

# Body Percussion and Neuropsychology: An interdisciplinary

review

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## ABSTRACT

Body percussion, the practice of creating sound using one's body, involves a variety of techniques such as clapping, striking, stomping and patting. Traditional Indian music offers rich examples of body percussion through hand gestures as well as instruments like the Tabla and Pakhawaj. This review delves into the crossroads of the body percussion involved in Tabla and Pakhawaj instruments and neuropsychology, investigating its impact on the brain function, cognitive processes, and emotional health. It also discusses the theoretical concepts of laya and tala in Indian percussion, highlighting the relationship between rhythm and neuropsychological reactions.

KEY WORDS : Body Percussion, Neuropsychology, Cognitive flexibility, Tabla, Pakhawaj

## INTRODUCTION

Body percussion is a rhythmic technique that uses the body as a medium inorder to produce the required sound. This includes actions such as clapping, snapping fingers, stomping feet, striking and patting different parts of the body(Romero Naranjo). The main function of any percussion instrument is to lay a foundation of rhythm and laya. Laya can be defined as the time interval between the beats in the rhythmic cycle. The laya has to be kept constant throughout the performance. In ancient times the rhythm and laya was depicted only by hand gestures. With time, the percussion instruments were developed. Initially they were used to indicate a potential threat or during the commencement of the war. Later, the rhythmic patterns were explored and they were used for accompaniment of music. In the context of traditional Indian music, the tabla and pakhawaj are prime examples of sophisticated body percussion. The tabla, a set of two vertical drums, is played using finger and palm movements. On the other hand, the pakhawaj, a drum shaped like a barrel, is played mainly by using the palm (Team).

From a neuropsychological perspective, the study of the brain's structure and function and their relation to the behaviors and cognitive processes is crucial. When we are engaged in any form of the body percussion, multiple areas of the brain get activated. These include the motor cortex, auditory cortex, and regions responsible for rhythm and timing such as the basal ganglia and cerebellum(Ahokas). These findings suggest that the percussion field is more than just a musical form or physical activity. It can also be understood as a cognitive process which involves various sensory inputs, may it be auditory or visual, coordinated



motor actions and higher level cognitive functions(Ahokas). This in turn emphasizes on the possibility of profound impact of body percussion on our cognition and cognitive flexibility.

## **Body Percussion and Brain Function**

Another important aspect is planning, organizing and executing voluntary movements while playing the instruments in which the motor cortex (part of the frontal lobe) plays an important role. (Knierim). This is supported by studies which used the functional magnetic resonance imaging (fMRI). It showed increased activity in the motor cortex during these rhythmic tasks, highlighting its role in performing the complex motor sequences needed for body percussion(Knierim).

Similarly, the auditory-motor integration is another important component of body percussion. The sounds produced by percussive actions are then processed by the auditory cortex while the movements are controlled by the motor cortex.(Janzen et al.). This particular integration leads to enhancement of fine motor skills, auditory discrimination, and higher order cognitive functions. Thus, enhanced connectivity is present between the auditory and motor cortices which leads to fine coordination among musicians especially percussionists(Janzen et al.).

Participating in the body percussion can lead to significant cognitive and emotional benefits. Research has shown improvements in attention, memory, and executive functions due to the rhythmic and structured nature of the activity(R. Ahokas et al.). Furthermore, rhythmic activities are associated with emotional regulation and stress reduction. This could be due to their repetitive and predictable nature, which can induce a state of flow—a highly focused and enjoyable mental state(Romero-Naranjo).

## Body Percussion in Traditional Indian Music

Initially the rhythmic patterns were depicted by hand gestures which were replaced by percussion instruments later. The tabla, a significant percussion instrument in the Indian classical music, consists of two drums: the smaller "dayan" (right drum) and the larger "bayan" (left drum). The tabla is played using the fingers and and in case of some repertoire, the palm. Such percussion instruments are considered complex as the area of impact, strength and timing has to be precise to produce accurate sound repetitively. Therefore necessitating intricate movements and precise timing(Lockett)

- Theoretical Concepts: The tabla is played using various strokes, known as "bols," which are syllables that represent specific sounds. These bols are combined to create rhythmic patterns or "taals." Each taal has a specific number of beats (matras) and subdivisions (vibhags), providing a structured framework for improvisation and establishing a composition(Lockett). For example, the teental which is frequently used in accompaniment as well as a solo performance consists of 16 beats(matras).
- Cognitive Demands: Playing the tabla requires high levels of dexterity, coordination, and timing. The cognitive demands of learning and performing complex rhythmic patterns enhance neural connectivity and cognitive function(Jacob)
- Neuropsychological Impact: The bilateral coordination required in playing the tabla engages both the hemispheres of the brain, promoting interhemispheric communication. This engagement enhances cognitive flexibility, executive functions, and spatial-temporal skills(Farrell).



