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SYSTEMATIC REVIEW

Neural Correlates of Chanting: A Systematic Review

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ABSTRACT

Chanting is an ancient and globally widespread ritualistic practice involving rhythmic vocalization or repetition of words, phrases, or sounds. While previous reviews have considered the neurophysiological impact of meditation and spirituality, chanting has received limited systematic investigation. This review aimed to identify and synthesize neural correlates of chanting, examine methodological variability, and determine consistent neural patterns across chanting studies and styles. PsycINFO and PubMed databases were systematically searched for neuroimaging studies including chanting, mantra, and repetitive prayer. Articles published through October 8, 2024, were included, yielding 899 initial articles. After applying exclusion criteria, 24 studies were included. Study quality was assessed using the adapted Effective Public Health Practice Project (EPHPP) criteria. Findings demonstrate that chanting activates brain regions involved in attention and emotional regulation, including the prefrontal cortex, insula, and cingulate gyrus. Deactivation of default mode network (DMN) areas, particularly the posterior cingulate cortex and hippocampus, was also observed, suggesting reduced self-referential thought. Electroencephalography (EEG) studies revealed increased theta activity, indicating enhanced relaxation during chanting. Although heterogeneity in sample sizes, imaging modalities, participant characteristics, and control conditions preclude a formal meta-analysis, the findings lay a foundation for advancing research into the neural mechanisms of chanting. Chanting engages neural networks associated with attention and emotional regulation. The consistent pattern of prefrontal activation and DMN deactivation suggests mechanisms similar to other contemplative practices.

Chanting (also known as repetitive prayer, mantra, mantram or mantra meditation) is a widespread practice across cultures, manifesting in various forms, from spiritual and religious incantations during musical ceremonies to silent seated meditation (Bormann et al. 2014; Burchett 2008; Feuerstein 2012; Perry and Polito 2021). Chanting, a contemplative practice involving rhythmic, repetitive vocalization or mental repetition of sounds, prayers or mantras, is expressed uniquely in each tradition, appearing in spiritual and religious contexts, secular practices, meditation techniques, and ceremonial celebrations (Perry and Polito 2021). Research has demonstrated that chanting improves mental health (Lynch et al. 2018), reduces stress (Perry et al. 2023; Simpson et al. 2021), enhances social connection (Perry et al. 2016), improves cognitive processes and mood (Bormann et al. 2014; Perry et al. 2022) as well as induces altered states of consciousness (Perry et al. 2021, 2025). Although there are many different expressions of chanting (i.e., vocal, silent, individual, group, musical, non-musical, with dance, and sitting silently), this review seeks to examine chanting more broadly—as a vocal or mental repetitive contemplative practice—and how chanting practices impact neurophysiology.

Growing interest in neuroimaging has led to investigations of structural and functional brain processes during contemplative

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and spiritual practices. Previous research has examined neural correlates of transcendent states (Wahbeh et al. 2018), meditation (Acevedo et al. 2016; Fox et al. 2016), and spiritual/religious experiences (Rim et al. 2019; van Elk and Aleman 2017). These studies have utilized a variety of neuroimaging techniques, including functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and electroencephalography (EEG), each offering unique temporal and spatial resolution advantages.

A landmark review by Acevedo et al. (2016) identified neural signatures associated with various forms of meditation, including breath awareness, focused attention, and open monitoring, along with vocal forms of meditation such as silent and vocal chanting practices. They found activation patterns in the prefrontal cortex, insula, and cingulate gyrus, regions involved in attention, emotional regulation, and self-referential processing. Although the review included some studies involving chanting, its primary focus was on comparing present-moment awareness meditation with active meditative practices that integrate movement, breathing, and occasionally chanting (e.g., yoga). There remains a gap in the literature examining the distinct effects of chanting, mantra, and repetitive prayer practices, separate from movement or breathing-based interventions.

Some studies utilizing EEG have examined brain oscillations during chanting and found that alpha and theta frequencies are associated with relaxation and meditative states (Fox et al. 2016; Newberg 2014). Despite this foundational research, systematic investigation specifically targeting chanting practices remains limited. Chanting differs from other contemplative practices as it involves actively reciting sounds or phrases, either mentally or vocally, potentially engaging distinct neural networks and triggering unique physiological responses. These neural networks likely involve speech-related and auditory-motor regions, with vocalization or mental repetition of sounds enhancing attentional focus and control. This may result in unique neurocognitive and physiological effects. Moreover, there is a considerable body of new research that has emerged and is specifically focused on chanting practices. These recent investigations are included in this review and point to distinct neurophysiological and psychological mechanisms unique to chanting.

The current review aimed to (1) synthesize findings on neurophysiological effects of various chanting styles, including both vocal and silent chanting, mantra, and repetitive prayer, (2) comprehensively examine methodological variability and participant characteristics, and (3) determine any consistent neural patterns across chanting styles and studies.

1 | Methods

A systematic review was conducted following PRISMA guidelines (Page et al. 2021). The review was not pre-registered, as it was conceived as a scoping synthesis aimed at mapping the current state of neuroimaging research on chanting rather than testing a specific hypothesis. Nevertheless, all stages of the search, screening, and data extraction were conducted independently by two reviewers, with any disagreements resolved through discussion and consensus. The study quality was assessed using validated criteria adapted from the Effective Public Health Practice Project (EPHPP; Thomas et al. 2004).

1.1 | Selection Criteria

The Inclusion criteria for the current study were:

1. Peer-reviewed studies.
2. Studies using chanting, mantra, or repetitive prayer as an intervention.
3. Studies employing neurophysiological measures (functional Magnetic Resonance Imaging [fMRI], Electroencephalography [EEG], Positron Emission Tomography [PET], Single Photon Emission Computed Tomography [SPECT], functional Near-Infrared Spectroscopy [fNIRS], and Magnetoencephalography [MEG]).
4. Articles published in English.

Exclusion criteria for the current study were:

1. Books, theses, book reviews, encyclopedia entries.
2. Studies not using chanting/mantra/prayer as the primary intervention.
3. Studies without neurophysiological measures.
4. Non-English publications.

1.2 | Search Strategy

PsycINFO and PubMed databases were systematically searched using keywords related to chanting practices and neuroimaging techniques.

PsycINFO search terms were: (Mantra* OR chant* OR pray*) AND (brain OR neuro* OR fMRI OR MRI OR magnetic resonance imaging OR EEG OR electroencephalogra* OR PET OR positron emission tomography OR SPECT OR single photon emission computed tomography OR fNIRS OR functional near-infrared spectroscopy).

PubMed search terms were: TITLE-ABS (“mantra*” OR “chant*” OR “pray*”) AND (“brain” OR “neuro” OR “fMRI” OR “MRI*” OR “magnetic resonance imaging” OR “EEG” OR “electroencephalogra*” OR “PET” OR “positron emission tomography” OR “SPECT” OR “single photon emission computed tomography” OR “fNIRS” OR “functional near-infrared spectroscopy” OR “MEG” OR “Magnetoencephalography”).

The search included articles from database inception through to the 8th of October 2024. Initial searches identified 899 articles (PubMed: $N=404$; PsycINFO: $N=495$). After removing duplicates and screening titles, abstracts, and full texts according to the eligibility criteria, 24 studies were included in the review (see Table 1 for details of the included studies).

TABLE 1 | Study characteristics of selected studies.

