A Case Study Exploration of Music-Based Interventions for Pervasive Developmental Disorder

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ABSTRACT

This case study underscores the evolving landscape of music therapy in India, transitioning from a general well-being approach to a neuroscientific one, targeted at addressing specific deficits in individuals with neurological conditions. With music therapy still in its early stages in the country, a unique opportunity exists to harness India's rich musical heritage to develop culturally relevant techniques for clinical application. Through the case of R, a 29-year-old diagnosed with Pervasive Developmental Disorder, the study showcases the effectiveness of structured Indian classical music intervention across a spectrum of cognitive, sensory, communication, physical, emotional, behavioral, social, and musical domains. By employing music therapy assessment and multi-modal problem analysis, the study identifies significant strengths, potentials, and resources within the individual, facilitating the development of systematic approaches for measuring therapy response.

Keywords:-*Pervasive developmental disorder, Music-based Intervention, Indian Classical music, Cognition, Behavior, Social response, Sensory-physical response, Communication, Affect-Emotion*

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INTRODUCTION

There is a growing interest in using traditional music, such as Indian classical music, in evidence-based research within the field of music therapy. Indian classical music encompasses a complex structure of elements like the saptasvaras (notes), form, Śruti (pitch perception and processing), laya (tempo or rhythm), rāga (melodic frameworks), and tāla (rhythmic cycles of beats), which evoke emotions or rasas and can be effective in addressing the needs of individuals with neurodiverse conditions. These elements can be systematically utilized to achieve positive outcomes, including improvements in mental strength, range of motion, balance, communication, cognition, and socialization (Paul, 2000). Music therapy, incorporating emotional intelligence, has shown promise in alleviating various anxiety disorders (Bhat, 2021).

Autism Spectrum Disorder (ASD) presents with a wide range of symptom severity across three core areas: social interaction, restricted interests/repetitive behavior, and language (Mehta, 2013). Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS), included within the autism spectrum in the DSM-5, shares similarities with ASD. Music therapy has emerged as a therapeutic approach for children diagnosed with Autism Spectrum Disorder (ASD) (Green et al., 2006; Reschke-Hernández, 2011). It is characterized as a structured intervention method where therapists utilize musical experiences and relationships to facilitate health promotion in clients. This definition underscores the dynamic role of music in fostering change within individuals (Bruscia, 1998). The present case report explores how structured music interventions can address non-musical goals such as enhancing self-esteem, developing coping skills, facilitating verbal and non-verbal communication, fostering social

relationships, and improving receptive and expressive communication through a multimodal approach.

Music is an essential topic for cognitive science. Leo Kanner's pioneering case series from 1943, which described the contemporary autistic phenotype, included three girls and eight boys. In this report, Kanner highlighted the musical abilities and interests of six of the children involved. Since then, the field of music therapy has evolved alongside research, diagnosis, and the evolving understanding of autism. The current landscape of research lacks comprehensive longitudinal studies focusing on Indian classical music interventions for individuals with Autism Spectrum Disorder (ASD). However, the familiarity and cultural significance of Indian classical music can potentially enhance its efficacy as a therapeutic tool for individuals with ASD in India. By integrating Indian classical music into music therapy sessions, therapists can offer a culturally sensitive approach tailored to the specific needs of individuals with ASD within the Indian context. This approach acknowledges the importance of cultural relevance in designing effective interventions and underscores the potential of Indian classical music to contribute positively to the well-being and development of individuals with ASD in India. Music therapy research holds significance for several reasons. Firstly, music is increasingly acknowledged as a universal aspect of human existence, influencing various aspects of daily life and spanning across different life stages. Secondly, music is integral to both the development of individuals and the evolution of humanity, particularly with language acquisition and development. Thirdly, from a psychological standpoint, music engages multiple levels of human experience, including perception, cognition, and emotion, making it an ideal subject for studying fundamental processes such as temporal processing, emotional regulation, and motor coordination (Pearce, 2012).

