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Research Paper

The Impact of Vedic Chanting Intervention on Sustained Attention and Working Memory

Shreeraksha Sreenivasan[1]*

ABSTRACT

Various spiritual practices enable us to encounter our inner dimensions, giving us the essence of life and existence. One such spiritual practice, the chanting of Veda Mantras, can be considered as a form of concentrative meditation and it requires focus, sustenance of attention and application of memory. Along with available evidence of the utility of chanting in structural changes seen in the brain and the development of different aspects of our personality and lifestyle, importance to the effect of chanting Mantras from a cognitive perspective should also be considered as an aspect of study. In order to test the same, 40 people (aged 30-60 years) who had innate interest in Vedic chanting were requested to participate and were randomly divided into two groups- experimental and control. An intervention was provided for one month duration to chant Medha Suktam, a mantra that focuses on both memory and attention. Various tests measuring verbal WM, visual WM and visual sustained attention were conducted on the participants both before and after the intervention. Testing the control group was intended to address the factor of practice effect. Both between-group and within-group comparisons were conducted statistically through independent sample and paired sample t-tests respectively. The effect of intervention on cognitive functions were shown through improvement in verbal WM and visual SA substantially through obtained test significance. Hence this study can be used as a foundation to explore more into the interventional application of Vedic chanting, which could be used in large to prevent the onset or development of various neuropsychiatric disorders.

Keywords: *Vedic Chanting, Intervention, Verbal Working Memory, Visual Sustained Attention*

Spirituality, or rather the "Science of Self", facilitates rediscovery of man by making them aware of the infinite powers masked within them. Even though it is quite challenging to consolidate the ideologies of science and spirituality together, their union could bring in wonders. Various practices such as Yoga, meditation, music, dance and other art forms have been effectively propagating the principles of spirituality. They do not just allow the spiritual growth in a person, but also aids in the physical, mental, social and moral well-being of the person. Along with these practices, chanting of Veda Mantras is one of the most efficient and effective forms.

[1]Master of Science in Neuropsychology, CHRIST (Deemed to be University), Bengaluru, Karnataka, India
*Corresponding Author

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The Vedas are also called *Srutis* because they are always obtained through hearing and repeating. The literal meaning of the term *Veda* is 'knowledge'. The profundity and vastness of the knowledge enclosed in the Vedas have been mesmerizing the scholars in India and all over from time immemorial. Vedas are the most ancient available scriptures in Sanskrit language. The Mantras are composed of very difficult Sanskrit words, which in turn enhances the tonal, verbal, linguistic and rhythmic capacities of a person. Earlier, during the *Gurukula* system of learning, the students had to learn chanting by mere listening and repetition, without the use of any texts for reference. It involved thorough memorization of the mantras forwards and backwards, with more emphasis on the exact pronunciation, in order to keep the originally heard verses intact (Joshua Mark, 2020). Hence, there is a very definite association of memory and attention with chanting, as in most other art forms.

There are different methods of chanting Mantras, which provides maximum priority on memorizing the verses. Few methods, such as *Pada Paatha, Krama Paatha, Jataa Paatha and Ghana Paatha* do not encourage the mere chanting of the verses as it is in the form of sentences. Rather, the sentences are broken down into words, and these words are arranged sequentially and repetitively and made to chant even in the reverse order, in order to make sure that the verses get completely imprinted in the student's mind. This remarkable insistence on recitation and memorization is extraordinary and unique to the form of education system followed in various Veda Paathashalas. (Uttam Kumar et al., 2021). Such nuances in chanting enable us to understand the importance of associating such practices with cognitive functioning of the human brain and also raise the curiosity if it could be used effectively for our better performance in these cognitive realms.

