Medical Research Archives

European Society of Medicine

OPEN ACCESS

Published: June 30, 2024

Citation: Chauhan N., et al., 2024. Role of Indian Classical Music in Treating Alzheimer's Disease and Related Dementias. Medical Research Archives, [online] 12(6). https://doi.org/10.18103/mra.v12i6.5388

DOI: https://doi.org/10.18103/mra.v12i6.5388

ISSN: 2375-1924

RESEARCH ARTICLE

Role of Indian Classical Music in Treating Alzheimer's Disease and Related Dementias

Neelima Chauhan[1]*, Purva Gujar-Kale[2,3], Mahesh Kale[3]

[1]Research & Development, VA Healthcare System
Department of Pediatrics, University of Illinois at Chicago, Chicago, IL 60612
[2]Dolby Laboratories, Inc., San Francisco, California, USA;
Mahesh Kale School of Music (MKSM), Indian Classical Music and Arts Foundation (ICMA), Meridian Media, Sunnyvale, California, USA
[3]Mahesh Kale School of Music (MKSM), Indian Classical Music and Arts Foundation (ICMA), Meridian Media, Sunnyvale, California, USA

*nchauhan51@gmail.com

ABSTRACT

The prevalence of Alzheimer's disease (AD) and Alzheimer's disease related dementias (ADRD) is on rise all around the globe with limited treatment options. Current symptomatic pharmacological treatments are modestly effective and are associated with adverse side effects. Therefore, there is an increased interest in validating non-pharmacological alternatives to treat AD/ADRD. One of such alternatives is music therapy which has recently picked up an upsurge not only in treating mental disorders but also other disparities. Many systematic reviews and meta-analyses using PubMed/Medline, Web of Science, Scopus, Google Scholar, and Cochrane database searches have revealed that music-based interventions successfully improved mood, depression, anxiety, verbal fluency, gait/motor abnormalities, autobiographic and episodic memory, and cognition, in neurological disorders including AD/ADRD and other dementias. In that regard, targeted effects of Indian Classical Music (Raga) are worth deciphering. In contrast to general emotional upliftment induced by other musical genres, Raga has an ability to evoke specific emotions based on its defined notational structure arranged in a specific ascending/descending order, and these effects are further magnified when the Raga is sung/performed at a designated time of the day based on its circadian specificity. Ragas containing the predominance of major notes are known to activate default mode network via induction of dopaminergic pathways and evoke cheerful/ happy emotions, causing mind-wandering and self-referential mental activity. On the other hand, the Raga becomes incrementally sentimental as the proportion of minor notes increase in a Raga structure. Ragas can affect brain activity, emotions, and autonomic functions. This review elucidates enhanced therapeutic potential of Indian Classical Music (Raga) as an advanced music therapy, that has an ability to exert Raga-specific health-effects in a circadian-specific manner. Raga therapy may be an effective disease-modifying treatment for treating AD and other dementias.

Keywords: Aging, Dopaminergic, Large-Scale Brain Networks, Alzheimer's Disease, Alzheimer's Disease Related Dementias, Music-based Interventions

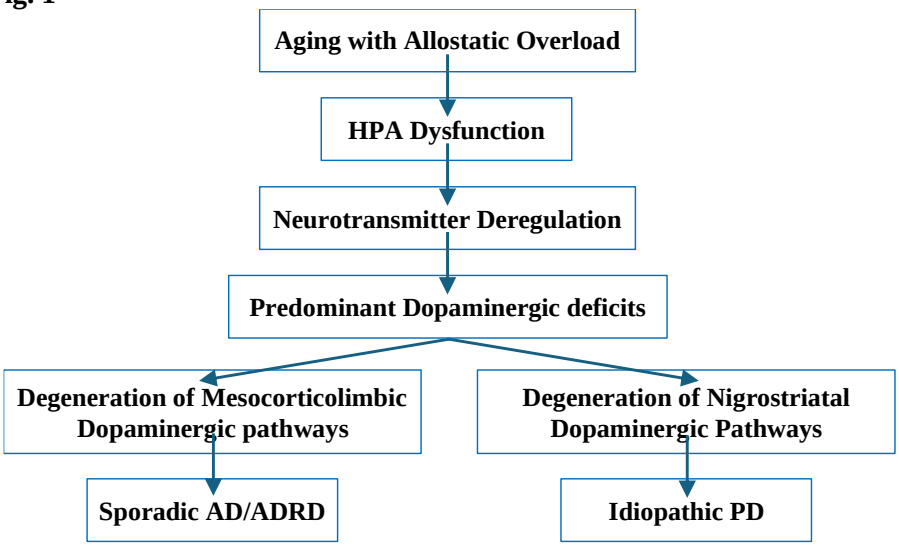
Introduction

Alzheimer's disease (AD) is a global health epidemic and a fifth leading cause of death in United States, currently afflicting ~7 million Americans (and ~55 million people worldwide) with AD[1]. By mid-century these numbers are projected to escalate by ~14 million Americans (and ~140 million people worldwide) suffering from AD and/or Alzheimer's disease related dementias (ADRD), if effective disease modifying treatments are not discovered[1-3].

The most prevalent form of AD is of non-genetic origin (age-associated late onset sporadic AD) while a small percentage of AD is of genetic origin (early onset familial AD)[1]. Regardless of its origin, terminal AD is characterized by the deposition of extraneuronal amyloid plaques and intraneuronal neurofibrillary tangles within the brain parenchyma, and functionally characterized by cognitive decline[1].

As detailed in Fig. 1, cognitive decline with increasing age results from allostasis-induced stress[4,5]. Stress deregulates Hypothalamo-Pituitary-Adrenal (HPA) axis[6], which in turn produces neurotransmitter deficits[7,8]. Although deficiencies in many neurotransmitter systems contribute to aging brain physiology[9-11], dopaminergic deficits are the most predominant ones[12,13], and fundamental to age-associated cognitive decline[14,15]. According to the "Unifying Hypothesis"[16], age-associated dopaminergic dysfunction, when splits for nigrostriatal dopaminergic degeneration, leads to the development of Parkinson's disease (PD), while degeneration of ventral tegmental mesocorticolimbic dopaminergic pathways leads to the development of AD/ADRD (Fig. 1).

Fig. 1



Thus, dopaminergic degeneration constitutes a prime causative factor for age-associated cognitive decline and early onset of neuropsychiatric symptoms (NPS), also known as behavioral and psychological symptoms of dementia (BPSD), in AD/ADRD[17-20].

Alzheimer's disease (AD) begins decades prior to the manifestation of clinical symptoms[21,22]. AD pathology exists over the disease continuum from a preclinical asymptomatic stage spanning over ~15-25 years to the progressive symptomatic stage(s) consisting of mild cognitive

impairment (MCI) and dementia[1,23]. Therefore, timely diagnosis of AD is very critical to catch the window of opportunity in treating AD/ADRD[24,25]. Given the non-feasibility of pathological confirmation of amyloid plaques and neurofibrillary tangles in the brain autopsy[26], primary diagnosis of probable AD/ADRD is determined by the degree and severity of cognitive decline based on NPS/BPSD index[1,27,28], confirmed by differential diagnosis of cerebrospinal fluid biomarkers i.e. Reduced amyloid and Increased tau, and diagnostic brain scans i.e. Positron Emission Tomography for brain amyloid, fluorodeoxyglucose for hypometabolism, and functional magnetic resonance imaging for brain atrophy, to determine the presence of AD/ADRD[29,30].

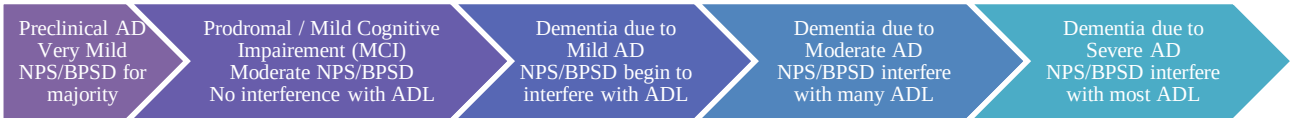
Current symptomatic drugs, including cholinesterase inhibitors and N-methyl-D-aspartate modulators, treat terminal/late-stage AD[1,31]. However, there are no preventive treatments targeting early NPS/BPSD symptoms[31,32]. The use of dopamine-rebalancing anti-psychotics and anti-depressants for treating NPS/BPSD are associated with numerous adversities[1,33]. Therefore, there is an unmet medical need to validate preventive therapies during early stages of the disease that can interrupt the progression of AD/ADRD before the appearance of advanced symptoms[34].

Relatively safer non-pharmacological interventions targeting early stages of AD/ADRD include Cognitive Behavioral Therapy[35,36], Validation Therapy[37,38] and Music Therapy[39-41]. Music-Based Interventions (MBIs)[42,43], are increasingly recognized as the safe and effective alternative(s) in combating NPS/BPSD, that alleviate pain, anxiety, stress, depression, improve psychological, motor symptoms, and uplift emotional well-being in people with AD/ADRD and other dementias[44-46].

This review discusses enhanced therapeutic potential of Indian Classical Music (Raga), attributed to its defined notational structure along with other salient features, inducing Raga -specific emotions and associated health-effects in a circadian-dependent manner[47,48] for treating age-related neurodegenerative disorders with particular emphasis on AD/ADRD.

Alzheimer's Continuum

Fig. 2: Alzheimer's Disease (AD) Continuum



Alzheimer's Disease (AD); Mild Cognitive Impairment (MCI); Behavioral and Psychological Symptoms of Dementia (BPSD); Activities of Daily Living (ADL)

The progression of Alzheimer's disease from brain changes that are unnoticeable to the person affected, to the brain changes causing problems with memory, eventually leading to physical disability, are known as the "Alzheimer's Disease Continuum. On this continuum, there are three broad phases: Preclinical AD; Mild Cognitive Impairment (MCI) due to AD; and Dementia due to mild/Moderate/Severe AD[1] (Fig.2).