Engagement with music, whether active or passive, supports various cognitive functions, including sensory processing, attention, memory, perception-action mediation involving the mirror neurons, multisensory integration, emotional processing, understanding musical syntax and meaning, and social cognition (Koelsch, 2009). While typically developing children naturally acquire language and communication skills, individuals with neurological disorders, such as ASD, may face challenges in this area. Children with ASD may struggle to communicate in conventional ways and may rely on non-verbal communication methods or exhibit atypical behavior due to difficulties in sensory processing, sensory overload, auditory issues, cognitive deficits, comprehension difficulties, or deficits in social-emotional reciprocity. The rationale for using music therapy for individuals with communication disorders is supported by research from infant researchers such as Stern and Trevarthen, who describe sound dialogues between mothers and infants using musical terms (Stern, 1985; Stern, 1989; Stern, 2010; Trevarthen, 2000). Trevarthen (1999) highlights the sensitivity of very young infants to the rhythmic and melodic aspects of maternal speech, as well as its emotional tone, indicating that humans are inherently prepared to engage with the musicality of communication during conversations. This understanding allows music to serve as an effective medium for facilitating non-verbal social interaction in both children and adults with ASD.

Several studies have highlighted the effectiveness of music therapy in supporting individuals with various disabilities, with a particular emphasis on its benefits for children, adolescents, and adults with autism. Inclusive practices, such as integrating students with autism into non-traditional settings like music classes, are becoming more common (Duvall, 2020). Howard Gardner, an influential developmental psychologist, challenged traditional notions of intelligence with his Theory of Multiple

Intelligences outlined in his book "Frames of Mind." Gardner proposed that intelligence is not a singular entity but rather a diverse spectrum of capacities. He identified several distinct types of intelligence, including musical intelligence, bodily-kinaesthetic intelligence, interpersonal intelligence, intrapersonal intelligence, spatial-visual intelligence, verbal-linguistic intelligence, and logical-mathematical intelligence (Seider, 2011). According to Gardner, musical intelligence is particularly noteworthy as it has the potential to foster the development of other forms of intelligence concurrently (Gardner, 1999). This perspective underscores the significance of nurturing musical abilities in individuals with neurodiverse needs, as it can serve as a pathway to enhancing their overall cognitive and socio-emotional skills. Furthermore, Gardner's criteria for determining intelligence acknowledge the existence of exceptional individuals, such as autistic savants or stroke victims, who exhibit exceptional abilities or deficits in specific cognitive domains (Gardner, 1999). This framework supports the exploration of music as a means to stimulate multiple senses and engage individuals with neurodiverse needs in meaningful educational experiences tailored to their specific interests and goals.

Moreover, research in music education has demonstrated that skills cultivated through music education and intervention can transfer to other domains, highlighting the broader social benefits of musical engagement (Hallam, 2010). In particular, the development of musical behavior has been linked to enhanced socio-emotional communication abilities, contributing to adolescent and adult adjustment and well-being. Therefore, involvement in music offers measurable social benefits and serves as an indicator of broader socio-emotional competence.

Music possesses a unique ability to evoke profound emotional responses in individuals, a phenomenon recognized by scholars and philosophers throughout history(Sanivarapu, 2015). Plato, for instance, theorized that different modes of music could elicit distinct emotional states, with major and minor chords conveying contrasting emotions. Major chords are often associated with feelings of joy and happiness, while minor chords evoke sentiments of sadness or pathos (Trimble & Hesdorffer, 2017). Listening to music can elicit a wide range of emotional states, including joy, love, tenderness, humor, and compassion. These emotional responses add depth and richness to our engagement with music, shaping our perceptions and experiences. When these emotions are integrated into the process of learning and delivering music interventions, they enhance the meaningfulness and impact of the interventions.

In the realm of Classical Indian aesthetics, the emotive essence embodied within Indian melodies is encapsulated by the term 'rasa'. It serves as the defining characteristic of vocal and instrumental music, as well as various performing arts, enabling a spectrum of emotional responses and effects to be evoked, including surprise, emotional resonance, positive sentiments, and more. The Navarasas, or nine fundamental emotions expressed by classical ragas, encompass a diverse range of experiences, including love/joy (Śṛṅgāra), humor (Hāsya), compassion (Kāruṇya), anger (Raudra), valor (Veera), fear (Bhayānaka), disgust/frustration (Bībhatsa), wonder/surprise (Adbhuta), and peace/tranquility (Śānta).