Most of the available studies on the impact of Vedic chanting emphasizes on the fact that chanting of Veda Mantras has a huge influence on the brain and its activities. The structural changes observed in these studies provide an insight that the associated cognitive functions will also be affected. The number of studies conducted in this area of research are very few, but their influence is immense. Hence, further studies in this field would enable deeper understanding of efficacy of Veda Mantras. Through this study, the effect of constant rehearsal of a particular Mantra for a definite period of time on memory and attention could also be investigated. This study aims to substantiate the outcome of a constant chanting practice on different types of memory and sustained attention, by comparing it with people with no exposure to chanting. The study involves both male and female participants, which is not much observed in other studies. Participants chosen for this study are older adults, aged 30 to 60 years, with an intention to see improvement in their performance so that chanting could further be used as an intervention tool for the same population at large to prevent any early onsets of age-related cognitive decline and neurodegenerative disorders such as dementia. The impact of chanting Mantras is noted not only on memory and attention, but also on most of the other cognitive functions. Other spiritual practices such as music and Yoga have been the primary topic in various studies to examine their impact on different cognitive functions. But, very few studies have been conducted on the effect of Vedic chanting on the same. This study thus intends to examine the impact of an intervention of Vedic chanting on cognitive functions such as working memory and sustained attention.

Scientists and philosophers throughout the world have been conducting various studies to determine the aftereffects of constant practice of these spiritual activities on various cognitive functions. Although studies done on Vedic chanting aren't umpteen in number, yet

they have proven to show the connection it shares with the brain and its functions. These are the few studies that have motivated me to take up this topic.

Research was conducted to determine the effect of Vedic chanting on memory and sustained attention, considering the fact that both memory and attention are very much operating while chanting. (Sripad Ghaligi et al., 2006) 35 participants (males) were selected with an age range of 13-15 years. The experimental group had a prior experience of chanting for a minimum of two years, while the control group did not have any previous chanting experiences. Delayed recall test and letter and character cancellation test were conducted to assess memory and sustained attention respectively. The analysis of the results obtained enabled the authors to conclude that the chanting group obtained quicker and better results in both the tests, and that there was a positive correlation between chanting and performance of these cognitive abilities.

Various studies have focused on the structural changes associated with perpetual chanting. A study was conducted by a neuroscientist to explore the impact of Sanskrit language on mind and memory, (James Hartzell, 2018) which effectively proved that the brain's massive grey matter density and cortical thickness increases in those who have learnt and chant the Sanskrit texts regularly. He conducted an MRI study on 21 male participants who had memorized the complete Yajurveda Samhita. Dr. Hartzell and his team found that the grey matter of the Pandits' cerebellum was 33% denser and larger compared to those of the control subjects, which was remarkable. The right temporal cortex, associated with speech prosody and voice identity, was also substantially thicker. The factors of memorizing such large texts and memorizing a text in the Sanskrit language both create an impact on the obtained results. A very similar study was conducted on the topic of association of brain plasticity with extensive long-term verbal memory training. (Uttam Kumar et al., 2021) Similar to previous studies, a group of scholars trained in reciting Vedas were evaluated by multiple structural brain analysis methods to record the changes in their brain structures, compared to non-chanters. The results showed a significant increase in both grey matter and white matter volumes in regions of midbrain, pons, thalamus, parahippocampus, and orbitofrontal regions in pandits; and increased gyrification in the insula, supplementary motor area, medial frontal areas, and increased cortical thickness (CT) in the right temporal pole and caudate regions of the brain. Most of these regions are primarily responsible for memory formation, visuo-spatial navigation and synchronization of speech articulations. In this way there was a clear-cut association established between important memory regions in the brain and long term practice of the Veda Mantras.

Mere reading or chanting of Vedic Sanskrit texts, without the knowledge of their meaning, could also produce a distinct physiological state. (F Travis et al., 2001) Along with chanting of Bhagavad Gita, transcendental meditation was also administered for the subjects and compared with translations of the same texts in German, Spanish and French. Standards such as EEG, heart rate, breathe rate and skin conductance were measured after the administration.

Observation of high alpha power and coherence, and decreased skin conductance levels during Sanskrit reading and meditation compared to other practices suggested that the high state gained during transcendental meditation practice could be integrated with active mental processes by reading Sanskrit verses.