Preclinical AD: The continuum of AD begins with a long latent phase referred to as preclinical AD[49,50] - the earliest asymptomatic phase of AD continuum[51]. Preclinical AD is characterized by few mild NPS/BPSD including hyperactivity, psychosis, anxiety, and apathy[52,53], along with altered cerebrospinal fluid biomarkers[54], and abnormal brain-scans[55]. Despite individual variations, preclinical AD typically spans over ~6-10 years[25,56]. Not all, but ~20% of preclinical AD with mild NPS/BPSD may advance to MCI due to AD[25].

MCI due to AD: People with MCI due to AD have biomarker evidence of Alzheimer's brain changes plus new but subtle problems with memory, language and thinking[1,49]. These cognitive problems may be noticeable to the individual, family members and friends, but not to others, and these new problems don't interfere with activities of daily living (ADL). People with MCI due to AD, initially exhibit short-term memory impairment, followed by subsequent decline in additional cognitive domains[25]. Approximately, 20-30% of people with MCI develop dementia due to Alzheimer's within ~2-5 years[57]. MCI is expressed as non-amnestic MCI (nMCI) and amnestic MCI (aMCI)[58]. Progressive dopaminergic degeneration accounts for the conversion of nMCI to aMCI[59,60]. The conversion rate of aMCI to AD is ~80-90% after ~6 years from initial diagnosis[61].

Dementia Due to Mild/Moderate/Severe Alzheimer's Disease: Dementia due to AD is characterized by severe NPS/BPSD, showing predominant impairments in memory, language, thinking and ADL, in presence of established Alzheimer-specific biomarkers[1]. As AD/ADRD progresses, the severity of dementia increases affecting the degree of damage from mild/moderate/severe dementia[25,29]. Mild dementia due to AD is characterized by loss of recent memory, poor problem-solving, personality changes, trouble organizing/expressing thoughts, getting lost, misplacing belongings; Moderate dementia due to AD shows increasing memory loss and poor judgement, noticeable personality changes, some of the ADLs impaired; While severe dementia due to AD shows greater loss of memory, increasingly poor judgement, severe ADL disruptions, impaired problem solving, mixed up perception of time/space, language/speech problems, social withdrawal, and changes in mood/personality/behavior[25,50].

Neuromodulatory Changes during Cognitive Aging

Cognitive aging is a process in which older adults typically experience dysfunctionality in many cognitive domains that negatively impact their quality of life[62,63]. Cognitive decline ranges from mild cognitive impairment to dementia, a form of decline in abilities severe enough to interfere with ADL[64,65]. Cognitive decline is characterized by predominant atrophy of frontoparietal cortex, anterior cingulate gyrus, and hippocampus, involved in executive functioning, episodic and working memory[66-69].

There are multiple aging factors that contribute to cognitive aging, but early neurotransmitter deficits[9-11], and dopaminergic deficits in particular[70,71], play a significant role in cognitive aging of the brain. *Cognitive decline stems from dysfunctional neurosynaptic connectivity mainly orchestrated by Dopamine*[72-75]. Studies show that higher level of dopamine synthesis capacity was associated with relative stability of cognitive performance in aging[76,77], and

interpreted as a compensatory mechanism towards building resilience against age-associated cognitive decline[78].

Postmortem analyses of aging brains revealed different degrees of degeneration in midbrain dopaminergic neurons and reduced density of dopamine receptors[79,80]. Dopaminergic dysfunction is observed in late-life depression[71]. Dopamine transporter system is critically involved in the age-related synaptic plasticity[81]. Brain imaging studies showed that loss of midbrain dopaminergic neurons and dopamine receptors paralleled frontoparietal atrophy and was strongly correlated with declined cognition[82], indicating a central role played by dopamine in maintaining cognitive functions in aging[83]. Recent studies showed that progressive dopaminergic degeneration leads to conversion of nMCI to aMCI[59,60], and continued dopaminergic loss as the early pathophysiological sign of progressive neurodegeneration[84,85].

Memories are encoded through experience-dependent modifications of synaptic strength, which are regulated by catecholamines i.e. dopamine and noradrenaline[86]. While cognitive aging research demonstrates how dopaminergic neuromodulation from the substantia nigra and ventral tegmental area regulates hippocampal synaptic plasticity and memory, recent findings indicate that the noradrenergic locus coeruleus sends denser inputs to the hippocampus[87]. The locus coeruleus produces dopamine as biosynthetic precursor of noradrenaline, and releases both noradrenaline and dopamine, required to modulate hippocampal plasticity and memory[19,88]. Although, no unifying genetic or non-genetic factor(s) have been identified as a cause for cognitive deterioration, aberrant mutations in dopamine receptor genes are recognized to be associated with cognitive decline[89].

Thus, progressive loss of dopaminergic components during aging constitutes a causative factor for age-associated cognitive decline and early onset of neurodegeneration/ dementia in absence of the disease, while elevated dopamine synthesis capacity represents a neurobiological mechanism of cognitive resilience for preserving age-associated cognitive decline[78,90].

Alzheimer's Pharmacological and Non-Pharmacological Therapy

Food and Drug Administration (FDA)-approved pharmacotherapy for AD/ADRD consists of cholinesterase inhibitors (Donepezil, Rivastigmine, Galantamine), NMDA modulators (Memantine) and combined use of Donepezil /Memantine[1]. These symptomatic drugs give temporary relief, but do not alter the course of the disease, and are associated with many adversities[91,92]. A newly introduced anti-amyloid antibody aducanumab (Aduhelm) reduces cerebral amyloid but there is no data on effectiveness or safety, and if the clinical benefits are not verified, it may be withdrawn[93,94]. Pharmacological use of dopamine receptor activation, monoamine oxidase inhibition, Levodopa/Carbidopa, or dopaminergic neuromodulators (antipsychotics, anxiolytics, and antidepressants) in treating hallucinations, agitation, and anxiety components of NPS/ BPSD of AD/ADRD/PD[27,95], appears partially effective but associated with adversities, drug interactions, intolerance and patient-non-compliance, and pose an increased risk of stroke and death in individuals with dementia[96,97].

These limitations of AD-pharmacotherapy prompted the emergence of non-pharmacological treatment(s) for AD/ADRD, which may not change the underlying biology of the disease but may prevent disease progression and improve overall quality of life by reducing NPS/BPSD. A review of nonpharmacologic treatments for agitation and aggression in people with dementia concluded that non-drug interventions are safe and more effective than pharmacologic interventions for reducing aggression and agitation as they pose minimal risk[98].

Various studies have considered the use of cannabis, which is legal in some parts of the USA, but still illegal under federal statute. A randomized control trial evaluated tetrahydrocannabinol (the active ingredient in cannabis), compared to placebo for control of aggression among 50 patients with AD, vascular, or mixed dementia, with 24 receiving tetrahydrocannabinol and 26 receiving placebo, and found that there were no significant differences in NPS/BPSD, agitation, or ADL[99]. In a meta-analysis of randomized trial, patients receiving 22–24 weeks of *gingko biloba* experienced a reduction in BPSD, except for psychosis which was not changed[100]. Multiple studies have evaluated whether aromatherapy, specifically lavender spray, reduces BPSD, but no significant reduction in agitation was observed[101,102].

Relatively safer non-drug interventions for combating NPS/BPSD in AD/ADRD include Cognitive Stimulation Therapy[103,104], Validation Therapy[37,105], and Music Therapy[39]. Of all, Music Therapy can better enhance memory and emotional functions[40,106,107] by virtue of its ability to uplift emotions, stimulate reward, motivation, pleasure, arousal, and memory[108,109]. Music is known to suppress anger, shame, fear, anxiety by inducing reward/motivation and physiological arousal[110,111] and increase social integration[112,113]. Clinical studies have shown benefits of Music Therapy in many neuropsychiatric disorders including AD/ADRD[38,106].

Alzheimer's Music Therapy

Music has been used in healing since centuries all over the world[114,115]. A growing body of anecdotal and clinical research shows health benefits of music as a non-pharmacological alternative for treating NPS/BPSD in many brain disorders including AD/ADRD[41,116-118]. Given escalating prevalence of AD/ADRD all around the globe[1,2,119], and failure of pharmacotherapy in treating AD/ADRD[1,120-122], there is a sharp emergence in validating non-pharmacological therapies, such as music therapy, not only for treating AD/ADRD but also for other disparities[123,124]. MBIs uplift emotions and combat BPSD in AD/ADRD[125-127].

Accumulating evidence shows that musicability is relatively well preserved in aging and dementia[40]. Music for memory can remain intact in persons with AD, even while experiencing rapid cognitive decline[128,129], because musical memory networks are independent of traditional temporal lobe memory networks[130] and are spared until the terminal stages of AD[131]. These observations suggest that music perception forms "Islands of Cognitive Reserve" in otherwise cognitively impaired people, and hence can be effectively exploited even in late stages of AD/ADRD[128,132].

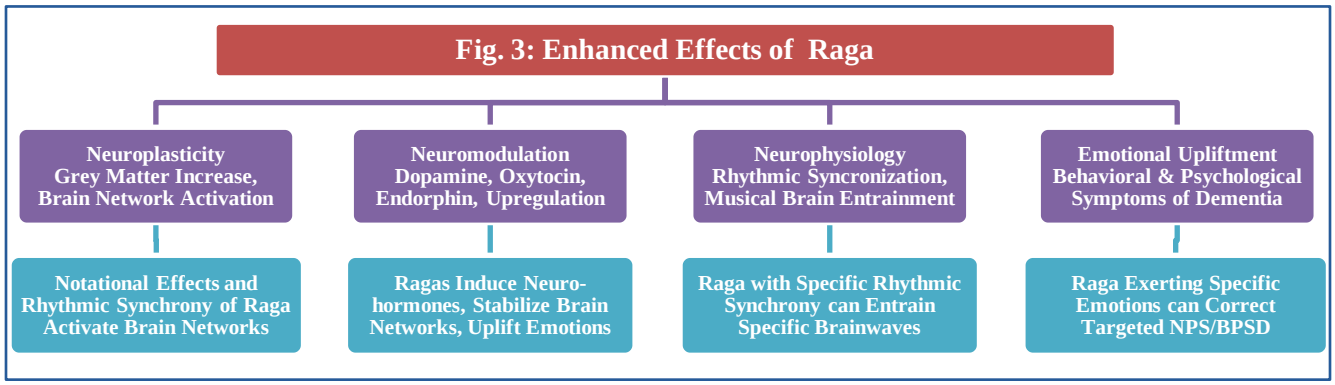
A study that utilized brain scans to investigate if music listening brain areas are affected by

Alzheimer's pathology in relation to amyloid deposition and glucose metabolism, found that specific brain areas involved in music listening, experienced less pathology[131]. Simmons-Stern et al. have observed that music enhanced verbal encoding and memorial awareness in AD patients[133,134], and lowered stress in AD as indicated by reduced salivary cortisol levels[135].