Author (year)	Study design	Intervention type and length	Sample characteristics	Neuroscience technique and analysis focus	Main findings	Limitations
Avvenuti et al. (2020)	Mixed design (pre-test, post-test measurements, with an intervention vs. control group). Control group is self-selected (non-random).	Intervention group: Transcendental Meditation (TM; silent mantra repetition). Intervention Length: 20-min morning & evening for 3 months (66 h total); preceded by 4-day training course. Control group: No treatment.	*Sample size*: Intervention group: $n = 22$ (19 in final analysis). Control group: $n = 15$ *Gender ratio*: Intervention group: 14F, 5M in final analysis. Control group: 7F, 8M *Age*: Intervention group: $M = 30$, SD = 9 ($M = 29$, SD = 9 in final analysis), Range = 24–58 Control group: $M = 32$, SD = 11, Range = 23–58. *Sample type and experience*: Convenience sample. Experience not specified, but the training course implies they were novices.	Structural MRI and resting-state MRI (pre-test, post-test resting state)	3-month practice of TM leads to an increase in Default Mode Network (DMN) functional connectivity involving PCC, precuneus and left superior parietal lobe. TM practice is associated with increased functional connectivity between PCC and right insula. No significant changes in cortical thickness.	Limited sample size. Non-randomized assignment to conditions. Lack of active control.
Barcelona et al. (2020)	Within-subject design. Two condition experiment (Experimental vs. control condition).	Experimental condition: Repeated prayer, *Hail Mary*' followed by "*Our Father*." Control condition: Rest. Alternating 3 prayer and 3 rest sessions (3 min each).	*Sample size*: $n = 33$ *Gender ratio*: 33F *Age*: $M = 80.1$, SD = 8.3, Range = 61–89 *Sample type and experience*: Catholic Dominican sisters. Experience not specified.	Task-based EEG (32-channel) Alpha power; Frontal alpha asymmetry	Significantly higher alpha power in posterior-occipital regions during prayer compared to rest. No significant difference in Frontal Alpha Asymmetry (FAA) across conditions, but it is positive for both conditions (indicative of positive emotions).	Absence of control task. Limited generalizability due to a small or unrepresentative sample.

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TABLE 1 | (Continued)

Author (year)	Study design	Intervention type and length	Sample characteristics	Neuroscience technique and analysis focus	Main findings	Limitations
Berkovich-Ohana et al. (2015)	Within-subject design. Three condition experiment (during word repetition, verbal fluency, and rest conditions).	Silently repeating the word "one" (in Hebrew "Echad") vs. silent generation of words that begin with a specific, randomly chosen, letter. 5 RS blocks 21 s each	*Sample size*: $n = 23$ *Gender ratio*: 15M, 8F *Age*: $M = 40$, $SD = 9.5$ *Sample type and experience*: Healthy convenience sample. Experience not specified.	Task-based fMRI	*Repetitive Speech (RS) vs. Rest*: reduction in activity across several cortical regions including the bilateral posterior, anterior cingulate cortex, precuneus as well as right inferior parietal lobule, medial frontal gyrus, and insular cortex. *Repetitive Speech (RS) vs. Verbal Fluency (VF)*: similar depth of deactivation in Default Mode Network (DMN). VF showed increased activity in frontal areas including left Broca, dorsolateral prefrontal cortex and inferior frontal gyrus. However, RS showed marginally significant increased activation clusters in some language-related regions compared to VF.	Sample experience not specified.

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TABLE 1 | (Continued)

Author (year)	Study design	Intervention type and length	Sample characteristics	Neuroscience technique and analysis focus	Main findings	Limitations
Bhargav et al. (2016)	Mixed design with pre-test post-test measures, and experimental (Om chanting) vs. control group ("ss" chanting). Groups were also subdivided into "Mobile phone on" and "Mobile phone off," so there were four groups in total; (1) Mobile phone on followed by Om chanting, (2) Mobile phone off followed by Om chanting, (3) Mobile phone on followed by "ss" chanting, (4) mobile phone off followed by "ss" chanting.	Chanting Om vs. chanting "ss" 1 week training by yoga teacher; 5 min during functional Near-Infrared Spectroscopy (fNIRS)	*Sample size*: $n = 20$ ($n = 5$ per group) *Gender ratio*: 12F, 8M *Age*: $M = 18.25$, $SD = 0.44$ *Sample type and experience*: Convenience sample from educational institutes in Bangalore. Novices.	Resting-state fNIRS (64-channel)	Frontal activity (fNIRS channel 13) was lower after Om chanting compared to "ss" chanting. There was a reduction in frontal activity after Om chanting compared to before Om chanting.	Inadequately small sample size. Limited to recording only frontal activity.
Engström and Söderfeldt (2010)	Single-n case study with three conditions: (1) Repeating a Swedish sentence, (2) Repeating a Sanskrit sentence, and (3) Engaging in Compassion Mantra Meditation.	Compassion meditation while repeating traditional Buddhist mantra (Om mani padme hum) 6×30 s	*Sample size*: Case study ($n = 1$) *Gender ratio*: F *Age*: 59 *Sample type and experience*: Active Buddhist, daily meditator.	Task-based fMRI	Mantra meditation shows higher activity relative to Swedish in the left inferior frontal gyrus and right insula.	Relying on a single sample size limits the ability to generalize findings.

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TABLE 1 | (Continued)

Author (year)	Study design	Intervention type and length	Sample characteristics	Neuroscience technique and analysis focus	Main findings	Limitations
Engström et al. (2010)	Within-subject design with two conditions: mantra meditation vs. short phrase repetition.	Mantra meditation vs. Swedish word repetition. 4 × 2 min block of mantra meditation vs. 4 × 2 min blocks of repeating Swedish phrase.	*Sample size*: Kundalini yoga $n = 5$; Acem meditation $n = 3$ *Gender ratio*: 5F, 3M *Age*: $M = 35$, Range = 21–50 *Sample type and experience*: Cohort of Acem and Kundalini yoga meditators practicing meditation at least 2 times a week for 6–24 months.	Task-based fMRI	Mantra meditation shows higher activity relative to Swedish in the left inferior frontal gyrus and right insula. Mantra meditation shows higher activity compared to Sanskrit in the right rectal gyrus, right superior frontal gyrus, and left frontal parietal junction.	Relying on a single sample size limits the ability to generalize findings. A single sample size is insufficient for conducting inferential statistical analysis.
Gao et al. (2017)	Two-factor within-subject design. Participants were exposed to either neutral or negative pictures while chanting either the names of Amitabha or Santa Claus, or without engaging in any chanting.	Silently chanting the name of Amitabha against control conditions 6 × 40 s silent chanting (20 s chanting than 20 s chanting plus picture watching) for each condition.	*Sample size*: $n = 21$ *Gender ratio*: 10F, 11M *Age*: Range = 40–52 *Sample type and experience*: Participants with at least 1 year (approximately 200–3000 h) of experience in chanting the name of Amitabha. The average chanting experience of the participants was 2.1 years.	Task-based EEG (128-channel)	Amplitude in late processing potential (LPP, 300–600 ms) was reduced in chanting conditions compared to control condition during the viewing of negative pictures (i.e., increased LPP was not observed when chanting Amitabha). ERP source analysis indicated that LPP mainly originated from the central-parietal regions of the brain.	The study did not adequately account for the familiarity effect when comparing the effects of chanting Amitabha to control chanting. The generalizability of the findings may be limited due to the characteristics of the sample used in the study.

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TABLE 1 | (Continued)

Author (year)	Study design	Intervention type and length	Sample characteristics	Neuroscience technique and analysis focus	Main findings	Limitations
Gao et al. (2019)	Within-subject design. Silently chanting either, the names of Amitabha or Santa Claus, or without engaging in any chanting.	Silently chanting the name of Amitabha against control conditions	*Sample size*: $n = 21$ (one EEG dataset excluded due to operational error); $n = 1$ also underwent fMRI *Gender ratio*: EEG sample: 12F, 9M. Single fMRI: 1F *Age*: EEG sample: $M = 46.5$, SD = 2.6, Range = 40–52; Single fMRI participant: Age = 43 *Sample type and experience*: Participants with at least 1 year of meditative experience in spiritual/religious chanting. The fMRI participant was an experienced Buddhist monastic.	Task-based EEG (128-channel) Task-based fMRI	Independent component analysis identified 7 clusters, including one corresponding to the posterior cingulate cortex (PCC). That cluster showed higher delta EEG power during spiritual/religious chanting compared to non-spiritual/religious chanting, but no difference between these two conditions compared to the rest condition.	Study did not account for the familiarity effect of chanting Amitabha compared to control chanting. EEG and fMRI data were collected from different participants. There is a potential lack of independence in the EEG data, as it may overlap with the data from a previous study (Gao et al. 2017). The study primarily focuses on the Posterior Cingulate Cortex (PCC). Effects in delta band were not significantly different compared to the control condition.

