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Exploring the Effects of Chanting and Meditation on Mental Health: a Comprehensive Review of Neuroscientific and Traditional Perspectives Insights

Sarika K. Swami[1] and Dr. Mukta G. Dhopeshwarkar[2]
Department of CS and IT[1,2]
Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinager, MH, India.
sarikakswami@gmail.com and drmuktanaik@gmail.com

Abstract: *This study examines neuroscientific research and traditional practices to investigate the therapeutic and cognitive effects of meditation and chanting on mental health. It has been demonstrated that meditation and mantra chanting boost cognitive and physiological processes, lower stress levels, and increase emotional resilience. Reduced cortisol levels and improvements in cardiovascular health are seen, while EEG and fMRI studies show enhanced alpha and theta brainwave activity, which indicates relaxation and emotional regulation. Their effects are further validated by improved brain connection, memory, and focus. Notwithstanding encouraging results, methodological irregularities and small sample numbers underscore the necessity of standardized procedures and thorough longitudinal studies.*

Keywords: Cognitive Functions, Physiological Functions, EEG, Brain Waves, Meditation, Cardiovascular And Immunological Function, Chanting and Mantra, MRI Scan

I. INTRODUCTION

Mantra chanting enhances physical, mental, and emotional well-being by combining spiritual and scientific benefits. Its ability to reduce tension and anxiety has been shown in neuroscientific research. Just ten minutes of chanting can suppress stress hormones like cortisol, creating a calm and resilient state that lasts for up to 48 hours, according to research from the University of California. Furthermore, MRI scans show a reduction in activity in anxiety-related brain regions, which helps those with social anxiety. Additionally, this technique improves physical health by activating the parasympathetic nervous system and promoting proper digestion function by stimulating the vagus nerve. Reduced inflammation, increased immunological response, and enhanced body healing capacity are the results of this stimulation. Additionally, by increasing self-discipline through changes in the prefrontal cortex, reducing stress-induced eating patterns, and cultivating mindfulness, mantra chanting can help with weight management. Mantra practice has also been shown to enhance focus, memory, and sleep. Due to increased restfulness, a 2018 study including emergency medical personnel showed improved sleep quality and fewer mistakes. In the face of everyday distractions, the peaceful practice promotes better focus by lengthening attention span. Strengthening the neuronal connections between the prefrontal cortex and the amygdala can improve emotional regulation, self-awareness, and compassion. Mantra chanting is also beneficial for respiratory and cardiovascular health. Imperial College London studies revealed better cholesterol, decreased blood pressure, and lowered heart rates. Chanting helps people with respiratory disorders like asthma by encouraging deep diaphragmatic breathing, which increases lung capacity and improves oxygen delivery to the brain.

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Chanting mantras essentially balances the body and the mind, providing a simple, natural way to improve resilience and health. Its all-encompassing advantages enable people to live more peaceful, healthy, and connected lives with regular application.[1]

Physiological and Cognitive processes both are integral part of health **"Cognitive Functions"** include mental operations that support learning and decision-making, such as memory, attention, and problem-solving. The term **"Physiological Functions"** describes the processes that keep the body stable, such as breathing, heart rate, and hormone balance. They all have an impact on people's thoughts, emotions, and behaviours.

No table of figures entries found.Electroencephalography (EEG) :

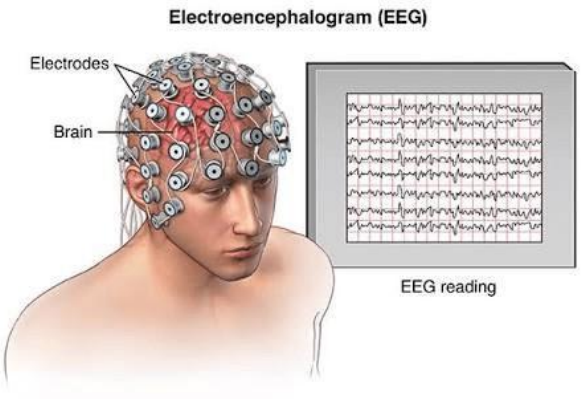

Figure 1: EEG brain wave test

The method of recording the electrical activity of the brain without invasive procedures is called electroencephalography, or EEG. In order to identify voltage variations brought on by neural activity, electrodes are applied to the scalp. EEG allows researchers and clinicians to study how the brain works by recording these electrical impulses. Numerous neurological problems, such as epilepsy, sleep disorders, and cognitive deficiencies, are diagnosed with the help of this technology. EEG is also crucial for the development of braincomputer interface technologies and for supporting cognitive science studies.