A systematic review mentioned that music interventions were best at reducing BPSD such as agitation and anxiety[136]. Studies which used individualized playlists improved cognitive outcomes in both active music therapy and music listening, compared to methods that used music chosen by an experimenter[137,138]. Another systematic review reported that music therapy effectively reduced depression in dementia[139,140]. Additional systemic reviews between 2006-2022 using PubMed and Science Direct data bases[40,141], and other reviews between 2012-2023 including Cochrane, PubMed, PubMed/Medline, PsycINFO databases[40,41,142,143], showed benefits of music therapy on cognition (memory, attention, language), emotion, behavior (anxiety, depression, agitation, irritability), autobiographical recall, and verbal fluency. Thus, the effectiveness of music therapy in AD/ADRD is widely recognized.

Enhanced Therapeutic Potential of Raga Therapy

While music therapy in general is widely recognized not only in treating AD/ADRD but also other disparities, specific targeted effects of Raga therapy are not well understood. Music therapy per se is postulated to work through four potential mechanisms that include Neuroplasticity, Neuromodulation, Brain Entrainment, and Emotional upliftment[144]. Indian Classical Music (Raga) has a potential to further enhance these basic music mechanisms due to Raga's structural uniqueness, defined rhythmicity, and circadian specificity[47,145] (Fig. 3).



Raga: The word "*Raga*" is derived from the Sanskrit phrase "*Ranjayiti Iti Raga*" – 'one which entertains by inducing emotions in mind' – defined as uniquely designed melodic framework and the constructive core of Indian Classical Music for improvisation and composition[146-149]. Ragas are composed of permutations/ combinations of seven "natural" notes derived from the sounds of nature such as birds and animals, known as (Shuddha Swara) (major notes), and five "modified or movable" notes (Vikruta Swara), making a total of 12 notes/ Swaras (Table 1), composed in an ascending/ descending order, to create a melodic framework known as Raga[150-155]. If the frequency of a given note is more than its mean value,

then it is termed as "*Tivra*" Swara (sharp note), while if the frequency of a given note is less than the mean value, then it is called "*Komal*" Swara (flat/minor note) (Table 1)[151,153].

Table 1: Indian Musical Notes Corresponding to Western Musical Notes[151,155]

Indian Musical Notes (*Swara*)	Corresponding Western Equivalent	Frequency (Hz)
Shadja (Sa)	C (Unison)	100
Shuddha Re	D (Major Second)	112.5
Komal Re	C#, D*b* (Minor Second)	106.66
Shuddha Ga	E (Major Third)	125
Komal Ga	D#, E*b* (Minor Third)	112.7
Shuddha Ma	F (Perfect Fourth)	133
Tivra Ma	F# (Augmented Fourth)	142
Pancham (Pa)	G (Perfect Fifth)	150
Shuddha Dha	A (Major Sixth)	167
Komal Dha	G#, A*b* (Minor Sixth)	159
Shuddha Ni	B (Major Seventh)	189
Komal Ni	A#, B*b* (Minor Seventh)	178

Structural Uniqueness of Raga

The *Ragas* evoke various emotions in a listener/performer, such as sadness, romance, peace, strength, anger, devotion, longing, and passion[146,156]. Raga is known to express inherent emotion(s) (Bhava) and the emotional response evoked in the listeners (Rasa)[157], nevertheless, Rasa term is frequently used to present both Bhava and Rasa[155].

Specific notes of Raga are known to elicit distinct Rasa/emotions[148,149,158,159]. Predominance of Shuddha Swaras (major notes) makes the Raga "Happy" and "Cheerful" (Shringar Rasa)[148,158,160], which modulates reward-driven music-memory consolidation[107,161], by activating dopaminergic system in music-evoked pleasure[162,163]. Whereas predominance of *Komal* Swaras makes the Raga progressively sentimental, elevating emotional seriousness from cheerfulness to sympathy to sad/sorrow/ tensed to peace and tranquility[151,164-168].

The use of *Komal Re* (Western C#, D*b* - Minor Second) creates sentimental feelings, longing/ craving/desire[169,170], *Komal Dha* (Western G#, A*b* - Minor Sixth) produces serene and calm feelings[165-167], while *Komal Ga* (Western D#, E*b* - Minor Third) and *Komal Ni* (Western A#, B*b* - Minor Seventh) create the mood of compassion/sympathy, submission, sorrow[164]. The inclusion of *Tivra Ma* (Western F# - Augmented Fourth) intensifies the inherent effects (calmness, subtle joy, gentle feelings of affection/joy) of a given Raga[151]. These Swara -specific emotional effects produced by Ragas have neurochemical basis. Neural correlates underlying emotional response of music showed that listening to pleasurable music induces dopamine in the nucleus accumbens and mesocorticolimbic pathway, responsible for producing reward, emotions, and memory[163,171-173]. Pleasurable music also increases opioid circulation and mu-opioid receptor expression[173-176], and activates insular cortex, superior temporal lobe, and caudate putamen

associated with awareness of emotions[177,178]. These neurohormones are known to modulate large scale brain networks i.e. salience network, central executive network, and default mode network[179,180], which are involved in reviving autobiographic/episodic memory - the components highly compromised in AD/ADRD. Thus, Pleasure producing Ragas have an ability not only to uplift emotions but also to activate dopaminergic and opioid pathways, correct the functioning of large-scale brain networks, resulting in the improvement of NPS/BPSD, learning/memory, and cognition.

Defined Rhythmicity of Raga

Rhythmic-auditory stimulation induced by music facilitates motor activities, smoother gait and attenuates ADL[144], involving large-scale brain networks[181,182], activation of motor brain areas including many cortical and sub-cortical regions involved in rhythmic timings i.e. cerebellum, basal ganglia, parietal, pre-frontal, pre-motor cortices and supplementary motor area[183-186]. Thus, multisensory stimulation with music therapy can improve NPS and autobiographic memory[40,106,142,143,168,187].

Raga has a defined rhythmicity. Raga composition is conventionally presented in two to three different rhythmic modes consisting of an arhythmic mode called "Aalap", followed by a second mode called "Gat" with a faster tempo with Raga-specific rhythmic cycles, followed by a third mode called "Tarana" with the fastest tempo of all with a specific rhythmic cycle, these rhythmic phases may produce differential rhythmic stimulation[47,145,148-150,158].

Arhythmic slow-tempo "Aalap" mode sets a mood for the selected follow-up Raga[148,150,158], while incremental modifications tempo/rhythm of "Gat" and "Tarana" modes differentially elevate the mood with gradual transition between lower-slower to higher-faster beats of Raga, inducing a "Controlled" mind-wandering state involving balanced switching between heightened mind wandering (attention to self) and reduced mind wandering (attention to music) states, respectively[48]. Such defined rhythmicity of Raga renders comprehensive brain entrainment, in contrast to electromagnetic single frequency stimulation.

The "Aalap" mode of Raga is usually less than 70 bpm (< normal heartbeat), is expected to produce calming effects. While the "Gat" mode of Raga is usually of 70 bpm (= normal heartbeat), will produce pleasurable/happy effects. The "Tarana" mode of a Raga on the other hand, is usually greater than 70 bpm (> normal heartbeat), which will produce excitement. Thus, Raga has an ability for comprehensive entrainment of slow/neutral/fast brainwaves[48,168].

Circadian Specificity of Raga

In addition to the above-mentioned specificities, each Raga has circadian specificity. Human physiology exhibits differential arousal patterns that match with circadian rhythms, with reduced arousal at night, rising arousal during the morning, peak arousal at mid-day, and declining pattern towards the end of the day. Traditionally, Ragas are designed to be performed at specific times of day, such as dawn, dusk, midday, evening, and night to match the bodily physiological rhythms, with the goal of obtaining peak-optimum effects of a given Raga[146,168,188,189].

Thus, Raga with various components described above can exert comprehensive effects on brain physiology ensuring enhanced health benefits,

which makes the Raga as an advanced therapy, not only for treating AD/ADRD, but also other disparities.

Postulated Raga Therapy for Alzheimer's Disease and Related Dementias

Current literature search revealed very few reports showing the effect of Indian classical music on brain in refining overall brain functions [47,190-193]. By and large, Raga Bhupali (also known as Bhoopali, Bhup or Bhoop) has been implicated in improving memory and cognition. Nagarajan et al. showed that listening to Raga Bhupali instilled "happy/joy" emotions, uplifted sad/low mood, and improved Wechsler memory scale as evidenced by increased attention and concentration[166]. Sarkar and co-workers showed that Raga Bhupali was effective in curing mental disorders[194]. Sanyal et al. reported that Raga Bhupali produced calm/joy effects and relieved tension[154,195]. Another study reported that Raga Bhupali induced alpha and theta brainwaves, increased memory, and reduced mental fatigue, stress, and anxiety[196]. Ahuja et al. showed that Raga Bhupali increased frontal and central alpha and theta brainwaves, lowered sympathetic activity, raised vagal tone, reduced anxiety, induced positivity, and exerted relaxing effects in patients suffering from Schizophrenia[197].

These findings strongly support the notion that Raga Bhupali may be a "Candidate Raga" that has an ability to correct alterations in alpha/theta coherence paralleling with improved working memory in MCI and AD[198-200], leading to cognitive betterment[201,202], and emotional upliftment[203].

