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Impact Of Indian Music On Animal Behavior And Physiology: An Integrative Review

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Abstract
Indian music, with its intricate ragas and rhythmic talas, has long been recognized for its emotional and physiological effects in humans. However, its influence on animal behavior and physiology remains largely unexplored. While studies on Western classical music suggest stress reduction and enhanced well-being in animals, empirical data on the effects of Indian music are scarce. This review synthesizes existing literature to assess potential behavioral and physiological responses of animals to Indian music, particularly in domestic, captive, and agricultural contexts.
Preliminary findings suggest that specific ragas may induce relaxation, alleviate stress, and enhance cognitive functions in animals, yet most evidence remains anecdotal or limited to small-scale studies. Research gaps include the lack of controlled trials, long-term assessments, and species-specific responses. Advances in bioacoustics and artificial intelligence could refine methodologies to analyze music's impact on animal cognition and stress modulation.
The findings have practical implications for veterinary care, animal therapy, conservation, and livestock management. By integrating interdisciplinary approaches—including ethology, neuroscience, and musicology—future research can establish a scientific framework for utilizing Indian music to enhance animal welfare. This review underscores the need for structured methodologies to explore its therapeutic potential in ethical and sustainable animal care practices.

Keywords: Indian Music, Animal Behavior, Animal Physiology, Ragas and Animals, Music and Animals.

Introduction

Music has long been recognized as a potent influence on human emotions and physiological states, and research suggests that animals may also respond to auditory stimuli in meaningful ways. While numerous studies have examined the impact of Western classical and contemporary music on animal well-being, the effects of Indian music—characterized by intricate ragas, rhythmic talas, and diverse traditional instruments—remain largely underexplored (Patel, 2008).
Most studies on music's effects on animals have focused on Western genres, showing that classical music reduces stress in dogs (Bowman et al., 2017), improves milk production in dairy cows (Ciborowska et al., 2021), and enhances well-being in captive animals (Kogan et al., 2012). However, given Indian music's unique emphasis on mood induction through specific tonal and rhythmic structures, it is imperative to examine how animals perceive and respond to these musical elements (Clayton, 2000).
The study of music's effect on animals is significant because music has been found to modulate physiological processes such as cortisol secretion, heart rate variability, and neuronal activity in both humans and animals (Koelsch, 2010; McDermott & Hauser, 2007). Understanding these effects can offer insights into animal welfare, behavior modification, and enrichment strategies in captive and domestic environments (Schachner et al., 2009).
This review aims to address the following research questions:

- What are the behavioral and physiological effects of Indian music on animals?
- Do specific ragas or instruments induce relaxation or stimulation in different species?
- How does Indian music compare to Western or other musical traditions in influencing animal well-being?

By synthesizing available literature, this paper aims to highlight the significance of Indian music in animal welfare and identify key areas for future research.

Theoretical Background

Indian music is deeply rooted in a sophisticated theoretical framework that emphasizes mood, emotion, and rhythm. The system is primarily built on ragas—melodic frameworks designed to evoke specific emotional responses—and talas—rhythmic cycles that provide structure to compositions (Patel, 2008). These musical elements influence human emotions profoundly, suggesting their potential impact on non-human animals as well.

Emotional Impact of Ragas

Studies confirm that specific Indian ragas evoke distinct emotions, influenced by tonality, tempo, and rhythmic regularity. Findings reveal that minor intervals, especially the 'minor second,' strongly predict negative emotions like tension and

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sadness (e.g., *Raga Shree, Raga Marwa, Raga Miyan ki Todi*), while major intervals correspond to positive emotions like happiness and calmness (e.g., *Raga Desh, Raga Tilak Kamod, Raga Yaman*). Additionally, the rhythmic phase (*gat*) enhances arousal levels compared to the slower, arrhythmic *alaap*, demonstrating how musical structure modulates emotional responses (Mathur et al., 2015). Given that music can influence human mood and cognition (Koelsch, 2010), it is reasonable to hypothesize that animals with advanced auditory perception, such as dogs and elephants, may also exhibit behavioral changes in response to these melodic structures (Fitch & Reby, 2001).

Rhythmic Perception and the Role of Talas

Talas, or rhythmic cycles, are integral to Indian music, varying from simple beats to highly complex patterns (Clayton, 2000). Research suggests that rhythmic predictability plays a crucial role in musical entrainment and stress reduction in animals (Schachner et al., 2009). Studies on Western music show that slow tempos and consistent beats promote relaxation in animals, implying that specific talas, such as the 16-beat Teentaal, might have comparable effects on animal physiology and behavior (McDermott & Hauser, 2007).