Many studies emphasize on the effect of Mantra meditation, Yoga or other spiritual practices as an interventional tool to cure a few disorders. In a review article, the effect of mantra meditation and other Yogic therapies on Attention deficit / hyperactivity disorder has been discussed. (Krisanaprakornkit T et al., 2010). Meditation has been increasingly used for treating various psychological conditions and here, the authors suggest that it could be used as a tool for attentional training in the ADHD population. Mantra meditation and yogic interventions were compared with drugs, relaxation training, non-specific exercises and standard treatment control for ADHD. Mind-based meditation or rather the Mantra meditation emphasizes the cognitive process which focuses on the use of selective categorization of attention; in this study the authors showed from previous studies that the participants learned to focus and refocus their attention. These points clearly show that there is a strong correlation between Mantra chanting/meditation and other spiritual practices with attention. In another study, a comparison was made between sustained effects of classical music listening and Mantra meditation on neurocognitive outcomes of breast cancer survivors. (Ashley Henneghan et al., 2021) Both Mantra meditation and classical music listening were administered as interventions for a period of 8 weeks for two groups of cancer survivors, who suffered from both cognitive and psychological impairments. Different cognitive functions such as verbal fluency, attention, immediate memory recall, perceived cognitive impairment and quality of life showed considerable improvement in both the groups. Such studies guide us towards the interventional abilities of Mantras. There are many studies available on the implications of music on cognitive abilities. In one such study, they pooled results from two RCTs to demonstrate that vocal music enhances memory and language recovery after stroke. (Alexi J. Sihvonen et al., 2020). This study emphasized on the fact that vocal music enhanced verbal memory more than instrumental music or audiobooks, mainly in aphasic patients. Even though there are numerous studies which show that listening to music can aid stroke recovery, this study helped to determine the stimulus-dependent effects and neural mechanisms driving this effect. Application of vocal music (influence of language is noticed in vocal music than instrumental music) in cognitive recovery processes in many disorders brings in a ray of hope for a similar tool such as Vedic chanting to be used as a rehabilitation tool, to notice preferred changes.

After a thorough review of all the above studies it is now evident that Vedic chanting has a significant impact on various cognitive functions, such as memory and attention. Changes in structural components of the brain can also be related to the associated functions, as mentioned above. But all the above studies have been conducted on a longitudinal or prolonged basis, i.e., participants have had the exposure of chanting for many years and changes in their cognitive abilities have been measured. In these studies, chanting has not been used as an interventional tool for improving memory or attention. My research questions also denote the same aspect - if chanting a particular Mantra for a particular period of time could enhance these functions effectively. With this idea, I would like to test these hypotheses through my study -

- H_1 - There will be a significant improvement in verbal and auditory working memory performance after the Vedic chanting intervention.
- H_2 - There will be a significant improvement in visual working memory performance after the Vedic chanting intervention
- H_3 - There will be a significant improvement in visual sustained attention performance after the Vedic chanting intervention

METHODOLOGY

Sample

A total of 40 volunteers, aged between 30 to 60 years (M = 43.2, S.D = 10.35) were requested to participate in the study. All participants are students who have just joined a Vedic school in Bangalore. Both males and females were selected for the study. Among the participants, through simple random sampling method, 20 of them were assigned to the experimental group who underwent the intervention. It was made sure that the demographic aspects, such as age and gender were matched between both the groups.

The following criteria were included during the recruitment of participants:

a) A minimum knowledge of Sanskrit or any other Indian language, to enable the learning of the Mantra.
b) Mere interest in learning the Mantra for the benefit of self and world at large.

The following criteria were excluded during the recruitment of participants:

a) Presence of any particular neurological disorder which might affect the learning during intervention.
b) Presence of any sort of auditory or visual impairments.
c) A prior learning experience of Vedic chanting for many years, which might alter the expected outcome.
d) Extreme proficiency in other artforms or spiritual practices, such as music or Yoga, which might create biased outcomes.

The study has used a quantitative research approach, since the dependent variables of memory and attention have been quantified by the process of collecting and analyzing the experimental data. The research design used is an experimental design. It has enabled a comparison between two groups - experimental and control, and tried to establish the cause-and-effect relationship between the two. There is a clear use and manipulation of an independent variable on the dependent variables to obtain the expected outcome.