In addition to the support from literature reviewed above, we also are certain of added benefits of Raga Bhupali exerted due to its notational structure (Swara structure)[148,149,158,159], and Raga-specific association with *Chakras* or "Yogic Energy Centers" linked to autonomic neuronal plexuses that govern the brain/body physiology[204-206].

Raga Bhupali is an Indian Classical Raga with a pentatonic scale (uses 5 notes-all notes Shuddha Swaras/major notes)[166,194]. The predominance of Shuddha Swaras (major notes) makes the Raga "Happy" and "Cheerful" [148,158,160], which modulates reward-driven music-memory consolidation[107,161], orchestrated by the activation of dopaminergic system in music-evoked pleasure[162,163]. Thus, Raga Bhupali can instill "happy/joy" emotions, uplifting sad/low mood, attributed to the presence of all five Shuddha Swaras. In addition, Raga Bhupali can induce devotional peacefulness due to the omission of "Ma" (a note associated with Cardiac plexus/*Anahata Chakra*, signifying love/affection), and "Ni" (associated with Carotid plexus/*Ajnya Chakra*, signifying lust) in its Swara structure[151,207,208], that can help increasing attention and concentration[166]. These effects get magnified if Raga Bhupali is performed/listened during its designated circadian window of the day between 6-9 PM[166,194].

Whilst todays Indian Classical Music is very commonly heard as Ragas, its existence and evolution is rooted in the ancient yogic system known as "Nada Yoga"[207-209]. Nada Yoga is the yogic practice of body-mind-spirit integration through internal/*Anahata* (such as mediation) or external/*Ahata* (such as mantras/chanting/music) sound(s), via vibration of specific energy centers (*Chakras*) resonating in the body through specific sound frequencies[207-210]. Integrative therapeutic use of Raga (*Raga Chikitsa/Therapy*) is a part of Nada Yoga, in which

defined melodic structure of a given Raga is aimed at synchronizing with its associated *Chakras* and vibrating/activating them[151,207,208]. There are seven prime *Chakras* having close correlation with autonomic nerve plexuses[205,206,210,211]. The scientific observations show near-perfect alignment of major autonomic nerve plexuses with each of the seven prime *Chakras*, as confirmed by cadaveric[212], electro-photonic[208] and contemplative cross-referencing[205,206]. Raga Bhupali is known to be associated with "*Ajnya Chakra*" or Eyebrow/ Third Eye Energy Center associated with Carotid plexus[205,206,208]. It is known as the "Sixth Sense", responsible for analytical reasoning, intelligence, rational thinking, intellectual ability, and cognition[205,206,208]. With these *Chakra*-associated qualities, Raga Bhupali is postulated to correct cognitive disabilities observed in AD/ADRD. Based on these facts, we theorize that the evening Raga Bhupali will be an effective disease modifying treatment for AD/ADRD.

Conclusions

The prevalence and incidence of Alzheimer's disease (AD) and Alzheimer's disease related dementias (ADRD) is on rise with increasing aged population around the globe. Besides existing limited benefits of symptomatic treatment(s) associated adversities, there is no cure for AD/ADRD. Therefore, there is an emerging interest in validating non-pharmacological therapies to treat AD/ADRD. Music constitutes one of such non-pharmacological therapies option that offers non-invasive, safe, and effective treatment. Many systemic reviews including PRISMA, PubMed/ MEDLINE, Cochrane, Scopus, and Science Direct databases, have revealed the therapeutic usefulness of music in alleviating not only AD/ADRD, but also other neurological disorders. Current review elucidated added health benefits of Indian Classical Music-Raga therapy, attributed to its defined notational-structure, rhythmic variability, circadian specificity, and its association with yogic "*Chakra*", in treating AD/ADRD and other disparities.

Conflict of Interest Statement:

The authors report no conflict of interests pertaining to this work.

Acknowledgement Statement:

Authors gratefully acknowledges the support provided by the Fulbright U.S. Scholar Program, U.S. Department of State and United States-India Educational Foundation (USIEF) Fulbright Commission, India. Its contents are solely the responsibility of the author and do not represent any official views of Fulbright Program, U.S., or USIEF. Authors acknowledge the support provided by the Indian Classical Music and Arts Foundation (ICMA), Mahesh Kale School of Music (MKSM), and Meridian Media, Sunnyvale, California, USA. Authors also acknowledge the support provided by the Department of Pediatrics, University of Illinois at Chicago, Chicago, IL, USA; and Department of Veterans Affairs, VA Healthcare System.

Funding Statement:

Neelima Chauhan (Fulbright-Nehru Academic and Professional Excellence Awardee; Grant #APE 2023-24 USIEF) gratefully acknowledges the support provided for this publication by the Fulbright U.S. Scholar Program, U.S. Department of State and United States-India Educational Foundation (USIEF) Fulbright Commission.

References:

1. Alzheimer's disease facts and figures-2023. *Alzheimers Dement.* 2023;19(4):1598-1695.

2. Monteiro AR, Barbosa DJ, Remiao F, Silva R. Alzheimer's disease: Insights and new prospects in disease pathophysiology, biomarkers and disease-modifying drugs. *Biochem Pharmacol.* 2023;211:115522.

3. Karkou V, Aithal S, Richards M, Hiley E, Meekums B. Dance movement therapy for dementia. *Cochrane Database Syst Rev.* 2023;8(8):CD011022.

4. Guidi J, Lucente M, Sonino N, Fava GA. Allostatic Load and Its Impact on Health: A Systematic Review. *Psychother Psychosom.* 2021;90(1):11-27.

5. Parker HW, Abreu AM, Sullivan MC, Vadiveloo MK. Allostatic Load and Mortality: A Systematic Review and Meta-Analysis. *Am J Prev Med.* 2022;63(1):131-140.

6. Misiak B, Loniewski I, Marlicz W, et al. The HPA axis dysregulation in severe mental illness: Can we shift the blame to gut microbiota? *Prog Neuropsychopharmacol Biol Psychiatry.* 2020;102:109951.

7. Bao AM, Swaab DF. The human hypothalamus in mood disorders: The HPA axis in the center. *IBRO Rep.* 2019;6:45-53.

8. Bao AM, Swaab DF. The stress systems in depression: a postmortem study. *Eur J Psychotraumatol.* 2014;5:26521.

9. Gasiorowska A, Wydrych M, Drapich P, et al. The Biology and Pathobiology of Glutamatergic, Cholinergic, and Dopaminergic Signaling in the Aging Brain. *Front Aging Neurosci.* 2021;13:654931.

10. Aquilani R, Cotta Ramusino M, Maestri R, et al. Several dementia subtypes and mild cognitive impairment share brain reduction of neurotransmitter precursor amino acids, impaired energy metabolism, and lipid hyperoxidation. *Front Aging Neurosci.* 2023;15:1237469.

11. Smith GS, Kuwabara H, Yan H, et al. Serotonin Degeneration and Amyloid-beta Deposition in Mild Cognitive Impairment: Relationship to Cognitive Deficits. *J Alzheimers Dis.* 2023;96(1):215-227.

12. Baik JH. Stress and the dopaminergic reward system. *Exp Mol Med.* 2020;52(12): 1879-1890.

13. Quessy F, Bittar T, Blanchette LJ, Levesque M, Labonte B. Stress-induced alterations of mesocortical and mesolimbic dopaminergic pathways. *Sci Rep.* 2021;11(1):11000.

14. D'Amico D, Amestoy ME, Fiocco AJ. The association between allostatic load and cognitive function: A systematic and meta-analytic review. *Psychoneuroendocrinology.* 2020;121:104849.

15. Lenart-Bugla M, Szczesniak D, Bugla B, et al. The association between allostatic load and brain: A systematic review. *Psychoneuroendocrinology.* 2022;145:105917.

16. Krashia P, Nobili A, D'Amelio M. Unifying Hypothesis of Dopamine Neuron Loss in Neurodegenerative Diseases: Focusing on Alzheimer's Disease. *Front Mol Neurosci.* 2019;12:123.

17. James T, Kula B, Choi S, Khan SS, Bekar LK, Smith NA. Locus coeruleus in memory formation and Alzheimer's disease. *Eur J Neurosci.* 2021;54(8):6948-6959.

18. Morgan DG, May PC, Finch CE. Dopamine and serotonin systems in human and rodent brain: effects of age and neurodegenerative disease. *J Am Geriatr Soc.* 1987;35(4):334-345.

19. Dahl MJ, Kulesza A, Werkle-Bergner M, Mather M. Declining locus coeruleus-dopaminergic and noradrenergic modulation of long-term memory in aging and Alzheimer's disease. *Neurosci Biobehav Rev.* 2023;153: 105358.

20. Chen APF, Chen L, Kim TA, Xiong Q. Integrating the Roles of Midbrain Dopamine Circuits in Behavior and Neuropsychiatric Disease. *Biomedicines.* 2021;9(6).

21. Paganini-Hill A, Bukhari S, Montine TJ, Corrada MM, Kawas CH. Alzheimer's Disease Neuropathologic Change and Vitamin Supplement Use Decades Earlier: The 90+ Study. *Alzheimer Dis Assoc Disord.* 2023;37 (1):1-6.

22. Ritchie K, Ritchie CW, Yaffe K, Skoog I, Scarmeas N. Is late-onset Alzheimer's disease really a disease of midlife? *Alzheimers Dement (N Y).* 2015;1(2):122-130.

23. Brucki SMD, Cesar-Freitas KG, Spera RR, Borges CR, Smid J. Are we ready to use anti-amyloid therapy in Alzheimer's disease? *Arq Neuropsiquiatr.* 2022;80(5 Suppl 1):15-23.

24. Liss JL, Seleri Assuncao S, Cummings J, et al. Practical recommendations for timely, accurate diagnosis of symptomatic Alzheimer's disease (MCI and dementia) in primary care: a review and synthesis. *J Intern Med.* 2021;290 (2):310-334.

