Title:
The Neural Impacts of Sanskrit and Vedic Learning

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ABSTRACT:
This study investigates how learning and chanting Sanskrit hymns and Vedic scriptures may influence brain structure and neurobehavioral functioning in individuals with Autism Spectrum Disorder (ASD), using a systematic review and an observational parent survey. A systematic literature review (using PubMed, Google Scholar, and NIH) synthesized findings from 16 peer-reviewed studies spanning: (i) direct Sanskrit/Vedic chanting in highly trained non-autistic priests and scholars, and (ii) interventions in autistic populations involving Vedic chants, music, rhythm-based activities, or pragmatic language therapy. In non-ASD experts, long-term Sanskrit/Vedic chanting has been associated with increased grey and white matter density, greater cortical thickness, and altered gyrification in temporal, orbitofrontal, and memory-related regions, alongside enhanced verbal memory. In autistic populations, Vedic chant programs and related rhythm- and language-based interventions have been reported to reduce anxiety and hyperactivity; improve attention, social communication, and motor coordination; and support behavioral regulation, consistent with broader literature on language learning, bilingual exposure, and neuroplasticity in ASD. To examine real-world relevance, an observational survey was administered to parents of 18 autistic children and adolescents (5–18+ years) engaged in regular Sanskrit/Vedic chanting. Parents provided retrospective before-and-after ratings across 13 health-related aspects; average scores increased across all domains, with the most notable perceived improvements in attention/focus, memory, mood, reduced anxiety/stress, and growth/adaptability. Correlational analyses suggested that greater weekly engagement and longer exposure duration were moderately associated with more favorable cognitive, emotional, and autonomic outcomes. Converging evidence from prior studies and parent-reported data suggests that the phonetic, rhythmic, and prosodic features of Sanskrit/Vedic chanting may support neuroplastic, cognitive, and emotional functioning in ASD, tentatively positioning it as a promising, low-cost, culturally rooted therapeutic candidate. However, findings are preliminary due to small,

heterogeneous samples, reliance on parent-reported outcomes, and limited ASD-specific neuroimaging, underscoring the need for controlled, longitudinal, mechanistic research.

LITERATURE REVIEW SECTION:

1. Autism Spectrum Disorder (ASD) and Brain Differences

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition increasingly prevalent worldwide, characterized by deficits in social interaction and communication and by restricted and repetitive behaviors (Hodges, 2020). ASD occurs across all racial, ethnic, and economic groups but is diagnosed more frequently in some populations – for example, Caucasian children are more likely to receive a diagnosis than black or Hispanic children – and is more commonly identified in males. In females, autism is often underdiagnosed because symptoms may be less overt or “camouflaged” through masking (Hodges, 2020). Although both genetic and environmental influences on brain development are implicated, the precise etiology of ASD remains unclear.

Neuroimaging studies show that ASD affects multiple brain systems. Cerebellar abnormalities, including reduced vermis size and decreased cerebellar grey matter volume, have been observed, and lobular cerebellar grey matter volume is often inversely related to the severity of social and communication symptoms (Bloomer, 2022). Altered cerebellar structure and reduced functional connectivity with other regions are associated with motor deficits and impaired social interaction in ASD.

Abnormalities are also found within limbic and motor networks. During emotional language processing, individuals with ASD show reduced activation in limbic structures and motor regions such as the cingulate cortex, particularly when processing emotional words (Moseley, 2015). The extent of hypoactivation relates to symptom severity (e.g., Autism Spectrum Quotient scores), suggesting that diminished engagement of these circuits contributes to the emotional and social difficulties characteristic of ASD. Overall, fMRI and MRI findings indicate that ASD is associated with widespread alterations in neural connectivity, but the great heterogeneity of the spectrum makes it difficult to generalize specific neural patterns to all autistic individuals.

At the molecular level, genes involved in brain development, neurotransmission, and synaptic function contribute to ASD risk, often through effects on proteins at the synapse or through broader neuronal changes (Hodges, 2020). Clinically, ASD is accompanied by a multitude of other physical and medical disorders, including gastrointestinal problems, sleep disturbances, obesity, seizures and epilepsy, anxiety, ADHD, and mood and obsessive–compulsive symptoms (Hodges, 2020). Risk is further influenced by parental and perinatal factors such as late maternal age or maternal health complications, which are associated with prematurity and increased likelihood of ASD (Hodges, 2020).

Given that ASD fundamentally alters both brain structure and function, language and communication – which depend heavily on these systems – are particularly affected.

2. Language and Bilingualism in ASD

Language and social communication delays are often among the earliest signs of ASD, although the presentation is highly variable. Language abilities span a broad continuum, from nonverbal status to idiosyncratic, overly literal, or excessively verbose speech with unusual tone, prosody, and inflection (Mody, 2013). Because minimally verbal or nonverbal children are challenging to assess, they have often been underrepresented or excluded from research.

Early developmental differences in ASD include impairments in joint attention, receptive language, and early vocal output. Whereas typically developing toddlers begin to combine words into phrases, many children with ASD show delayed or atypical phrase speech. Language usage may also be highly context-dependent, with some children able to use words in specific settings but unable to communicate effectively across situations. Verbal children on the spectrum generally produce speech sounds accurately but tend to speak less in social contexts and display atypical pragmatic use of language, suggesting that social motivation and cognition strongly influence linguistic behavior (Mody, 2013).

The potential “bilingual advantage” is particularly relevant to ASD. In typically-developing populations, speaking more than one language has sometimes been associated with better executive functions, including cognitive flexibility, inhibitory control, and working memory. However, findings are mixed, and the extent of any advantage depends on multiple factors. In ASD, executive function is often impaired, with difficulties in flexibility and inhibition manifesting as repetitive and restricted behaviors. This has led many caregivers to worry that bilingual exposure might further burden autistic children.

Recent evidence, however, suggests that bilingualism does not harm, and may even support, language and cognitive outcomes in ASD. Studies show that autistic children raised in bilingual households can learn a second language – even when intellectual disability is present – and often achieve language skills comparable to or better than those of monolingual autistic peers (Romero, 2021). Some work suggests advantages in vocabulary, nonverbal intelligence, and aspects of executive function among bilingual children with ASD. Overall, current research does not support restricting bilingual exposure for autistic children and instead points to the potential cognitive benefits of rich language environments.

These findings link language experience, cognition, and brain function, which are all fundamentally shaped by neuroplasticity.

3. Neuroplasticity and Brain Development (General and in ASD)

Neuroplasticity, first described conceptually by William James and later formalized by Jerzy Konorski, refers to the brain’s capacity to reorganize its structure and function in response to experience and environmental factors (Marzola, 2023). Plastic changes occur at multiple levels – molecular, synaptic, circuit, and behavioral – and underlie learning, memory, higher-order cognition, and recovery from brain injury (Kolb, 2011). Key processes include changes in synaptic strength, formation and elimination of synapses, neurogenesis, neural migration and maturation, synaptic pruning, and myelination, all modulated by internal factors (e.g., hormones and growth factors) and external experiences (e.g., stress, enrichment, or substance use) (Marzola, 2023; Kolb, 2011).

Two broad forms of neuroplasticity are often distinguished. Structural plasticity involves physical changes in the brain – such as adult neurogenesis and dendritic remodeling – while functional plasticity refers to rapid changes in neural network activity, including long-term potentiation (LTP), long-term depression (LTD), and cortical reorganization (Marzola, 2023). Plasticity can also be classified as experience-expectant, in which an early overproduction of synapses is followed by pruning based on typical environmental input, and experience-dependent, in which synapses are formed or eliminated throughout life in response to specific experiences and learning (Kolb, 2011).

Neuroplasticity is especially robust during perinatal and early childhood periods, when multiple "windows of opportunity" allow the developing brain to be shaped by environmental stimuli. With age, plasticity becomes more constrained and context-dependent, yet meaningful change remains possible across the lifespan (Marzola, 2023). Importantly, plasticity can be adaptive or maladaptive: enriched, stimulating environments promote increased brain size, cortical thickness, and synaptic density, whereas early adversity, chronic stress, or harmful habits (e.g., substance use) can lead to detrimental reorganization (Marzola, 2023).

In ASD, neuroplasticity mechanisms appear to be altered. For example, expression of genes such as NCAM1 and higher levels of brain-derived neurotrophic factor (BDNF) have been linked to motor skills and atypical synaptic function in autistic children (Garcia, 2025). Imbalances between Hebbian plasticity (which strengthens synapses based on coincident activity) and homeostatic plasticity (which stabilizes network activity) are thought to contribute to the abnormal connectivity and network instability characteristic of ASD (Garcia, 2025). While structural neuroplastic changes in autistic brains are increasingly studied, findings remain highly heterogeneous due to the wide intellectual and clinical diversity within the spectrum, making it difficult to draw broad conclusions.

Because neuroplasticity can be shaped by cognitive experiences, language learning has emerged as a particularly powerful, non-pharmaceutical way to induce beneficial plastic changes.

4. Effect of Language Learning on the Brain

Learning a foreign language is a cognitively demanding activity that recruits multiple neural networks involved in memory, attention, auditory and speech processing, and cognitive control (Klimova, 2018). As a result, foreign language learning has been proposed as a non-pharmacological intervention to enhance neuroplasticity, support cognitive function, and potentially delay cognitive decline. Unlike many medical treatments, language learning has minimal side effects and is relatively accessible.

