The Science of Mantra Chanting

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***Abstract*—Mantra chanting is a disciplined meditative meditation that involves the repetition of a word, phrase or group of syllables. Its cultural connotations are varied, but a burgeoning scientific literature indicates that chanting can be investigated as an embodied intervention involving the combination of singing, timed breathing, auditory feedback, attentional modulation and emotional evaluation. This paper collates peer-reviewed evidence gathered from autonomic physiology, neuroimaging, electrophysiology and clinical trials, and suggests a mechanism for the science of mantra chanting. The results of cardiorespiratory studies suggest that rhythmic recitation has the effect of reducing breathing rate and synchronizing heart rate and blood pressure oscillations. Neurofunctional imaging and connectivity analysis of Om chanting shows deactivation of the limbic system and changes in interconnection between affect-regulation and interoceptive areas. EEG/ERP results point to alterations in attentional processing of emotional stimuli; clinical studies using mantra-based meditation show small-to-moderate improvements in anxiety, stress, post-traumatic stress symptoms, sleep and mental health-related quality of life, but with important limitations in study quality. The paper also suggests a multimodal measurement architecture for future trials, which integrates the use of vocal acoustics, ECG/ PPG-HRV, respiration, EEG/fNIRS, and validated psychological outcomes. To differentiate the effects of breath pacing, sound vibration, semantic salience and attentional training, a rigorous active-control research design is recommended, which takes into account cultural sensitivity.**

***Index Terms*—Mantra chanting; Om chanting; heart rate variability; vagal modulation; fMRI; EEG; meditation; psychophysiology**

I. INTRODUCTION

The practice of mantra chanting is deeply rooted and has been used for centuries in contemplative traditions of South Asia, religious groups, and various wellness practices. There has been growing scientific interest in the practice because chanting is not just a verbal ritual: it's a repeatable behavioral protocol that can be measured in many ways including respiration, voice acoustics, autonomic activity, brain dynamics and subjective outcomes. In a typical Om or A-U-M practice, the person is asked to breathe in, make Om or A-U-M while breathing out as long as they can, provide auditory and somatosensory feedback, and then repeatedly refocuses their attention to a small sound object. This blend is suitable for a learning paradigm on the intersection of breath regulation, motor control of the vocal system, interoception, affect regulation, and contemplative attention.

The title of this paper, The Science of Mantra Chanting, is not based on the assumption that anything that can be said to have happened in ancient times, is accepted without any testing. Instead, it considers the chanting of mantras to be a complex mind-body exposure that can be broken down into discrete components that can be assessed. A research question, evidence handling that is clearly presented, a defensible mechanism, and careful limits on making causal claims would be expected in a journal that is indexed in Scopus. This manuscript is not intended to be an experimental report, but rather a narrative review and conceptual framework. It makes no effort to make up its own primary data and concentrates on a publishable framework which may be extended with original measurements.

II. FOCUSED NARRATIVE REVIEW METHOD

A narrative synthesis was prepared which focused on peer-reviewed studies and reviews in biomedical and psychological databases that included reports on Om chanting, mantra-based meditation, autonomic regulation, fMRI, EEG/ERP, and clinical outcomes.

Primary experimental studies using physiological or neural measures, randomized controlled trials, and systematic reviews/meta-analyses were prioritized. The purpose was not to conduct a full PRISMA systematic review but to collate the evidence into an overview of the mechanisms identified as being common to all the studies, the methodological shortcomings, and the needs for a future confirmatory trial.

III. MECHANISTIC MODEL

A model of chanting that is scientifically useful must take into consideration at least four interacting pathways. Firstly, the chant is normally chanted in a long exhalation that regulates respiration. Second, vibration and audio feedback provides sensory cues to anchor the voice one's thoughts that can help to decrease spontaneous verbal thinking and focus attention. Third, slow respiratory rhythm can affect vagal outflow, respiratory sinus arrhythmia and baroreflex modulated cardiovascular oscillations. Fourth, personally meaningful repetition of a phrase might change appraisal and emotion regulation, providing a cognitive anchor for attention.