Tools used in the study

1. ***Medha Suktam* - Mantra taught for the intervention:** *Medha Suktam* is a set of mantras from the *Taittireeyopanishat* (from chapters 1 and 4) of *Krishna Yajurveda*. The term Medha means wisdom / intelligence / memory. It also refers to the ability to understand and hold what one has learnt through various sources. Hence, this powerful *Suktam* was taught to the participants, which was recited by them repeatedly 9 times a day for a period of one month. This repeated chanting is believed to bring about enhanced performance in memory and sustained attention tasks.
2. **Verbal n-Back test (NIMHANS version):** The n-back test is a widely used tool to assess the verbal working memory function. (Kirchner WK, 1958). In this test, the participants are instructed to monitor a series of stimuli and to respond whenever a stimulus is presented, which is the same as the one presented 'n' trials previously. For example, in the 2-back task, (which is chosen here), the participants will have to respond to stimuli that were presented two trials earlier. Greater the number of hits shown on the n-back test, we can imply that greater will be the verbal working memory capacity. This test shows high test-retest reliability and construct validity. (G DeDe, 2013)
3. **Letter - number sequencing (WMS-III):** The letter–number sequencing task is a working memory capacity measure included as part of the Wechsler's Memory Scale

(WMS) (Wechsler. D., 1997). This test focuses on the subject's command of receptive language due to the need to understand the information that is being transmitted. This assessment requires the participant to mentally arrange a random sequence of letters and numbers after hearing it. The participant should then state the numbers in ascending order and the letters in alphabetical order. (Mielicki et al., 2018). The total score obtained in this test determines the performance in verbal working memory.

4. **Digit span test (WMS-III):** Measures of forward and backward digit span (DS) are among the oldest and most widely used neuropsychological tests to test short-term verbal memory (Richardson, 2007). This test is also a component of WMS- III (Wechsler. D., 1997). In this test, digit sequences are presented starting with a length of two digits, which keeps increasing, and two trials are presented at each increasing list length. Testing ends when the subject fails to accurately report either a trial at one sequence length or when the maximal list length is reached (9 digits forward, 8 backward). The total number of trials reported correctly is combined across forward span and backward span to produce a total correct score. The Digit span tests show high internal reliability:.70-.90 (Conway et al., 2005). The test-retest reliability is also good (.50-.70), and it can even reach .83 (Wechsler, 1997). The test also shows high criterion validity.
5. **e-Corsi test:** The Corsi block-tapping test is a psychological test that evaluates visuo-spatial working memory. In this task, nine blocks are displayed on the screen, in which a few of them will light up in a particular sequence. The task of the participant is to click on the blocks in the same order as shown. The number of boxes will increase as the participant responds correctly. The score is recorded in the form of Corsi span, which is generally 5-6 for normal adults. (Corsi P M, 1972)
6. **Stroop test:** The Stroop Test is a classic phenomenon presenting the importance of attentional filtering and interference. (Stroop JR, 1935). The typical stroop effect explains that there is a simultaneous processing of two streams of information, one which is fast and automatized (reading) and one which is slower (colour naming). When there is an incompatibility between the two dimensions, it affects the responses and the response inhibition duration. The stroop test on psytoolkit.org is used for the current study. For scoring, the number of correct responses and errors will be calculated, since this test has been used only to test for visual sustained attention and not response inhibition.
7. **Sustained Attention to Response Task:** Sustained Attention to Response Test (SART), involves a motor response to frequent stimuli and a withheld motor response to a rare stimulus. In this test, the participant will view digits 1 to 9, among which they will have to respond only to go trials (all numbers except 3). The number of go mistakes and no-go mistakes are recorded, out of 200 and 25 respectively. The SART was indeed found to be sensitive to the ability to sustain attention to dull but demanding tasks (Robertson et al., 1997).