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Author (year)	Study design	Intervention type and length	Sample characteristics	Neuroscience technique and analysis focus	Main findings	Limitations
Gao et al. (2020)	Same as above in Gao et al. (2019)	Silently chanting the name of Amitabha against control conditions. 3 × 40 s silent chanting (20 s chanting than 20 s chanting plus picture watching) for each condition.	*Sample size*: $n = 21$ *Gender ratio*: 10F, 11M *Age*: *Range* = 40–52 *Sample type and experience*: Participants with at least 1 year of meditative experience, chanting Amitabha for at least 15 min per day.	Task-based fMRI	Spiritual/religious chanting (RC) vs. non-spiritual/religious chanting (NRC) and rest: asymmetric amygdala activity with higher activity in left than right amygdale for all three conditions but more intense during spiritual/religious chanting. Increased activity in midbrain and left parahippocampus during RC compared to NRC and Rest. RC versus NRC: stronger activity in subcortical regions including thalamus, amygdala, cerebellum, and brainstem.	Study did not account for the familiarity effect of chanting Amitabha compared to control chanting. Findings were based on data with uncorrected thresholds, which may impact the robustness of the results.
Harne and Hiwale (2018).	Within-subject pre-test vs. post-test following Om chanting.	Om chanting for 30 min.	*Sample size*: $n = 23$ *Gender ratio*: F14, M9 *Age*: $M = 20.99$, $SD = 0.99$, Range = 18–22 *Sample type and experience*: Engineering students without meditation training.	Resting-state EEG	Significant increase in EEG Theta power after compared to before chanting.	Absence of a control condition or control group.

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Author (year)	Study design	Intervention type and length	Sample characteristics	Neuroscience technique and analysis focus	Main findings	Limitations
Kalyani et al. (2011)	Within-subject 3 condition design: loud Om chanting; loud control chanting; rest.	Om chanting vs. control chanting and vs. rest. Om chanting training before imaging (duration undefined); during neuroimaging 10 × 15 s of loud Om chanting, alternated with blocks of rest and control chanting.	*Sample size*: $n = 12$ *Gender ratio*: 3F, 9M *Age*: $M = 28$, SD = 6, Range = 22–39 *Sample type and experience*: Healthy convenience sample with mixed experience (some had formal meditation training, while others were novices).	Task-based fMRI	Om chanting vs. Rest: Significant deactivation in amygdala, anterior cingulate gyrus, hippocampus, insula, orbitofrontal cortex, parahippocampal gyrus and thalamus. Control chanting vs. Rest: No significant changes detected	Limited sample size. Solely focused on region of interest analysis Lacks a direct statistical comparison between intervention and control condition.
Kang et al. (2018)	Within-subject pre vs. post before; 1 week after (week 9), and 2-month follow-up (week 17).	TM (silent mantra). Total of 14 h individual and group sessions. Participants were instructed to meditate for 8 weeks twice a day for 15–20 min at home.	*Sample size*: $n = 29$ (23 completed the trial) *Gender ratio*: 6F, 23M *Age*: $M = 59.0$, SD = 12.8 *Sample type and experience*: Participants with DSM-IV PTSD diagnosis, 87.7% on medication, some with meditation training other than TM.	Resting-state EEG	Significant increase in delta/theta power (1–7 Hz) across the three time points.	Absence of a control condition.
Khalsa et al. (2009)	Within-subject design (post meditation vs. rest).	Kundalini meditation/ Kirtan Kriya (breathing pattern, word set (Sa, Ta, Na, Ma) and fingertip movements). 12 min of meditation (2 min aloud chanting; 2 min whispering; 4 min silently chanting; 2 min whispering chants; 2 min aloud chanting).	*Sample size*: $n = 11$ *Gender ratio*: 5F, 6M *Age*: $M = 54.4$, SD = 13.5 *Sample type and experience*: Clinical program participants, one with history of mild depression, mostly experienced meditators (10).	Task-based Single-photon-emission computed tomography (SPECT) regional cerebral blood flow (rCBF) imaging.	Uncorrected significant activations in the right temporal lobe and posterior cingulate gyrus. Significant deactivations (corrected for multiple comparisons) were observed in parietal (BA 7) and occipital (BA 19) clusters.	Limited sample size. Solely focused on region of interest analysis. Lacks a direct statistical comparison between intervention and control condition.

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Author (year)	Study design	Intervention type and length	Sample characteristics	Neuroscience technique and analysis focus	Main findings	Limitations
Lee et al. (1997)	Within-subject design (pre-test, post-test, and during three stages of intervention: chanting, movement, and meditation).	1 h of Qi-training, involving three stages: 25 min reciting Chunmoon (8 lines of 51 "meaningless" words); 15 min of body motion, and 20 min of meditation.	*Sample size*: $n = 13$ *Gender ratio*: 6F, 7M *Age*: $M = 25$, Range = 20–32 *Sample type and experience*: Members of ChunDoSunBup Qi-training center, no involvement in meditation or other activities for stress reduction.	Resting-state EEG (12-channel)	Increase in right occipital alpha power during sound, relative to pre-training control.	Lack of pre- vs. post-intervention comparisons. Susceptibility of "sound" condition to potential confounding from movement artifacts. Limited sample size.
Perez-Diaz et al. (2023)	Within-subject 2×2 design, with all conditions involving internal speech, examining two factors: "Domain" (spiritual vs. secular) and "Speech-act" (formalized vs. improvised), plus additional control condition (backwards counting).	Each condition involved 6 repetitions of 26 s. In the formalized spiritual condition, participants recited the Lord's Prayer ("Father"), and in the improvised spiritual condition, they prayed to the Divine Mother ("Mother"). For the secular conditions, they recited a well-known poem ("Poem") or made improvised wishes to Santa Claus ("Santa"). A control condition involved counting backwards from 100.	*Sample size*: $n = 16$ *Gender ratio*: 10F, 6M *Age*: $M = 48$, SD = 10.3 Range = 24–63 *Sample type and experience*: All participants had more than 7 years of daily practice experience in meditation.	Task-based fMRI	Deactivation of the bilateral thalamus, ventrolateral prefrontal cortex, temporal pole, dorsolateral cortex, precentral gyrus, supplementary motor area, and anterior cingulate cortex was observed during both prayer ("Father" and "Mother") conditions compared to secular tasks ("Poem" and "Santa").	Limited sample size.

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Author (year)	Study design	Intervention type and length	Sample characteristics	Neuroscience technique and analysis focus	Main findings	Limitations
Rao et al. (2018)	Within-subject design (loud Om chanting; loud SS chanting; rest).	Om chanting training before imaging (duration undefined); during neuroimaging 10 blocks × 15 s of loud Om chanting, alternated with blocks of rest and SS chanting.	*Sample size*: $n = 12$ *Gender ratio*: 3F, 9M *Age*: $M = 28$, SD = 6, Range = 22–39 *Sample type and experience*: Healthy convenience sample with mixed experience, including some with formal meditation training.	Task-based fMRI Network analysis	Om chanting vs. rest: Significantly reduced output from insula, anterior cingulate and orbitofrontal cortices. Highlights a reduced output from these regions to the amygdala limbic region Om chanting compared to rest. Om chanting vs. control chanting: similar results to Om chanting vs. rest Control chanting vs. rest: no significant changes in connectivity	Limited sample size. Exploratory analysis revealed complex connectivity patterns that are challenging to interpret
Rogers and Walter (1981)	Within-subject design (six listening conditions: listening to: rhythmic classical music; slow vocal chanting; fast vocal chanting; speech, rhythmically pulsed white noise, and no sound).	5 min per sound condition; except for white noise, which was 9 min long (nine different frequencies for 1-min each); presented twice 1-week apart.	*Sample size*: $n = 8$ *Gender ratio*: Not provided *Age*: Not provided *Sample type and experience*: UCLA students, experience not specified.	Task-based EEG (6-channel)	During rhythmic chanting and music, alpha band activity was more synchronized than during non-rhythmic speech.	The study employed a limited and vaguely defined sample. Use of outdated analysis approach. Only four epochs per condition of 8 s length were analyzed. Study predominantly concentrates on the impacts of rhythmic versus non-rhythmic auditory signals. Study primarily involved passive listening without active engagement or interaction.