The pakhawaj, another traditional Indian percussion instrument, is characterized by its horizontal barrel-shaped drum and deep resonant sound. It is played using both the hands, with a variety of strokes producing different sounds.

- Theoretical Concepts: The pakhawaj uses a system of mnemonic syllables, similar to the tabla, to represent different strokes. However the nature of the sound produced is bassy as compared to the tabla. These syllables, or "bols," are combined into rhythmic cycles known as "taals". The Pakhawaj style and characteristics is similar to the Tabla.
- Cognitive Demands: Playing the pakhawaj requires synchronized movements of both hands, engaging multiple brain regions involved in motor control and timing. The cognitive demands of maintaining rhythmic patterns and improvising within the framework of a taal enhance motor coordination and cognitive functions(Team).
- Neuropsychological Impact: The bilateral coordination and rhythmic complexity of playing the pakhawaj promote neural plasticity and cognitive enhancement(Mahala)

## **Body Percussion and Theoretical understanding**

Embodied cognition is another theoretical framework that provides insights into the practice of body percussion. This perspective suggests that the cognitive processes are deeply rooted in the body's interactions with the environment. The body itself becomes a musical instrument. The physical actions of clapping, striking, stomping, and patting different body parts creates a multisensory experience, where cognitive processes are intertwined with motor and sensory functions. Embodied cognition emphasizes the integration of multiple sensory modalities. Body percussion involves auditory, tactile, and proprioceptive senses, creating a rich, immersive experience. The embodied cognition model suggests that the physical activities can influence cognitive processes and vice versa. In body percussion, the rhythmic patterns and physical movements stimulate cognitive functions, while cognitive processes such as pattern recognition and memory guide the physical actions(R. Ahokas et al).

Lifelong benefits engaging in rhythmic training, such as body percussion, can lead to significant neural adaptations. These adaptations manifest as functional changes in the brain regions which are responsible for the motor control and auditory processing. Long-term percussion training has been associated with the increased gray matter density in the motor cortex (a region crucial for planning and executing movements). This increase in gray matter is a testament to the brain's adaptability and its capacity for learning.

Percussion training also enhances the integrity of white matter, particularly in the corpus callosum, which facilitates communication between the two hemispheres of the brain. Enhanced white matter integrity improves the efficiency of the neural connections, supporting better coordination and cognitive functions(Gaser & Schlaug).

During rhythmic behavior, the brain creates internalized rhythms that sync to the beat when listening to music. Brain networks involved in the sensory-motor integration during the rhythmic cycles include the cerebellum and a cortical circuit involving cerebral regions such as the premotor cortex, supplementary motor area, and inferior frontal gyrus. Pursuing music, especially body percussion, can help in set shifting abilities as well as developing cognitive flexibility. Wherein set shifting is a cognitive process which includes shifting attention between tasks. Which can be related to the major concepts in percussion. For example, in



Indian classical music, there are three classifications of the laya ie Vilambit (slow), madhya (medium) and drut (fast). In a percussion performance or learning, musician often needs to shift between different tempos. Which often requires cognitive flexibility as the individual has to quickly and efficiently shift their attention and actions to match the changing tempo which breaks the monotony of a single task. This can be difficult when the shifts are rapid or unexpected. Though the exact relationship between these aspects is complex and more studies have to be conducted. Adding to which the anterior left hippocampus also shows enhanced functional responses due to musical expertise(Li et al.)

## **Critical Periods and Lifelong Benefits**

The concept of critical periods in neuroplasticity suggests that early exposure to rhythmic training can have lasting benefits. However, the brain retains its plasticity throughout the life, which means adults can also benefit from the rhythmic training.

Children who are engaged in body percussion or rhythmic training show enhanced cognitive development as well as academic performance. Early exposure to rhythmic activities can influence the development of motor skills, auditory processing, and cognitive functions (Rauscher & Hinton). During the early stage of development of the brain, adults can also reap benefits from rhythmic training. Regular practice of body percussion can lead to improvements in motor coordination, cognitive functions, and emotional well-being. The brain's ability to learn and adapt, known as neuroplasticity, is retained throughout the lifespan, making rhythmic training a valuable tool for cognitive enhancement at any age (Merzenich et al).

