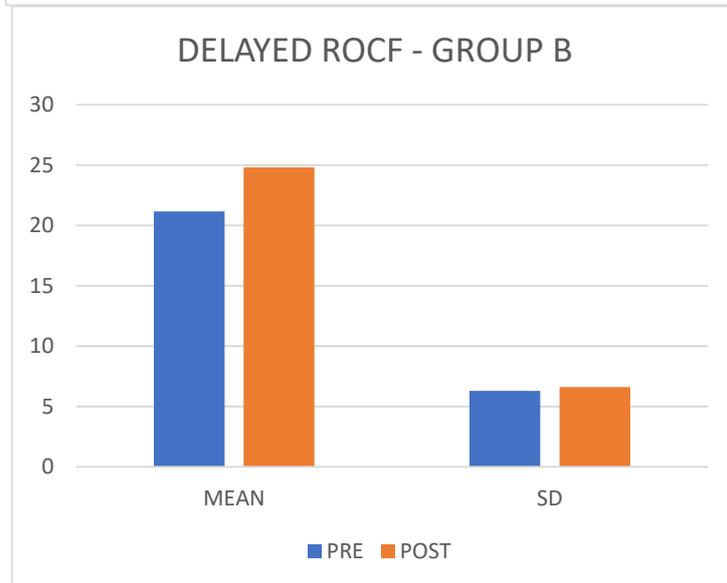
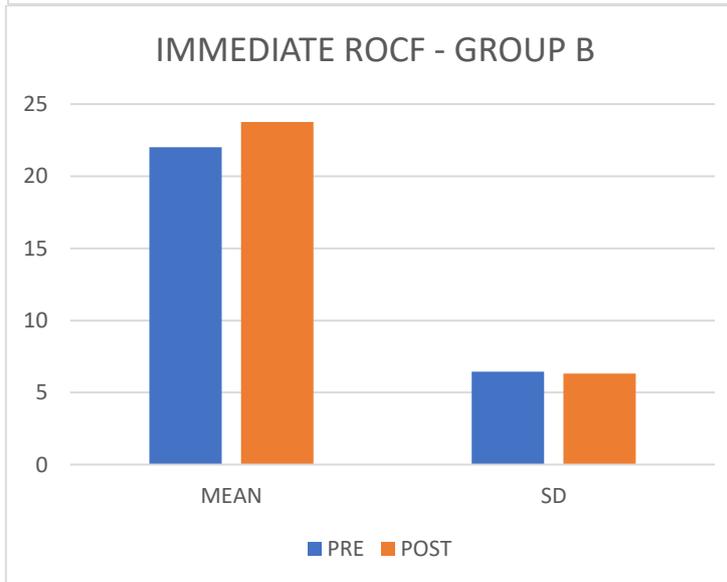
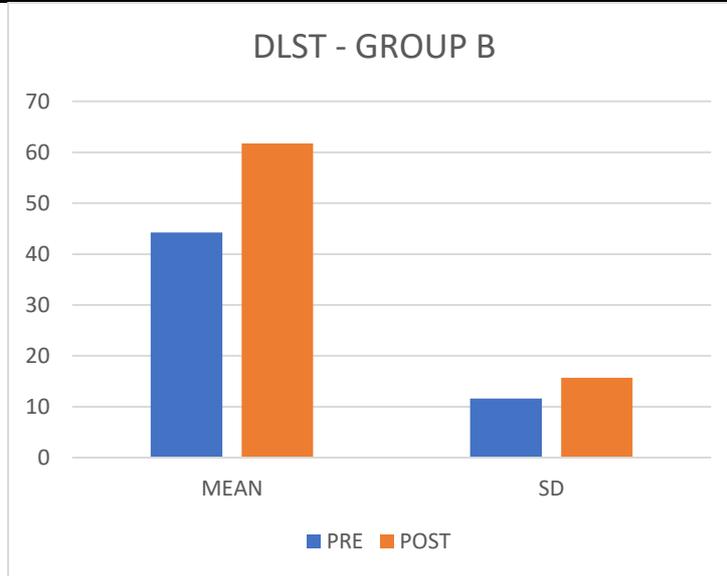




Difference between pre and post data for ROCF was statistically significant in SDB group.