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Author (year)	Study design	Intervention type and length	Sample characteristics	Neuroscience technique and analysis focus	Main findings	Limitations
Saini et al. (2024)	Within-subject 2 × 2 design, featuring two conditions: vocal mantra repetition of Om and listening to Om chanting.	Vocal repetition or repeated listening of Om for 5 min each.	*Sample size*: $n = 20$ *Gender ratio*: F0, M20 *Age*: $M = 27$, SD = 7.5. *Sample type and experience*: Healthy Indian university students without previous exposure to yoga.	Resting-state EEG (128-channel) with 20 s of pre- and post-condition activity, incorporating standardized Low-Resolution Brain Electromagnetic Tomography (sLORETA) source localization analysis.	Both vocal repetition and listening to Om led to increased post-task activity in the Default Mode Network (DMN), frontoparietal control network (FPCN), and attentional networks. No significant differences were observed between the active and passive conditions at the post-task stage.	The 20-s EEG analysis interval raises concerns about fully capturing brain activity variability, reducing the reliability, generalizability, and reproducibility of results.
Sharma et al. (2022)	Within-subject design (silent mantra, breathing meditation) (both eyes closed), and external point meditation (eyes open).	Three minutes per condition: silent mantra (choice of Sanskrit mantra), focus on breath, and focus on external point (i.e., focusing on external object). 3 min per condition in fixed order: mantra, breath external point.	*Sample size*: $n = 34$ *Gender ratio*: F22, M12 *Age*: Majority (29.41%) in the 39–48 range, overall range = 18–68 *Sample type and experience*: Healthy adults with mixed experience (beginners, intermediate, and advanced meditators).	Task-based EEG (5-channel) Analysis of percentage in "calm state" as per Muse app.	Significantly, more time is spent in a "calm state" during mantra and breath meditation compared to external point meditation.	"Eyes Open" and "Eyes Closed" states presents a potential confounding factor in EEG activity. The definition of the "Muse Calm state" needs further clarification.

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Author (year)	Study design	Intervention type and length	Sample characteristics	Neuroscience technique and analysis focus	Main findings	Limitations
Shimomura et al. (2008)	Within-subject design (Silent reciting (Narmu Amidsa Butsu), silent reading of sutras, word generation game, rest).	Silent reciting (Narmu Amidsa Butsu) vs. silent reading of sutras vs. Word generation game 30 s per condition (rest at the beginning, in between and at the end; 4 × 30 s in total).	*Sample size*: $n = 8$ *Gender ratio*: M8 *Age*: $M = 40.8$, SD = 12.3, Range = 25–64 *Sample type and experience*: Healthy Japanese monks, reciting sutras daily for more than 1 h for at least 10 years.	Task-based fMRI	Silent Nenbutsu recitation showed activity in the superior and medial frontal cortex compared to rest, but it is unclear if this occurred at a corrected threshold or not. Sutra recitation activates the left middle frontal gyrus, the right angular gyrus, and the right supramarginal gyrus compared to rest.	Unclear whether the results were computed using a corrected or uncorrected statistical threshold. Comparisons were made only against the rest conditions, and not against the control task conditions.
Sovilj et al. (2019)	Within-subject design (silent prayer vs. rest).	3 min silent (repeated) recitation of Lord's prayer	*Sample size*: Case study ($n = 1$) *Gender ratio*: F *Age*: 22 *Sample type and experience*: Orthodox Christian with university degree, familiar with the Lord's Prayer for a long time.	Task-based EEG (19-channel)	Unclear findings, uncommon measures, and no statistics presented.	Case study design precludes statistical analysis

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TABLE 1 | (Continued)

Author (year)	Study design	Intervention type and length	Sample characteristics	Neuroscience technique and analysis focus	Main findings	Limitations
Stigsby et al. (1981)	Mixed design: two groups (TM mediators vs. non-meditators) and four conditions (TM meditations (silent mantra), wakefulness, drowsiness, and sleep).	20 min of TM (silent mantra).	*Sample size*: Meditation group: $n = 14$; Control group: $n = 13$ *Gender ratio*: Meditation group: 5F, 9M; Control group: 8F, 5M *Age*: Meditation group: Median = 27, Range = 22–60; Control group: Median = 28, Range = 21–63 *Sample type and experience*: Meditation group practiced TM daily for at least 2 years; control group did not practice any form of meditation.	Task-based EEG (16-channel)	No significant difference in EEG mean frequencies and amplitudes between the TM group and control group during eyes-closed, wakefulness or drowsiness. TM group exhibited slower mean frequencies (1 Hz), and lower amplitudes compared to the control group.	Analysis approach is outdated. There is no equivalent control condition (i.e., only a resting condition is used). Group comparisons are made based on non-randomly selected samples.
Thomas et al. (2014)	Mixed design, two groups (yoga teachers vs. yoga students), three conditions (silent mantra meditation using mala beads, body-steadiness meditations, and control condition) (mental calculations).	10 min per condition.	*Sample size*: Teacher group: $n = 6$; Student group: $n = 6$ *Gender ratio*: 3F, 3M in each group *Age*: Teacher group: $M = 54$, SD = 6.5; Student group: $M = 42$, SD = 8.0 *Sample type and experience*: Satyananda Yoga Academy participants; teachers had an average of 30 years of practice, students had an average of 4 years of practice.	Task-based EEG (25-channel)	Higher beta and gamma band activity was observed in yoga teachers compared to students during mantra meditation. Source analysis suggests that this activity originates in the gyrus rectus and insula, respectively. In contrast, higher alpha and theta activity was found in students compared to teachers during mantra meditation. Source analysis suggests that these activities originate in the inferior parietal and precentral gyrus, respectively.	Group differences may be confounded by factors such as age and other individual characteristics. The number of electrodes used is insufficient for reliable source localization. The effects observed in the alpha and gamma frequency bands are not exclusive to meditation and are also significant in the "calculation" control condition.

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TABLE 1 | (Continued)

Author (year)	Study design	Intervention type and length	Sample characteristics	Neuroscience technique and analysis focus	Main findings	Limitations
Ventura et al. (2024)	Between-subjects design with four groups: Mantra meditation, Shoonya meditation (open focus), Vipassana meditation (body focus), and a meditation-naive control group, with a within-subjects comparison across three conditions: breathing meditation, tradition-specific meditation, and instructed mind-wandering.	The three conditions in this study (breathing meditation, tradition-specific meditation, and instructed mind-wandering) were conducted with eyes closed, with each session lasting 10 min, and the order of conditions was counterbalanced across participants.	*Sample size*: Vipassana group: $n = 15$; Mantra group: $n = 24$; Shoonya group: $n = 19$; Control group: $n = 27$ *Age*: Vipassana group: $M = 47$, SD = 15; Mantra group: $M = 49$, SD = 13; Shoonya group: $M = 40$, SD = 10; Control group: $M = 45$, SD = 10 *Sample type and experience*: Vipassana meditators: $M = 4983$ h, SD = 3616; Mantra meditators: $M = 14{,}309$ h, SD = 14,361 Shoonya meditators: $M = 3260$ h, SD = 2866; Control group: $M = 0$ h, SD = 0.	Task-based EEG (64-channel) autocorrelation analysis	When comparing the effects of condition-specific meditation, the Mantra group exhibited shorter autocorrelation windows compared to the Shoonya (open focus) group. During breathing meditation, the Mantra group exhibited shorter autocorrelation windows compared to the control group. During instructed mind-wandering, the Mantra meditation group exhibited shorter autocorrelation windows compared to the Shoonya and control groups.	The substantial variability in meditation experience between groups could pose a potential confounding factor. The relatively small sample size and the high number of group comparisons may have introduced greater variability in the results, potentially affecting the statistical power and reliability of the findings.