Among these emotions, those considered positive, such as love/joy, compassion, valour, peace, and wonder, hold particular significance in facilitating connections with neurodiverse children and eliciting responses tailored to their individual states of mind, circumstances, and adaptability. Additionally, the pace, tempo, or rhythmic cadence of music plays a crucial role in influencing emotional responses. Faster-paced music tends to evoke a sense of happiness or excitement, while slower tempos may evoke more subdued emotions. Considering both the emotive essence encapsulated by classical ragas

and the rhythmic dynamics of music allows for a nuanced and sensitive approach to engaging with neurodiverse children and fostering meaningful connections through music therapy interventions.

In the development of Music Therapy-specific treatment models, Music Therapists often incorporate various non-music-based therapy methods. Many commonly used Music Therapy techniques are rooted in psychological theories and treatment models. One notable but underexplored connection in the Indian context is between music therapy and cognitive-behavioral therapy (CBT). Cognitive-behavioral therapy is a form of psychotherapy that focuses on identifying and altering negative thought patterns that influence behavior and emotions(Hoffman, 2012). It operates on the premise that cognitive processes shape emotional responses, which subsequently affect behavior. The Multimodal Approach, another influential therapeutic framework, suggests that addressing psychological issues requires consideration of seven interconnected modalities: behavior, affect, sensation, imagery, cognition, interpersonal factors, and drug/biological factors (Lazarus, 2004). This integrative approach underscores the importance of addressing cognitive factors alongside other modalities in therapy.

In any music therapy intervention, having a reliable assessment model is crucial for documenting the patient's issues, music-related behaviors, and the planned goals of music therapy intervention. Cassity and Cassity (2006) introduced a systematic procedure for collecting information on music behavior and activity therapy assessment. Their multimodal model encompasses methodical assessment and intervention across a patient's BASIC I.D. (basic identity), considering various factors that contribute to or represent an individual's personality vectors. Prof. Arnold A. Lazarus, in his book 'The Practice of Multimodal Therapy: Systematic, Comprehensive, and Effective Psychotherapy' (1989), highlights that our personalities are shaped by ongoing behaviors, affective processes, sensations, images, cognitions, interpersonal relationships, and biological functions, emphasizing the biological and neurophysiological aspects of human beings. This eclectic model integrates a wide range of therapies, making it particularly suitable for addressing diverse needs in music therapy practice. It includes seven multimodal categories—Behavior, Affect, Sensation, Imagery, Cognitive, Interpersonal, and Drugs—tailored for children, adolescents, and adults seeking music therapy intervention. Upon gathering the patient's case history, the Psychiatric Music Therapy Questionnaire (PMTQ) is administered to construct the patient's multimodal profile. The PMTQ aims to identify problem-oriented behaviors to tailor music therapy interventions effectively. The questionnaire comprises three parts:

1. Part I utilizes a five-point Likert scale to gauge music preferences.
2. Part II, Multimodal Problem Analysis, features a 75-item inventory to identify problems treatable by music therapists. Clients rate each item on a Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5).
3. Part III allows the music therapist to assess the client's performance on fifteen different behaviors post-interview.

Following PMTQ administration, the therapist documents the client's problems, ratings, and analysis, selecting appropriate music therapy interventions accordingly. The intervention is tracked for three time periods; end of 1st month, 6 months and 12 months.

Case background: This case study presents R, a 29-year-old male diagnosed with Pervasive Developmental Disorder (PDD) at the age of 16.

He has been primarily under the care of his mother, as his father has been absent from the family for an extended period. According to his mother, R experienced feelings of rejection from his father, which significantly impacted his emotional well-being. Despite encountering numerous academic challenges, his mother persistently encouraged him to complete his matriculation. However, frequent conflicts with his mother, compounded by his father's rejection, contributed to R's withdrawal, engagement in self-directed speech, and socially inappropriate behaviors.

Given his mother's heightened stress levels, it was difficult to address her understanding of the triggers underlying R's symptoms and behavioral manifestations. R was referred for music therapy to target his prominent symptoms and engage him in therapeutic musical activities. His diagnostic evaluation indicated mild to borderline intellectual functioning with pronounced challenges in pragmatic language skills, verbal reasoning, and logical thinking. He also exhibited low self-esteem characterized by heightened anxiety during social interactions and a profound sense of loneliness.