Short- and long-term language learning can induce both structural and functional brain changes. Studies show increases in grey and white matter density, especially in frontal regions and language-related pathways, and improvements in functional connectivity between language and control networks (Klimova, 2018; Bubbico, 2019). Notably, significant changes have been observed in the corpus callosum, suggesting a shift from a predominantly left-hemisphere language system to a more bilateral network, with the right hemisphere showing unexpected neuroplastic adaptations (Klimova, 2018). These changes are associated with improved cognitive abilities, including attentional control and mental flexibility, and may contribute to a form of "cognitive reserve" that helps protect against conditions such as dementia.

While age can influence the rate and effort required for language acquisition, the duration and intensity of exposure appear to be more critical for driving structural changes than age alone (Klimova, 2018). Older adults may learn more slowly, but they often have high motivation and can still benefit from language-induced neuroplasticity. Overall, learning additional languages keeps individuals cognitively engaged, supports mental flexibility, and can help delay cognitive decline, making it a promising activity for individuals across the lifespan.

Beyond modern foreign languages, certain traditional linguistic practices – such as Sanskrit and Vedic chanting – may provide a particularly structured, rhythmic form of language input with unique cognitive and emotional effects.

5. Unique Features of Sanskrit and Vedic Learning

Sanskrit, an ancient Indian language often described as a "mother language," is central to many religious, philosophical, scientific, and literary traditions. Vedic scriptures, among the world's oldest texts and composed in Sanskrit, are considered to encode fundamental principles of existence and are believed to have been intuited by sages in deep meditative states (Yadav, 2023).

A defining feature of Vedic and Sanskrit practice is the emphasis on precise pronunciation, rhythm, and memorization. Many texts, including the Upanishads, are chanted in specific melodic and metrical patterns that are considered inseparable from their meaning and efficacy. Proponents argue that the syllabic sound vibrations of Sanskrit mantras have a healing and balancing effect, promoting concentration, reducing stress and anxiety, and fostering feelings of peace and spiritual connection (Yadav, 2023). Because chanting demands sustained, one-pointed focus and involves rhythmic repetition, it may act as both a meditative and cognitive training practice.

As interest grows in integrating ancient Indian knowledge systems into modern health and education, Sanskrit/Vedic learning is increasingly being explored for its potential contributions to mental well-being, harmony with nature, and sustainable development (Yadav, 2023).

These theoretical claims are supported by a small but growing body of empirical research on Sanskrit and Vedic learning in neurotypical populations.

6. Previous Research on Sanskrit/Vedic Learning

Existing empirical studies on Vedic chants and Indian classical music, though limited, suggest measurable physiological and neural effects. Listening to Vedic chants and slow, calming Indian instrumental music has been associated with significant reductions in anxiety, decreases in systolic and diastolic blood pressure, lower heart and respiratory rates, and increased oxygen saturation (SpO_2) (Sharma, 2017). Faster, more stimulating music can produce the opposite pattern. These effects are thought to involve neurochemical changes and engagement of mesocorticolimbic pathways, linking auditory input to hormonal and emotional responses (Sharma, 2017).

Structural MRI studies of Vedic priests and scholars – who undergo intensive, long-term training in memorizing and chanting Sanskrit texts – have identified cortical thickening in regions such as the left orbitofrontal cortex and right inferior temporal gyrus, as well as other areas involved in verbal encoding and controlled, context-dependent retrieval (Kalamangalam, 2014). These changes appear to result from the demands of prolonged memorization and precise recitation, rather than from innate "priestly talent." Right temporal lobe mechanisms are particularly engaged in the semantic memory of Vedic material, likely influenced by the melody and meter of the chants, and cognitive abilities such as memorization are enhanced (Kalamangalam, 2014).

Taken together, these findings suggest that Indian music and Sanskrit mantras may serve as low-risk, low-cost therapeutic tools, offering psychological and physiological calming and promoting beneficial neuroplastic changes (Sharma, 2017). However, most existing work has been conducted in neurotypical adults, and systematic research on their effects in autistic populations is scarce.

7. Research Gaps and Purpose of This Review

Despite growing interest, there is still little thorough research on how Sanskrit chanting and Vedic learning affect cognition, behavior, and brain structure in autism. Most prior studies have focused on neurotypical individuals or have examined related but broader topics (e.g., general music therapy, foreign language learning, or neuroplasticity in ASD) using small samples and primarily cross-sectional designs. Consequently, the evidence base is limited, and it is difficult to determine whether the specific combination of rhythmic, phonetic, and memorization demands in Sanskrit chanting might uniquely support autistic brains, which often differ in connectivity, language processing, and sensory experience.

This review aims to synthesize existing findings on the mental, structural, and functional impacts of Sanskrit and Vedic practices, drawing on literature about ASD, language learning, and neuroplasticity. By integrating these strands of research, the review seeks to clarify what is currently known, identify key gaps, and explore the potential of Sanskrit and Vedic learning as a complementary, non-pharmacological intervention for individuals with ASD.

All referenced studies with their key findings are listed in Supplementary Table 1.

SOURCES SUMMARY TABLE (SUPPLEMENTARY TABLE 1):

Paper	Author and Year	Participants	Effects
Vedic Chants Intervention in Children with Autism	Badhe, 2023	Children with ASD exposed to structured Vedic chant programs	• Reported improvements in behavior and cognitive function • Reductions in hyperactivity and harmful behaviors, and more positive effects
The Potential Role of Rhythmic Entrainment and Music Therapy Intervention for Individuals with Autism Spectrum Disorders	Bharathi, 2019	Narrative review of existing studies on individuals with autism spectrum disorder (no new sample); focuses on children with ASD with motor, oral-motor, and social-communication difficulties	• Rhythm and music-based interventions can improve oral-motor skills, attention, and sensorimotor regulation in ASD • Rhythmic entrainment and neurologic music therapy may enhance cortical plasticity, motor control, and social-communication outcomes in ASD, but high-quality

			controlled trials remain limited
Cerebellar Structure and Function in Autism Spectrum Disorder	Bloomer, 2022	Review article (no new participants); synthesizes findings across human neuroimaging, lesion/preterm infant studies, postmortem work, and mouse models relevant to ASD	• Cerebellar abnormalities (e.g., vermis/Crus I–II volume differences, Purkinje-cell related findings) are linked to core ASD symptoms • Cerebellar-prefrontal connectivity differences are highlighted as a mechanism for social-cognitive difficulties • Early cerebellar injury/developmental disruption is associated with higher ASD risk and altered developmental trajectories • In animal models, cerebellar circuit manipulations can shift social and repetitive behaviors, supporting a causal role
Communication Interventions for Autism Spectrum Disorder in Minimally Verbal Children	Brignell, 2018	Systematic review of 2 RCTs, total N = 154 minimally verbal children with ASD (ages 32 months–11 years); one trial of a verbally based parent-implemented intervention (FPI, 70 children), one trial of an AAC intervention (PECS, 84 children)	• FPI: No overall significant improvement in expressive spoken language post-intervention; some gains only in children with very low baseline expressive language • PECS: Increased PECS use and verbal/non-verbal initiations immediately post-intervention, but effects were not maintained at 10-month follow-up • No clear improvement in expressive vocabulary, speech frequency, or social/pragmatic communication • Overall evidence rated very low quality; limited and short-lived benefits
Impact of Learning a Foreign Language on Cognition and Brain	Bubbico, 2019	Review of human learners acquiring a foreign/second language	• Foreign language learning is associated with increased grey/white matter and improved connectivity • Often enhances executive functions and is considered neuroprotective
The Neurochemistry of Music	Chanda, 2013	Narrative review of existing research; synthesizes data from various human and animal studies	• Modulates dopamine and opioids to drive reward, pleasure, and motivation • Lowers cortisol and stress hormones to regulate arousal and anxiety • Influences oxytocin to promote

			social bonding, trust, and group affiliation • Boosts immune markers and antibody production to support physical health
Rhythm-Based Interventions for ASD	Ding, 2024	Children with ASD in rhythm-based therapies	• Rhythm interventions produced large effects on social interaction and emotion • Improved neural and interbrain synchronization
Neuroplasticity in Autism Spectrum Disorder	Garcia, 2025	Review of genetic, molecular, and imaging studies in ASD	• ASD involves imbalances in plasticity, leading to atypical connectivity • Experience-dependent interventions may help normalize circuits
Oxytocin Improves Synchronization in Leader-Follower Interaction	Gebauer, 2016	Human dyads (leader-follower finger-tapping pairs) received intranasal oxytocin or placebo; then performed synchronization tasks with each other or with a metronome	• Oxytocin improved synchronization when following an unresponsive (self-paced) partner • Oxytocin reduced tapping variability in followers compared with placebo • No clear oxytocin effect on synchronizing with a metronome or when both partners mutually adapted
Autism Spectrum Disorder: Overview	Hodges, 2020	Review of epidemiologic and clinical data on ASD	• Defines ASD as a neurodevelopmental disorder with social communication deficits and restricted behaviors • Structural changes and altered connectivity relate to symptom severity
Cortical Thickening in Vedic Priests with Exceptional Memory	Kalamangalam, 2014	Vedic priests with intensive long-term memorization vs. matched non-priest controls	• Found focal cortical thickening in regions for verbal encoding/retrieval • Changes attributed to long-term memorization practice
“OM” Chanting and Brain Activity	Kalyani, 2011	Adults performing OM chanting, studied with fMRI	• OM chanting produced vagus nerve stimulation and deactivation in emotional/autonomic circuits • Resembled a relaxed resting state
Second Language Learning and Neuroplasticity	Klimova, 2018	Review of human studies on second-language acquisition	• Second language learning induces neurogenesis and synaptic modifications • Duration/intensity predicts structural changes and