GROUP B – GM CHANTING pre post analysis using Wilcoxon rank sum test

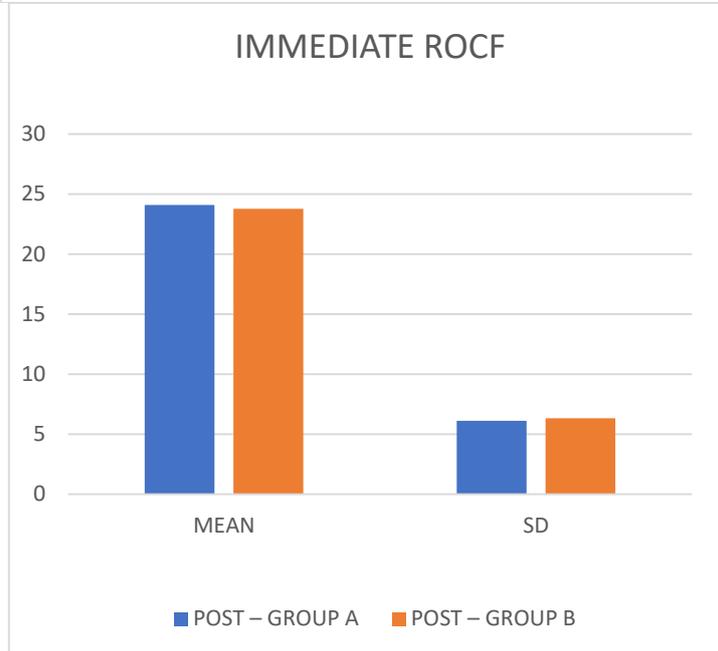
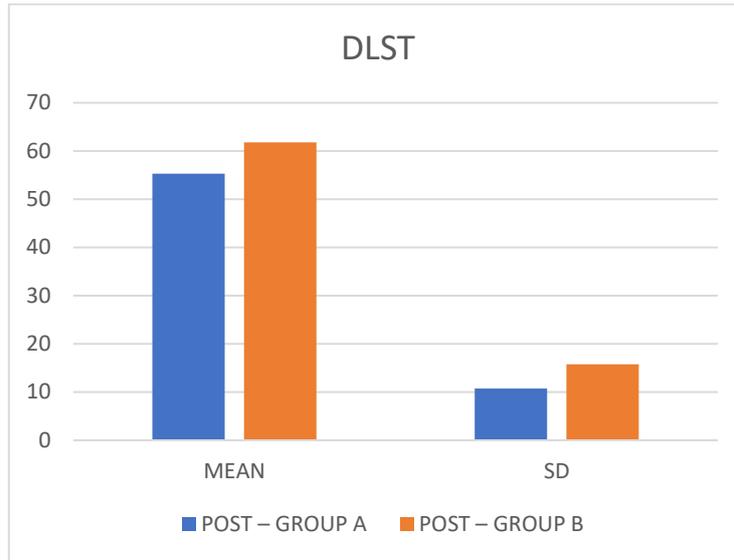
TEST	MEAN	SD	SIGNIFICANCE (p-value)
DLST			<0.001
PRE	44.26	11.63	
POST	61.76	15.72	
IMMEDIATE ROCF			0.091
PRE	22.01	6.46	
POST	23.76	6.32	
DELAYED ROCF			<0.001
PRE	21.15	6.29	
POST	24.81	6.61	