Procedure

An informed consent form, with complete details of the study, the ethical considerations and risk factors included in the study, was provided to all the 40 participants. The same was conveyed to the participants orally, and all doubts were clarified. After obtaining the consent, a pre-test was conducted for all the participants - which included all the 6 tests - n-back test, letter-number sequencing test, digit span test, Corsi test, Stroop test and Sustained Attention to Response Test. All the scores were recorded and analyzed. This was considered as the pre-test scores. The participants were then divided into two groups - experimental and

control, with an equal number of participants in each, based on simple random sampling technique. The experimental group was provided with an intervention during the course of the study. They were taught the powerful *Medha Suktam*, which went on for a few meeting sessions. Before they began the intervention, it was made sure that they recited it accurately with perfect diction, in order to ensure the expected outcome. Once the participants learnt the *Suktam*, they were asked to chant it 9 times a day. This could be done at a single sitting or in intervals. They required around 45 mins to complete the recitation every day. A detailed track of every participant's involvement in the task was kept throughout the intervention period, i.e., for one month.

After the completion of 30 days of chanting, all the participants were again administered with all the above-mentioned tests, and these were considered as post-tests. The tests were reconducted or the control group participants as well, after a period of one month, but without any intervention being provided. The data collected was analyzed and recorded as post-test scores.

Ethical Considerations

The study followed all the guidelines set by the IRB. The study aims to merely benefit individuals and do no harm to them. It safeguards the welfare and rights of the participants. It respects the dignity, and the rights of individuals to privacy, confidentiality, and self-determination. The purpose of the research, duration, and procedures; the participant's right to withdraw or decline to participate, any research benefits, limits of confidentiality, incentives for participation; and whom to contact for questions about the research and their rights were mentioned in the consent form. The private information of the participants is going to be kept as confidential as possible. Participants will be informed about the use of information (if any) and use it only for the purpose which is conveyed to them. There is an honest report of data, results, methods and procedures. The study did not fabricate or misinterpret the data.

Data analysis

All the collected data were statistically analyzed to test the validity of the above-mentioned hypotheses. The data analysis was done on Jamovi version 2.2.5. All variables were screened for extreme univariate outliers such that values outside the limits were excluded. First descriptive statistics was done to know the mean, median, and standard deviation of the data. Second, the data was put through normality testing using the Shapiro-Wilks test. The data was normally distributed. The t-tests were used for statistical analysis. Independent samples t-test was used for between group comparison, while paired sample t-test was used for within group comparisons.

RESULTS

In order to compare the within-group test scores (pre-test vs. post-test scores), paired sample t-test was used. From the initial descriptive analysis, it was found that the data was normally distributed ($p>0.05$) in all aspects. Hence, parametric tests itself were conducted.

Table 1: Descriptives of pre-test and post-test scores of experimental group

	N	Mean	Median	SD
2-back no. of hits pre	20	6.25	6.00	1.020
2-back no. of hits post	20	7.70	8.00	0.470
LNS score pre	20	12.50	12.00	2.439
LNS score post	20	16.35	16.00	2.159

	N	Mean	Median	SD
DS score pre	20	21.10	20.50	4.340
DS score post	20	26.05	26.00	3.332
Corsi span pre	20	4.95	5.00	1.099
Corsi span post	20	5.70	5.50	0.801
No. of errors stroop pre	20	3.70	3.00	3.045
No. of errors stroop post	20	1.05	0.50	1.572
SART errors pre	20	7.80	6.50	5.809
SART errors post	20	3.55	3.00	3.086

Table 2: Paired Samples T-Test between pre and post-tests of experimental group

			statistic	p
Verbal 2-back pre	Verbal 2-back post	Student's t	-6.18	< .001**
LNS score pre	LNS score post	Student's t	-10.56	< .001**
DS score pre	DS score post	Student's t	-7.38	< .001**
Corsi span pre	Corsi span post	Student's t	-3.00	0.007*
Stroop errors pre	Stroop errors post	Student's t	5.31	< .001**
SART errors pre	SART errors post	Student's t	3.71	0.001*