Note: In the included studies, Om chanting is variously labeled as "Om," "OM," or "om." For consistency, we refer to this practice throughout as Om chanting.

1.3 | Data Collection

Two authors independently extracted information in line with PRISMA protocols regarding (1) study design, (2) participant characteristics, (3) intervention characteristics, (4) measurement characteristics, (5) statistical methods, and (6) neuroimaging outcomes. Any disagreements between the two authors were resolved through discussion until a consensus was reached.

1.4 | Outcome Measures

Primary outcomes included neuroimaging signals: fMRI event–related BOLD responses and resting state functional connectivity, gray matter density/volume, SPECT regional cerebral blood flow, fNIRS hemodynamic responses, and EEG/MEG event–related responses, power, and connectivity measures.

1.5 | Quality Assessment

Two authors independently assessed the quality of studies using an adapted Effective Public Health Practice Project (EPHPP) criteria (Thomas et al. 2004) to evaluate (1) selection bias, (2) study design, (3) neuroimaging methodology, and (4) analysis quality. The papers were classified as high, moderate, or low quality (see Table 2 for the full quality assessment). Any disagreements between the two authors were resolved through discussion with a third author.

2 | Results

2.1 | Study Characteristics

The PRISMA flow diagram in Figure 1 illustrates the study selection process. From 899 initial records, 24 studies met inclusion criteria after duplicate removal and eligibility screening. Across the 24 included studies (summarized in Table 1), diverse neuroscience methods investigated neuroimaging signals: EEG ($n = 12$), task-based fMRI ($n = 9$), resting-state and structural MRI ($n = 1$), resting-state fNIRS ($n = 1$), and SPECT ($n = 1$).

Most studies employed within-subjects designs ($n = 17$), with others using mixed ($n = 4$), between-subjects ($n = 1$), or single-case studies ($n = 2$). Sample sizes ranged from single participants to 85. Nineteen studies involved healthy participants, while five focused on clinical populations (PTSD, mild depression). Chanting experience levels varied: eight studies recruited experienced practitioners, six used mixed-experience samples, three included novices, and seven did not specify levels of experience. Although case studies are included in the summary table for completeness, results from these studies are not reported in the main analysis due to their limited generalizability.

Chanting interventions varied from silent mantra repetition and vocal Om chanting to spiritual/religious recitation (e.g., Amitabha, Lord's Prayer), and tradition-specific meditative chants/prayers, reflecting practices across diverse cultural and spiritual traditions. However, all shared a core feature of rhythmic, vocal, or mental sound repetition, reflecting their common contemplative function.

2.2 | Hemodynamic Neuroimaging Findings (fMRI, PET, SPECT, fNIRS)

Eight studies reported on task-based hemodynamic activity (Berkovich-Ohana et al. 2015; Bhargav et al. 2016; Engström et al. 2010; Engström and Söderfeldt 2010; Gao et al. 2019; Kalyani et al. 2011; Rao et al. 2018; Shimomura et al. 2008), while one examined resting-state hemodynamic activity and structural neural features (Avvenuti et al. 2020). These are outlined thematically below.

2.3 | Attention and Executive Control Networks

Multiple studies demonstrated activation in prefrontal regions during chanting (Engström et al. 2010; Engström and Söderfeldt 2010; Gao et al. 2019, 2020; Shimomura et al. 2008). Engström et al. (2010) reported significant corrected activation foci in bilateral hippocampal and parahippocampal formations, the right inferior frontal cortex, and right medial frontal cortex. Similarly, Shimomura et al. (2008) found higher superior and medial frontal cortex activation during silent Nenbutsu recitation compared to rest, while a silent sutra-reading task induced significant activation within the left lateral middle frontal gyrus, the right supramarginal gyrus, and the right angular gyrus compared to rest.

Other studies reported deactivation in prefrontal regions. For example, Perez-Diaz et al. (2023) noted ventrolateral and dorsolateral prefrontal disengagement during spiritual prayer conditions. Further, the anterior cingulate regions (gyrus and cortex) showed deactivation across 2 studies (Kalyani et al. 2011; Perez-Diaz et al. 2023), suggesting engagement of attention regulation and conflict monitoring processes during chanting practices (Bush et al. 2000; Ganesan et al. 2025).

Bhargav et al. (2016) examined resting state differences in hemodynamic activity before and after Om chanting using fNIRS. Results revealed lower frontal activity following chanting compared to before chanting. Results also indicated lower frontal activity following chanting compared to a control (Bhargav et al. 2016). While some changes were observed over time in certain fNIRS channels, the overall presentation of the results is difficult to interpret with precision.

2.4 | Emotional Regulation Networks

Several studies identified insula activation during chanting, suggesting engagement of interoceptive awareness and emotional processing. During a religious/spiritual chanting task, Gao et al. (2020) demonstrated higher hemodynamic activity in the fusiform gyrus, bilateral occipital lobes, prefrontal lobes,

TABLE 2 | Quality assessment ratings using the adapted effective public health practice project criteria.

Study	Avvenuti et al. (2020)	Barcelona et al. (2020)	Berkovich-Ohana et al. (2015)	Bhargav et al. (2016)	Engström and Söderfeldt (2010)	Engström et al. (2010)	Gao et al. (2017)	Gao et al. (2019)	Gao et al. (2020)
A. Selection bias									
1. Are the individuals selected to participate likely to be representative of the target population/general population? (yes = 1; no/unclear = 0)	1	1	0	1	0	1	1	1	1
B. Study design									
1. Was sample size sufficient and/or derived from a power calculation? (yes = 1; no = 0)	0	1	1	0	0	0	1	1	1
2. Were appropriate details of sample characteristics included? (yes = 1; no = 0)	1	1	1	1	1	1	1	1	1
3. Did the design include an equivalent control group and/or active control condition? (yes = 1; no = 0)	1	0	1	1	1	1	1	1	1
C. Neuroimaging methodology									
1. Is a valid method of data acquisition and analysis used? (yes = 1; no/unclear = 0)	1	1	1	1	1	1	1	1	1
D. Analysis quality									
1. Has the analysis controlled for potential confounders? (yes = 1; no/unclear = 0)	1	1	1	1	1	1	1	1	1
2. Was the statistical analysis adjusted for multiple comparisons if appropriate? (yes/not applicable = 1; no/unclear = 0)	1	0	1	1	1	1	1	1	0

(Continues)

TABLE 2 | (Continued)

Study	Avvenuti et al. (2020)	Barcelona et al. (2020)	Berkovich-Ohana et al. (2015)	Bhargav et al. (2016)	Engström and Söderfeldt (2010)	Engström et al. (2010)	Gao et al. (2017)	Gao et al. (2019)	Gao et al. (2020)
Total score (0–7)	6	5	6	6	5	6	7	7	6
Global rating (high = 7; moderate = 5–6; low = 0–4)	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	High	Moderate