25. Porsteinsson AP, Isaacson RS, Knox S, Sabbagh MN, Rubino I. Diagnosis of Early Alzheimer's Disease: Clinical Practice in 2021. *J Prev Alzheimers Dis.* 2021;8(3):371-386.

26. Khan S, Barve KH, Kumar MS. Recent Advancements in Pathogenesis, Diagnostics and Treatment of Alzheimer's Disease. *Curr Neuropharmacol.* 2020;18(11):1106-1125.

27. Pless A, Ware D, Saggu S, Rehman H, Morgan J, Wang Q. Understanding neuropsychiatric symptoms in Alzheimer's disease: challenges and advances in diagnosis and treatment. *Front Neurosci.* 2023;17:1263 771.

28. Iravani B, Abdollahi E, Eslamdoust-Siahestalkhi F, Soleimani R. Neuropsychiatric Symptoms of Alzheimer's Disease and Caregiver Burden. *Front Neurol.* 2022;13:877 143.

29. Breijyeh Z, Karaman R. Comprehensive Review on Alzheimer's Disease: Causes and Treatment. *Molecules.* 2020;25(24).

30. Petersen RC, Wiste HJ, Weigand SD, et al. NIA-AA Alzheimer's Disease Framework: Clinical Characterization of Stages. *Ann Neurol.* 2021;89(6):1145-1156.

31. Varadharajan A, Davis AD, Ghosh A, et al. Guidelines for pharmacotherapy in Alzheimer's disease - A primer on FDA-approved drugs. *J Neurosci Rural Pract.* 2023;14(4):566-573.

32. Behfar Q, Richter N, Kural M, et al. Improved connectivity and cognition due to cognitive stimulation in Alzheimer's disease. *Front Aging Neurosci.* 2023;15:1140975.

33. Ralph SJ, Espinet AJ. Increased All-Cause Mortality by Antipsychotic Drugs: Updated Review and Meta-Analysis in Dementia and General Mental Health Care. *J Alzheimers Dis Rep.* 2018;2(1):1-26.

34. Assuncao SS, Sperling RA, Ritchie C, et al. Meaningful benefits: a framework to assess disease-modifying therapies in preclinical and early Alzheimer's disease. *Alzheimers Res Ther.* 2022;14(1):54.

35. Fonte C, Smania N, Pedrinolla A, et al. Comparison between physical and cognitive

treatment in patients with MCI and Alzheimer's disease. *Aging (Albany NY).* 2019;11(10):3138-3155.

36. Blackman J, Swirski M, Clynes J, Harding S, Leng Y, Coulthard E. Pharmacological and non-pharmacological interventions to enhance sleep in mild cognitive impairment and mild Alzheimer's disease: A systematic review. *J Sleep Res.* 2021;30(4):e13229.

37. Berg-Weger M, Stewart DB. Non-Pharmacologic Interventions for Persons with Dementia. *Mo Med.* 2017;114(2):116-119.

38. Quail Z, Carter MM, Wei A, Li X. Management of cognitive decline in Alzheimer's disease using a non-pharmacological intervention program: A case report. *Medicine (Baltimore).* 2020;99(21):e20128.

39. Harrison TC, Blozis SA, Schmidt B, et al. Music Compared with Auditory Books: A Randomized Controlled Study Among Long-Term Care Residents with Alzheimer's Disease or Related Dementia. *J Am Med Dir Assoc.* 2021;22(7):1415-1420.

40. Matziorinis AM, Koelsch S. The promise of music therapy for Alzheimer's disease: A review. *Ann N Y Acad Sci.* 2022;1516(1):11-17.

41. Bleibel M, El Cheikh A, Sadier NS, Abou-Abbas L. The effect of music therapy on cognitive functions in patients with Alzheimer's disease: a systematic review of randomized controlled trials. *Alzheimers Res Ther.* 2023;15(1):65.

42. Nayak S, Coleman PL, Ladanyi E, et al. The Musical Abilities, Pleiotropy, Language, and Environment (MAPLE) Framework for Understanding Musicality-Language Links Across the Lifespan. *Neurobiol Lang (Camb).* 2022;3(4):615-664.

43. Gustavson DE, Coleman PL, Iversen JR, Maes HH, Gordon RL, Lense MD. Mental health and music engagement: review, framework, and guidelines for future studies. *Transl Psychiatry.* 2021;11(1):370.

44. Gonzalez-Hoelling S, Bertran-Noguer C, Reig-Garcia G, Suner-Soler R. Effects of a Music-Based Rhythmic Auditory Stimulation on Gait and Balance in Subacute Stroke. *Int J Environ Res Public Health.* 2021;18(4).

45. Mayer-Benarous H, Benarous X, Vonthron F, Cohen D. Music Therapy for Children With Autistic Spectrum Disorder and/or Other Neurodevelopmental Disorders: A Systematic Review. *Front Psychiatry.* 2021;12:643234.

46. Wang SG, Cevasco-Trotter AM, Silverman MJ, Yuan SH. A narrative review of music therapy for neuropsychiatric symptoms in Alzheimer's disease and rationale for protocolized music teletherapy. *Front Med (Lausanne).* 2023;10:1248245.

47. Babel S, Baral S, Srivastava A. Impact of Listening to Indian Classical Music, or Ragas, on the Electroencephalogram: A Meta-Analysis. *Cureus.* 2023;15(11):e49592.

48. Sharma S, Sasidharan A, Marigowda V, et al. Indian classical music with incremental variation in tempo and octave promotes better anxiety reduction and controlled mind wandering-A randomised controlled EEG study. *Explore (NY).* 2021;17(2):115-121.

49. Hendrix SB, Dickson SP. Editorial: Usefulness of Anchor Based Methods for Determining Clinically Meaningful Change in MCI due to AD. *J Prev Alzheimers Dis.* 2023;10(1):7-8.

50. Rafii MS, Aisen PS. Detection and treatment of Alzheimer's disease in its

preclinical stage. *Nat Aging.* 2023;3(5):520-531.

51. Tahami Monfared AA, Byrnes MJ, White LA, Zhang Q. Alzheimer's Disease: Epidemiology and Clinical Progression. *Neurol Ther.* 2022; 11(2):553-569.

52. Huang L, Huang Q, Xie F, Guo Q. Neuropsychiatric symptoms in Alzheimer's continuum and their association with plasma biomarkers. *J Affect Disord.* 2024;348:200-206.

53. Yoon EJ, Lee JY, Kwak S, Kim YK. Mild behavioral impairment linked to progression to Alzheimer's disease and cortical thinning in amnestic mild cognitive impairment. *Front Aging Neurosci.* 2022;14:1051621.

54. Papaliagkas V, Kalinderi K, Vareltzis P, Moraitou D, Papamitsou T, Chatzidimitriou M. CSF Biomarkers in the Early Diagnosis of Mild Cognitive Impairment and Alzheimer's Disease. *Int J Mol Sci.* 2023;24(10).

55. Sperling RA, Donohue MC, Raman R, et al. Association of Factors With Elevated Amyloid Burden in Clinically Normal Older Individuals. *JAMA Neurol.* 2020;77(6):735-745.

56. Vermunt L, Sikkes SAM, van den Hout A, et al. Duration of preclinical, prodromal, and dementia stages of Alzheimer's disease in relation to age, sex, and APOE genotype. *Alzheimers Dement.* 2019;15(7):888-898.

57. Petersen RC, Lopez O, Armstrong MJ, et al. Practice guideline update summary: Mild cognitive impairment: Report of the Guideline Development, Dissemination, and Implementation Subcommittee of the American Academy of Neurology. *Neurology.* 2018;90(3):126-135.

58. Du C, Dang M, Chen K, Chen Y, Zhang Z. Divergent brain regional atrophy and associated fiber disruption in amnestic and non-amnestic MCI. *Alzheimers Res Ther.* 2023;15(1):199.

59. Albin RL, Burke JF, Koeppe RA, Giordani B, Gilman S, Frey KA. Assessing mild cognitive impairment with amyloid and dopamine terminal molecular imaging. *J Nucl Med.* 2013;54(6): 887-893.

60. Guzman-Ramos K, Osorio-Gomez D, Bermudez-Rattoni F. Cognitive Impairment in Alzheimer's and Metabolic Diseases: A Catecholaminergic Hypothesis. *Neuroscience.* 2022;497:308-323.

61. Blanco K, Salcidua S, Orellana P, et al. Systematic review: fluid biomarkers and machine learning methods to improve the diagnosis from mild cognitive impairment to Alzheimer's disease. *Alzheimers Res Ther.* 2023;15(1):176.

62. Brito DVC, Esteves F, Rajado AT, et al. Assessing cognitive decline in the aging brain: lessons from rodent and human studies. *NPJ Aging.* 2023;9(1):23.

63. Lewis S. Unfolding cognitive decline mechanisms. *Nat Rev Neurosci.* 2023;24(7): 394.

64. Krivanek TJ, Gale SA, McFeeley BM, Nicastri CM, Daffner KR. Promoting Successful Cognitive Aging: A Ten-Year Update. *J Alzheimers Dis.* 2021;81(3):871-920.

65. Cohen RA, Marsiske MM, Smith GE. Neuropsychology of aging. *Handb Clin Neurol.* 2019;167:149-180.

66. Soldan A, Pettigrew C, Zhu Y, et al. Association of Lifestyle Activities with Functional Brain Connectivity and Relationship to Cognitive Decline among Older Adults. *Cereb Cortex.* 2021;31(12):5637-5651.

67. Schnellbacher GJ, Hoffstaedter F, Eickhoff SB, et al. Functional Characterization

of Atrophy Patterns Related to Cognitive Impairment. *Front Neurol.* 2020;11:18.

68. Tao J, Liu J, Chen X, et al. Mind-body exercise improves cognitive function and modulates the function and structure of the hippocampus and anterior cingulate cortex in patients with mild cognitive impairment. *Neuroimage Clin.* 2019;23:101834.

69. Bubb EJ, Metzler-Baddeley C, Aggleton JP. The cingulum bundle: Anatomy, function, and dysfunction. *Neurosci Biobehav Rev.* 2018;92:104-127.