			strengthens attention and working memory
Neuroplasticity (General Mechanisms)	Kolb, 2011	Conceptual review of plasticity	• Explains how LTP, LTD, pruning, and circuit remodeling support learning and memory • Enriched environments and training increase cortical thickness and synaptic density
Extensive Long-Term Verbal Memory Training is Associated with Brain Plasticity (Vedic Pandits)	Kumar, 2021	25 professional Vedic pandits vs. 25 matched controls	• Pandits showed increased grey and white matter density in various brain regions • Long-term Vedic recitation was linked to structural plasticity and improved verbal memory
Exploring the Role of Neuroplasticity in Development, Aging, and Neurodegeneration	Marzola, 2023	Narrative review (synthesizes animal and human data)	• Neuroplasticity is lifelong and can be modulated by experience • Disrupted plasticity contributes to neurodevelopmental and neurodegenerative conditions
Language in Autism Spectrum Disorder	Mody, 2013	Review of language development and profiles in children with ASD	• Language abilities range from nonverbal to highly verbal with atypical prosody/pragmatics • Early delays in joint attention and receptive language are common
Lost for Emotion Words: What Motor and Limbic Brain Activity Reveals About Autism and Semantic Theory	Moseley, 2015	18 high-functioning adults with ASC vs. 18 matched controls; right-handed, native English speakers; fMRI during passive reading of emotion words, abstract verbs, and animal names	• ASC: reduced activation to emotion words in motor cortex and cingulate/limbic areas • No comparable reduction for abstract verbs or animal names • In ASC, lower motor activation to emotion words correlated with more autistic traits (higher AQ)
Pragmatic Language Interventions in ASD	Parsons, 2017	Meta-analysis/systematic review of pragmatic language interventions in ASD	• Structured pragmatic language interventions improved social communication and related skills • Heterogeneous but often meaningful effect sizes
Bilingualism in Autism Spectrum Disorder	Romero, 2021	Children with ASD in bilingual vs. monolingual environments	• Bilingual exposure does not always harm language in ASD and can yield equal or better outcomes • Some evidence for better executive function in bilingual ASD groups
Effect of Listening to Vedic Chants and Indian Instrumental Music	Sharma, 2017	Human participants (non-ASD) exposed to Vedic chants vs. Indian	• Listening to Vedic chants reduced state anxiety and lowered blood pressure/heart

		instrumental classical music	rate • Supports chants as a low-risk adjunct for stress reduction
Importance of Sanskrit Mantras and Ancient Indian Knowledge Systems	Yadav, 2023	Conceptual/essay	• Sanskrit mantras' sound vibrations are proposed to promote concentration and reduce stress • Stresses the importance of correct pronunciation, rhythm, and memorization

METHODOLOGY:
This study is a narrative review of existing literature (combined with an observational parent survey) examining the effects of learning Sanskrit hymns and Vedic scriptures on brain structure and development, with a particular focus on individuals with Autism Spectrum Disorder (ASD). To identify relevant studies, an online search was conducted using predefined keyword combinations grouped into diagnostic, outcome, interventional, and neuroscientific categories (Table 1).

Search Strategy

Table 1. Keyword Categories Used in the Literature Search

Diagnostic Terms	Outcome Terms	Interventional Terms	Neuroscientific Terms
Autism ASD Autistic	Language Brain development	Sanskrit and Vedic learning Listening Language Rhythm Music	Brain development Neuroplasticity Structure Function

Searches were primarily performed in PubMed and Google Scholar. Most articles were retrieved from the National Institutes of Health (NIH) database or other reputable, peer-reviewed journals. No strict limits were placed on publication year, given the emerging nature of this topic; instead, studies were selected based on conceptual and methodological relevance to the following domains:

- Sanskrit and Vedic chanting or learning
- Language learning and bilingualism
- Neuroplasticity and brain development
- Cognitive and neural aspects of ASD

Titles and abstracts were screened for relevance, and full texts were reviewed when studies appeared to address at least one of these domains. Detailed notes were taken for each included article, summarizing main findings and identifying conceptual links across studies (for example, connections between neuroplasticity, language experience, and Sanskrit/Vedic practices).

Studies were excluded if they:

- Were books, commentaries, or purely philosophical/theological texts without empirical data; or
- Focused solely on peripheral or bodily effects of music or language (e.g., heart rate and blood pressure) without addressing neural or cognitive outcomes.

Given the relative novelty of this field, empirical research directly examining Sanskrit/Vedic learning in ASD is limited. Many available studies use small samples, cross-sectional designs, or heterogeneous methods and outcome measures, which constrains direct comparison and supports the choice of a narrative rather than strictly systematic review.

Survey Component

To supplement the limited published evidence, an online observational survey (Google Forms) was distributed to parents/guardians of children diagnosed with autism or other neurodevelopmental disorders at a school for neurodiverse students. The survey collected parent-reported observations on the perceived effects of Sanskrit exposure (listening to or chanting Sanskrit hymns) across multiple functional domains.

Parents rated their child before and after regular exposure to Sanskrit chanting on 13 health-related aspects (attention/focus, memory, mood, anxiety/stress levels, sleep quality, sensory sensitivities, motor skills, social skills, learning engagement, growth/adaptability, problem-solving skills, overall brain health, and overall well-being) using Likert-type scales. Each item also included an “N/A” option so that parents could indicate when a particular domain was not applicable or could not be rated. Because “N/A” is a non-numerical response, any before–after pair in which either the pre- or post-exposure score was marked as N/A was excluded from the quantitative calculations for that aspect.

For the main quantitative analysis, only paired observations – cases where both pre- and post-exposure ratings were available and numeric for a given aspect – were included. For each aspect, the following were calculated based on these complete pairs:

- Mean “before” score
- Mean “after” score
- Mean change score (delta = after – before)
- Number of valid pairs (N_pairs) (e.g., Attention/Focus: N = 16, Mood: N = 17, etc.)

These values were summarized in a table of average scores before and after exposure to Sanskrit chanting across health aspects. All delta calculations and domain-level summaries were therefore based exclusively on these paired, non-missing pre- and post-exposure observations.

To highlight which functional areas showed the greatest average change, the 13 aspects were then grouped into broader neurofunctional domains (cognitive, emotional, social, motor, sensory, autonomic, and general), and a treemap visualization was created to display the distribution of average delta scores across these domains. In this treemap, the size of each block reflected the magnitude of average change for that subdomain, and color coding distinguished the broader domain categories.

To explore whether age and expressive language level influenced outcomes, participants were also grouped by age range (3–5, 6–10, 11–15, and 16+) and comprehension/vocabulary level (full comprehension, under 50 words, and under 20 words). For each age–comprehension pair, the average post-exposure score and average delta score were calculated and summarized in a table. This allowed comparison of score changes across developmental stages and language abilities, while acknowledging that several pairs had small sample sizes.

Next, correlational analyses were performed at the participant level to examine relationships between key characteristics and outcomes. Characteristics included:

- Engagement per week (frequency of Sanskrit exposure)
- Total duration of exposure
- Presence of an intellectual/developmental disability (IDD) diagnosis
- Verbal ability (coded as an ordinal variable)
- History of therapy (e.g., receiving other therapeutic services)

For each participant, an overall delta score and an overall post-exposure score were computed (by aggregating across aspects), and Pearson correlation coefficients were calculated between these outcome measures and each characteristic. These results were summarized in a correlation table showing associations with both change scores and post-exposure scores.

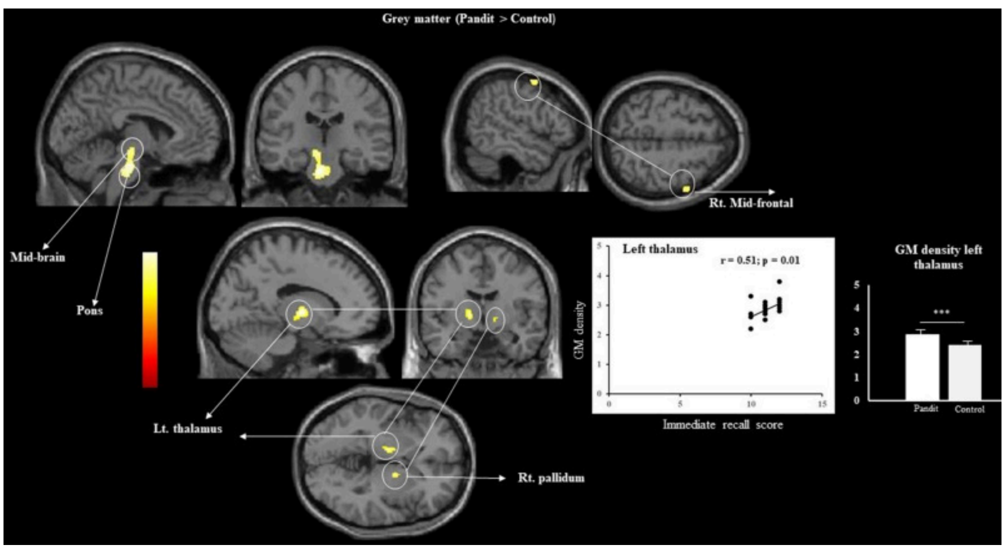
To investigate domain-specific patterns, additional correlation matrices were generated by neurofunctional domain (cognitive, social, language/auditory, emotional, autonomic, sensory, and motor). The language/auditory domain, previously not included in analysis of average change in these domains, only consisted of after scores because it solely applied to open-response questions addressing the effects experienced by children post-exposure to Sanskrit/Vedic chants. For each domain, average correlations between the three main characteristics (exposure duration, engagement per week, and verbal ability) and post-exposure or delta scores were computed. These data were visualized using clustered bar charts, allowing comparison of how strongly each characteristic related to outcomes within each domain.