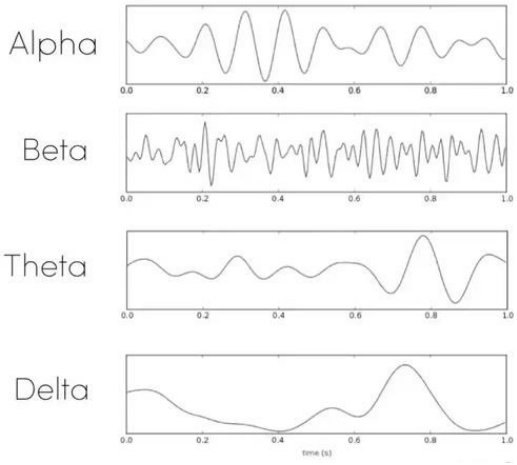

Figure 2: EEG Brain Waves

EEG Signals:

Different frequency ranges are used to categorise electroencephalogram (EEG) signals, and each one corresponds to distinct mental states or brain activity. These consist of:

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- 1-3 Hz: Delta waves, which happen when you sleep deeply
- 4–7 Hz: Theta waves are linked to relaxation and light sleep.
- 8–12 Hz: Alpha waves, a sign of relaxed attentiveness
- 13–30 Hz: Beta waves are associated with cognitive activity.
- 30–100 Hz: Gamma waves are associated with intricate brain processes.

This classification aids in comprehending how the brain functions in many situations.

The technique offers significant advantages. EEG is perfect for real-time brain activity monitoring because it is portable, affordable, and has remarkable time-based precision. Because of these benefits, it can be used for scientific research and medical diagnosis.

EEG is a useful tool, but it has some drawbacks such poor spatial resolution and susceptibility to outside disruptions like eye and muscle movements. However, because EEG may provide instantaneous insights into cerebral functioning, it continues to be essential for studying brain activity. Its affordability, ease of use, and capacity for diagnosis confirm its significance in medical and neurological research. In order to ensure its future relevance and improved capacities in comprehending the complexity of the human brain, ongoing research attempts to solve its weaknesses, such as merging EEG with MRI technologies.[2]

Meditation:

Meditation is a focused attention technique that has drawn more attention due to its ability to improve mental health and lessen psychological issues like stress, anxiety, and depression. According to research, it can affect how people regulate their emotions and thoughts through structured programs like Mindfulness-Based Stress Reduction (MBSR).

After reviewing more than 18,000 studies, a thorough analysis that was published in JAMA Internal Medicine found 47 rigorous trials with 3,515 individuals. According to the findings, an eight-week mindfulness meditation practice produced a moderate reduction in the symptoms of despair and anxiety. Accordingly, studies published in Psychiatry Research showed that MBSR significantly decreased stress biomarkers in people with generalised anxiety disorder when compared to control groups. Additionally, meditation is essential for controlling emotions. According to a study published in Consciousness and Cognition, novice meditators' physiological reactions to anger were reduced after just one session.Additional research, which was published in Frontiers in Human Neuroscience, showed that meditation accelerated emotional recovery after being exposed to upsetting stimuli, as seen by measurements of brain activity. Additionally, meditation has shown promise in managing stress, which is known to contribute to long-term health problems. Meditation's ability to improve mental resilience and general well-being was highlighted by a study published in Psychoneuroendocrinology that showed that short, 25-minute meditation sessions spread over three days dramatically reduced stress responses under high-pressure tasks.[3]

Statement of problem:

Chanting and meditation are being used more and more for mental and emotional health, but little is known about their precise psychological and physiological impacts. In order to investigate the mechanics, efficacy, and therapeutic applications of these practices, this review attempts to compile the body of available material and pinpoint areas in need of further investigation.

II. RESEARCH METHODOLOGY

The research methodology follows a methodical approach, focusing on meditation and chanting. Relevant scholarly literature is gathered from reliable databases, examined methodically to extract important conclusions, and then examined to spot patterns and areas in need of exploration. In addition to being used to investigate computational applications, the synthesized ideas are recorded in a coherent report.