70. Sala A, Caminiti SP, Presotto L, et al. In vivo human molecular neuroimaging of dopaminergic vulnerability along the Alzheimer's disease phases. *Alzheimers Res Ther.* 2021;13 (1):187.

71. Taylor WD, Zald DH, Felger JC, et al. Influences of dopaminergic system dysfunction on late-life depression. *Mol Psychiatry.* 2021.

72. Mariggio MA, Palumbi R, Vinella A, et al. DRD1 and DRD2 Receptor Polymorphisms: Genetic Neuromodulation of the Dopaminergic System as a Risk Factor for ASD, ADHD and ASD/ADHD Overlap. *Front Neurosci.* 2021;15:705890.

73. Kosillo P, Bateup HS. Dopaminergic Dysregulation in Syndromic Autism Spectrum Disorders: Insights From Genetic Mouse Models. *Front Neural Circuits.* 2021;15:700 968.

74. Paval D, Miclutia IV. The Dopamine Hypothesis of Autism Spectrum Disorder Revisited: Current Status and Future Prospects. *Dev Neurosci.* 2021;43(2):73-83.

75. Huang Y, Yu S, Wilson G, et al. Altered Extended Locus Coeruleus and Ventral Tegmental Area Networks in Boys with Autism Spectrum Disorders: A Resting-State Functional Connectivity Study. *Neuropsychiatr Dis Treat.* 2021;17:1207-1216.

76. Berry AS, Shah VD, Baker SL, et al. Aging Affects Dopaminergic Neural Mechanisms of Cognitive Flexibility. *J Neurosci.* 2016;36(50): 12559-12569.

77. Backman L, Lindenberger U, Li SC, Nyberg L. Linking cognitive aging to alterations in dopamine neurotransmitter functioning: recent data and future avenues. *Neurosci Biobehav Rev.* 2010;34(5):670-677.

78. Ciampa CJ, Parent JH, Lapoint MR, et al. Elevated Dopamine Synthesis as a Mechanism of Cognitive Resilience in Aging. *Cereb Cortex.* 2021.

79. De Marco M, Venneri A. Volume and Connectivity of the Ventral Tegmental Area are Linked to Neurocognitive Signatures of Alzheimer's Disease in Humans. *J Alzheimers Dis.* 2018;63(1):167-180.

80. D'Amelio M, Puglisi-Allegra S, Mercuri N. The role of dopaminergic midbrain in Alzheimer's disease: Translating basic science into clinical practice. *Pharmacol Res.* 2018; 130:414-419.

81. Lubec J, Kalaba P, Hussein AM, et al. Reinstatement of synaptic plasticity in the aging brain through specific dopamine transporter inhibition. *Mol Psychiatry.* 2021.

82. Meyer PT, Frings L, Rucker G, Hellwig S. (18)F-FDG PET in Parkinsonism: Differential Diagnosis and Evaluation of Cognitive Impairment. *J Nucl Med.* 2017;58(12):1888-1898.

83. Klein MO, Battagello DS, Cardoso AR, Hauser DN, Bittencourt JC, Correa RG. Dopamine: Functions, Signaling, and Association

with Neurological Diseases. *Cell Mol Neurobiol.* 2019;39(1):31-59.

84. Serra L, D'Amelio M, Esposito S, et al. Ventral Tegmental Area Disconnection Contributes Two Years Early to Correctly Classify Patients Converted to Alzheimer's Disease: Implications for Treatment. *J Alzheimers Dis.* 2021;82(3):985-1000.

85. Nobili A, Latagliata EC, Viscomi MT, et al. Dopamine neuronal loss contributes to memory and reward dysfunction in a model of Alzheimer's disease. *Nat Commun.* 2017;8:14727.

86. Morgese MG, Trabace L. Monoaminergic System Modulation in Depression and Alzheimer's Disease: A New Standpoint? *Front Pharmacol.* 2019;10:483.

87. Matchett BJ, Grinberg LT, Theofilas P, Murray ME. The mechanistic link between selective vulnerability of the locus coeruleus and neurodegeneration in Alzheimer's disease. *Acta Neuropathol.* 2021;141(5):631-650.

88. Dahl MJ, Bachman SL, Dutt S, et al. The integrity of dopaminergic and noradrenergic brain regions is associated with different aspects of late-life memory performance. *Nat Aging.* 2023;3(9):1128-1143.

89. Shaikh A, Ahmad F, Teoh SL, Kumar J, Yahaya MF. Targeting dopamine transporter to ameliorate cognitive deficits in Alzheimer's disease. *Front Cell Neurosci.* 2023;17:1292 858.

90. Cabib S, Latagliata C, Orsini C. Role of Stress-Related Dopamine Transmission in Building and Maintaining a Protective Cognitive Reserve. *Brain Sci.* 2022;12(2).

91. Se Thoe E, Fauzi A, Tang YQ, Chamyuang S, Chia AYY. A review on advances of treatment modalities for Alzheimer's disease. *Life Sci.* 2021;276:119129.

92. Athar T, Al Balushi K, Khan SA. Recent advances on drug development and emerging therapeutic agents for Alzheimer's disease. *Mol Biol Rep.* 2021;48(7):5629-5645.

93. Dhillon S. Aducanumab: First Approval. *Drugs.* 2021;81(12):1437-1443.

94. Rabinovici GD. Controversy and Progress in Alzheimer's Disease - FDA Approval of Aducanumab. *N Engl J Med.* 2021;385(9): 771-774.

95. Wichniak A, Samochowiec J, Szulc A, et al. The position statement of the Working Group of the Polish Psychiatric Association on the use of D2/D3 dopamine receptor partial agonists in the treatment of mental disorders. *Psychiatr Pol.* 2021;55(5):941-966.

96. Chen YJ, Chang MC, Jhang KM, Wang WF, Liao YC. Neuropsychiatric Symptoms Predict Faster Cognitive Decline in Dementia Collaborative Care Than Antipsychotic Use. *Neuropsychiatr Dis Treat.* 2024;20:689-696.

97. Ippoliti I, Ancidoni A, Da Cas R, Pierantozzi A, Vanacore N, Trotta F. Anti-dementia drugs: a descriptive study of the prescription pattern in Italy. *Neurol Sci.* 2023; 44(5):1587-1595.

98. Watt JA, Goodarzi Z, Veroniki AA, et al. Comparative Efficacy of Interventions for Aggressive and Agitated Behaviors in Dementia: A Systematic Review and Network Meta-analysis. *Ann Intern Med.* 2019;171(9): 633-642.

99. van den Elsen GA, Ahmed AI, Verkes RJ, et al. Tetrahydrocannabinol for neuropsychiatric symptoms in dementia: A randomized controlled trial. *Neurology.* 2015;84(23):2338-2346.

100. Savaskan E, Mueller H, Hoerr R, von Gunten A, Gauthier S. Treatment effects of

Ginkgo biloba extract EGb 761(R) on the spectrum of behavioral and psychological symptoms of dementia: meta-analysis of randomized controlled trials. *Int Psychogeriatr.* 2018;30(3):285-293.

101. O'Connor DW, Eppingstall B, Taffe J, van der Ploeg ES. A randomized, controlled cross-over trial of dermally-applied lavender (Lavandula angustifolia) oil as a treatment of agitated behaviour in dementia. *BMC Complement Altern Med.* 2013;13:315.

102. Watson K, Hatcher D, Good A. A randomised controlled trial of Lavender (Lavandula Angustifolia) and Lemon Balm (Melissa Officinalis) essential oils for the treatment of agitated behaviour in older people with and without dementia. *Complement Ther Med.* 2019;42:366-373.

103. Brueggen K, Kasper E, Ochmann S, et al. Cognitive Rehabilitation in Alzheimer's Disease: A Controlled Intervention Trial. *J Alzheimers Dis.* 2017;57(4):1315-1324.

104. Jung YH, Lee S, Kim WJ, Lee JH, Kim MJ, Han HJ. Effect of Integrated Cognitive Intervention Therapy in Patients with Mild to Moderate Alzheimer's Disease. *Dement Neurocogn Disord.* 2020;19(3):86-95.

105. Ouldred E, Bryant C. Dementia care. Part 2: understanding and managing behavioural challenges. *Br J Nurs.* 2008;17(4):242-247.

106. Popa LC, Manea MC, Velcea D, Salapa I, Manea M, Ciobanu AM. Impact of Alzheimer's Dementia on Caregivers and Quality Improvement through Art and Music Therapy. *Healthcare (Basel).* 2021;9(6).

107. Ferreri L, Mas-Herrero E, Cardona G, et al. Dopamine modulations of reward-driven music memory consolidation. *Ann N Y Acad Sci.* 2021;1502(1):85-98.

108. Arroyo-Anllo EM, Dauphin S, Fargeau MN, Ingrand P, Gil R. Music and emotion in Alzheimer's disease. *Alzheimers Res Ther.* 2019;11(1):69.

109. Mas-Herrero E, Dagher A, Farres-Franch M, Zatorre RJ. Unraveling the Temporal Dynamics of Reward Signals in Music-Induced Pleasure with TMS. *J Neurosci.* 2021;41(17): 3889-3899.

110. Chanda ML, Levitin DJ. The neurochemistry of music. *Trends Cogn Sci.* 2013;17(4):179-193.

111. Groarke JM, Hogan MJ. Development and Psychometric Evaluation of the Adaptive Functions of Music Listening Scale. *Front Psychol.* 2018;9:516.

112. Haslbeck FB, Jakab A, Held U, Bassler D, Bucher HU, Hagmann C. Creative music therapy to promote brain function and brain structure in preterm infants: A randomized controlled pilot study. *Neuroimage Clin.* 2020;25:102171.

113. Sutcliffe R, Du K, Ruffman T. Music Making and Neuropsychological Aging: A Review. *Neurosci Biobehav Rev.* 2020;113:4 79-491.

114. Nobakht N, Kamgar M, Tavanaei M, Bilder RM, Nobakht E. Music and Medicine: Promoting Harmony for Health. *Am J Med.* 2024;137(2):92-98.