Recommendations from his assessment emphasized the need for supervision and guidance in peer-related social settings, experience-based learning opportunities, and vocational training. During initial observations, R appeared anxious and demonstrated difficulty maintaining consistent eye contact during interactions, although he was able to follow simple instructions. Signs of persistent echolalia, irrelevant responses, excessive yawning, stretching, and stimming were noted, particularly during episodes of anxiety. Additionally, loud, irrelevant laughter, as well as self-talk and self-directed verbalizations while performing tasks or responding to stimuli, were prominent behaviors.

Specific observations: R demonstrated a strong inclination toward learning and showed enthusiasm for meeting expectations. He thrived in group learning environments, actively engaging with peers and responding spontaneously to verbal greetings and handshakes, reflecting his social engagement. Notably, R exhibited exceptional musical abilities, quickly mastering music-related vocabulary and demonstrating remarkable proficiency in pitch and rhythm. However, his learning process was intermittently disrupted by behavioral patterns such as self-talk, stimming, echolalia, and other socially inappropriate behaviors. Arriving late for sessions caused noticeable tension and anxiety, which often impacted his focus during the initial moments. Despite these challenges, R found solace in activities like art and yoga, with music serving as his primary therapeutic and expressive medium.

Following the completion of the PMTQ assessment and the development of a detailed multimodal profile, Carnatic music therapy interventions were introduced. Progress was systematically monitored through assessments conducted at one, six, and twelve months, evaluating key domains: communication, sensory/physical response, behavior, emotional/affective response, cognition, social interaction, and musical ability. A comprehensive framework was employed to document R's level of response across each process within these domains, categorized as high, medium, low, or none, and supported by domain-specific observations and comments.

Based on an in-depth review of R's history and the PMTQ assessment for adults, a detailed Personality Vectors Profile was established, guiding the implementation and evaluation of targeted therapeutic interventions.

Table 1: Personality vectors of 'R' in Interpersonal, Behavior, Affect, Cognition and communication modalities

Personality vectors	
MODALITY	**PROBLEMS**
Interpersonal	• Resistance to participation in group settings, challenges adhering to rules. • Struggles to form connections with others, demonstrated by a lack of friendships and frequent conflicts with parents. • Shows reluctance to engage in music community groups; prone to wandering.
Behavior	• Difficulty asserting leading to challenges in expressing needs, emotions, and preferences. • Exhibits limited awareness of personal boundaries; interrupts during group activities; demonstrates inappropriate social behavior, both verbally and non-verbally, towards peers and the therapist.
Affect	• Struggles with expressing and recognizing emotions, both in oneself and others, through verbal and nonverbal means; shows limited emotional expression and inconsistency between emotions and verbalization. • Experiences anger and frustration, often leading to impulsive behavior. • Displays excitability, engages in self-talk, and self-touching. • Experiences free-floating anxiety, restlessness, and muscle tension. • Exhibits impulsive emotional outbursts such as excessive laughter and repetitive irritable expressions or noises; demonstrates difficulty in self-control.
Cognition	• Struggles with low self-esteem and holds a negative self-concept; tends to make negative self-statements. • Experiences difficulty in following directions, showing an inability or unwillingness to listen or comprehend instructions.
Communication	• Experiences challenges in sustaining a conversation. • Makes attempts to communicate but often interjects with irrelevant comments regarding the topic being discussed.

Following the personality vectors, R's Multimodal Music Therapy profile was constructed.

I. **MUSIC PREFERENCES:**

R exhibited a keen interest in a wide array of music genres, including Hindustani bhajans, Western classical, Carnatic bhajans, instrumental music (especially on the keyboard), and popular film music in Kannada and Hindi. However, he expressed a clear dislike for folk music. He eagerlyII. anticipated opportunities to learn and showcase his musical talents, whether individually or as part of a group. At home, he often engaged with his keyboard as a favorite leisure activity. While he could not identify specific composers or favorite performers, he displayed a natural affinity for music, enjoying it instinctively. Notably, R demonstrated exceptional pitch accuracy and found enjoyment in both melody-driven and fast-paced rhythmic compositions.

MULTIMODAL PROBLEM ANALYSIS

The following table indicates the problems in different modalities and corresponding music-based intervention strategies.