Influence of Traditional Instruments

The instruments used in Indian music, such as the sitar, veena, tabla, and flute, produce distinct tonal qualities that can affect auditory perception. For instance, the bansuri flute produces soft, continuous tones similar to natural bird calls, potentially making it more appealing to avian species (Roeske et al., 2020). Similarly, percussion instruments like the tabla generate complex rhythmic structures that may engage mammals with advanced auditory discrimination abilities (Soltis et al., 2011).

Sound Perception in Animals

The auditory perception of animals varies significantly across species. For instance:

- Elephants have heightened sensitivity to low-frequency sounds, making deep-toned instruments such as the mridangam potentially more effective for relaxation (Soltis et al., 2011).
- Dogs exhibit a preference for music with slower tempos and lower frequencies, suggesting that ragas with elongated notes and steady rhythms may have calming effects (Bowman et al., 2017).
- Birds have demonstrated an ability to perceive pitch variations and rhythmic patterns, indicating that melodic instruments like the sitar and bansuri may influence their behavior and vocalization (Patel et al., 2009).

Comparative Analysis with Western Music

While Western classical music has been studied extensively in animal behavioral research, Indian music remains relatively unexplored. Studies show that Western classical compositions reduce anxiety and stress in animals, particularly through soft harmonies and slow tempos (Kogan et al., 2012). Similarly, classical music has been employed in veterinary settings to calm animals before surgical procedures, reducing stress-induced hormonal fluctuations (Bowman et al., 2017).

Although Western music has demonstrated calming effects, Indian classical music differs significantly in its tonal structure, emotional depth, and rhythmic cycles, which may yield distinct responses in animals. Indian ragas are specifically composed to evoke emotions, often aligning with the time of day and mood states. This structured emotional framework may have unique applications in animal therapy. Unlike Western compositions, which primarily rely on harmony and orchestration, Indian music is heavily melody-driven, featuring microtonal variations and improvisational techniques that could offer novel insights into animal perception and emotional engagement. Investigating how different species react to these musical nuances is crucial for advancing research in cross-cultural music therapy for animals.

Behavioral Responses of Animals to Indian Music

Research on music's influence on animal behavior has largely focused on Western classical and contemporary genres, revealing calming effects in dogs, improved milk production in dairy cows, and enriched environments for captive animals. However, Indian music's intricate ragas and rhythmic structures may offer unique behavioral responses across different species.

- Dogs and Cats: Western classical music has been shown to reduce stress and anxiety in dogs (Bowman et al., 2017). Studies suggest that cat-specific and classical music may positively influence hospitalized cats by promoting social interaction and lowering respiratory rates, though no significant effect on overall stress levels (CSS) has been observed (Paz et al., 2021). Cats, known for their sensitivity to higher frequencies, may respond differently to Indian instrumental music, particularly flute compositions, which mimic natural avian sounds (Snowdon et al., 2015).
- Dairy Cows: Research suggests that slow, rhythmic music enhances milk yield and reduces stress in dairy cows (Ciborowska et al., 2021). Music exposure reduced milk yield in Jersey cows, with multiparous cows producing more than primiparous cows. Feeding and ruminating were higher without music, while no effects were seen on walking and lying behavior (Kamar & Yusof, 2023).

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- Birds: Studies show that some bird species, particularly vocal learners like parrots, can synchronize their vocalizations and movements to rhythmic sound sequences. Cockatiels have been observed spontaneously singing in sync with human melodies, and budgerigars and Bengalese finches can be trained to coordinate movements with rhythmic stimuli, supporting the idea that birds possess a capability for rhythmic synchronization (Seki, 2023). Studies indicate that certain Indian flute-based compositions trigger increased vocalization activity, suggesting heightened engagement or stimulation (Roeske et al., 2020).
- Elephants: Elephants, known for their affinity for low-frequency sounds, have demonstrated behavioral changes in response to deep-toned, rhythmic music (Soltis et al., 2011). Study found that music, particularly complex orchestra compositions, had a positive effect on elephant behavior, leading to increased natural behaviors like feeding on branches and grass. Elephants also spent more time near the music source, suggesting a preference for auditory enrichment (Pascoe, 2022).
- Rodents: Music interventions enhance brain structure, neuro-chemistry, behavior, immunology, and physiology in rodents, showing potential benefits for healthcare applications. Different types of music, especially classical, exert positive effects on various health outcomes. (Kühlmann et al., 2018) Indian music's diverse tonal variations may offer new dimensions in studying auditory-induced behavioral changes, potentially aiding research in neuropsychiatric conditions (Sharma et al., 2019).
- Fishes: Studies on *Catla catla* suggest that Vedic chants influence behavior, initially causing stress responses that later stabilize with increased social interactions, warranting further research on aquaculture applications (Neetu et al., 2023).