115. Siemer CP, Siemer LC, Schlesinger JJ. Music in Medicine: Novel Use of an Ancient Medium. *Anesth Analg.* 2023;137(3):708-713.

116. Lorek M, Bak D, Kwiecien-Jagus K, Medrzycka-Dabrowska W. The Effect of Music as a Non-Pharmacological Intervention on the Physiological, Psychological, and Social Response of Patients in an Intensive Care Unit. *Healthcare (Basel).* 2023;11(12).

117. Yin Z, Li Y, Bao Q, et al. Comparative efficacy of multiple non-pharmacological interventions for behavioural and psychological symptoms of dementia: A network meta-analysis of randomised controlled trials. *Int J Ment Health Nurs.* 2023.

118. Rossi E, Marrosu F, Saba L. Music Therapy as a Complementary Treatment in Patients with Dementia Associated to Alzheimer's Disease: A Systematic Review. *J Alzheimers Dis.* 2024;98(1):33-51.

119. Paul D, Agrawal R, Singh S. Alzheimer's disease and clinical trials. *J Basic Clin Physiol Pharmacol.* 2024;35(1-2):31-44.

120. Deng Y, Wang H, Gu K, Song P. Alzheimer's disease with frailty: Prevalence, screening, assessment, intervention strategies and challenges. *Biosci Trends.* 2023;17(4):283-292.

121. Boxer AL, Sperling R. Accelerating Alzheimer's therapeutic development: The past and future of clinical trials. *Cell.* 2023;186(22):4757-4772.

122. Liu N, Liang X, Chen Y, Xie L. Recent trends in treatment strategies for Alzheimer(')s disease and the challenges: A topical advancement. *Ageing Res Rev.* 2024;94:102 199.

123. Lin TH, Liao YC, Tam KW, Chan L, Hsu TH. Effects of music therapy on cognition, quality of life, and neuropsychiatric symptoms of patients with dementia: A systematic review and meta-analysis of randomized controlled trials. *Psychiatry Res.* 2023;329:115498.

124. Aalbers S, Fusar-Poli L, Freeman RE, et al. Music therapy for depression. *Cochrane Database Syst Rev.* 2017;11(11):CD004517.

125. Reschke-Hernandez AE, Gfeller K, Oleson J, Tranel D. Music Therapy Increases Social and Emotional Well-Being in Persons With Dementia: A Randomized Clinical Crossover Trial Comparing Singing to Verbal Discussion. *J Music Ther.* 2023;60(3):314-342.

126. Pac Soo V, Baker FA, Sousa TV, et al. Statistical analysis plan for HOMESIDE: a randomised controlled trial for home-based family caregiver-delivered music and reading interventions for people living with dementia. *Trials.* 2023;24(1):316.

127. Baker FA, Pac Soo V, Bloska J, et al. Home-based family caregiver-delivered music and reading interventions for people living with dementia (HOMESIDE trial): an international randomised controlled trial. *EClinicalMedicine.* 2023;65:102224.

128. Sarkamo T. Cognitive, emotional, and neural benefits of musical leisure activities in aging and neurological rehabilitation: A critical review. *Ann Phys Rehabil Med.* 2018;61(6):414-418.

129. Vanstone AD, Cuddy LL, Duffin JM, Alexander E. Exceptional preservation of memory for tunes and lyrics: case studies of amusia, profound deafness, and Alzheimer's disease. *Ann N Y Acad Sci.* 2009;1169:291-294.

130. Groussard M, Viader F, Landeau B, Desgranges B, Eustache F, Platel H. Neural correlates underlying musical semantic memory. *Ann N Y Acad Sci.* 2009;1169:278-281.

131. Jacobsen JH, Stelzer J, Fritz TH, Chetelat G, La Joie R, Turner R. Why musical memory can be preserved in advanced Alzheimer's disease. *Brain.* 2015;138(Pt 8):2438-2450.

132. Baird A, Samson S. Music and dementia. *Prog Brain Res.* 2015;217:207-235.

133. Simmons-Stern NR, Deason RG, Brandler BJ, et al. Music-based memory enhancement

in Alzheimer's disease: promise and limitations. *Neuropsychologia.* 2012;50(14):3295-3303.

134. Deason RG, Strong JV, Tat MJ, Simmons-Stern NR, Budson AE. Explicit and implicit memory for music in healthy older adults and patients with mild Alzheimer's disease. *J Clin Exp Neuropsychol.* 2019;41(2):158-169.

135. de la Rubia Orti JE, Garcia-Pardo MP, Iranzo CC, et al. Does Music Therapy Improve Anxiety and Depression in Alzheimer's Patients? *J Altern Complement Med.* 2018;24(1):33-36.

136. Abraha I, Rimland JM, Trotta FM, et al. Systematic review of systematic reviews of non-pharmacological interventions to treat behavioural disturbances in older patients with dementia. The SENATOR-OnTop series. *BMJ Open.* 2017;7(3):e012759.

137. Leggieri M, Thaut MH, Fornazzari L, et al. Music Intervention Approaches for Alzheimer's Disease: A Review of the Literature. *Front Neurosci.* 2019;13:132.

138. Gomez Gallego M, Gomez Garcia J. Music therapy and Alzheimer's disease: Cognitive, psychological, and behavioural effects. *Neurologia.* 2017;32(5):300-308.

139. van der Steen JT, van Soest-Poortvliet MC, van der Wouden JC, Bruinsma MS, Scholten RJ, Vink AC. Music-based therapeutic interventions for people with dementia. *Cochrane Database Syst Rev.* 2017;5(5):CD 003477.

140. van der Steen JT, Smaling HJ, van der Wouden JC, Bruinsma MS, Scholten RJ, Vink AC. Music-based therapeutic interventions for people with dementia. *Cochrane Database Syst Rev.* 2018;7(7):CD003477.

141. Garcia-Casares N, Moreno-Leiva RM, Garcia-Arnes JA. [Music therapy as a non-pharmacological treatment in Alzheimer's disease. A systematic review]. *Rev Neurol.* 2017;65(12):529-538.

142. Colverson AJ, Trifilio E, Williamson JB. Music, Mind, Mood, and Mingling in Alzheimer's Disease and Related Dementias: A Scoping Review. *J Alzheimers Dis.* 2022;86(4):1569-1588.

143. Yang H, Luo Y, Hu Q, Tian X, Wen H. Benefits in Alzheimer's Disease of Sensory and Multisensory Stimulation. *J Alzheimers Dis.* 2021;82(2):463-484.

144. Brancatisano O, Baird A, Thompson WF. Why is music therapeutic for neurological disorders? The Therapeutic Music Capacities Model. *Neurosci Biobehav Rev.* 2020;112: 600-615.

145. Ganguli KK, Rao P. On the perception of raga motifs by trained musicians. *J Acoust Soc Am.* 2019;145(4):2418.

146. Konsam M, Praharaj SK, Panda S, Shetty J, Ravishankar N, D'Souza SRB. Effectiveness of health literacy and relaxing music on quality of sleep and risk for antenatal depression. *Indian J Psychiatry.* 2023;65(10):1035-1043.

147. Castellano MA, Bharucha JJ, Krumhansl CL. Tonal hierarchies in the music of north India. *J Exp Psychol Gen.* 1984;113(3):394-412.

148. Valla JM, Alappatt JA, Mathur A, Singh NC. Music and Emotion-A Case for North Indian Classical Music. *Front Psychol.* 2017;8: 2115.

149. Midya V, Valla J, Balasubramanian H, Mathur A, Singh NC. Cultural differences in the use of acoustic cues for musical emotion experience. *PLoS One.* 2019;14(9):e0222380.

150. Rohrmeier M, Widdess R. Incidental Learning of Melodic Structure of North Indian Music. *Cogn Sci.* 2017;41(5):1299-1327.

151. Balasubramanian SV, Balasubramanian G, Ramanathan G. Integrative Medicine System Based on Music. *Altern Ther Health Med.* 2016;22 Suppl 1:14-23.

152. Gandhe V, Tare M. Therapeutic effects of ancient Indian classical music. *Indian Journal of Applied Research*. 2020;10(8):41-43.

153. Desai NM, Sanjay H, Desai DM, Kunikullaya K, Sinha AK. An Overview of the Indian System of Raagas and their Positive Effects on Health. *Journal of Drugs Addiction & Therapeutics SRC/JDAT-112 Page.* 2021;3: 3-6.

154. Sanyal S, Banerjee A, Basu M, Nag S, Ghosh D, Karmakar S. Do musical notes correlate with emotions? A neuro-acoustical study with Indian classical music. Paper presented at: Proceedings of Meetings on Acoustics 179AS A2020.

155. Kaufmann W. Rasa, rāga-mālā and performance times in North Indian rāgas. *Ethnomusicology.* 1965;9(3):272-291.

156. Hegde S. Music therapy for mental disorder and mental health: the untapped potential of Indian classical music. *BJPsych Int.* 2017;14(2):31-33.

157. Krishnaswamy A. Application of pitch tracking to South Indian classical music. Paper presented at: 2003 International Conference on Multimedia and Expo. ICME'03. Proceedings (Cat. No. 03TH8698)2003.

158. Mathur A, Vijayakumar SH, Chakrabarti B, Singh NC. Emotional responses to Hindustani raga music: the role of musical structure. *Front Psychol.* 2015;6:513.

159. Schofield KB. Emotions in Indian music history: anxiety in late Mughal Hindustan. *South Asian Hist Cult.* 2021;12(2-3):182-205.

160. Bowling DL, Sundararajan J, Han S, Purves D. Expression of emotion in Eastern and Western music mirrors vocalization. *PLoS One.* 2012;7(3):e31942.

161. Ferreri L, Rodriguez-Fornells A. Memory modulations through musical pleasure. *Ann N Y Acad Sci.* 2022;1516(1):5-10.

162. Ferreri L, Mas-Herrero E, Zatorre RJ, et al. Dopamine modulates the reward experiences elicited by music. *Proc Natl Acad Sci U S A.* 2019;116(9):3793-3798.