Study	Harne and Hiwale (2018)	Kalyani et al. (2011)	Kang et al. (2018)	Khalsa et al. (2009)	Lee et al. (1997)	Rao et al. (2018)	Rogers and Walter (1981)	Sharma et al. (2022)	Shimomura et al. (2008)
A. Selection bias									
1. Are the individuals selected to participate likely to be representative of the target population/general population? (yes = 1; no/unclear = 0)	1	1	1	0	1	1	0	1	1
B. Study design									
1. Was sample size sufficient and/or derived from a power calculation? (yes = 1; no = 0)	1	0	1	0	0	0	0	1	0
2. Were appropriate details of sample characteristics included? (yes = 1; no = 0)	1	1	1	1	1	1	0	1	1
3. Did the design include an equivalent control group and/or active control condition? (yes = 1; no = 0)	0	1	0	0	1	1	1	1	1
C. Neuroimaging methodology									
1. Is a valid method of data acquisition and analysis used? (yes = 1; no/unclear = 0)	1	1	1	1	1	1	0	0	1

(Continues)

TABLE 2 | (Continued)

Study	Harne and Hiwale (2018)	Kalyani et al. (2011)	Kang et al. (2018)	Khalsa et al. (2009)	Lee et al. (1997)	Rao et al. (2018)	Rogers and Walter (1981)	Sharma et al. (2022)	Shimomura et al. (2008)
D. Analysis quality									
1. Has the analysis controlled for potential confounders? (yes = 1; no/unclear = 0)	1	0	1	1	0	1	0	0	0
2. Was the statistical analysis adjusted for multiple comparisons if appropriate? (yes/not applicable = 1; no/unclear = 0)	0	1	0	0	1	1	0	1	0
Total score (0–7)	5	5	5	3	5	6	1	5	4
Global rating (high = 7; moderate = 5–6; low = 0–4)	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Low

Study	Sovilj et al. (2019)	Stigsby et al. (1981)	Thomas et al. (2014)	Perez-Diaz et al. (2023)	Saini et al. (2024)	Ventura et al. (2024)
A. Selection bias						
1. Are the individuals selected to participate likely to be representative of the target population/general population? (yes = 1; no/unclear = 0)	0	1	1	1	1	1
B. Study design						
1. Was sample size sufficient and/or derived from a power calculation? (yes = 1; no = 0)	0	0	0	0	0	1
2. Were appropriate details of sample characteristics included? (yes = 1; no = 0)	1	1	1	1	1	0
3. Did the design include an equivalent control group and/or active control condition? (yes = 1; no = 0)	0	1	1	1	1	1
C. Neuroimaging methodology						
1. Is a valid method of data acquisition and analysis used? (yes = 1; no/unclear = 0)	0	0	0	1	1	1

(Continues)

TABLE 2 | (Continued)

Study	Sovilj et al. (2019)	Stigsby et al. (1981)	Thomas et al. (2014)	Perez-Diaz et al. (2023)	Saini et al. (2024)	Ventura et al. (2024)
D. Analysis quality						
1. Has the analysis controlled for potential confounders? (yes = 1; no/unclear = 0)	0	1	0	1	1	1
2. Was the statistical analysis adjusted for multiple comparisons if appropriate? (yes/not applicable = 1; no/unclear = 0)	0	0	1	1	1	1
Total score (0–7)	1	4	4	6	6	6
Global rating (high = 7; moderate = 5–6; low = 0–4)	Low	Low	Low	Moderate	Moderate	Moderate

Note: This table outlines the quality rating scores using an adapted Effective Health Practice Project criteria (EPHPP; Thomas et al. 2004) to evaluate (A) selection bias, (B) study design, (C) neuroimaging methodology, and (D) analysis quality. The papers were classified as high (7), moderate (5–6), or low (0–4) quality.

thalamus, amygdala, parahippocampus, and cerebellum in response to fearful stimuli, compared to neutral stimuli. Higher asymmetric activity in the left amygdala during chanting was also observed. Subcortical activity in regions including the thalamus, amygdala, cerebellum, and brainstem was stronger during religious/spiritual chanting compared to non-religious/spiritual chanting.

Using voxel-based morphometry (VBM), Gao et al. (2020) also found experienced religious/spiritual chanters possessed rightward structural asymmetry in the temporal lobe, limbic system, and cerebellum. Avvenuti et al. (2020) demonstrated increases in resting-state functional connectivity between the PCC and right insula following a transcendental meditation intervention (TM; silent mantra repetition). A correlation showed that TM was also associated with DMN functional connectivity involving the PCC, precuneus, and the left superior parietal lobule (Avvenuti et al. 2020). Taken together, these findings suggest that spiritual chanting engages brain regions involved in emotional valence and arousal.

2.5 | Default Mode Network Modulation

Deactivation of DMN regions during chanting was found across multiple neuroimaging studies, which may suggest reduced mind wandering and self-referential thought. Berkovich-Ohana et al. (2015) demonstrated that repetitive chanting of "one" in Hebrew reduced bilateral activity in the posterior and anterior cingulate cortex, precuneus, right inferior parietal lobule, medial frontal gyrus, and insular cortex compared to rest. Kalyani et al. (2011) and Rao et al. (2018) reported similar deactivation patterns during Om chanting, including bilateral orbitofrontal cortex, anterior cingulate, parahippocampal gyri, thalami, and hippocampi. Further, the fMRI network analysis by Rao et al. (2018) also revealed reduced output from the insula, anterior cingulate, and orbitofrontal cortices.

Lastly, Saini et al. (2024) examined the effects of Om chanting and listening using resting-state EEG with standardized Low-Resolution Brain Electromagnetic Tomography (sLORETA) source localization analysis. They found both conditions resulted in increased post-task activity in the DMN, frontoparietal control network (FPCN), and attentional networks. No significant differences were observed between the active and passive conditions at the post-task stage.

2.6 | Electrophysiological Neuroimaging Findings (EEG)

2.6.1 | Alpha Band Activity

Four studies reported task-related alpha band differences suggesting relaxed attention states. Barcelona et al. (2020) found increased alpha activity in parietal and posterior-occipital regions during spiritual prayer compared to rest; however, no differences in frontal alpha asymmetry (FAA) were observed. Lee et al. (1997) found increased right occipital alpha during vocalized sound production (reciting meaningless vibrational