Open-ended, qualitative responses were analyzed using a simple coding and scoring procedure. Each comment was coded into one or more of the following neurodomains: executive function, speech motor planning, social cognition, autonomic regulation, language acquisition, cognitive processing, emotional regulation, cognitive flexibility, and motor coordination. Frequencies of mentions per domain were tabulated, and representative quotes from parents were selected to illustrate each category. A Parent Perceived Impact Score (PPIS) was also calculated for each participant from the parents' perceived impacts. The maximum PPIS value possible was 12, as Questions 1 and 3 (addressing positive effects and overall benefits of the intervention) had score ranges from 0–5, with 0 being no effect/benefit and 5 signifying profound impact; Question 2 (regarding negative impacts) ranged from 0–3, with 0 being no effect and 3 being significant distress; and Question 5 (asking parents whether Sanskrit should be further studied as a potential intervention for ASD) had a score range from 0–2, with 0 being "No," 1 being "Unsure," and 2 being "Yes." PPIS values were plotted against the number of neurodomains mentioned in a bubble chart, where the *x*-axis represented PPIS, the *y*-axis represented the breadth of domains, and bubble size reflected the number of participants at each combination. This visualization was used to examine whether higher perceived impact was associated with a wider range of reported benefits.

All survey data were entered into a spreadsheet and analyzed using basic descriptive statistics (e.g., means, deltas, and correlations). Charts and visualizations (e.g., treemaps, clustered bar charts, and bubble charts) were created using spreadsheet tools and data visualization software (e.g., Power BI) to facilitate interpretation of patterns across domains, characteristics, and participants.

RESULTS:
Literature Review

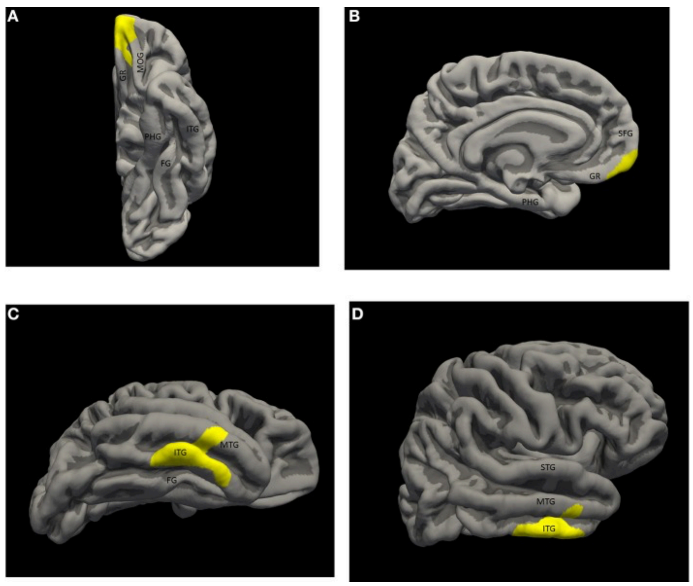
Engagement with Sanskrit and Vedic chants has been shown to be strongly associated with cognitive and structural brain differences in neurotypical individuals. In a study by Kumar et al., immediate recall performance among Hindu pandits and priests extensively trained in Sanskrit and Vedic chanting was found to be exceptional, with a mean score of 11.16 ± 0.68 on the PGI (Post Graduate Institute) memory scale. This enhanced performance was accompanied by increased grey matter volume in brain regions such as the midbrain, the pons, the left angular gyrus, and the left thalamus, with additional grey matter increases reported in other areas. A pictorial representation of these measures, compared to a control group, is shown in Supplementary Figure 1.



Supplementary Figure 1. Grey Matter Density for Pandits/Priests versus Control Group. "Results of VBM Group Comparison. The Result Rendered into Standard Stereotactic Space and Superimposed on to Transverse, Sagittal, and Coronal Section of Magnetic Resonance Image (MRI) Which is Itself in Standard Space. The Image Shows Increased GM Value in Pandit/Priest as a Result of the Two-Sample T-Test Comparing with the Control, at a Threshold of P < 0.05 (FWE) Corrected. The Figure also Specifies GM Density Differences in Two Group and Result of Correlation Analysis Between GM Density and Immediate Recall Behaviour Score."
(Increased grey matter was seen in the brains of priests compared to the control group, and there was a positive correlation between grey matter density and immediate recall score.)
Adapted from Kumar et al., 2021.

Cortical thickness was greater in the right temporal pole and right caudate, and increased gyrification was observed in the left insula, left supplementary motor area, and left superior medial frontal region. Higher white matter volume was also reported in the left parahippocampus, left superior orbitofrontal region, and right superior temporal pole.

Similarly, a study by Kalamangalam et al., focusing on Vedic priests with exceptional memorization training, found focal cortical thickening in regions involved in verbal encoding, controlled and context-dependent retrieval, and auditory processing (see Supplementary Figure 2). Significant increases in cortical thickness were reported in the left orbitofrontal cortex, as well as over the right inferior temporal gyrus and middle temporal gyrus. Right temporal lobe mechanisms involved in semantic memory for Vedic material were also affected. Across these studies, increased grey matter thickness was attributed to the demands of long-term memorization rather than chanting skill alone.



Supplementary Figure 2. Focal Cortical Thickening in Clusters for Vedic Priests. (Left hemisphere contains one cluster extending over the medial, ventral, and polar orbito-frontal cortex. Right hemisphere has a larger cluster in the middle inferior temporal neocortex, over the inferior temporal gyrus and sulcus, and part of the middle temporal gyrus.)
Adapted from Kalamangalam et al., 2014.

Other work has examined physiological and affective responses to Sanskrit-related practices. In a study by Kalyani et al., “OM” chanting was associated with vagus nerve stimulation via the auricular branch and bilateral deactivation patterns comparable to a resting brain state in several regions, including the bilateral orbitofrontal cortex, anterior cingulate, parahippocampal gyri, thalami, insula, hippocampi, and right amygdala. Limbic deactivation was also observed, suggesting a quieting of networks related to emotional arousal. In a study by Sharma et al., listening to Vedic chants was compared with Indian instrumental classical music. For participants exposed to Vedic chants, anxiety state scores decreased from 40.4 ± 8.9 to 38.5 ± 10.7 on standardized measures, indicating a measurable reduction in self-reported anxiety.

Although relatively few studies have specifically targeted autistic populations, related evidence from music, rhythm, and language-based interventions in ASD provides important context. In a study by Bharathi et al., engaging music and predictable rhythmic patterns were associated with improvements in oral-motor activities, social communication, motor skills, and attention in individuals with Autism Spectrum Disorder (ASD). Participants exposed to structured musical experiences showed increased verbal and gestural communication, greater social interest, and changes in outward behaviors, such as reduced repetitive pacing and decreased anxiety. At the neural level, listening to music was reported to activate motor-related brain regions and support sensorimotor integration, with rhythm engaging both sensory perception and motor entrainment. Prior work cited in this context indicates that music can modulate activity in the precentral gyrus, cerebellum, auditory cortex, and occipital areas; promote cortical plasticity; and enhance structural and functional connectivity, including activity in the ventral premotor cortex (Bharathi, 2019; Ding, 2024).

Pragmatic language interventions have also been studied in ASD. Parsons et al. examined interventions targeting pragmatic language, defined as the use of language in context and encompassing verbal, paralinguistic, nonverbal, social, emotional, and communicative aspects. Outcomes for individuals with ASD varied widely, with effect sizes ranging from 0.162 to 1.288; approximately 24% of participants showed large effects, 29% medium effects, and 29% relatively small effects. Pragmatic language, social skills, and emotional understanding were found to be closely interconnected, underscoring the complexity of communication-focused interventions in this population.

Rhythm-based interventions have been further investigated in a meta-analysis by Ding et al., which reported improvements in social behaviors and synchrony in children with ASD. In summary, interventions produced large effects on social interaction and emotion, smaller effects on communication, and very slight effects on empathy, with low heterogeneity for some outcomes. Sensorimotor and interbrain synchronization were reported to increase, and overall social skills showed medium effects (with high heterogeneity across studies). Rhythm presented with a clear external cue (such as a metronome) was associated with more synchronous behaviors, including aspects of intonation and pronunciation. Prior work cited in this context indicates that music can increase production of certain neuropeptides and support speech, motor, and language networks, as well as cortical reorganization and functional neuroplastic changes (Chanda, 2013; Gebauer, 2016).

More directly related to Vedic chanting and ASD, a study by Badhe et al. examined the effects of listening to Vedic chants in children with autism, even when the children did not understand the semantic content. Parents and observers reported improvements in behavioral patterns and cognitive functioning, along with changes suggestive of hormonal or endocrine modulation. Following exposure to Vedic chants, reductions in hyperactivity and harmful tendencies were noted, and many children were described as exhibiting more positive affect.