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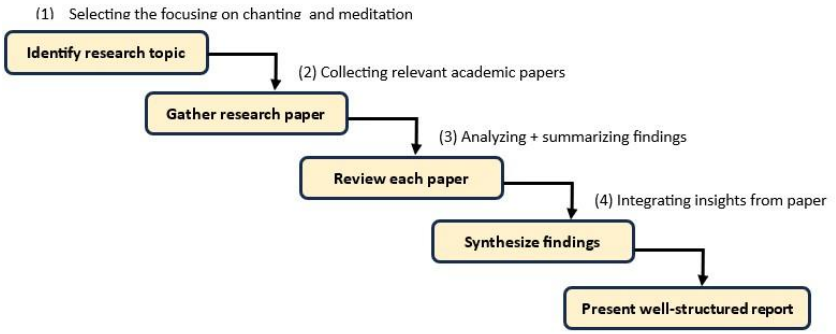

Figure 3: Workflow

Previous research works:

J. P. Dudeja (2017) investigates the scientific foundations of mantra-based meditation, highlighting its quantifiable impacts on psychological and physiological metrics. The study emphasizes the significance of conscious focus, accurate pronunciation, and specific mantra frequencies in affecting neurophysiological processes. The results of experiments show that profound relaxation and cognitive coherence are linked to notable changes in brainwave activity, including shifts to Alpha, Theta, and Delta waves. Physiological measures reveal improvements in cardiovascular and immunological function, including decreases in oxygen consumption, heart rate, and blood pressure, as well as an increase in nitric oxide generation. Better hemisphere synchronization is shown by EEG investigations, which supports increased emotional balance and mental clarity. The study combines physiological monitoring, EEG analysis, and neuroacoustics to support its assertions. Mantra-based meditation appears to create a state of "restful alertness," which supports emotional stability, stress resilience, and general well-being, according to the results. Further research is necessary to fully explore this evidence-based approach's potential for addressing chronic illnesses including diabetes and hypertension. [4]

J. Lynch et al. (2018) examined the impact of mantra meditation, including techniques like Transcendental Meditation (TM), on mental health in non-clinical, healthy populations. It used data gathered from PubMed and MEDLINE to assess 37 papers published between 1970 and 2018. With positive findings in 17 out of 23 studies on anxiety, 12 out of 14 on stress, and 8 out of 11 on depression, the results showed that mantra meditation might significantly lower anxiety, stress, and depression. There were also some advantages in controlling anger and burnout, albeit these outcomes were less reliable. The strength of the findings was, however, limited by a number of research' shortcomings, including selection bias, inadequate tracking of meditation practice, and nonstandardized intervention techniques. The evaluation emphasizes mantra meditation's potential as a beneficial technique for mental health in spite of these drawbacks. To confirm its efficacy, more thorough designs and improved reporting are needed in future studies.[5]

Veera Raghava Swamy Nalluri (2019) investigates how Vedic chanting affects the human nervous system both technically and therapeutically. Using sophisticated signal processing techniques including spectrum analysis and wavelet transformations, the study examines the acoustic characteristics of chants, such as rhythm, frequency, and amplitude. The use of MATLAB allowed for accurate analysis, which provided insights into how chanting affects neurotransmission, namely in the limbic and para-limbic regions. The results of experiments show quantifiable advantages, such as notable decreases in stress, anxiety, and depression as well as improvements in memory, focus, and physiological indicators like heart rate and cortisol levels. According to these findings, Vedic chanting promotes emotional and cognitive equilibrium by strengthening brain networks and modifying the body's homeostatic processes. The study emphasizes how effective Vedic chanting may be as a non-invasive stressreduction and cognitive-

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enhancement technique. By combining conventional methods with contemporary scientific frameworks, it advocates for more research into different Vedic literature in order to broaden applications across populations.[6]

J. Gao et. al. (2019) focuses on chanting the Amitābha Buddha, this study investigates the neurophysiological effects of religious chanting. Artefact removal (ICA), filtering, and signal reconstruction were preprocessed using 22 subjects' EEG, fMRI, and HRV data. Delta-band power in the HRV and PCC indices were important characteristics. Methodology integrated HRV analysis, ECM for brain connectivity, and EEG clustering. The findings indicated that chanting boosted PCC delta activity, which was indicative of improved emotional states and a decrease in self-referential thoughts. Improved heart stability was shown by HRV analysis. The research highlights how chanting differs from other religious or meditation activities in its capacity to reduce stress and its potential therapeutic uses.[7]