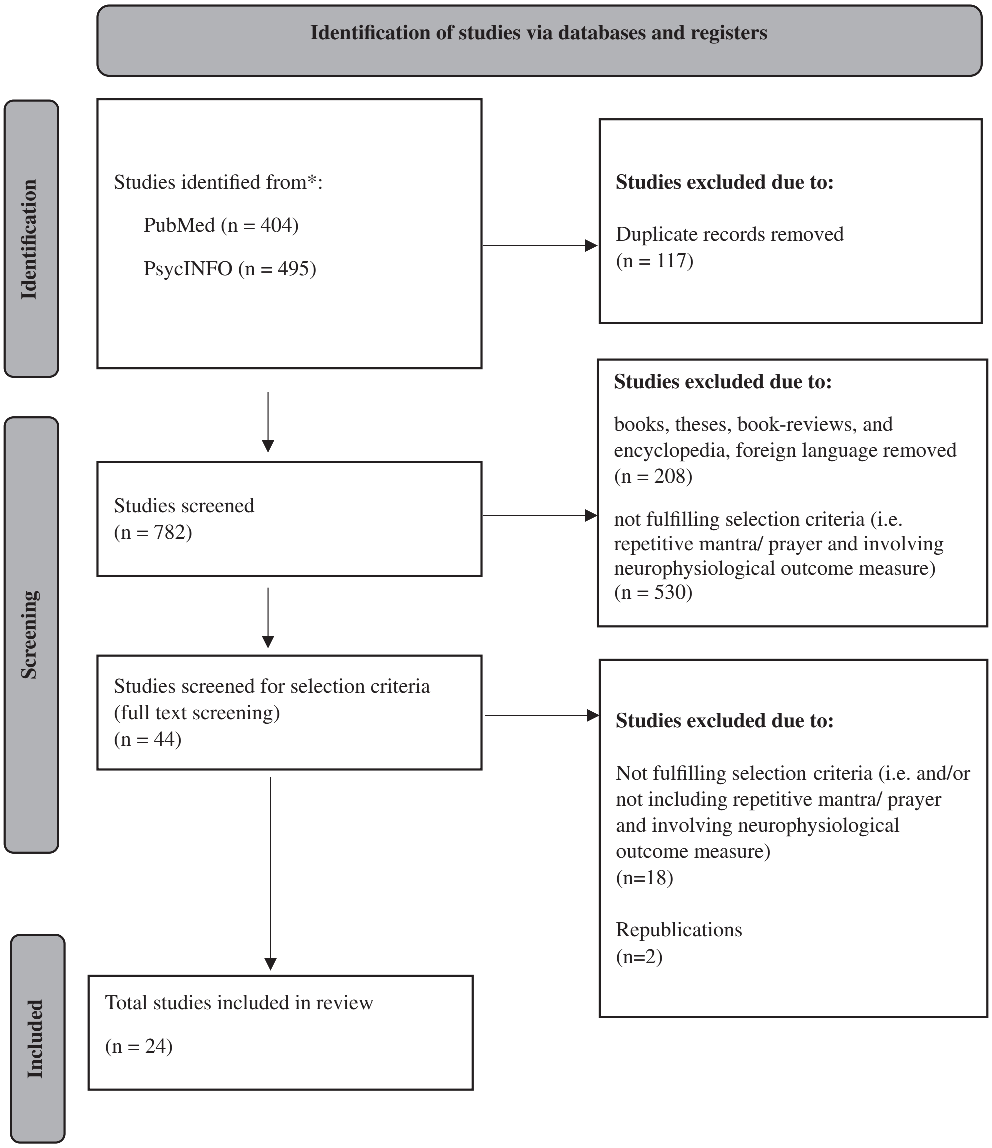

FIGURE 1 | Prisma chart of study selection process.

sounds for 25 min), while Rogers and Walter (1981) found greater alpha synchronization during listening to rhythmic chanting compared to non-rhythmic speech. Lastly, Thomas et al. (2014) found that during mantra meditation, yoga students showed higher alpha activity (originating from the inferior parietal and precentral gyrus, respectively) than yoga teachers.

2.6.2 | Theta and Delta Activity

Theta and delta activity increases were reported in multiple studies (Harne and Hiwale 2018; Kang et al. 2018; Thomas et al. 2014), indicating parasympathetic activation and deep relaxation. Harne and Hiwale (2018) found theta increased following 30-min Om chanting sessions. Similarly, Kang et al. (2018) found increases in both theta and delta activity across three time points during an 8-week transcendental meditation (TM) intervention. Lastly, Thomas et al. (2014) reported higher theta activity in yoga students compared to teachers during mantra meditation.

2.6.3 | Event-Related Potentials

Gao et al. (2017) assessed event-related potentials, finding reduced late processing potential (LPP: 300-600 ms) amplitude during chanting while viewing negative images, with source analysis indicating central-parietal origins, demonstrating modified emotional processing during chanting.

2.7 | Quality Assessment Results

Of 24 included studies, most received moderate quality ratings ($n = 16$), with only two achieving high quality and six receiving low ratings. Common methodological weaknesses included insufficient power calculations, unclear control condition equivalence, and inadequate adjustment for multiple comparisons. Details of the quality rating scores are outlined in Table 2.

3 | Discussion

This systematic review identified 24 studies that utilized a range of neuroimaging techniques, including fMRI, EEG, fNIRS, and SPECT. Most studies employed task-based designs examining both vocal and silent forms of chanting, with sample sizes ranging from single cases to 85 participants (including healthy and clinical populations). Findings should be interpreted in light of the methodological variability across studies, including differences in sample characteristics, intervention protocols, and control conditions. Despite this heterogeneity, the convergence of prefrontal and insula activation across multiple modalities suggests emerging neural patterns worth further examination.

Specifically, findings demonstrate that chanting engages brain networks associated with attention, self-referential processing, and emotional regulation. Functional and structural imaging studies show that chanting activates regions involved in sustained attention and cognitive control (Avvenuti et al. 2020; Engström et al. 2010; Engström and Söderfeldt 2010; Perez-Diaz et al. 2023; Rao et al. 2018; Thomas et al. 2014). Multiple studies demonstrate reduced activity in the DMN (Berkovich-Ohana et al. 2015; Kalyani et al. 2011; Rao et al. 2018). Finally, modulation of subcortical structures associated with emotional regulation (such as the amygdala, thalamus, and insula) was found across studies (Avvenuti et al. 2020; Gao et al. 2020; Kalyani et al. 2011; Rao et al. 2018). Together, these findings suggest that chanting is associated with neural markers involved in focused attention, reduced self-processing, and improved emotional regulation.

3.1 | Attention Network Engagement

Studies showed consistent changes in brain regions associated with attention and control. For example, deactivation of the anterior cingulate cortex, a region typically involved in conflict monitoring and cognitive control, was observed in multiple studies (Berkovich-Ohana et al. 2015; Kalyani et al. 2011; Perez-Diaz et al. 2023; Rao et al. 2018). This indicates engagement of conflict monitoring and attention regulation processes, which may reflect less effortful attention and a more automatic, absorbed state, particularly during repetitive or practiced vocal repetition.

Chanting also appears to recruit prefrontal regions that support sustained focus and cognitive control. For example, Shimomura et al. (2008) found superior and medial frontal cortex activation during silent Nenbutsu recitation, reinforcing the role of chanting in maintaining concentrated attention. Lastly, enhanced alpha activity, associated with focused attention, was observed during chanting in multiple studies (Barcelona et al. 2020; Lee et al. 1997; Rogers and Walter 1981). Increased alpha activity is associated with the suppression of irrelevant sensory input and enhanced internal focus, supporting the idea that rhythmic and repetitive chanting may facilitate an inwardly directed mental state (Foxe and Snyder 2011). The reviewed studies, though modest in scale, highlight engagement of neural regions associated with attention and emotional regulation. These preliminary findings lay the groundwork for future research on the cognitive and emotional effects of chanting.

3.2 | Default Mode Network Suppression

Deactivation of DMN regions, particularly the posterior cingulate cortex, precuneus, and medial prefrontal areas (Berkovich-Ohana et al. 2015; Kalyani et al. 2011; Rao et al. 2018) suggests a reduction in self-referential processing and mind-wandering during chanting. Berkovich-Ohana et al. (2015) demonstrated that repetitive chanting of the word “one” in Hebrew reduced bilateral activity in the posterior and anterior cingulate cortex, precuneus, right inferior parietal lobule, medial frontal gyrus, and insular cortex compared to rest. Similarly, Kalyani et al. (2011) reported significant deactivation during Om chanting in the bilateral orbitofrontal cortex, anterior cingulate, parahippocampal gyri, thalami, and hippocampi.

This pattern was further supported by Rao et al. (2018), who used network analysis to demonstrate reduced output from the insula, anterior cingulate, and orbitofrontal cortices to limbic areas during chanting. Perez-Diaz et al. (2023) observed widespread deactivation in the bilateral thalamus, ventrolateral prefrontal cortex, and anterior cingulate cortex during spiritual prayer conditions. The DMN suppression during chanting is aligned with findings in other meditation practices, indicating a common neural signature of focused contemplative states and reduced self-referential thinking (Brewer et al. 2011). It is important to note that DMN findings vary depending on both modality and timescale. Task-based fMRI studies generally report deactivation of DMN regions during chanting, consistent with reduced self-referential thought (e.g., Berkovich-Ohana et al. 2015; Kalyani et al. 2011; Rao et al. 2018; Perez-Diaz et al. 2023). In contrast, the only EEG study that localized the DMN (Saini et al. 2024) reported increased post-task DMN activity. These differences likely reflect the temporal sensitivity of EEG to immediate rebound effects following chanting, compared with the slower, in-task changes captured by fMRI. Taken together, these findings suggest that apparent discrepancies may reflect distinct processes unfolding over different timescales. The limited data on these processes imply a need for further research. Overall, the most convergent evidence supports DMN deactivation during chanting, while post-task dynamics require further study.