Table 2: R's problems in different modalities and Music therapy- Intervention Strategies

Problems in 'Interpersonal' domain	*Music Therapy – Intervention strategies*
Resistance to participating in group activities and challenges adhering to established guidelines.	• Engage him in a group choir to foster group cohesion and awareness. • Utilize Tibetan bowls or Indian chimes designated for each member, providing clear instructions and working towards collective completion. • Incorporate his favorite compositions to ensure his full participation, while also establishing essential rules. For example, singing a line twice, repeating a paragraph, returning to the first line, and then passing to the next member, or refraining from singing while others are vocalizing.
Challenges in forming connections with peers, demonstrated by a limited social circle and frequent conflicts with parents.	• Facilitate bonding through group singing activities. • Encourage him to communicate openly about difficulties to foster better understanding. • Implement turn-taking strategies during music lessons. For example, singing lines of a Nottuswaram and passing to the next person. • Sequential svara prasthāras (logical sequences) in increment and decrement formats during turn-taking. sa, r, gā, ma, pa, dha, ni, sa´ r, gā, ma, pa, dha, ni, sa´ gā, ma, pa, dha, ni, sa´ ma, pa, dha, ni, sa´ pa, dha, ni, sa´ ni, sa´ sa´
Struggles to actively participate in music community gatherings; prone to wandering.	• Incorporate parallel activities such as playing Jenga or Uno while engaging in music community groups. • Allocate adjustment time to address sensory overload issues that may arise. • Provide positive social reinforcements to encourage participation in music community groups.
Problems in the 'Affect' domain	*Music Therapy Intervention strategies*
Struggles with verbal or nonverbal expression and identification of feelings or emotions in oneself or others; exhibits restricted emotional expression and lacks congruence between emotional state and verbal communication.	Engage him in discussions about songs, focusing on the emotions conveyed. Assist him in identifying and expressing specific feelings, encouraging him to relate them to his own life experiences. E.g. The rasa (emotion) felt while singing kalyāni or Yamuna kalyāni (usually invokes joy or devotion); The emotion felt while listening to Shubha Pantuvarāli or Chakravākam

	(usually invokes pathos) • Ask him to write about his feelings while listening to a song. • Have him bring songs or passages to the session related to issues he has faced at home or elsewhere
Experiences frustration-induced anger and stress, leading to impulsive behavior.	• Introduce activities that break the monotony of negative emotions, such as allowing him to sing a song of his choice or engage in a preferred activity. • Provide a rhythm instrument, such as Western drums or a Cajon, to help him channel and release frustration and anger.
Displays behaviors of excitability, including self-talking and self-touching.	• Incorporate Sanskrit shlokas or sing logical sequences at varying speeds to engage him. • Implement social stories to teach appropriate behavior in social settings regarding self-touching.
Free-floating anxiety, restlessness, muscle rigidity	• Implement relaxation techniques such as deep breathing exercises or progressive muscle relaxation to alleviate free-floating anxiety and muscle rigidity. • Engage in calming activities such as listening to soothing music or participating in gentle movement exercises like yoga to reduce restlessness.
Spontaneous emotional outbursts like frequent laughter and repetitive vocalizations of irritability, often occurring without restraint or self-regulation.	• Employ soothing melodies or calming music. • Redirect attention towards activities that are positively reinforced or utilize relaxation and breathing exercises.
Problems in 'Cognition' domain	*Music Therapy Intervention strategies*
Demonstrates low self-esteem and negative self-perception through self-deprecating remarks	• Highlight and reinforce each of his musical achievements through visual documentation like photos or video recordings, accompanied by the sound of applause and positive feedback from fellow parents and caregivers. • Whenever a negative statement is expressed, establish an achievable musical objective and offer encouragement through verbal praise and applause.
Struggles with adhering to instructions; challenges with spatial understanding	• Incorporate music-based exercises focused on learning spatial concepts like distinguishing between right and left or up and down. For instance, imitate rhythm patterns using the left hand and then the right. • During group music activities, encourage practicing spatial awareness by directing movements next to, behind, or in front of others.