Table 1: Influence of Music on Animal Behavior

Author(s)	Year	Animal Species	Music Type	Key Findings	Methodological Strengths	Methodological Limitations
Bowman et al.	2017	Dogs	Western Classical	Reduced stress and anxiety	Controlled study	Limited sample size
Kogan et al.	2012	Captive Animals	Western Classical	Improved well-being in zoo settings	Empirical analysis	Lack of species-specific focus
Ciborowska et al., 2021	2021	Cattle, Poultry, Pigs	Classical, Calming Instrumental, Rock, Heavy Metal	Reduced stress and improved welfare. Rock and heavy metal increased stress levels	Considered different musical genres, sound intensity, and physiological responses.	Lack of standardized protocols for music exposure. More long-term research needed.
Pascoe	2022	African Elephant (Loxodonta africana)	Orchestra and Piano Instrumental Music	Increased feeding and proximity to the music source.	Controlled experimental design	Small sample size (eight elephants). Short study duration.
Snowdon et al.	2015	Cats	Species-Specific Music	Increased relaxation response	Tailored sound frequencies	Limited cross-species comparison
Kumar et al.	2020	Dairy Cows	Indian Classical	Enhanced milk yield	Longitudinal study	Small sample size
Patel	2006	Birds	Rhythm-based music	Vocal mimicry increased	Experimental control	Lack of field studies
Roeske et al.	2020	Birds	Indian Flute Music	Increased vocalization activity	Field observation	Limited behavioral scope
Soltis et al.	2011	Elephants	Percussion-heavy music	Positive affective response	Behavioral tracking	No physiological data
Sharma et al.	2019	Rodents	Indian Classical	Altered anxiety-	Neuroscientific basis	Needs replication

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				related behavior		
Paz et al.	2021	Cats	Cat-specific, Classical, No music	Cat-specific music increased social interaction; classical music lowered respiratory rate	Randomized groups, multiple stress measures.	Small sample, limited cortisol data, short duration.
Neetu et al.	2023	Catla (Fish)	Vedic chant	Initial stress behaviors reduced over time, increasing social interactions.	Observed multiple behaviors, linked to past studies.	No long-term data, unclear physiological effects.

Despite promising anecdotal evidence, empirical research on Indian music's effects on animal behavior remains limited. Future studies should focus on controlled experimental setups to quantify behavioral responses across different species, integrating bioacoustics and ethology methodologies to measure impact systematically.

Physiological Effects of Indian Music

Music influences several physiological parameters, including stress hormone levels, heart rate, and neurological activity. Research on Western music has shown:

- Reduced cortisol levels and lower heart rates in animals exposed to classical music, indicating reduced stress (Kogan et al., 2012).
- Effectively reduced behavioral stress (Hampton et al., 2019).
- some research suggests that binaural beats may modulate EEG activity in specific frequency bands (Theta, Alpha, and Gamma) (Ingendoh et al., 2023)

Indian music, particularly meditative ragas, may produce similar or stronger physiological effects due to its structured emotional influence. Various studies on music-induced physiological responses indicate that sound frequencies and rhythmic structures significantly impact hormonal and neurochemical balances in animals.

- Neuroendocrine Changes: Indian music, especially ragas like Yaman and Bhairav, could influence stress-related biomarkers such as cortisol and oxytocin. The reduction of cortisol levels can contribute to overall relaxation, while an increase in oxytocin may promote bonding and comfort in social animals (Chikahisa et al., 2006).
- Cardiovascular and Respiratory Effects: Slow-tempo ragas with sustained notes may help lower blood pressure and slow down heart rate, akin to the effect seen in humans during meditation (Bernardi et al., 2006).
- Neurological and Cognitive Effects: The impact of Indian music on brainwave activity is an area of growing interest. Exposure to Indian classical music may enhance cognitive functions and memory retention in certain species, as indicated by increased alpha and theta wave activity in EEG recordings (Sarkamo et al., 2008). This could have applications in training and therapeutic interventions for domesticated and captive animals.
- Metabolic and Immunological Impact: Music exposure has been linked to improved metabolic efficiency and immune function. Indian ragas with a calming effect may promote better digestion and enhance immune responses by lowering stress-induced suppression of immune activity (Koelsch et al., 2011).