N. Kumar (2019) examines research uses the Color Stroop Test to test how undergraduate students' selective attention is affected by chanting the Gayatri mantra (GM) and Om. 30 participants, ages 18 to 30, received interventions over the course of two days. They each received 15 minutes of GM recitation and Om chanting. We looked at the Stroop scores before and after the session. Both methods significantly increased selective attention ($p < 0.001$), however the benefits of Gayatri mantra were greater (16.16%) than those of Om chanting (9.26%). Additionally, the Wilcoxon Signed Rank Test was used to achieve statistical validation. According to the research, chanting Om and the Gayatri mantra both improve cognitive attention, although the effects of the former are greater. To validate these findings and investigate more extensive applications, more studies with bigger sample sizes are advised.[8]

S. S. Samajdar et. al. (2020)investigate a demanding, comparative methodology to examine the cognitive and psychological effects of reciting the Gayatri Mantra (GM) on young athletes. Tested using validated psychometric instruments, it shows that GM chanting significantly improves participants' attention, memory, anxiety reduction, and mental state when compared to silent meditation or control subjects.The mantra's calming benefits are highlighted by reductions in state and trait anxiety, while key metrics such as six-letter cancellation and digit span tests show higher performance in the attention and memory domains. Because rhythmic recitation promotes brain activation in areas related to working memory, attention, and visuospatial processing, as well as enhanced cerebral blood flow to memory-associated regions, these gains have been reported.The study proves the effectiveness of GM chanting as a cognitive and psychological intervention by fusing traditional Vedic methods with modern psychometric assessment. To demonstrate wider applicability, future research should concentrate on longitudinal studies and a variety of demographics.[9]

K. Wani et. al. (2020) study focuses on the scientific investigation of the sacred sound "OM," evaluating its physiological and psychological advantages using sophisticated spectral and EEG studies. Different frequencies within the syllables A, U, and M are identified using methods such as wavelet transforms and power spectral density analysis, which associate these frequencies with the throat, heart, and navel, respectively.The detailed modeling of OM's vibrational properties is made possible by the use of machine learning techniques, such as neural networks and KNN, for feature extraction and sound classification. EEG results show increased theta power after chanting, which is a sign of relaxation and improved cognitive states. These results highlight the therapeutic potential of OM chanting in lowering stress, improving mental focus, and stabilizing physiological parameters like blood pressure and heart rate.The study emphasizes the need for larger datasets and standardized protocols despite encouraging results. The combination of AI and advanced acoustics presents future opportunities to optimize chanting practices and validate the holistic benefits of OM.[10]

Nitiinn S Morrey et.al (2021) investigates the academic and cognitive benefits of guided recitation of the Pradhnyavivardhan Stotra in children between the ages of 10 and 15. Using a pre- and post-experimental design and a difference-in-difference (DiD) analysis, the study finds notable gains in academic proficiencies, such as sequencing,

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perception, and problem-solving, cognitive faculties, such as reasoning, evaluation, and comprehension, and memory retention of words, figures, and meanings.In all psychometric measures, Group I showed an increase of 10–15%, and in post-test evaluations, the experimental subset of Group II performed better than its control counterparts. To ensure methodological rigor, the Jnana Prabodhini Institute of Psychology provided standardized tools. Research shows that Vedic chanting's rhythmic and meditative elements are crucial for improving cognitive function, neural connectivity, and academic ability. Regarding the cognitive benefits of Vedic practices, the study supports conventional claims and promotes their incorporation into educational models. It is advised to conduct additional randomized controlled trials to confirm and expand these findings.[11]

C. Pascoe et. al. (2021)examine the meditation is an effective way to improve mental health since it elevates mood, lowers stress levels, and builds emotional resilience. It has psychological, physiological, and neurobiological impacts, such as improved mindfulness, decreased rumination, and modifications to brain regions related to emotional regulation. Variations in individual reactions and methodological discrepancies underscore the need for additional research, even if meta-analyses validate its efficacy in mitigating symptoms of anxiety and depression. Expanded population research and standardized procedures are essential to maximizing the therapeutic benefits of meditation in the treatment of mental illness.[12]

B. Satish Tawade et. al. (2021) demonstrates the profoundly improved physiological and cognitive function of meditation and mantra chanting. Meditation improves focus, emotional resilience, gyrification, memory, and grey matter density. Vibratory energy is utilized in mantras to balance the body's frequencies, which is good for your physical well-being and helps you cope with stress. MRI imaging offers scientific proof of improved cognitive and emotional stability as well as decreased cardiovascular risk, anxiety, and sadness. The benefits of these techniques for creativity, focus, and mental health are just as strong as those of prescription treatments. Mediation could be integrated into healthcare and education systems to support holistic development and improve the health of individuals or society as a whole. [13]