Taken together, these prior studies consistently report cognitive, emotional, and neural changes associated with Sanskrit/Vedic chanting and related rhythmic or musical interventions, in both neurotypical and autistic populations. These findings provided the empirical background and specific domains of interest (e.g., attention, memory, mood, social skills, and self-regulation) that guided the design of the present survey and the selection of outcome measures summarized in the subsequent survey results section.

Survey Component

Significant data were also collected from the survey itself, as summarized in Tables 2–5 and Figures 1–4.

Table 2. Average Scores Before and After Exposure to Sanskrit/Vedic Chanting Across Health Aspects

Aspect	Average of Before Scores	Average of After Scores	Average of Delta	N_pairs
Attention/Focus	2.44	3.50	1.06	16
Memory	3.06	4.13	1.06	16
Mood	2.53	3.41	0.88	17
Anxiety/Stress Levels	2.56	3.44	0.88	16
Sleep Quality	3.06	3.59	0.53	17
Sensory Sensitivities	2.53	3.24	0.71	17
Motor Skills	2.88	3.29	0.41	17
Social Skills	2.35	3.18	0.82	17
Learning Engagement	2.38	3.00	0.63	16
Growth and Adaptability	2.65	3.59	0.94	17
Problem-Solving Skills	2.53	3.12	0.59	17
Overall Brain Health	2.76	3.47	0.71	17
Overall Well-Being	2.88	3.56	0.69	16

Table 2. Average Scores Before and After Exposure to Sanskrit/Vedic Chanting Across Health Aspects. (Analysis restricted to only paired observations with both before and after scores.)

Table 2 summarizes the average scores across 13 health-related aspects before and after Sanskrit/Vedic intervention, along with the mean change (delta) and sample size for each measure. The greatest improvements were observed in Attention/Focus and Memory, both showing an average increase of 1.06 points. Emotional aspects such as Mood and Anxiety/Stress Levels also improved substantially (0.88 points each). Growth and adaptability also experienced an improvement by 0.94 points. Slighter gains were seen in Motor Skills (0.41) and Problem-Solving Skills (0.59). These results align with the broader trend observed in the treemap visualization (Figure 1), where cognitive and emotional domains dominated the overall delta distribution. *N_pairs* refers to the number of participants with both before and after exposure scores available for each aspect in the survey.

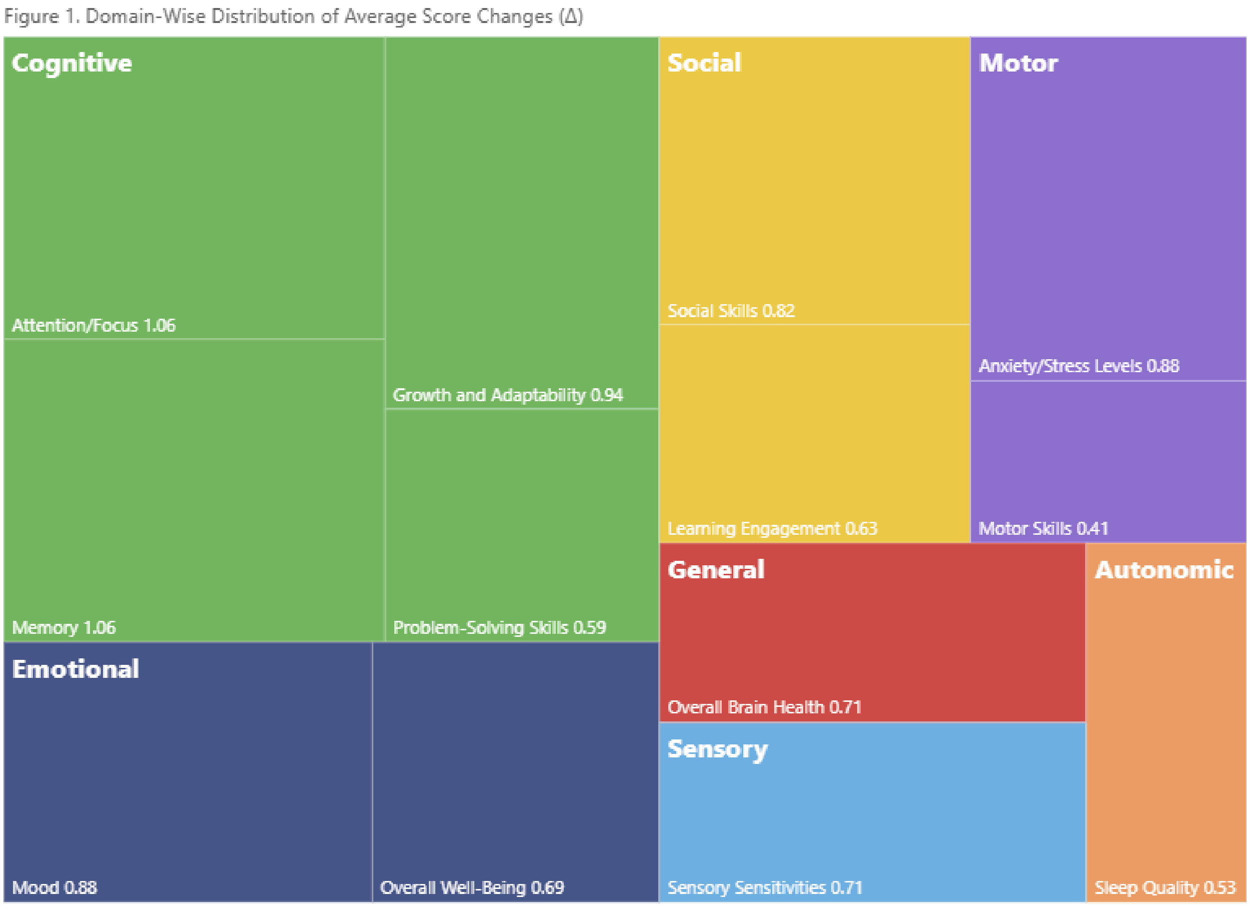


Figure 1. Domain-Wise Distribution of Average Score Changes (Δ). (Treemap visualization of average delta scores across cognitive, emotional, social, motor, sensory, autonomic, and general domains. Block size indicates magnitude of change; color coding distinguishes broad domain categories. Language/Auditory not included as a broad neurodomain in this mapping as it only encompasses after scores from additional reflection questions [considered in later figures and tables, such as Figure 2]. Subdomains include the various aspects of attention, memory, mood, sleep quality, and others.)

Figure 1 illustrates the distribution of average score changes across functional domains following exposure to Sanskrit and/or Vedic chanting. Cognitive subdomains – particularly attention/focus and memory – occupy the largest blocks, indicating pronounced improvements. Emotional and social domains also show meaningful gains, with mood and social skills contributing notably. In contrast, changes in sleep quality and motor skills are more modest. The treemap format emphasizes relative impact, suggesting that cognitive and emotional functions may be especially responsive to this intervention.

Table 3. Average Post-Exposure and Delta Scores by Age Group and Comprehension Level

Age Group	Verbal Ability	# Participants	Avg. Post-Exposure Scores	Avg. Delta Scores
11-15	Full comprehension	5	3.70	0.81
16+	Full comprehension	2	3.68	1.28
6-10	Full comprehension	4	3.58	0.52
11-15	Under 20 words	2	2.96	0.88
11-15	Under 50 words	3	3.11	0.68
3-5	Under 50 words	1	2.77	0.38

Table 3. Average Post-Exposure and Delta Scores by Age Group and Comprehension Level. (Analysis restricted to paired observations with both pre- and post-exposure scores. Comprehension levels reflect expressive vocabulary ranges; delta scores represent average change post-exposure to Sanskrit/Vedic chanting.)

Table 3 summarizes post-exposure scores and average score changes across age groups and comprehension levels. Participants with full comprehension consistently showed higher post-exposure scores (e.g., 3.70 for ages 11–15) and moderate improvements ($\Delta = 0.81$), while those with limited vocabulary (e.g., under 50 words) exhibited lower baseline scores and variable gains. Notably, the highest delta score ($\Delta = 1.28$) was observed in the 16+ age group with full comprehension, suggesting potential age-related responsiveness. However, small sample sizes (e.g., $n = 1$–3 in several cells) require cautious interpretation and highlight the tentative nature of these findings.

Table 4. Correlations Between Participant Characteristics and Outcome Scores

Variable	Correlation with Delta Scores	Correlation with Post-Exposure Scores
Engagement Per Week	0.32	0.32
Total Duration of Exposure	0.31	0.18
IDD Diagnosis	-0.03	-0.14
Verbal Ability	-0.04	0.33
Therapy	-0.35	-0.48

Table 4. Correlations Between Participant Characteristics and Outcome Scores. (Pearson correlation coefficients between participant-level variables, delta scores, and post-exposure scores. Positive values indicate direct associations; negative values suggest inverse relationships.)

Table 4 presents correlations between participant characteristics and outcome scores. Engagement per week and total exposure duration show moderate positive correlations with both delta and post-exposure scores ($r \approx 0.31$–0.32). Verbal ability correlates positively with post-exposure scores ($r = 0.33$) but not with delta scores.

Interestingly, therapy history shows negative correlations with both outcome measures (r = –0.35 and –0.48). IDD diagnosis shows negligible but negative associations with both delta and post-exposure scores (r = –0.03 and –0.14, respectively).