Table 3: Descriptives of pre-test and post-test scores of control group

	N	Mean	Median	SD
2-back no. of hits pre	20	6.20	6.00	1.152
2-back no. of hits post	20	6.55	7.00	0.945
LNS score pre	20	11.25	11.00	2.918
LNS score post	20	11.60	11.50	2.761
DS score pre	20	20.25	20.50	3.864
DS score post	20	19.35	20.00	4.030
Corsi span pre	20	5.20	5.00	1.105
Corsi span post	20	5.20	5.00	0.523
No. of errors stroop pre	20	3.35	3.00	2.159
No. of errors stroop post	20	3.25	3.00	1.997
SART errors pre	20	7.70	5.50	7.575
SART errors post	20	7.05	5.50	5.735

Table 4: Paired Samples T-Test between pre and post-tests of control group

			statistic	p
Verbal 2-back pre	Verbal 2-back post	Student's t	-1.437	0.167
LNS score pre	LNS score post	Student's t	-1.437	0.167
DS score pre	DS score post	Student's t	2.781	0.012*
Corsi span pre	Corsi span post	Student's t	0.000	1.000
Stroop errors pre	Stroop errors post	Student's t	0.227	0.823
SART errors pre	SART errors post	Student's t	0.943	0.358

Table 2 shows the paired sample T-test results of the experimental group comparing the pre-test and post-test scores. The experimental group showed a statistically significant difference after the completion of intervention in verbal WM tests - the verbal 2-back test (M= 7.70, p= <.001), the letter-number sequencing test (M= 16.35, p = <.001) and the digit span test (M= 26.05, p = <.001); and visual sustained attention tests being the stroop task (M = 38.95, p = <.001) and the sustained attention to response task (M(errors) = 3.55, p = .001). However,

the results were less, but still significant for the visual WM test, the corsi test (M = 5.70, p = .007).

Table 4 shows the paired sample T-test results of the control group comparing the pre-test and post-test scores. The control group participants did not show any statistically significant difference in any of the performed tests, except the digit span test.

Table 1 and table 3 show the descriptives of both pre-test and post-test scores of experimental and control groups respectively. In table 2, there are drastic differences between the pre-test and post test scores of mean and median values in all those tests that have shown significance. This pattern is not observed in table 4, i.e., there is not much difference observed in these values in the control group.

Table 5: Independent Sample T-Test between pre-post difference of both experimental and control groups.

		Statistic	df	p
2-back hits	Student's t	3.25	38.0	0.002*
LNS total score	Student's t	8.00	38.0	< .001**
DS total score	Student's t	8.32	38.0	< .001**
Corsi span	Student's t	2.21	38.0	0.033*
Stroop errors	Student's t	-4.12	38.0	< .001**
SART errors	Student's t	-2.82	38.0	0.008*

In order to get a between-group comparison between experimental and control groups, the difference between post-test and pre-test data were considered in both the groups. This score was then grouped and analyzed using an independent sample t-test. From table 5, it is very clear that all scores between the groups are significant ($p<0.05$), suggesting violation of assumption of variances.

Figures 1-5: Descriptive plots comparing the scores obtained in post test by both groups