It is similar to earlier autonomic studies, where the practitioners of meditation with experience demonstrated reduced heart rate during mental repetition of Om than in a non-targeted thinking control [2]. It is also similar to the findings of the BMJ comparative study that rosary prayer and yoga mantras lowered respiration to around 6 cycles per minute and correlated the heart and breathing rhythm [1]. More recent HRV studies indicate that 5 minutes of loud Om chanting can lead to the increased contribution of the parasympathetic or vagal system in experienced yoga practitioners as reflected in a rise in high frequency HRV [5].

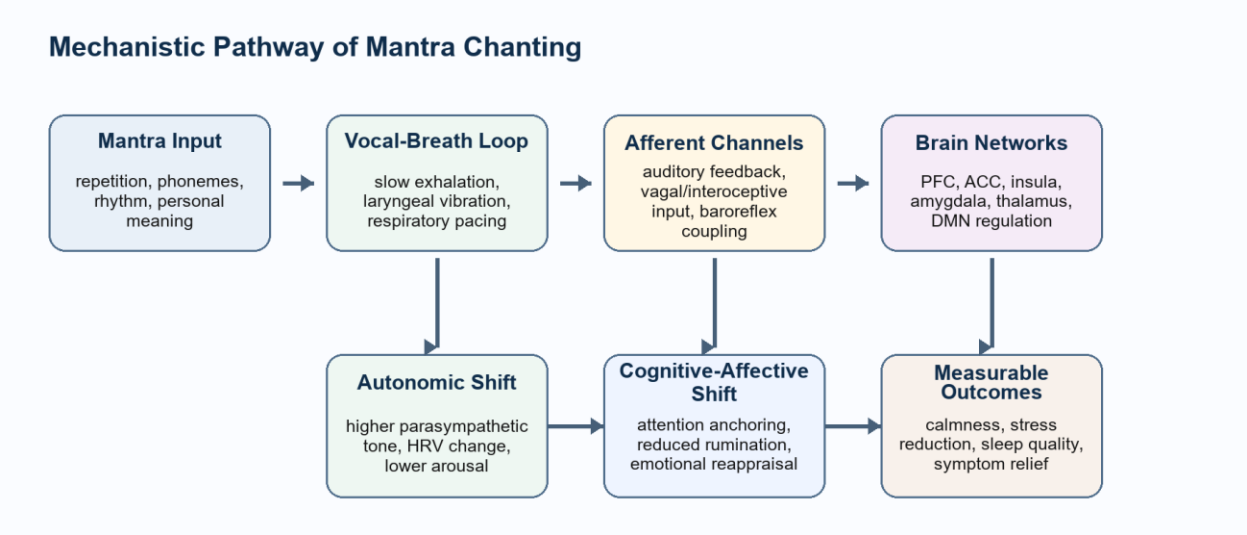


Figure 1. Proposed mechanistic pathway linking mantra input, vocal-breath dynamics, afferent channels, brain-network modulation and measurable outcomes.

IV. NEUROPHYSIOLOGICAL EVIDENCE

4.1 Autonomic and Respiratory Regulation

The most powerful physiological way to hear the chant is by using respiratory pacing. Large oscillations in heart rate have been correlated with engagement of the baroreflex and slow breathing with periods around 0.1 Hz or six cycles per minute several times. The natural tendency of mantra recitations is to have longer exhalations, and this recitation likely also serves as a culturally embedded practice of paced breathing. The study of Om chanting using slow speech (about 0.05 Hz) found that respiration, heart period and systolic BP become more synchronized, not only at the Om chanting frequency, but also at unexpected 0.1 Hz oscillations of the cardiovascular system [6]. These findings indicate that sound is not the only factor at play in the effects of chanting; breath phase, the length of the phrase, and vocal timing play an important role.