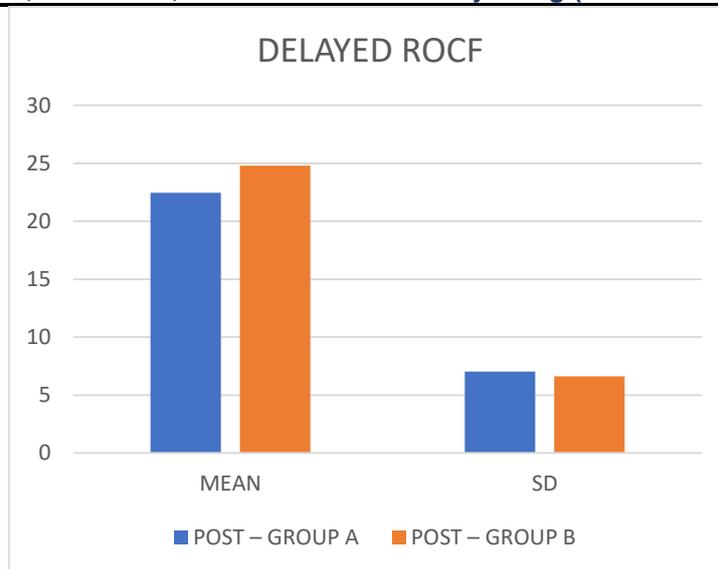


Difference between pre and post data for ROCF was statistically significant in GM group.

COMPARISON BETWEEN GROUP A AND GROUP B using Mann-Whitney U test

TEST	MEAN	SD	SIGNIFICANCE (p-value)
DLST			0.083
POST - A	55.26	10.73	
POST - B	61.76	15.72	
IMMEDIATE ROCF			0.779
POST - A	24.1	6.1	
POST - B	23.76	6.32	
DELAYED ROCF			0.26
POST - A	22.46	7.03	
POST - B	24.81	6.61	





Inter group comparison was statistically insignificant between SDB and GM group.

6 Discussion

Effect of slow deep breathing (SDB) on cognitive functions have not been studied in adolescent age groups. Breathing is a spontaneous process. SDB is a controlled breathing technique involving breathing in for longer time than at rest followed by a longer exhalation. Systematic review of slow deep breathing (SDB) techniques in adults concluded that breath control results in decreased anxiety and arousal. SDB increases focused attention or effortless awareness by inducing spatiotemporal patterns of brain activity along with respiratory afferent activity. Effects of SDB on different parts of body is already known through evidence. Adolescence is known for its emergence of concrete thinking abilities as children in this age group are starting to learn abstract thinking while moving on from concrete thought processes. This change is due to increase in processing speed and efficiency due to improvement in existing skills. Thus, enhancement of cognitive skills is possible in this age. Noradrenergic neurons of locus coeruleus (LC) located in the brainstem region are responsible for arousal, attention and response to stress.