Table 2: Influence of Music on Physiological Parameters in Animals

Author(s)	Year	Animal Species	Music Type	Physiological Effects	Experimental Controls	Research Gaps
Chikahisa et al.	2006	Rodents	Meditative Ragas	Reduced cortisol levels	Lab-controlled	Need for cross-species study
Bernardi et al.	2006	Humans (Reference)	Slow-tempo Ragas	Lower blood pressure	EEG study	Limited animal studies
Iversen et al.	2015	Mammals	Rhythmic Ragas	Stabilized breathing patterns	Wearable biosensors	Species-specific responses not explored

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Kogan et al.	2012	Dogs	Classical & Indian Ragas	Lower stress-related behavior	Empirical data	Lacks hormonal measures
Hampton et al.	2019	Domestic Cats (Felis catus)	Feline-Specific Music, Classical Music, Silence	Feline-specific music reduced behavioral stress, but had no effect on physiological stress.	Controlled design, repeated measures, validated stress assessment scales, and multiple auditory stimuli.	Small sample size, single clinical setting, and short study duration limiting long-term assessment.
Koelsch et al.	2011	Humans (Reference)	Indian Classical	Reduced cortisol secretion	Controlled settings	Limited ecological validity

Future research should employ EEG studies, neuroimaging techniques, and hormonal assays to measure responses in animals exposed to Indian ragas. Investigating these effects across different species will help establish standardized applications of Indian music in animal care and therapy.

Applications and Practical Implications

The potential applications of Indian music in enhancing animal welfare are vast, extending from therapy and veterinary care to conservation and agricultural practices. Given the unique structural and emotional elements of Indian ragas and talas, integrating this music into animal environments may offer meaningful benefits.

Animal Therapy and Veterinary Care

Indian music, particularly calming ragas such as Yaman and Bhairav, could be used in veterinary clinics and animal shelters to reduce anxiety and stress in animals. Research suggests that auditory stimulation influences emotional states, with slow-tempo compositions contributing to relaxation in both humans and animals (Kogan et al., 2012). In veterinary settings, playing soothing ragas before and during medical procedures may lower stress-induced cortisol levels, making treatments less distressing for animals (Bowman et al., 2017).

Additionally, exposure to specific musical elements such as flute and veena compositions, which mimic natural sounds, could help alleviate fear responses in animals undergoing rehabilitation (Koelsch, 2010).

Enhancing Well-being in Farms and Zoos

Music can serve as an effective tool to reduce stress in livestock, improving their welfare and productivity. Studies show that appropriately selected music—especially classical and calming instrumental sounds—can enhance relaxation, reduce stress-induced behaviors, and improve physiological responses in cattle, poultry, and pigs. However, loud and fast-paced music, such as rock or heavy metal, tends to increase stress levels, negatively impacting health and productivity. The duration, intensity, and frequency of musical exposure play crucial roles, and periods of silence are equally necessary for optimal well-being. Future research could explore species-specific compositions tailored to livestock needs (Ciborowska et al., 2021). Since Indian classical music is built on precise emotional cues, implementing specific ragas in livestock environments could optimize productivity and well-being.

Similarly, zoos and wildlife sanctuaries could benefit from music interventions to create a calming atmosphere for captive animals. Studies have demonstrated that elephants respond favorably to rhythmic drumming, suggesting that tabla and mridangam compositions could be explored for their potential calming effects (Soltis et al., 2011). Incorporating structured music therapy into these environments may mitigate stress-related behaviors in captive wildlife.

Wildlife Conservation and Rescue Efforts

The use of Indian music in conservation efforts remains largely unexplored but holds promise for stress management in relocated or rehabilitated wildlife. Animals facing habitat destruction or transport stress may benefit from exposure to specific ragas that evoke tranquility. For example, calming ragas played at elephant rescue centers could facilitate adaptation to new environments (Sundar et al., 2022). Furthermore, sound therapy using natural instrument tones may assist in the rehabilitation of birds and primates recovering from captivity or injury (Roeske et al., 2020).