4.2 Brain Networks and Affective Regulation

The most quoted evidence for neuroimaging is from a pilot fMRI study where 12 healthy volunteers heard themselves chant Om, then heard a matched 'ssss' control, then heard nothing. When comparing with rest, Om chanting resulted in deactivation of limbic and paralimbic areas such as orbitofrontal, anterior cingulate, parahippocampal, thalamic, hippocampal, insular and right amygdala regions, while the control sound did not deactivate these areas to the same extent [3]. During Om chanting, a subsequent directionality analysis of the same data revealed decreased activity in the insula, anterior cingulate cortex and orbitofrontal cortex to the amygdala [4]. The findings are also of a mechanistic nature, as the regions involved in salience, interoception, and emotion regulation were involved; however, the sample size was small, and they need to be replicated with larger samples and active control.

A further broad level of plausibility is provided by the results of meditation neuroimaging reviews. A meta-analysis of 78 functional MRI studies identified distinct activation and suppression networks for each meditation style including mantra recitation [12]. Assuming activity in the default mode network, meditation experience has been proposed to modulate self-referential processing networks [13]. The results should be interpreted with caution when applied to the domain of mantra chanting at the level of its specific practice, but they can be helpful in situating the practice of mantra chanting in the broader field of neuroscience of attentional and affective self-regulation.

4.3 EEG, ERP and Cognitive-Affective Processing

Electrophysiological studies offer greater temporal resolution than fMRI and can help to identify the timing of changes in information processing during chanting. A silent Om chanting during viewing unpleasant and neutral images has been tested in an ERP experiment with 33 undergraduate participants, where the unpleasantness ratings and activity levels of negative images were lowered, ERP analyses revealed modified P1 and late positive potential (LPP) responses, especially for neutral images [7]. The authors suggested that this might reflect modulation of affective evaluation and early-to-late processing stages during Om chanting, and that it is possible for all responses to be captured to highly negative stimuli too automatically to be modulated by a brief chanting instruction. This pattern helps to create the nuanced claim that chanting might have a regulating function with regard to appraisal and vigilance, but this function is not consistently observed across the scope of emotion, participant experience, or task design.

Domain	Representative evidence	Observed signal	Interpretive value
Respiratory-autonomic	Rosary/mantra rhythm study; OM-HRV studies [1,5,6]	Slower respiration, HRV change, blood pressure and RR synchrony	Chanting may entrain cardiorespiratory rhythms through paced exhalation and baroreflex-vagal pathways.
Neuroimaging	Pilot fMRI and directional connectivity studies [3,4]	Limbic deactivation and reduced outputs from insula/ACC/OFC to amygdala	Supports a network-level model for affective down-regulation, but causal claims remain preliminary.
Electrophysiology	ERP and EEG reports [7]	Altered P1/LPP responses and increased relaxation-related rhythms	Suggests that chanting can alter attention allocation and emotional stimulus processing.
Clinical outcomes	Systematic reviews and PTSD RCT [8-10]	Small-to-moderate symptom reductions; insomnia and PTSD benefits in some trials	Clinical promise is present, but study bias, heterogeneity and long-term evidence gaps require stronger trials.

Table 1. Evidence domains relevant to a scientific model of mantra chanting.

V. PROPOSED MEASUREMENT ARCHITECTURE

One of the limitations of the current literature is that many studies only assess one level of responding to the chant. A multimodal architecture would enhance an empirical paper of Scopus level by considering the chanting as a time-locked signal, which is embodied. The duration of chants, stability of level and loudness of chants can be quantified using voice acoustics. ECG/ PPG can be used to obtain HRV and Heart Rate metrics, including RMSSD, SDNN, HF power and the LF/HF ratio. For physiological shifts, a respiration belt or nasal airflow sensor can be used to determine if the shift is due to breathe rate, or mantra meaning. EEG or fNIRS can measure attention and affective processing and prefrontal hemodynamics. Last, validated physiological/self-report instruments can be used to

correlate physiology and perceived calmness, anxiety, sleep quality or trauma symptoms.