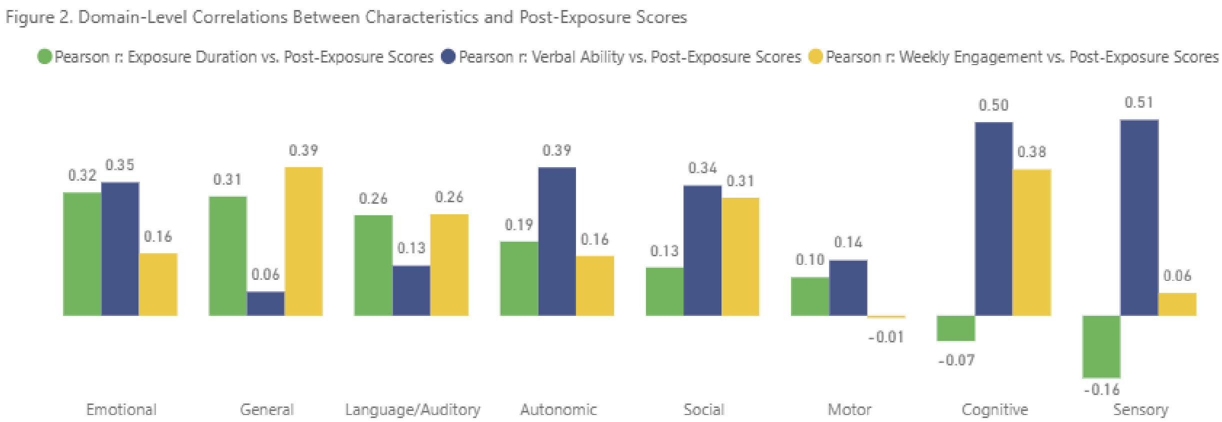


Figure 2. Domain-Level Correlations Between Characteristics and Post-Exposure Scores. (Clustered bar chart showing average correlations between three characteristics – exposure duration, engagement per week, and verbal ability – and post-exposure scores across eight neurofunctional domains. Language/Auditory domain after scores included.)

Figure 2 summarizes the relationships between three participant characteristics and neurofunctional outcomes. Verbal ability showed the strongest post-exposure correlations in the sensory (r = 0.51) and cognitive (r = 0.50) domains; exposure duration was most strongly associated with emotional (r = 0.32) and general (r = 0.31) domains; and engagement per week correlated most with general (r = 0.39), cognitive (r = 0.38), and social (r = 0.31) domains.

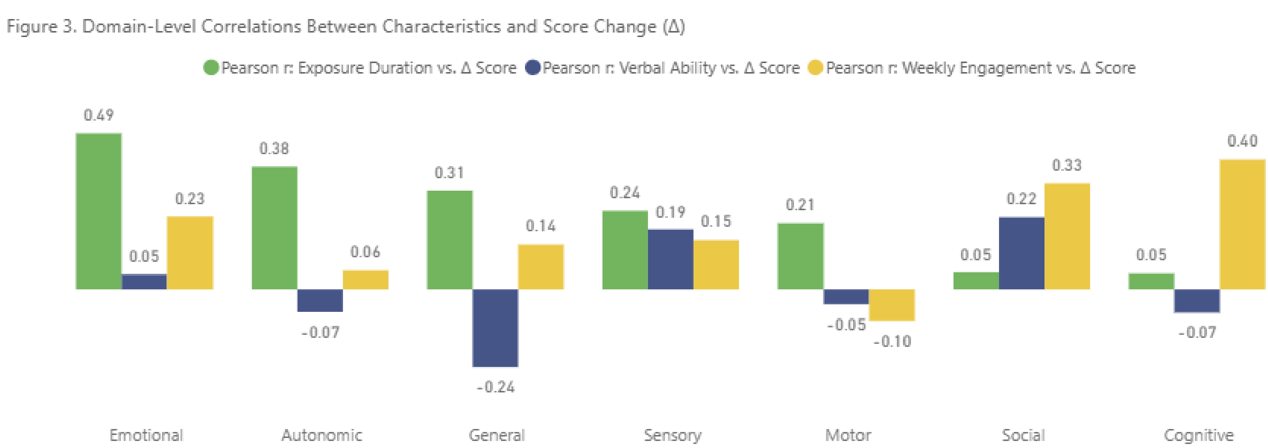


Figure 3. Domain-Level Correlations Between Characteristics and Score Change (Δ). (Clustered bar chart showing average correlations between three characteristics – exposure duration, engagement per week, and verbal ability – and delta scores across seven neurofunctional domains [Language/Auditory domain not included].)

Figure 3 illustrates domain-level correlations between participant characteristics and score changes (Δ) following exposure to Sanskrit and/or Vedic chanting. The cognitive domain showed the strongest association with weekly engagement (r = 0.40). Emotional and autonomic domains were most influenced by exposure duration (r = 0.49 and 0.38, respectively). Verbal ability showed mixed effects, including an especially negative correlation in the general domain (r = –0.24). Social domain responsiveness was also notable, with engagement per week yielding a moderate correlation (r = 0.33).

Table 5. Frequency and Representative Quotes of Neurodomain Mentions

Neurodomain	Frequency	% of Responses	Example Quotes
Executive Function	11	61.11%	"[...]Focus, [...] have definitely improved", "improved attention and focus"
Speech Motor Planning	9	50.00%	"better diction,improved clarity with speech","able to pronounce complex words clearly"
Social Cognition	8	44.44%	"[...] increased [...] patience levels","More socialization/communication"
Autonomic Regulation	7	38.89%	"It is calming and soothing",“Able to tolerate different sounds"
Language Acquisition	7	38.89%	"[...] can read Sanskrit alphabets, Follow thru in english text","able to listen and repeat"
Cognitive Processing	6	33.33%	"Grasping new things quickly", " [...] and memory have definitely improved"
Emotional Regulation	4	22.22%	"seems to help with [...] anxiety and OCD stress","Keeps chanting stotrams when anxious"
Cognitive Flexibility	3	16.67%	"trying harder things","Adaptable to changes"
Motor Coordination	1	5.56%	"swimming skills also improved"

Table 5. Frequency and Representative Quotes of Neurodomain Mentions. (Summary of participant-reported impacts categorized by neurodomain. Frequencies reflect the number of distinct mentions per domain, with representative quotes from different parents highlighting perceived changes in executive function, speech motor planning, social cognition, and other areas.)

Table 5 presents the frequency with which specific neurodomains were mentioned from parent feedback, offering qualitative insight into perceived areas of improvement. Executive function (n = 11) and speech motor planning (n = 9) were the most frequently cited domains, with participants reporting gains in focus, attention, and speech clarity. Social cognition (n = 8) and autonomic regulation (n = 7) also emerged prominently.

Language acquisition and cognitive processing were each mentioned in 6–7 instances, indicating broader cognitive benefits. Emotional regulation and cognitive flexibility were less frequently cited (n = 4 and n = 3, respectively) but still reflected meaningful shifts such as reduced anxiety and increased adaptability.

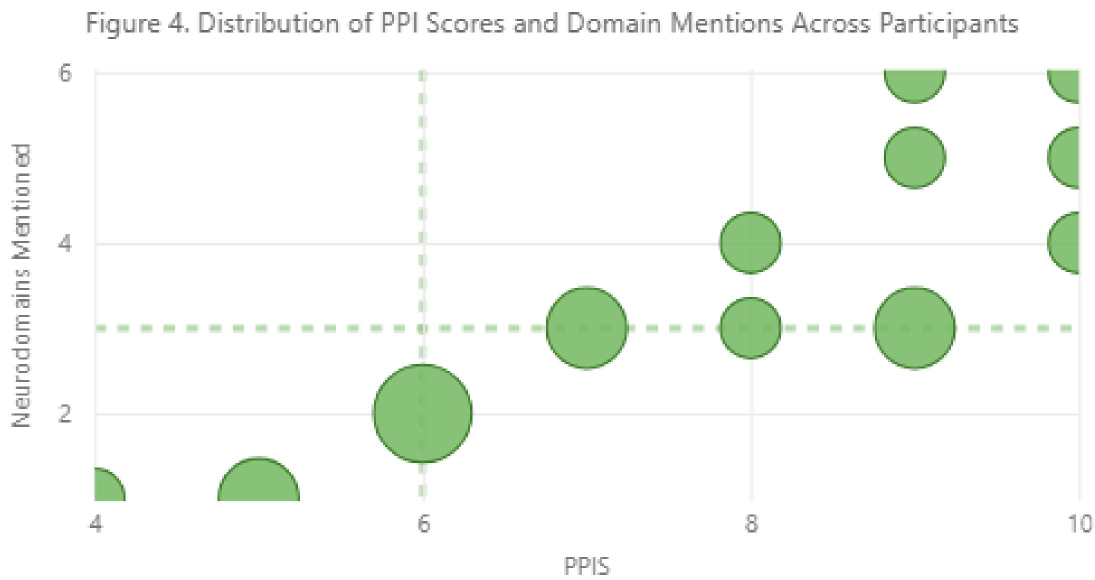


Figure 4. Distribution of PPI Scores and Neurodomain Mentions Across Participants. (Bubble chart showing the relationship between individual PPI Scores (x-axis) and the number of neurodomains mentioned (y-axis). Each bubble represents the participants; bubble size reflects the number of parents who made the mention. Dashed lines indicate approximate median thresholds [PPIS = 6, Domains Mentioned = 3].)

Figure 4 illustrates the distribution of participant-level PPI scores in relation to the breadth of neurodomain impacts reported. A positive trend is observable, with participants scoring above the median PPIS tending to mention a wider range of neurodomains. 14 participants scored on or above the median PPIS (≥ 6), and 11 scored on or above the median number of domains mentioned (≥ 3).