Fig 1: 2-back exp vs. 2-back con

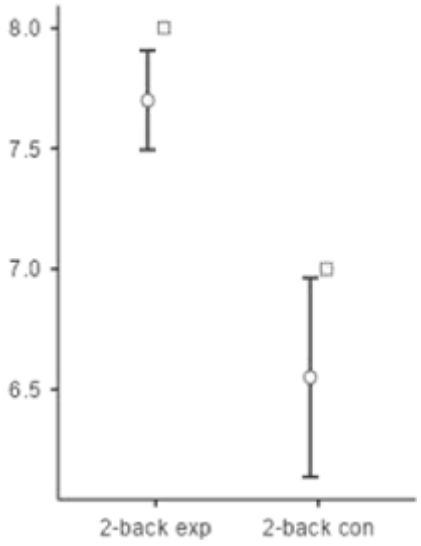


Fig 2: LNS exp - LNS con

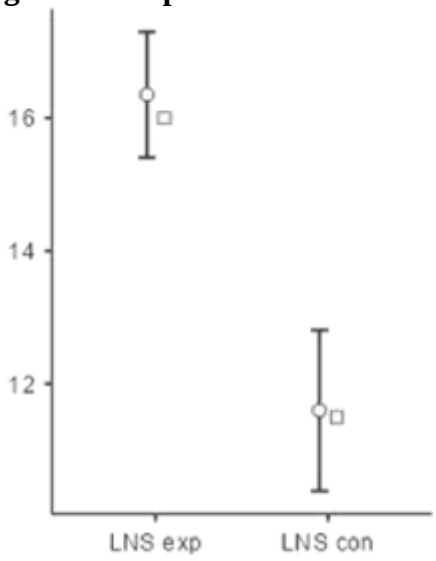


Fig 3: DS exp - DS con

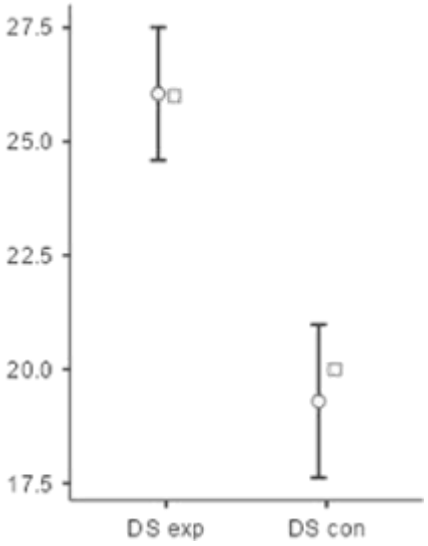
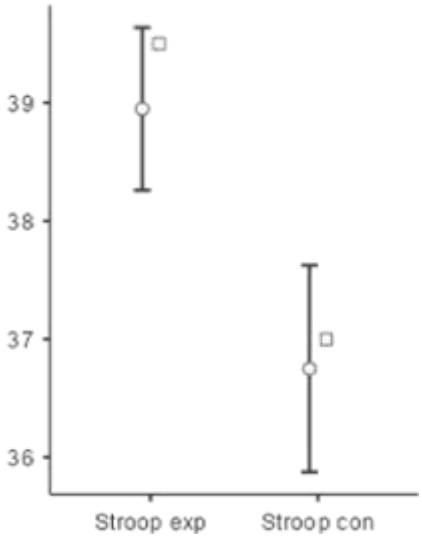
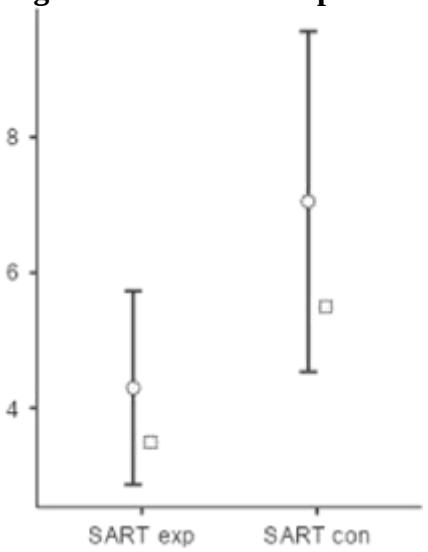


Fig 4: Stroop score exp – Stroop score con



(calculated based on responses)

Fig 5: SART errors exp - SART errors con



The figures depict the between-group comparison. It can be clearly observed from the figures that the post-test scores obtained by the experimental group are much ahead of those obtained by the control group. Figures 1-4 show the scores obtained on verbal 2-back test, letter-number sequencing test, digit span test and stroop task respectively, all of which show significant difference when compared to the control group. Whereas, figure 5 shows the total number of errors on the sustained attention to response task, in which control group participants have more errors than the experimental group as expected.