3.3 | Emotional Regulation Network Modulation

Insula activation and modified amygdala responses across multiple studies suggest that chanting influences emotional processing networks. The insula, a region associated with emotion and bodily awareness, was activated during chanting tasks, indicating that vocal repetition may heighten emotional and physiological awareness. Gao et al. (2020) found increased hemodynamic activity during spiritual chanting in several emotion-related regions, including the amygdala, thalamus, parahippocampus, and cerebellum, particularly in response to fearful versus neutral stimuli. Further, subcortical activation in the thalamus, amygdala, brainstem, and cerebellum was stronger during religious/spiritual chanting than during non-religious chanting, suggesting deeper affective processing when practices are imbued with meaning or belief. This is aligned with previous chanting research showing that greater devotion is associated with cognitive benefits and altered states of consciousness (Perry et al. 2021, 2022). These findings suggest that personal belief may amplify the neurophysiological impact of chanting.

In addition to task-related activation, structural and resting-state findings also support chanting's role in emotional modulation. Voxel-based morphometry (VBM) revealed rightward asymmetry in the temporal lobe, limbic system, and cerebellum among experienced spiritual chanters (Gao et al. 2020). This could reflect long-term structural changes related to emotional processing.

Lastly, Avvenuti et al. (2020) reported increased resting-state functional connectivity between the posterior cingulate cortex (PCC) and right insula following a transcendental meditation (TM) intervention, along with enhanced connectivity in DMN regions (PCC, precuneus, and left superior parietal lobule) associated with positive psychological outcomes. Together, these findings suggest that chanting engages a network of regions associated with emotional salience and interoceptive monitoring. These activations may contribute to improved emotional self-regulation and psychological well-being, particularly when practices are performed with spiritual or personal significance.

3.4 | Theta Activity and Emotional Regulation

Increased theta activity, often associated with relaxation, emotional stability, and reduced reactivity, was observed across multiple EEG studies during and following chanting practices. Harne and Hiwale (2018) reported elevated theta power after Om chanting, Kang et al. (2018) found a progressive increase in theta and delta power during an 8-week transcendental meditation (TM) program, and Thomas et al. (2014) observed greater theta activity in novice practitioners during mantra meditation. Increased theta activity indicates that chanting may facilitate relaxation and reduced emotional reactivity (Aftanas and Golocheikine 2001; Lagopoulos et al. 2009).

3.5 | Applications and Future Research

While the current review focused on studies with healthy participants, and clinical efficacy was not systematically reviewed, the observed modulation of emotional regulation networks, including the amygdala and insula, may have potential relevance for future research to examine chanting and emotion. Indeed, research has found chanting to decrease symptoms of depression (Anjana et al. 2022; Wolf and Abell 2003), PTSD (Bormann et al. 2014), stress and anxiety (Perry et al. 2023). While our systematic review did not aim to exclude clinical populations, most studies (19 out of 24) involved healthy participants, while fewer (five out of 24) focused on clinical populations (PTSD, mild depression). This highlights the need for further research to determine whether the neural changes observed in healthy individuals also occur in clinical groups, particularly given the involvement of regions such as the amygdala and insula in conditions like anxiety and depression.

Additionally, DMN hyperactivity is implicated in depression, particularly increased self-referential thinking and rumination. The consistent DMN suppression observed across chanting studies (Berkovich-Ohana et al. 2015; Kalyani et al. 2011; Rao et al. 2018) while engaging attention networks provides a potential for the use of chanting as an intervention for depressive symptoms. Khalsa et al. (2009) demonstrated benefits in participants with mild depression, showing increased right temporal lobe and posterior cingulate activity during Kundalini meditation. Further, the enhanced emotional regulation through modified amygdala-prefrontal connectivity (Gao et al. 2020; Rao et al. 2018) and altered emotional processing (Gao et al. 2017) showing reduced late processing potentials to negative stimuli could complement traditional treatments for mood disorders.

3.6 | Limitations

The studies included in this review show methodological diversity in design, participant characteristics, and neuroimaging techniques. While many employ small sample sizes, this reflects the current stage of research in the field. Collectively, these studies nonetheless offer valuable insights into emerging neural patterns associated with chanting. The prevalence of small samples across reviewed studies raises concerns about effect size estimation and replicability. Single-case studies (Engström and Söderfeldt 2010; Gao et al. 2019; Sovilj et al. 2019) provided detailed observations but limited generalizability. Even larger studies rarely exceeded 30 participants, with the largest being Ventura et al. (2024) with 85 participants. Many studies lacked power calculations (as noted in quality assessments), suggesting potential Type II errors or inflated effect sizes.

Further, the diversity in control conditions, chanting styles, participant experience, and outcome measures prevented the potential for a meta-analysis. For example, control conditions ranged from simple rest (Kalyani et al. 2011) to active controls like verbal fluency tasks (Berkovich-Ohana et al. 2015) to secular speech conditions (Gao et al. 2017; Perez-Diaz et al. 2023). Participant experience also varied, from novices (Bhargav et al. 2016; Harne and Hiwale 2018) to experienced chanting practitioners (Gao et al. 2017; Shimomura et al. 2008).

Future studies could aim for greater standardization in experimental protocols, including the use of control conditions, randomized control trials, and larger, more diverse sample sizes to increase the robustness of findings. Additionally, integrating multimodal imaging approaches, such as combining EEG and fMRI, could provide a more comprehensive understanding of the temporal and spatial dynamics of neural activity during chanting.

Lastly, neural responses attributed to chanting may be influenced by a range of factors such as vocalization, respiratory coupling, auditory feedback, and spiritual aspects of the practice. Such variables are difficult to isolate without compromising ecological validity. It is, however, important to note that familiarity and semantic matching are field-level challenges when designing control conditions for chanting. Experienced practitioners may carry strong associations, embodied habits, and intention-driven engagement with their chanting practices. These factors may introduce expectancy and emotional responses that cannot be fully matched by neutral stimuli. Future studies could compare vocal versus silent chanting conditions or employ control tasks that are matched on selected variables.

4 | Concluding Remarks

This review demonstrates that chanting engages distinct neural networks modulating attention, emotion, and self-referential processing. Activation of the prefrontal cortex, insula, and cingulate gyrus across studies suggests that chanting, whether silent or vocal, may facilitate states of focused attention and emotional stability, similar to the neurological effects observed in other meditative practices. Additionally, the deactivation of regions such as the DMN during chanting indicates a reduction in self-referential thoughts and mind-wandering. However, these conclusions must be interpreted in relation to the underlying study designs, sample sizes, and analytic rigor. Much of the available evidence is derived from small, exploratory studies with heterogeneous methods and variable use of control conditions. As a result, findings remain preliminary and require replication in larger, more rigorously designed investigations.

Beyond its cultural and spiritual roots, chanting represents a promising non-pharmacological intervention with potential applications in mental health. Given the neural engagement observed in areas related to emotional regulation, chanting practices could be examined further in future research for their potential in managing conditions such as anxiety, depression, and PTSD. Examining the neural mechanisms of chanting provides a foundation for future research to develop targeted, evidence-based chanting practices to support psychological well-being across diverse populations.

Author Contributions

Gemma Perry: conceptualization, writing – original draft, methodology, validation, writing – review and editing, investigation. **Lee Wolff:** data curation, validation, writing – review and editing. **Nicholas Powers:** data curation, validation, writing – review and editing. **William Forde Thompson:** funding acquisition, supervision, writing – review and editing. **Oliver Baumann:** conceptualization, methodology, validation, supervision, writing – review and editing.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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