Respiration and attention form a coupled system via LC which is affected by SDB causing reduced arousal and enhancement in flexible attentional states. Fluctuations occur in neural firing due to respiratory cycle in CNS structures namely LC, central nucleus of amygdala (CeA) and hippocampus (HC). These structures are known to regulate anxiety state (CeA), attention and arousal (LC), and memory (HC) and these are projected in entire forebrain. Stimulation of nucleus of tractus solitarius (NTS) activates paraventricular nucleus of hypothalamus through CeA which in return controls the release of cortisol. Interactions between these three occurs due to SDB causes effects on cognitive and behavioral state.⁵ Physiological occurrence in fluctuations of R-R intervals is known as heart rate variability (HRV). HRV along with blood pressure changes occur rhythmically. Respiratory sinus arrhythmia (RSA) is HRV in synchrony with the phases of respiration. Due to these R-R intervals are shortened during inspiration and lengthened during expiration. Therefore, RSA frequency changes with respiratory rate. Thus, increase in tidal volume and diaphragmatic breathing along with slower respiratory rates significantly increases RSA. The theory of RSA suggests that respiratory and cardiovascular centers in the medulla oblongata generates cardiorespiratory rhythms. Nucleus tractus solitarius (NTS) and the Nucleus ambiguus are known as pacemaker neurons phase phrenic nerve activity with its oscillations and produce an intrinsic cardiorespiratory rhythm that regulates autonomic and parasympathetic system. Respiratory gate theory suggests that inspiratory neurons in NTS opens or closes the gate synchronized with the phases of respiration. Inspiration coincides with closing of the gate and activates pulmonary stretch receptors while expiration coincides with opening of the gate. It allows autonomic efferents relaying activity from peripheral reflexes that accumulate within the NTS to flow into the nucleus ambiguus and be delivered to the heart. This allows respiratory modulation of autonomic outflow as the primary generator of RSA. Thus, autonomic nervous system is under the influence of central respiratory centres. Parasympathetic effects on heart are achieved via vagus nerve which causes cardiac slowing due to acetylcholine release. Similarly, sympathetic effects are achieved by release of norepinephrine via sympathetic chain of the thoracic spinal cord which increases heart rate. However, the parasympathetic influence is much faster than the sympathetic influence due to faster signal induction and acetylcholine receptor kinetics. Thus, it has been said that prolonged practice of slow deep breathing causes parasympathetic dominance which enhances sympatho vagal balance and reactivity to physical and mental stress.⁶ SDB is also associated with reductions in theta and increase in the alpha activity on EEG which has been associated with increased inwardly directed attention caused due to active control of the breathing rhythm. BOLD (Blood oxygenation level dependent) reflects changes in deoxyhemoglobin depending on changes in brain blood flow and suggests increased blood oxygenation. They are seen in the anterior prefrontal, motor, supplementary motor and parietal cortices are seen in EEG during slow breathing techniques.⁹ A study proved that diaphragmatic breathing can modulate cognitive performance as it balances sympathetic and parasympathetic systems and shows improvement in the sustained attention.²⁶ SDB improves cognitive processes due to rich oxygen supply to the brain. It modulates reticular activating system which is responsible for behaviour and arousal. The level of phenylethylamine PEA in blood is controlled by lungs. Lungs inactivate monoamines i.e., MAO A and MAO B whereas in return MAO A inactivates 5-HT and noradrenaline and MAO B inactivates PEA activity. This results in increase in blood levels of PEA. Phenylethylamine (PEA) causes release of norepinephrine and dopamine. It is a monoamine and is the neuronal substrate for attention and is known to cause improvement in cognition. Also, SDB causes increase in corticosteroid activity which causes further decrease in MAO activity in brain which increases in blood levels of PEA and this would increase PEA levels in brain. During SDB subject concentrates on breathing which causes regular training of cortex and improves concentration. This stabilizing effect on nervous system is seen in EEG as synchrony in alpha waves.²⁷

According to the Hindu scriptures Gayatri mantra is considered as the most significant and most effective mantra. Gayatri mantra (GM) chanting is mantra-based meditation technique in which the process of quieting and focusing the mind using a sound, word or phrase.²⁸ Researches specific to GM chanting are less. Literatures found are with collective effect of Vedic chanting. Mantra as a mediator creates a state of vibration and help in achieving state of 'restful alertness'. The neuromotor response generated through it acts on cerebral hemispheres functions and improves cognitive and cardiovascular functions. Vedic chanting done in repetitive and continuous manner activates brain cells which improves attention, memory, reduces anxiety and brings calmness of mind. Religious chanting helps individual to reduce distress and reduce emotional reactivity to negative stressors. It also modulates brain response to negative stimuli during late-stage emotional or cognitive processing. In religious chanting the verbal repetitions of a sequence of a particular tune or the vibration of sound utilized as contemplative aids acquires attentiveness, presence of mind, and triggers a series of positive associations through correlative thinking.²⁹ Recitation of the mantra slows down the respiration rate to 6 breath per minute. It also reduces the chemoreflex sensitivity which reduces the episodes of shortness of breath during exercise. Long term effects also include lower blood pressure, slower baseline breathing and higher brain oxygen saturation. Meaning and the language of the mantra matters. It was seen that pronunciation of the Sanskrit words showed increased alpha activity (associated with relaxation and the lack of cognitive processing) compared to reading the verses in other languages. As in the study with the fake mantra, results support the importance of the sound vibration of the mantra. One other study used functional magnetic resonance imaging (fMRI) to measure brain changes during two mantra meditations. The same parts of the brain were activated in the meditators with either mantra meditation, but different areas were activated while reciting "tables and chairs." The areas of the brain activated during the mantras have a role in the awareness of body sensations, whereas areas activated during the word recitation are associated with language function. Therefore, reciting mantra brings the brain to a more "aware" state compared to repeating a routine phrase. fMRI studies showed that mantra activates the regions of the brain responsible for generating and staying focused on a phrase. These regions include the motor control network and the pre-motor and supplementary motor cortices, as well as the putamen. Mantra also activates an area related to speech, while areas involved in the processing and comprehension of sounds and language are deactivated.³⁰ Activation of hippocampus and the prefrontal cortex is seen during silent mantra meditation. The significant activation was found in bilateral hippocampi along with middle cingulate and precentral cortex. Function of hippocampus is storage as well as consolidation of the memory. Theories also suggests that it keeps track of the memories with also the role in working memory as well as visuospatial memory. Middle cingulate and precentral cortex are involved with motor control and execution. The middle cingulate cortex orients the body position in response to sensory stimuli. This causes awareness of bodily sensations during meditation. Prefrontal area is involved in inducing and also maintaining meditation. This area is important for sustained and selective attention.³¹ SDB and GM chanting both are effective in school going children of 13-14 years of age for increasing attention, memory and visuo-perceptual ability but when compared with one another no significant difference was found in its effectiveness. Thus, no intervention can be stated as superior to the another.