Several participants with lower PPI scores still reported multiple domain effects, indicating that perceived impact and observed change do not always align linearly. Bubble size variation further highlights differences in intensity or emphasis, with some individuals expressing concentrated improvements in specific domains. These patterns reinforce the multidimensional nature of the intervention and support the integration of both quantitative and qualitative metrics in evaluating participant outcomes.

DISCUSSION:

1. Interpretation of Neuroplastic Changes in Sanskrit and Vedic Practitioners

This narrative review examined how learning Sanskrit and chanting Vedic hymns may influence brain structure, cognition, and behavior, and how these effects might translate to individuals with autism and other neurodevelopmental disorders. Across the literature, Sanskrit and Vedic engagement have been associated with increased cortical thickness, greater grey and white matter volume, and changes in gyrification in regions involved in memory, language, and executive control (Kumar, 2021; Kalamangalam, 2014). These structural differences are consistent with experience-dependent neuroplasticity, reflecting the intensive demands of long-term memorization, complex phonology, and sustained attention required in traditional Vedic training (Kumar, 2021; Kalamangalam, 2014). Studies of “OM” chanting and related mantra practices also report limbic and autonomic deactivation (Kalyani, 2011), suggesting a shift toward a calmer, resting-like state that may underlie reductions in anxiety and improvements in mood.

2. Cognitive and Affective Implications for Neurotypical Populations

Taken together, prior work indicates that Sanskrit and Vedic chanting are linked to cognitive enhancement and emotional regulation in neurotypical individuals. Improved immediate recall, stronger verbal encoding and retrieval, and heightened memorization ability have been documented, alongside measurable decreases in anxiety scores and subjectively reported calming effects (Kumar, 2021; Kalamangalam, 2014; Sharma, 2017). From a mechanistic perspective, these outcomes likely involve coordinated changes across auditory, motor, and limbic circuits, as well as autonomic pathways such as the vagus nerve (Kalyani, 2011; Sharma, 2017). Although much of this evidence comes from highly trained adult practitioners, the underlying components – rhythm, repetition, prosody, and controlled breathing – are relevant to a broader range of learners.

3. Translating Rhythm- and Sound-Based Mechanisms to Autism

Because autism is characterized by differences in communication, sensory processing, and social interaction, the potential relevance of Sanskrit and Vedic chanting for Autism Spectrum Disorder (ASD) is particularly notable. While relatively few studies have examined Vedic chants directly in autistic populations, a growing body of research on music and rhythm-based interventions in ASD shows that predictable rhythmic patterns, melodic structure, and engaging auditory input can support oral-motor skills, attention, social communication, and emotional regulation (Bharathi, 2019; Ding, 2024). Music and rhythm have been reported to reorganize atypical circuits in motor, auditory, and cerebellar regions, improve structural and functional connectivity, and enhance cortical plasticity (Bharathi, 2019). Predictable rhythms, in particular, create a sense of expectation that can reduce anxiety and facilitate joint engagement (Bharathi, 2019). Because an estimated 25–30% of individuals with ASD have minimal verbal communication (Brignell, 2018), early interventions that leverage rhythm and sound – rather than complex language alone – are critically important for supporting language and social development.

4. Mechanistic Overlap Between Sanskrit/Vedic Chanting and ASD-Relevant Processes

As aforementioned, rhythm- and music-based interventions demonstrate cognitive and neural benefits that likely align closely with those of Sanskrit and Vedic chanting. Sanskrit mantras combine clear articulation, strict rhythmic patterns, melodic contours, and repetitive structure (Yadav, 2023), all of which may be especially appealing and accessible to many autistic individuals. Rhythmic repetition provides a stable scaffold that can help regulate arousal and focus attention, while precise phonetics may suit individuals who respond better to clearly segmented, predictable sounds. In addition, chanting often incorporates paced breathing and sensory regulation (Kumar, 2021), which can help lessen hyperactive or restless behaviors and support self-regulation. One can therefore cautiously extrapolate from the broader literature that Sanskrit and Vedic chanting may offer similar benefits for children with ASD, especially when integrated into supportive, individualized routines.

5. Parent-Reported Outcomes and Convergence With Mechanistic Expectations

The present survey findings robustly support the hypothesis that Sanskrit and Vedic chanting have real-world cognitive benefits, extending them to a parent-reported context. Parents in this study generally perceived Sanskrit/Vedic chanting as beneficial across multiple neurobehavioral domains, including executive function, speech motor planning, language acquisition, and emotional regulation. Thematic analysis of open-ended responses indicated that parents most frequently described gains in attention and focus, verbal clarity, reading ability, calming effects, adaptability, and social engagement. These qualitative patterns mirrored the quantitative pre–post data, in which the largest average improvements were observed in attention/focus and memory, with substantial gains in growth and adaptability, mood, and anxiety/stress levels, and more modest but positive changes in social skills and sensory sensitivities. This convergence suggests that cognitive and emotional domains responded most strongly to chanting within this sample, while sensory and autonomic domains showed more gradual change.

6. Role of Engagement, Exposure, and Verbal Ability in Domain-Specific Effects

Quantitative analysis of parent responses provided additional insight into how engagement in chanting and individual characteristics shape outcomes. Parent Perceived Impact Scores (PPIS) were positively associated with the breadth of neurodomains mentioned, indicating that higher perceived impact tended to co-occur with a wider range of reported benefits. Children with greater weekly engagement and longer overall exposure to chanting showed higher post-exposure scores and larger gains, suggesting that sustained participation may enhance outcomes. Weekly engagement was most strongly associated with cognitive and social domains, total exposure duration with emotional and autonomic domains, and post-exposure sensory and cognitive outcomes were notably related to verbal ability.

These domain-specific patterns are consistent with prior research on auditory stimulation and neuroplasticity, which suggests that cognitive and emotional systems are particularly responsive to rhythmic and linguistic input. The differential impact of verbal ability on post-exposure scores may reflect baseline readiness or processing efficiency, while the importance of engagement underscores the role of consistent practice in supporting externally oriented (cognitive and social) and internally oriented (emotional and autonomic) functions.

7. Moderators of Response and Individual Variability

The correlation findings also point to potential moderators of response. Negative correlations between therapy history and outcome measures may reflect ceiling effects, extensive prior intervention, or differences in baseline functioning, implying that children already receiving intensive therapies may have less room for additional observable gains from chanting alone. The largely negligible correlations with IDD diagnosis suggest that diagnostic labels alone do not fully predict responsiveness, and that individualized engagement, sensory profiles, and family context may be more important determinants of benefit.

8. Acceptability, Tolerability, and Practical Adaptation of Chanting

Importantly, adverse effects were rare in this sample. A small number of parents reported resistance to chanting, often framed as reluctance to sit still or a preference for movement-based engagement rather than seated practice. These challenges were often mitigated by adapting the intervention, such as allowing children to chant while moving or integrating chants into daily routines, underscoring the importance of tailoring Sanskrit/Vedic practices to each child's sensory and behavioral profile. No parent reported sustained negative changes, supporting the view that chanting is a low-risk, acceptable complementary practice for many families.

9. Methodological Constraints of the Present Survey Study

At the same time, several limitations must be acknowledged when interpreting these findings. The survey sample size was modest and relied entirely on parent-reported outcomes, which may be subject to bias, expectancy effects, or incomplete information. The scoring rubric, although systematic and reproducible, was inherently interpretive and would benefit from validation against clinician ratings or standardized cognitive assessments. The study design was cross-sectional pre–post without a control group, which limits causal inference: improvements could partially reflect maturation, concurrent therapies, or other environmental changes rather than chanting alone.

10. Limitations and Gaps in the Broader Evidence Base

Limitations also extend to the broader evidence base. The 16 papers reviewed in this narrative synthesis were often characterized by small, relatively heterogeneous samples and cross-sectional designs, restricting generalizability and making it difficult to establish Sanskrit or Vedic chanting as the direct cause of observed structural or cognitive changes. Existing research in this area rarely focuses specifically on autistic children and has not yet fully addressed questions such as how cortical thickness or connectivity patterns change in ASD with Sanskrit learning over time. This gap is likely due in part to the heterogeneity of autism – spanning a wide spectrum of abilities, sensory profiles, and co-occurring conditions – which complicates recruitment, standardization, and replication. Some autism studies involving Vedic chanting have reported mixed or moderate effects and high variability (Badhe, 2023), emphasizing that chanting is unlikely to be uniformly effective and that customized, child-specific approaches are necessary.

11. Specificity of Effects: Sanskrit/Vedic Chanting Versus Other Rhythmic or Meditative Practices

Another open question is whether the observed cognitive and emotional benefits are unique to Sanskrit and Vedic learning or shared with other forms of memorization, meditation, and music-based practice. Some argue that similar gains occur with non-Sanskrit mantras, secular mindfulness exercises, or structured music therapy. The distinctive combination of complex language, melody, rhythm, and memorization in Sanskrit mantras is theoretically compelling, but comparative studies are needed to determine whether Sanskrit confers added value beyond general rhythmic and prosodic stimulation.

12. Future Directions for Mechanistic and Clinical Research in ASD

Future research should address these limitations by expanding sample sizes and recruiting more diverse participants, including autistic children across different language levels, cognitive profiles, and co-occurring conditions. Incorporating standardized neurocognitive assessments, clinician ratings, and objective measures (such as EEG, heart rate variability, or neuroimaging) would help validate parent-reported outcomes and clarify underlying mechanisms, including changes in auditory–motor integration, autonomic regulation, and structural or functional connectivity.