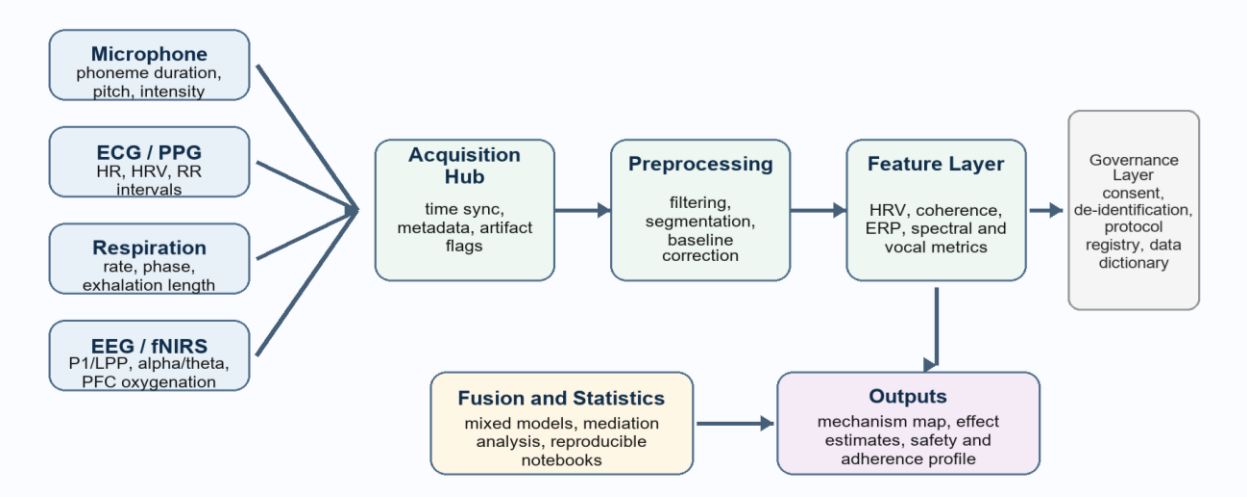
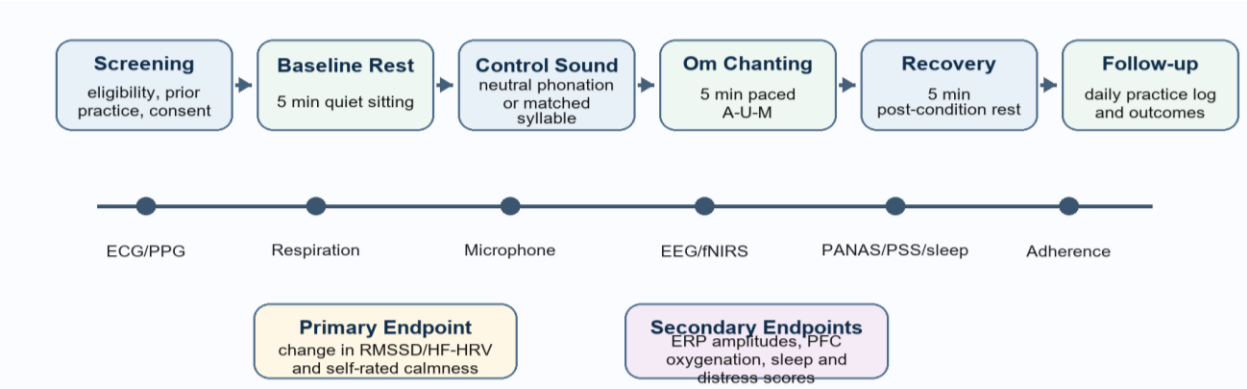


Figure 2. Proposed multimodal architecture for future mantra chanting research.

VI. PROPOSED EXPERIMENTAL PROTOCOL

The recommended design is randomized, counterbalanced, and active-controlled. The participant should undergo a baseline resting, neutral phonation, Om or other chanting condition and recovery conditions in a counterbalanced order. The active control should mimic the vocal effort, sound duration, and breathing rate as closely as possible, or else any found improvement may be attributed to slow expiration rather than to the mantra. Stratifying by prior yoga/chanting experience is crucial, because changes in HRV might be more pronounced among those with practice [5]. The protocol must be registered prospectively with primary endpoints, define rules for artifact rejection, and include safety monitoring even for very low risk applications.