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REFERENCES

1. K. Sembulingam, Prema Sembulingam. Essentials of medical physiology, 6th edition, New Delhi, 2012
2. John E. Hall, Arthur C. Guyton. Textbook of medical physiology, 13th edition, Philadelphia, 2016
3. Sheng Li, William Zev Rymer, Voluntary Breathing Influences Corticospinal Excitability of Non respiratory Finger Muscles. Journal of neurophysiology. 2011 Feb;105(2):512-521
4. L. C. McKay, K. C. Evans, R. S. J. Frackowiak, and D. R. Corfield, Neural correlates of voluntary breathing in humans. Journal of applied physiology. 2003 May; 95:1170-1178
5. Donald J. Noble and Shawn Hochman, Hypothesis: Pulmonary Afferent Activity patterns during slow, deep breathing contribute to the neural induction of physiological relaxation. Frontiers of physiology. 2019 Sept;
6. Marc A. Russo, Danielle M. Santarelli, Dean O'Rourke. The physiological effects of slow breathing in healthy human. Breathe. 2017 Dec;13(4):298-309
7. Kiat Hui Khng. A better state-of-mind: deep breathing reduces anxiety and enhances test performance through regulating test cognitions in children. Cognition and emotion. 2017;31(7):1502-1510
8. George Kanniah Sellakumar, Effect of Slow-Deep breathing exercise to reduce anxiety among adolescent school students in a selected higher secondary school in Coimbatore, India. Journal of psychological and educational research. 2015 May;23(1):54-72
9. Andrea Zaccaro, Andrea Piarulli, Marco Laurino, Erika Garbella, Danilo Menicucci, Bruno Neri and Angelo Gemignani. How Breath-Control Can Change Your Life: A Systematic Review on Psycho-Physiological Correlates of Slow Breathing. Frontiers in neuroscience. 2018 Sept;12(353)
10. Susan B. O'Sullivan, Thomas J. Schmitz, George D. Fulk. Physical Rehabilitation, 6th edition, New Delhi, 2014
11. Kristina Simonyan and Barry Horwitz. Laryngeal motor cortex and control of speech in humans. The neuroscientist. 2011 April;17(2):197-208