Longitudinal and, where possible, controlled designs are especially important for determining whether Sanskrit/Vedic chanting produces sustained, causal effects over time. Comparative studies that directly contrast Sanskrit chanting with other rhythmic or prosodic interventions (e.g., music therapy, non-Sanskrit mantra repetition, or metronome-based rhythm training) could clarify the unique contribution of Sanskrit language and Vedic content versus general rhythmic and melodic features. In ASD, future work should also explore early-stage interventions that leverage chanting for minimally verbal children, as well as more advanced programs that target complex social interaction, pragmatic language, and higher-order executive skills as children grow.

13. Clinical and Educational Implications for Complementary Use in Neurodevelopmental Disorders

Finally, integrating Sanskrit and Vedic chanting into structured educational or therapeutic programs, including parent-mediated approaches, may enhance accessibility and scalability. Given the low cost, cultural significance, and favorable safety profile suggested by current evidence (Yadav, 2023), Sanskrit/Vedic chanting appears to be a promising complementary tool that warrants further investigation as part of support for individuals with autism and other neurodevelopmental conditions.

CONCLUSION:

This review paper has examined how learning the ancient language Sanskrit, as well as chanting Vedic hymns, may influence neuroplasticity and alter brain structure over time, leading to changes in cognition and behavior. Both prior studies and the parent survey conducted for this project suggest that Sanskrit and Vedic chanting are associated with improvements in attention, memory, mood, self-regulation, and aspects of social engagement, particularly when exposure is regular and sustained. A clearer understanding of these neural and cognitive effects could help scientists and clinicians develop new, low-cost, low-risk therapeutic approaches to support emotional and mental well-being. At the same time, the current evidence base – especially in autistic populations – remains limited and methodologically constrained. Future research should use longitudinal designs, larger and more diverse samples, and standardized outcome measures to better establish causality and generalizability. In particular, systematically exploring Sanskrit and Vedic chanting as an intervention for Autism Spectrum Disorder may clarify its potential as a safe, culturally meaningful complementary practice that could eventually be integrated into broader clinical and educational care.

REFERENCES:

Badhe, S. (2023). A Review of Our Experiences in Implementing the Vedic Chants Intervention in Children with Autism. *Research Gate*. Retrieved 2025, from https://www.researchgate.net/profile/Sushrut-Badhe/publication/374755575_A_review_of_our_experiences_in_implementing_the_Vedic_Chants_intervention_in_children_with_Autism/links/652e3a1a7d0cf66a673468e3/A-review-of-our-experiences-in-implementing-the-Vedic-Chants-intervention-in-children-with-Autism.pdf

Bharathi, G., Jayaramayya, K., Balasubramanian, V., & Vellingiri, B. (2019). The Potential Role of Rhythmic Entrainment and Music Therapy Intervention for Individuals with Autism Spectrum Disorders. *Journal of Exercise Rehabilitation*, *15*(2), 180–186. https://doi.org/10.12965/jer.1836578.289

Bloomer, B. F. (2022). Cerebellar Structure and Function in Autism Spectrum Disorder. *Journal of Psychiatry and Brain Science*, *7*. https://doi.org/10.20900/jpbs.20220003

Brignell, A., Chenausky, K. V., Song, H., Zhu, J., Suo, C., & Morgan, A. T. (2018). Communication Interventions for Autism Spectrum Disorder in Minimally Verbal Children. *Cochrane Database of Systematic Reviews*, *5*(11). https://doi.org/10.1002/14651858.cd012324.pub2

Bubbico, G., Chiacchiaretta, P., Parenti, M., di Marco, M., Panara, V., Sepede, G., Ferretti, A., & Perrucci, M. G. (2019). Effects of Second Language Learning on the Plastic Aging Brain: Functional Connectivity, Cognitive Decline, and Reorganization. *Frontiers in Neuroscience*, *13*. https://doi.org/10.3389/fnins.2019.00423

Chanda, M. L., & Levitin, D. J. (2013). The Neurochemistry of Music. *Trends in Cognitive Sciences*, *17*(4), 179–193. https://doi.org/10.1016/j.tics.2013.02.007

Ding, X., Wu, J., Li, D., & Liu, Z. (2024). The Benefit of Rhythm-Based Interventions for Individuals with Autism Spectrum Disorder: A Systematic Review and Meta-Analysis with Random Controlled Trials. *Frontiers in Psychiatry*, *15*. https://doi.org/10.3389/fpsyt.2024.1436170

Garcia, G., Beatriz, A., Marques, B. O., Bragas, S., Rodrigues, I. B., Melo, R. S., & Rodrigues, K. (2025). Neuroplasticity in Autism Spectrum Disorder: A Systematic Review. *Dementia & Neuropsychologia*, *19*. https://doi.org/10.1590/1980-5764-dn-2024-0182

Gebauer, L., Witek, M. a. G., Hansen, N. C., Thomas, J., Konvalinka, I., & Vuust, P. (2016). Oxytocin Improves Synchronisation in Leader-Follower Interaction. *Scientific Reports*, *6*(1), 38416. https://doi.org/10.1038/srep38416

Hodges, H., Fealko, C., & Soares, N. (2020). Autism Spectrum Disorder: Definition, Epidemiology, Causes, and Clinical Evaluation. *Translational Pediatrics*, *9*(1), 55–65. https://doi.org/10.21037/tp.2019.09.09

Kalamangalam, G. P., & Ellmore, T. M. (2014). Focal Cortical Thickness Correlates of Exceptional Memory Training in Vedic Priests. *Frontiers in Human Neuroscience*, *8*. https://doi.org/10.3389/fnhum.2014.00833

Kalyani, B. G., Venkatasubramanian, G., Arasappa, R., Rao, N. P., Kalmady, S. V., Behere, R. V., Rao, H., Vasudev, M. K., & Gangadhar, B. N. (2011). Neurohemodynamic Correlates of “OM” Chanting: A Pilot Functional Magnetic Resonance Imaging Study. *International Journal of Yoga*, *4*(1), 3–6. https://doi.org/10.4103/0973-6131.78171

Klimova, B. (2018). Learning a Foreign Language: A Review on Recent Findings About Its Effect on the Enhancement of Cognitive Functions Among Healthy Older Individuals. *Frontiers in Human Neuroscience*, *12*(305). https://doi.org/10.3389/fnhum.2018.00305

Kolb, B., & Gibb, R. (2011). Brain Plasticity and Behaviour in the Developing Brain. *Journal of the Canadian Academy of Child and Adolescent Psychiatry*, *20*(4), 265. https://pmc.ncbi.nlm.nih.gov/articles/PMC3222570/

Kumar, U., Singh, A., & Paddakanya, P. (2021). Extensive Long-Term Verbal Memory Training is Associated with Brain Plasticity. *Scientific Reports*, *11*(1). https://doi.org/10.1038/s41598-021-89248-7

Marzola, P., Melzer, T., Pavesi, E., Gil-Mohapel, J., & Brocardo, P. S. (2023). Exploring the Role of Neuroplasticity in Development, Aging, and Neurodegeneration. *Brain Sciences*, *13*(12), 1–32. https://doi.org/10.3390/brainsci13121610

Mody, M., & Belliveau, J. W. (2013). Speech and Language Impairments in Autism: Insights from Behavior and Neuroimaging. *American Chinese Journal of Medicine and Science*, *5*(3), 157. https://doi.org/10.7156/v5i3p157

Moseley, R. L., Shtyrov, Y., Mohr, B., Lombardo, M. V., Baron-Cohen, S., & Pulvermüller, F. (2015). Lost for Emotion Words: What Motor and Limbic Brain Activity Reveals About Autism and Semantic Theory. *NeuroImage*, *104*, 413–422. https://doi.org/10.1016/j.neuroimage.2014.09.046

Parsons, L., Cordier, R., Munro, N., Joosten, A., & Speyer, R. (2017). A Systematic Review of Pragmatic Language Interventions for Children with Autism Spectrum Disorder. *PLOS ONE*, *12*(4), e0172242. https://doi.org/10.1371/journal.pone.0172242

Romero, C., & Uddin, L. Q. (2021). Bilingualism, Executive Function, and the Brain: Implications for Autism. *Neurobiology of Language*, *2*(4), 1–51. https://doi.org/10.1162/nol_a_00057

Sharma, N., Padam, A., Sastri, O. S. K. S., Mahajan, S., Sharma, R., & Sharma, D. (2017). Effect of Listening to Vedic Chants and Indian Classical Instrumental Music on Patients Undergoing Upper Gastrointestinal Endoscopy: A Randomized Control Trial. *Indian Journal of Psychiatry*, *59*(2), 214. https://doi.org/10.4103/psychiatry.indianjpsychiatry_314_16

Yadav, N. (2023). Importance of Sanskrit Mantras and Ancient Indian Knowledge Systems in Sustainable Development. *Research Gate*. https://www.researchgate.net/profile/Nidhi-Yadav-12/publication/371752096_Importance_of_Sanskrit_Mantras_and_Ancient_Indian_Knowledge_Systems_in_Sustainable_Development/links/656f2512a760eb7cc750638f/Importance-of-Sanskrit-Mantras-and-Ancient-Indian-Knowledge-Systems-in-Sustainable-Development.pdf