DISCUSSION

This study aimed to demonstrate a significant improvement in the performance of working memory and visual sustained attention tasks among a group of people who received a Vedic chanting intervention for a period of one month. In the Indian tradition, it is held that recital of mantra with resonance helps enhance memory (Rangan et al., 2009). Earlier, in the Gurukula system, the chanting was taught to the students without the aid of any script, by

mere repetition of the taught verses. Hence, application of verbal working memory is very much evident in chanting Vedic texts. But now, they are learnt with the help of texts, requiring visual working memory and visual sustained attention. Therefore, these cognitive functions were chosen for the current study. The test performance in the domains of verbal working memory and visual sustained attention showed significant improvement than that with visual working memory. One of the reasons might be that the corsi test measures a span that is usually 5-6 for a healthy adult. Only a few participants showed an increase in this span post intervention, hence the results were not statistically significant. In addition to this, it was also intended to check qualitatively if the older adults could efficiently memorize the chanting, irrespective of the fact that it is very difficult to learn and memorize with aging. 90% of the participants managed to memorize the Mantra by the end of the intervention, emphasizing the fact that even such difficult Sanskrit verses could be learnt at older age through constant rehearsal, which could be used as a strategy to improve memory irrespective of age.

One of the main objectives of this study was to determine an association between the previously depicted structural changes in the brain as an effect of chanting with the related cognitive functions. Most of the previous studies showed an increase in grey matter volumes and cortical thickness mainly in the right temporal and frontal cortices. Since these regions get activated for the cognitive functions chosen for this study, the association is clearly demonstrated. However, the previous studies have used a longitudinal design to present the structural data, recruiting participants who had many years of chanting experience. (Ghaligi et al., 2005) The current study aimed to introduce the chanting intervention to participants with no prior exposure to chanting to check if the intervention provided alone could bring about the desired development. The results obtained for the control group supported well to rule out the impact of practice effect (learning) over time and to also strengthen the accuracy of the predictions.

As people grow older, certain physiological changes in the brain can cause glitches in the performance of activities which have been taken for granted. Such lapses can cause turmoil and frustration in their mind. These lapses itself can later grow into serious problems such as mild cognitive impairment or subjective cognitive decline. In these conditions, older adults usually present with concerns about self-perceived cognitive decline but are found to have clinically normal functioning. (Smart CM et al., 2017). A significant proportion of such complaints might subsequently turn into dementia or other disorders. Regardless of etiology, older adults with similar problems may benefit from various non-pharmacological interventions that could enhance their current functioning or slow down their incipient cognitive decline. (Smart CM et al., 2017; Sheng C et al., 2020). The efficacy of other spiritual activities such as music, Yoga or meditation as intervention tools has already been discussed earlier in this study. Therefore, the older adult population itself was considered for this study, so that the impact of chanting interventions on prevention of such early onsets could be investigated. The results obtained from this study could be used as a groundwork to establish Vedic chanting as a regular practice to be advocated for all ages, in order to advance towards better quality of life.

CONCLUSION

The obtained results clearly support the assumption that Vedic chanting intervention could significantly improve the performance in the cognitive functions of verbal working memory and visual sustained attention. The intervention which was provided for a period of 1 month engaging in 40 minutes of chanting each day provided fruitful results in enhancing the test

scores. The cognitive functions of verbal working memory and visual sustained attention are very much essential in chanting as well, hence the results obtained also provide empirical evidence to support the connection between these aspects. The impact of the practice effect through learning were ruled out by comparing the results obtained with those of the control group. In addition, the current study included older adults with an equal balance of males and females, which leads us to application of such interventions towards age-related cognitive deficits that could be seen in conditions such as brain fog due to menopause, mild cognitive impairment or early onset of dementia.

Limitations

The study has been conducted on a very small number of participants (n=40), hence further studies could aim to investigate the effects on larger populations for better results. The study uses only simple assessments to investigate the memory and attention changes in the participants. Since the establishment between the structural and functional association of brain activities have already been clearly shown in the previous studies, use of specific neuroimaging techniques such as EEG or fMRI would be more effective to depict the impact of chanting accurately.

Scope of the study

The immense effects of Vedic chanting could be used to test for the improved cognitive abilities other than memory and sustained attention. The results obtained from this study could be used to show the rehabilitatory and interventional applications of chanting and other spiritual practices, by applying these interventions on clinical groups as well. Enhancement of memory in patients with various neurological disorders such as Alzheimer's, Dementia, PD, etc. and attention in patients with ADHD, TBI, etc. could be fulfilled using Vedic chanting interventions.

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Conflict of Interest
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