12. Shambo Samrat Samajdar, Shatavisa Mukherjee, Anushka Ghosh, Shashank Joshi. Gayatri Mantra Chanting and its effect on Attention, Memory, Anxiety and Mental State in Young Athletes. *International Journal of current research in physiology and pharmacology*. 2020;4(3):5-7
13. Narottam Kumar. Immediate role of two yoga based Mantra Recitation on selective attention in undergraduate students. *Dev sanskriti: Interdisciplinary International Journal*. 2019;13:1-7
14. Sripad Ghaligi, HR Nagendra, Ramachandra Bhatt. Effect of vedic chanting on memory and sustained attention. *Indian journal of traditional knowledge*. 2006;5(4):177-180
15. Balaram Pradhan, Seema Godse Derle. Comparison of effect of Gayatri Mantra and Poem chanting on digit letter substitution task. *Ancient Science of life*. 2012 Oct-Dec;32(2):89-92
16. Eva van de Weijer-Bergsma, Lex Wijnroks, Marian J. Jongmans. Attention development in infants and preschool children born preterm: A review. *Infant Behavior & Development*. 2007 Dec;31:333-351
17. Christina M. Karns, Elif Isbell, Ryan J. Giuliano, Helen J. Neville. Auditory attention in childhood and adolescence: An event-related potential study of spatial selective attention to one of two simultaneous stories. *Developmental cognitive neuroscience*. 2015 March;13:53-67
18. Clifford T. Morgan, Richard A King, John R. Weisz, John schopler. *Introduction to Psychology*, 2019
19. Elizabeth Vlok, Neeltje Smit, Juanita Bester. A developmental approach: A framework for development of an integrated visual perception programme. *South African journal of Occupational therapy*. Dec 2011;41(3):25-33
20. Colleen M. Schneck. Visual perception. *Occupational therapy for children*, 6th edition, 2010:373-403
21. Balaram Pradhan and HR Nagendra. Normative data for the digit-letter substitution task in school children. *International journal of yoga*. 2009 Jul-Dec;2(2):69-72
22. Wim van der elst, Martin P.J. Van Boxtel, Gerard J.P. Van Breukelen, Jelle Jolles. Detecting the significance of changes in performance o the stroop color-word test, Rey's verbal learning test, and the digit letter substitution test: The regression based change approach. *Journal of the international neuropsychological society*. 2008 Jan;14(1):71-80
23. W. Van der Elst, S. Dekker, P. Hurks, J. Jolles. The letter digit substitution test: Demographic influences and regression-based normative data for school-aged children. *Archives of clinical neuropsychology*. 2012 April;27:244-439
24. Marie-pier Tremblay, Olivier Potvin, Brandy Callahan, Sylvie Belleville, Jean-Francois Gagnon, Nicole Caza, Guylaine Ferland, Carol Hudon, Joel Macoir. Normative data for the Rey-Osterrieth and Taylor Complex Figure tests in Quebec-French people. *Archives of Clinical Neuropsychology*. 2015 Feb;30(1):78-87
25. Josefina Rubiales, Daiana Russo, Micaela Reina. Rey complex figure test and the evaluation of executive functions in children and adolescents. *Neuropsychological trends*. 2018 Nov
26. Xiao Ma, Zi-Qi Yue, Zhu-Qing Gong, hong Zhang, Nai-Yue Daun, Yu-Tong Shi, et. al. The effect of diaphragmatic breathing on attention, negative affect and stress in healthy adults. *Frontiers in Psychology*. 2017;8.
27. Sunaina Soni, Lata N. Joshi, Anjum Datta. Effect of controlled deep breathing on psychomotor and higher mental functions in normal individuals. *Indian J Physiol Pharmacol*. 2015;59(1):41-45
28. Jai Paul Dudeja. Scientific analysis of Mantra-based Meditation and its beneficial effects: An overview. *International Journal of Advanced Scientific Technologies in Engineering and Management Sciences*. 2017;3(6):21-26
29. Junling Gao, Jicong Fan, Bonnie W. Wu, Georgios T. Halkias, Maggie Chau, Peter C. Fung, et. al. Repetitive religious chanting modulates the late-stage brain response to fear- and stress- provoking pictures. *Frontiers in Psychology*. 2017;7:1-12
30. Julie K. Staples. *The science of mantra*. Science of Yoga therapist. 2018
31. Maria Engstrom, Johan Pihlsgard, Peter Lundberg, and Birgitta Soderfeldt. Functional Magnetic Resonance Imaging of Hippocampal Activation During Silent Mantra Meditation. *The journal of alternative and complementary medicine*. 2010;16(12):1253-1258