163. Salimpoor VN, Benovoy M, Larcher K, Dagher A, Zatorre RJ. Anatomically distinct dopamine release during anticipation and experience of peak emotion to music. *Nat Neurosci.* 2011;14(2):257-262.

164. Sharma YMaAK. Effects of Music on Mental Health and Longevity. *World Journal of Pharmaceutical Research.* 2020;9(4):305-312.

165. Karuna N, Srinivasan TM, Nagendra H. Review of Rāgās and its Rasās in Indian music and its possible applications in therapy. *International Journal of Yoga-Philosophy, Psychology and Parapsychology.* 2013;1(1): 21.

166. Nagarajan K, Srinivasan TM, Ramarao NH. Immediate effect of listening to Indian raga on attention and concentration in healthy college students: A comparative study. *Journal of Health Research and Reviews.* 2015;2(3): 103.

167. Nayar S. *Bhatkhande's contribution to music: A historical perspective.* Popular Prakashan; 1989.

168. Jumisree Sarmah Pathak AKS. Therapeutic Effects of Hindustani Classical Music with Reference to Raga Drabari Kanada, Raga Bageshree and Raga Malkauns. *GAP*

BODHI TARU-A Global Journal of Humanities-Special Issue on Indian Knowledge System. 2023;VI:104-109.

169. Priyadarshini S. How Hindustani classical ragas tickle our emotions. *Published online 8 May 2015.* 2015.

170. Moore S. *A Comparative Study of the Flat Second Pitch Degree in North Indian Classical, Ottoman Or Arabian Influenced, Western, Heavy Metal and Film Musics*, University of Sheffield, Department of Music; 2014.

171. Blood AJ, Zatorre RJ. Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion. *Proc Natl Acad Sci U S A.* 2001;98(20):11818-11823.

172. Koelsch S. Investigating the Neural Encoding of Emotion with Music. *Neuron.* 2018;98(6):1075-1079.

173. Zatorre RJ. Musical pleasure and reward: mechanisms and dysfunction. *Ann N Y Acad Sci.* 2015;1337:202-211.

174. Mallik A, Chanda ML, Levitin DJ. Anhedonia to music and mu-opioids: Evidence from the administration of naltrexone. *Sci Rep.* 2017;7:41952.

175. Hanba C, Hanba D. Opioid and Drug Prevalence in Top 40's Music: A 30 Year Review. *J Am Board Fam Med.* 2018;31(5): 761-767.

176. Mas-Herrero E, Ferreri L, Cardona G, et al. The role of opioid transmission in music-induced pleasure. *Ann N Y Acad Sci.* 2022.

177. Caria A, Venuti P, de Falco S. Functional and dysfunctional brain circuits underlying emotional processing of music in autism spectrum disorders. *Cereb Cortex.* 2011;21 (12):2838-2849.

178. Craig AD. How do you feel--now? The anterior insula and human awareness. *Nat Rev Neurosci.* 2009;10(1):59-70.

179. Nomi JS, Molnar-Szakacs I, Uddin LQ. Insular function in autism: Update and future directions in neuroimaging and interventions. *Prog Neuropsychopharmacol Biol Psychiatry.* 2019;89:412-426.

180. Usui C, Kirino E, Tanaka S, et al. Music Intervention Reduces Persistent Fibromyalgia Pain and Alters Functional Connectivity Between the Insula and Default Mode Network. *Pain Med.* 2020;21(8):1546-1552.

181. Alluri V, Toiviainen P, Jaaskelainen IP, Glerean E, Sams M, Brattico E. Large-scale brain networks emerge from dynamic processing of musical timbre, key and rhythm. *Neuroimage.* 2012;59(4):3677-3689.

182. Toiviainen P, Alluri V, Brattico E, Wallentin M, Vuust P. Capturing the musical brain with Lasso: Dynamic decoding of musical features from fMRI data. *Neuroimage.* 2014;88:170-180.

183. Grahn JA. Neural mechanisms of rhythm perception: current findings and future perspectives. *Top Cogn Sci.* 2012;4(4):585-606.

184. Schlaug G. Musicians and music making as a model for the study of brain plasticity. *Prog Brain Res.* 2015;217:37-55.

185. Olshansky MP, Bar RJ, Fogarty M, DeSouza JF. Supplementary motor area and primary auditory cortex activation in an expert break-dancer during the kinesthetic motor imagery of dance to music. *Neurocase.* 2015;21(5):607-617.

186. Chen X, Liu F, Yan Z, et al. Therapeutic effects of sensory input training on motor

function rehabilitation after stroke. *Medicine (Baltimore).* 2018;97(48):e13387.

187. Lopis D, Le Pape T, Manetta C, Conty L. Sensory Cueing of Autobiographical Memories in Normal Aging and Alzheimer's Disease: A Comparison Between Visual, Auditory, and Olfactory Information. *J Alzheimers Dis.* 2021; 80(3):1169-1183.

188. Sharma A, Moon E, Kim G, Kang SU. Perspectives of Circadian-Based Music Therapy for the Pathogenesis and Symptomatic Treatment of Neurodegenerative Disorders. *Front Integr Neurosci.* 2021;15:769142.

189. Agrawal T, Shanahan, D., Huron, D., & Keller, H. . Time-of-day practices echo circadian physiological arousal: An enculturated embodied practice in Hindustani classical music. *Musicae Scientiae.* 2023;27(1):70-93.

190. Ram K. Nawasalkar1 PKB. Analytical and Comparative Study on effect of Indian Classical Music on human body using EEG based signals. *International Journal of Modern Engineering Research (IJMER)* 2012;2(5):3289 -3291.

191. Ghosh A, Singh S, S M, Jagtap T, Issac TG. Music and the aging brain - Exploring the role of long-term Carnatic music training on cognition and gray matter volumes. *J Neurosci Rural Pract.* 2024;15(2):327-333.

192. Gupta A, Bhushan B, Behera L. Neural response to sad autobiographical recall and sad music listening post recall reveals distinct brain activation in alpha and gamma bands. *PLoS One.* 2023;18(1):e0279814.

193. Dharmadhikari AS, Tandle AL, Jaiswal SV, Sawant VA, Vahia VN, Jog N. Frontal Theta Asymmetry as a Biomarker of Depression. *East Asian Arch Psychiatry.* 2018;28(1):17-22.

194. Sarkar J BU. An effect of Raga Therapy on our human body. *Journal of Humanities and Social Science Research.* 2015;1(1):40-43.

195. Sanyal S, Nag S, Banerjee A, Sengupta R, Ghosh D. Music of brain and music on brain: a novel EEG sonification approach. *Cogn Neurodyn.* 2019;13(1):13-31.

196. Shyam N. The Impact of Hindustani raga Sangit on the Human Brain. *International Journal of Interdisciplinary and Multidisciplinary Studies (IJIMS).* 2021;8(2):70-74.

197. Ahuja S, Gupta RK, Damodharan D, et al. Effect of music listening on P300 event-related potential in patients with schizophrenia: A pilot study. *Schizophr Res.* 2020;216:85-96.

198. Mazaheri A, Segaert K, Olichney J, et al. EEG oscillations during word processing predict MCI conversion to Alzheimer's disease. *Neuroimage Clin.* 2018;17:188-197.

199. Wang R, Wang J, Yu H, Wei X, Yang C, Deng B. Decreased coherence and functional connectivity of electroencephalograph in Alzheimer's disease. *Chaos.* 2014;24(3):033136.

200. Guntekin B, Saatci E, Yener G. Decrease of evoked delta, theta and alpha coherences in Alzheimer patients during a visual oddball paradigm. *Brain Res.* 2008;1235:109-116.

201. Garces P, Angel Pineda-Pardo J, Canuet L, et al. The Default Mode Network is functionally and structurally disrupted in amnestic mild cognitive impairment - a bimodal MEG-DTI study. *Neuroimage Clin.* 2014;6:214-221.

202. Richardson GE, Jessup GT, Beall BS, Reilley RR, Nixon CJ. Assessment methods and procedures in corporate health programs. *Health Educ.* 1986;17(1):22-26.

203. Guntekin B, Hanoglu L, Akturk T, et al. Impairment in recognition of emotional facial

expressions in Alzheimer's disease is represented by EEG theta and alpha responses. *Psychophysiology*. 2019;56(11):e13434.

204. Patra S. Sukshma sareera (Astral Body) beyond our comprehension. *International Journal of Yoga-Philosophy, Psychology and Parapsychology*. 2017;5(2):29-29.

205. Loizzo JJ. The subtle body: an interoceptive map of central nervous system function and meditative mind-brain-body integration. *Ann N Y Acad Sci.* 2016;1373(1): 78-95.

206. Loizzo J. Meditation research, past, present, and future: perspectives from the Nalanda contemplative science tradition. *Ann N Y Acad Sci.* 2014;1307(1):43-54.

207. Sanivarapu SL. India's rich musical heritage has a lot to offer to modern psychiatry. *Indian J Psychiatry*. 2015;57(2):210-213.

208. Veerabrahmachar R, Bista S, Bokde R, Jasti N, Bhargav H, Bista S. Immediate Effect of Nada Yoga Meditation on Energy Levels and Alignment of Seven Chakras as Assessed by Electro-photonic Imaging: A Randomized Controlled Crossover Pilot Study. *Adv Mind Body Med*. 2023;37(1):11-16.

209. Mikes S. Nada Yoga. *[https://stephanmikescom]*. 2022.

210. Leadbeater C. *The Chakras*. Vol Second Edition. Second Edition ed. Theosophical Publishing House, Wheaton, IL, USA: Quest Books; 2013.

211. Shannahoff-Khalsa D. Lateralized rhythms of the central and autonomic nervous systems. *Int J Psychophysiol.* 1991;11(3):225-251.

212. Sweta KM, Awasthi HH, Godbole A, Prajapati S. Physio-anatomical resemblance of inferior hypogastric plexus with Muladhara Chakra: A cadaveric study. *Ayu*. 2017;38(1-2):7-9.