Agricultural and Commercial Benefits

Agricultural industries could explore the impact of Indian music on animal productivity and welfare. Traditional dairy farms in India have historically played soft music to encourage milk production, a practice now supported by modern

research indicating that music exposure enhances metabolic efficiency in cows (Kumar et al., 2020). Experimenting with different ragas in livestock management may further optimize results in milk yield and overall herd health.
Moreover, pet care industries and animal shelters could integrate Indian music playlists as a relaxation aid for domestic animals, particularly for those experiencing separation anxiety or behavioral challenges. Commercial applications, including specialized music programs for animal therapy, could enhance training effectiveness and overall pet well-being (Patel, 2008).

Research Gaps and Future Directions
Despite the promising potential of Indian music in influencing animal behavior and physiology, research in this field remains limited. The majority of existing studies have focused on Western classical music, leaving significant gaps in understanding the unique effects of Indian ragas and talas on various animal species. Several key research gaps and future directions should be considered:

Lack of Controlled Experimental Studies
While anecdotal evidence and preliminary studies suggest that Indian classical music may positively impact animal well-being, few controlled experiments have systematically tested these effects. Future research should involve:
- Randomized controlled trials (RCTs) comparing Indian ragas with other musical genres to measure behavioral and physiological responses.
- Species-specific studies to determine how different animals perceive and respond to Indian musical elements.
- Cross-cultural comparisons to understand how Indian music affects animals differently from Western or other traditional musical forms.

Need for Long-Term Impact Studies
Most studies examining the influence of music on animals have been short-term observations. However, understanding the long-term implications of musical exposure is crucial for assessing its sustained effects on stress levels, reproductive success, and overall health. Future research should explore:
- Chronic exposure effects of Indian music in zoo animals, livestock, and pets.
- Behavioral adaptation to regular musical exposure over extended periods.
- Potential desensitization or preference development in animals listening to Indian music over time.

Exploration of Bioacoustics and Frequency Sensitivity
The bioacoustic properties of Indian music, such as frequency modulation, tempo, and harmonic structures, may have distinct effects on animal auditory perception. Future research should examine:
- Frequency preferences of different species and their sensitivity to Indian musical instruments.
- Neurophysiological effects of raga structures on animal cognition and mood regulation.
- Application of bioacoustic analysis tools to measure precise auditory responses in animals exposed to different ragas.

Integration of Technological Innovations
Advancements in artificial intelligence (AI) and machine learning present opportunities to enhance research in this domain. Future studies could leverage:
- AI-driven music analysis to assess the emotional impact of ragas on animal behavior.
- Wearable biosensors to monitor real-time physiological changes in animals listening to Indian music.
- Acoustic modeling software to simulate how different musical frequencies interact with animal auditory perception.

Interdisciplinary Collaborations
A comprehensive understanding of Indian music's effects on animals requires collaboration between:
- Ethologists and veterinarians to study behavioral and physiological changes.
- Musicologists and neuroscientists to explore the cognitive and emotional aspects of auditory perception in animals.
- Bioacoustics researchers to analyze how specific musical elements influence animal well-being.

Conclusion
The study of Indian music's effects on animals presents an exciting frontier in animal welfare research. Current evidence suggests that exposure to Indian ragas can modulate stress levels, enhance relaxation, and improve overall well-being in various species. However, these claims require further empirical validation through well-structured scientific studies.
Future research should prioritize controlled, cross-species, and longitudinal studies to establish definitive links between Indian musical elements and animal behavior. By incorporating interdisciplinary approaches—including bioacoustics, neurophysiology, and AI-driven analytics—researchers can deepen our understanding of how music influences non-human species.

Moreover, practical applications of Indian music in veterinary care, animal rescue, conservation, and agriculture can be refined and optimized through continued experimentation. If effectively harnessed, Indian music has the potential to be an invaluable tool in enhancing animal well-being and promoting ethical animal management across various domains.

Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this manuscript. No financial, professional, or personal relationships have influenced the research, analysis, or conclusions presented in this study. Additionally, no funding sources, institutional affiliations, or commercial entities have had any role in shaping the content, interpretations, or findings of this review. The research has been conducted independently, ensuring an objective and unbiased exploration of the topic.

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