K. S. Bongarge et. al. (2022) review combines contemporary neuroscience with ancient yoga philosophy to investigate the effects of reciting the Omkar mantra on the neural system. Honored as "Pranav" in Patanjali's Yoga Sutras and the Upanishads, Om has been demonstrated to deactivate stress-related brain areas such the hippocampus, anterior cingulate cortex, and amygdala while also stimulating the vagus nerve. Studies employing fMRI and EEG demonstrate how Om chanting improves emotional management and cognitive abilities while lowering anxiety, tension, and depression. Om chanting's repetitive vibrations enhance brainwave coherence, boost endorphin, dopamine, and serotonin synthesis, and encourage relaxation. Chanting enhances oxygen levels through deep breathing, which also promotes stress reduction and mental clarity. These results support Om chanting as a useful and comprehensive strategy for enhancing mental wellness. Future studies with bigger sample sizes and more sophisticated neuroimaging can confirm its advantages and investigate more extensive therapeutic uses.[14]

G. Perry et. al (2022) examine how chanting affects cognition and psychology, focusing on how it affects quality of life, mindfulness, and altered states. Using statistical techniques like regression and path analysis, the study examines data from 456 people from various traditions to assess intentionality (sound, devotion, aim) and engagement (practice time, frequency, experience). Key findings show that intentionality promotes altered states like flow and mystical experiences, decreases mind wandering, and increases mindfulness. Chanting exercises that are longer and more frequent intensify these effects, suggesting a dose-response relationship. Chanting in different ways produces different results. For example, call-and-response chanting improves mystical experiences because of its social and rhythmic synchronization, while repetitive prayer reduces mind-wandering and cognitive distractions. This study demonstrates that chanting is a technically sound, non-invasive method of enhancing mental well-being and life quality. For optimal

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therapeutic uses, it emphasizes the necessity of customized procedures and more study into the effects on individuals and over time.[15]

K. Das et.al (2022) investigate that meditation has been practiced since ancient times and has been more and more popular in recent years as a natural means of improving both physical and mental health. Finding the molecular mechanism behind the positive effects of meditation is the subject of an ever-growing number of studies. The brain's electrical activity can be recorded non-invasively using a surface electroencephalogram (EEG), which provides crucial information on the various neurological processes occurring within the brain. Divergent neurophysiological states are linked to EEG rhythms, which are oscillations in various frequency bands seen in EEG signals.This article examines the impact of reciting the "Hare Krishna Mantra" (HKM) on electroencephalograms. A comparison is made between the relative band power of various rhythms before and after a round (108 times) of chanting HKM. It computes the band power using Fourier-Bessel series expansion, a non-stationary signal decomposition method. Alpha band power increased dramatically after mediation, suggesting a calm and relaxed state of mind. This study on how HKM chanting affects EEG rhythms might offer a straightforward yet efficient way to manage tension, stress, sadness, and other issues.[16]

Tseng A (2022) examines the therapeutic potential of mantra meditation (MM) with an emphasis on evidencebased health benefits for stress, anxiety, hypertension, and immunity. Improvements in physiological indicators such electroencephalogram (EEG) coherence, heart rate variability (HRV), and galvanic skin response (GSR) were consistent with MM's significant stress reduction. According to these results, it improves emotional stability and autonomic modulation. Likewise, MM successfully lowered both the diastolic and systolic blood pressure, confirming its usefulness in the treatment of cardiovascular disease. The effect on anxiety was equivocal, and the data indicated that it was more effective in people with higher baseline anxiety levels. Although encouraging, preliminary findings on immunological benefits—such as elevated levels of salivary immunoglobulin A (s-IgA) and immune cell activity—need more research. Limitations including small sample sizes and inconsistent methodology make it difficult to draw firm results, even if MM has promising health applications. To confirm the effectiveness of MM across a range of demographics and health domains, future research should prioritize standardized methods, larger cohorts, and sophisticated apparatus (such as fMRI, EEG). [17]

R. M. Shende (2023) examines the effects of chanting techniques, including the Om, Gayatri, and Hare Krishna mantras, on mental health and offers them as an affordable mental health treatment. According to EEG study, chanting helps people manage their emotions and reduce stress by increasing alpha and theta brainwave activity, decreasing beta wave power, and lowering cortisol and adrenaline levels. Additionally, the practice enhances oxygenation, regulates hormone activity, calms the amygdala and hypothalamus, and increases mindfulness, emotional control, and physiological well-being. The study uses participant training, EEG signal processing, and statistical analysis of psycho-physiological variables as part of its methodology. Chanting's therapeutic effects are validated by key elements such as stress indicators and brainwave oscillations. These results establish chanting as a comprehensive strategy for fostering relaxation, improving mental clarity, and bringing the mind and body into harmony. It is advised that more research be done in order to broaden its use as a common tool for mental health and stress management.[18]