#### **Therapeutic Applications of Music Therapy**

Music therapy, specifically body percussion, is gaining recognition as a therapeutic tool for various psychological and neurological conditions. One of the key areas where it has shown significant impact is in the treatment of Autism Spectrum Disorders (ASD). Body percussion activities, being rhythmic, provide a structured environment that promotes social interaction. The act of creating music together not only fosters a sense of community but also enhances social skills among the participants. This has been particularly beneficial for the individuals with ASD, who often struggle with social interactions(Reschke-Hernandez).

Body percussion aids in improving communication skills. The process of synchronizing movements with others and responding to auditory cues enhances sensory-motor integration, which is crucial for non-verbal communication. This aspect has been shown to be especially beneficial for people with ASD. The repetitive and structured nature of rhythmic activities helps people with ASD regulate their emotions. The physical activity involved provides sensory feedback that has a calming effect, thus reducing anxiety and stress. (Kim et al).

The therapeutic benefits of body percussion in music therapy are promising. However, it is important to note that these findings are based on preliminary research, and more comprehensive studies are needed to fully understand and validate these benefits. (Srinivasan et al).

#### **Rehabilitation through Body Percussion**

Body percussion has emerged as a valuable tool in the recovery of motor functions, particularly in stroke patients. One of the most important techniques is Rhythmic Auditory Stimulation (RAS), which uses rhythmic cues to guide movements. This method has been



effective in assisting stroke patients to regain control of their motor functions and coordination. The rhythmic patterns provide a predictable structure, which facilitates the relearning of motor skills and demonstrates significant improvements in patients' mobility and quality of life.(Thaut et al.). Aside from motor recovery, body percussion aids cognitive rehabilitation. It activates several brain regions involved in attention, memory, and executive functions. Maintaining rhythmic patterns and coordinating movements not only improves cognitive functions but also aids recovery.(Thaut et al.).

Body percussion appears to have promising therapeutic benefits in neurorehabilitation. However, more comprehensive studies are required to fully validate these findings.

#### **Case Study 1: Cognitive Enhancement through Tabla Training**

Hanna-Pladdy and Mackay conducted research on the cognitive benefits of tabla training in young adults. Over the course of six months, participants received intensive tabla training, which resulted in significant improvements in executive functions such as planning, flexibility, and inhibitory control. The findings suggest that long-term tabla practice can improve cognitive abilities.

Executive Functions: The complexity of tabla rhythms necessitates careful planning and flexibility. Its regular practice was found to be helpful in improving executive functions which then leads to efficient cognitive performance in other areas. The precision used by percussionists improves inhibitory control which then results in greater cognitive control and sustained focus.

#### Case Study 2: Pakhawaj in Music Therapy

Similarely, Sotomayor et al. conducted a case study on sample of individuals with Parkinson's disease assessing the therapeutic benefits of pakhawaj in music therapy. The bilateral movements and rhythmic patterns used while playing pakhawaj inturn aided in motor rehabilitation and was found to have provided emotional support emphasizing on its therapeutic value. As a percussionist, playing the pakhawaj or Tabla requires bilateral coordination, which in turn improves motor skills and coordination in people with Parkinson's disease aiding in motor rehabilitation. Adding to which results suggested that participating in rhythmic activities improved emotional well-being as well as physical activity and sensory feedback provided a sense of accomplishment and enjoyment, which helped to alleviate depression and anxiety.

#### **Future Directions and Research Opportunities**

This is a growing area of research thus longitudinal studies are required to investigate the long-term effects of body percussion on cognitive function and abilities. As Bégel et al. suggest, following up individuals over time can reveal both the long-term benefits and potential risks of intensive rhythmic training. Its possibility as a part of rehabilitation program can also be explored further.

## CONCLUSION

Body percussion, as demonstrated by techniques for instruments such as the tabla and pakhawaj, is an intriguing combination of music, physical movement, and neuropsychology. This novel approach has shown promise as a part of rehabilitation throught theories and



limited research, helping to improve motor skills, emotional health, and cognitive functions in a variety of groups. To truly reap the benefits of this unique approach, further research needs to be conducted to investigate potential applications, different cultural perspectives, and long-term implications.

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