VII. CLINICAL RELEVANCE

Mantra based meditation has also been tested in clinical mental health settings with mixed findings. A systematic review of the effects of mantra meditation in non-clinical adults suggested that mantra practice may lead to improvements in anxiety, stress, depression, burnout, and psychological distress, however more than 90% of the reviewed articles were rated weak in quality [8]. A wider systemic review and meta-analysis of RCTs found modest to moderate effects on anxiety, depression, stress, and post-traumatic stress, but warned against risk of bias, and the lack of long-term follow-up [9]. The benefits demonstrated by this modality include the finding of an RCT of 173 veterans with PTSD, in which mantra repetition delivered individually was superior to present-centered therapy in reducing PTSD symptoms

(clinician-rated) at both post-treatment and two-month follow-up, as well as insomnia symptoms [10].

These results are of clinical interest, particularly with respect to mantra chanting, and their applicability as low cost and readily accessible, personal modes of regulation. However, caution must be exercised when applying this evidence to clinical practice. The use of the mantra should not be positioned as a substitute for effective medical/psychiatric treatments; instead, chanting may be more properly presented as an attentional-breathing practice complementary to standard care that may assist sleep routines, affect regulation, and stress reduction in selected individuals.

VIII. DISCUSSION

The scientific study of mantra recitation is likely best approached as an interplay between physiology, attention, and meaning. It seems likely that the respiratory aspect is necessary, but not a sufficient condition-paced exhalation may account for a portion of the HRV and cardiovascular effects, whereas auditory input, vocal resonance and repeated cognitive anchoring may differentiate chanting from resting or normal speaking. These neural results are exciting because they implicate consistent affective and interoceptive networks, but these preliminary data should not be translated into definitive therapeutic prescriptions. Further development should focus on moving from single modality, exploratory studies to preregistered, sufficiently powered, and multimodal clinical trials. Cultural respect should also be part of any scientific endeavor. Whether it is the denotation, connotation, or identity implications of the mantra, these associations hold personal significance for the practitioner. While controlling for these effects enhances scientific rigor, it may compromise ecological validity. Similarly, it may prove difficult to elucidate biological mechanisms with culturally significant interventions alone. Henceforth, reporting on the specific mantra being used, a pronunciation protocol, the participant's familiarity, beliefs or expectancy, respiratory rate, dosage per session, therapist's experience, and adherence should be mandatory rather than optional variables-they constitute the intervention itself.

IX. LIMITATIONS AND FUTURE SCOPE

This is a conceptual narrative review, not a systematic review, not a de novo trial. Limitations include variability of sample sizes, intervention duration, control features, and quality across the source literature. Several impactful Om studies are based on small samples, small intervention durations, and very few control features. Larger sample sizes, shams or active controls, pre-registered endpoints, blind outcome assessment, longitudinal data, and explicit data-processing streams need to be established for any promising future research directions to be reliable. Machine learning might eventually reveal responder patterns, but only after a substantial, reliable data corpus is produced and after issues with interpretability and bias are examined.

X. CONCLUSION

Mantra chanting is conceptually plausible as a psychophysiological self-regulation practice by engaging rhythmic vocalization, slowed breathing, sensory input, attention anchoring, and affectively charged cognition. Existing evidence has demonstrated effects on the autonomic nervous system, a number of key brain networks including the prefrontal cortex and limbic regions, emotion processing, and positive mental health outcomes, among others. Further multimodal trials that isolate breath, sound, attention, and meaning, while maintaining cultural relevance, are currently needed. Such methods would provide reliable data for investigating mantra chanting not as a broad spiritual concept, but as a discrete, measurable embodied intervention.

DECLARATIONS

Ethics statement: Not applicable for this narrative review and conceptual framework. Any future human-participant study should obtain institutional ethics approval and informed consent.

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Conflict of interest: The author should declare any financial, institutional or spiritual-organization affiliation before submission.

Data availability: No new empirical data were generated. The cited literature is available through the referenced journals and databases.

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