A. Pundir et.al. (2024) investigates EEG studies demonstrate increased alpha and theta waves, indicating relaxation; fMRI scans show enhanced prefrontal connectivity and reduced default mode activity, boosting cognition and emotion regulation; psychological tests confirm improvements in attention, mood, and mindfulness; advanced techniques like wavelet analysis and machine learning enabled precise feature extraction; and the review shows the positive effects of "AUM" chanting on mental health, supported by scientific methods. The study positions "AUM" chanting as a cost-effective therapeutic tool, recommending more research with standardized protocols and longitudinal studies.[19]

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Vidya et. al. (2024) studied that In order to assess the impact of quiet meditation and reciting the Gayatri Mantra on university students' quality of life (QoL), this study looks at their physical, mental, emotional, and spiritual health. There were 120 students in all, ages 17 to 25, who were split into two groups at random: 60 in the experimental group and 60 in the control group. For 60 days, the control group did not receive any intervention, while the experimental group engaged in silent meditation for 10 minutes and Gayatri Mantra chanting for 30 minutes per day. Standardized questionnaires were used both before and after the intervention to measure quality of life. The experimental group's quality of life (QoL) significantly improved, as evidenced by mean scores rising from 79.55 to 96.83 ($t = 7.84$, $p < 0.05$), whereas the control group's mean scores did not significantly alter ($t = 1.96$, $p > 0.05$; mean scores: 79.28 to 77.05). These findings demonstrate the potential of mantra chanting and silent exercises as easy, affordable ways to improve students' mental health. To investigate their long-term advantages and scalability, more research is required.[20]

S. Sreenivasan et.al. (2024) Investigating how Vedic chanting affects cognitive processes, the study focuses on sustained attention and verbal and visual working memory. Among individuals aged 30 to 60, a one-month intervention utilizing the Medha Suktam mantra showed notable enhancements in cognitive performance. Chanting is an efficient way to activate brain regions related to memory and focus. The experimental group demonstrated improved performance in verbal memory tests (n-back, digit span, and letter-number sequencing), visual memory (Corsi block-tapping test), and attention (Stroop and SART). Chanting is a viable nonpharmacological method for improving cognitive abilities and averting age-related cognitive decline and neurodegenerative diseases, according to these findings. Because practice effects were ruled out, the study's strong experimental design confirmed the effectiveness of the intervention. However, the modest sample size indicates that more study with bigger populations and neuroimaging techniques is necessary to increase the use of chanting in clinical and preventive care and to better understand its neurocognitive advantages.[21]

A. Kundu et. al. (2024) This systematic review highlights the multifaceted effects of Gayatri Mantra chanting on mental, emotional, and physical health by combining scientific and traditional data. Through an analysis of nine experimental research and ancient writings, the review reveals notable gains in emotional regulation, memory, and concentration, along with decreases in anxiety and physiological stress markers like blood sugar levels and GSR. Additionally, neuroimaging research shows increased beta and gamma brainwave activity, which suggests better neural and cognitive processing.The results support mantra chanting's meditative and rhythmic qualities as a way to improve mental clarity, autonomic balance, and brain synchronization. The suggested chanting methodology, which combines whisper, mental, and spoken recitations, is in line with both historical and empirical data to optimize advantages.Although the evaluation supports the mantra's potential to improve overall health, it also emphasizes the need for longitudinal research and established procedures to validate and generalize these results across a range of demographics. [22]

III. CONCLUSION

Chanting and meditation is a blending of ancient traditions and modern science which offer substantial advantages for mental and emotional well-being. Research shows that they can enhance cognitive abilities, lessen psychological suffering, and enhance general wellbeing. While meditation promotes emotional resilience and stress reduction by affecting brain regions linked to cognitive and emotion regulation, chanting increases brain activity and emotional balance through rhythmic energy. When combined, they provide a comprehensive strategy for mental health. To increase applicability, future studies should concentrate on standardized procedures and bigger sample sizes. The quality of life, emotional stability, and mental clarity can all be improved by incorporating these techniques into therapeutic frameworks.

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