Problems in 'Behavior' domain	*Music Therapy Intervention strategies*
Difficulty in asserting, leading to challenges in expressing and communicating needs, preferences, feelings, and dislikes verbally.	• Foster peer interaction by prompting him to greet others regularly. • Facilitate group engagement through activities like passing a ball while music plays. When the music stops, encourage verbal responses to questions from the therapist. • Prompt discussions about any emotional experiences during music activities or while listening to or performing compositions.
Demonstrates challenges in respecting personal space and boundaries, often interrupting during group activities and exhibiting inappropriate verbal and nonverbal behaviors towards peers and the therapist.	• Incorporate him into a structured music group, such as a choir or performance ensemble, where he can learn and practice proper social skills within a group setting, including understanding the activity's structure and rules. • Redirect any inappropriate behavior to ensure he remains engaged in positive interactions. • Use social stories and videos to explain the concepts of personal space and boundaries, helping him understand these social norms more effectively.
Problems in the 'Communication' domain	*Music Therapy Intervention strategies*
Struggles with sustaining a conversation	• Engage in instrumental activities and response exercises where the therapist initiates a musical phrase, and the patient responds verbally with a corresponding musical continuation. For example, the therapist plays the first two lines of a composition on the veena, and the patient is tasked with recognizing and completing the next two lines. • Prompt him to sing a composition with clear articulation. • Encourage participation in "fill in the blank" singing exercises or songwriting activities
Makes attempts to communicate but provides irrelevant remarks regarding the ongoing topic of discussion.	• During music discussions, guide the patient's responses by asking questions related to the topic or composition until they arrive at relevant answers.

III. POST-INTERVIEW OBSERVATIONS

'R' initially struggled to maintain a composed posture with proper eye contact in the new setting. Despite this, he displayed eagerness to engage in music activities and demonstrated retention of simple instructions. While he took some time to follow instructions, they did not need to be repeated. 'R' exhibited signs of low self-esteem and appeared constantly distracted by

his mother's presence, causing him to feel anxious. However, he maintained a well-groomed appearance and displayed a positive attitude towards participating in music therapy activities.

IV. METHOD

For 12 months, 'R' participated in bi-weekly music therapy sessions, each lasting 60 minutes. These sessions integrated both receptive (passive listening) and active (participation-based and interactive) music therapy approaches. A systematic application of Carnatic music therapy interventions included a variety of practices, such as chanting Ōmkāra, reciting Sanskrit ślokas, singing bhajans in multiple languages, performing devotional compositions, and engaging in classical music lessons featuring diverse svara combinations and rāgas at varying speeds. Both individual and group sessions employed a combination of active and passive music therapy techniques, with active involvement from 'R's mother encouraged throughout the process.

Compositions in specific rāgas, including nōṭṭusvaras in Śaṅkarābharaṇaṃ, bhajans, dāsarapadas, and ślokas in Kalyāṇi, Yamunā Kalyāṇi, Tilang, Hamsadhvani, and Pīlu, were employed to evoke and convey emotions such as joy, heroism, peace, and devotion. On days when 'R' experienced meltdowns, individual and group warm-up vocal exercises were utilized along with parallel activities to help him relax before resuming therapy. During periods of complete breakdown, passive listening to vīṇā performances was introduced as a calming intervention. Additionally, Tibetan bowls, small congo drums, and Indian brass cymbals were used to redirect attention during socially inappropriate behaviors, aiding in reorienting focus and aligning with the rhythm of the compositions.

Vocal improvisations were conducted using rāgas such as Mohana, Kalyāṇi, Śaṅkarābharaṇaṃ, Hamsadhvani, Valachi, Rēvati, Mādhyamāvati, Ābhogi, Gambhīra Nāṭa, and Amṛtavarṣiṇi to explore and differentiate the rasas (emotions) associated with each rāga. The musical scales of these rāgas were translated onto the keyboard, enabling further exploration, improvisation, and practice as a leisure activity at home. 'R' achieved specific musical milestones through compositions such as Śrī Śāradā Bhujaṅgaprayātāṣṭakam, Acyutāṣṭakam by Ādi Śaṅkarācārya, and Nāmarāmāyaṇaṃ by Śrī Lakṣmaṇācārya, derived from ancient Sanskrit texts.

V. MUSIC THERAPY INTERVENTION PROGRESS AND RESULTS

The progress of the music intervention was monitored using a self-designed "Response to Intervention Tracking Sheet" over one month, six months, and twelve months, focusing on key domains including communication, sensory/physical response, behavior, emotional/affect, cognition, social interaction, and musical engagement.

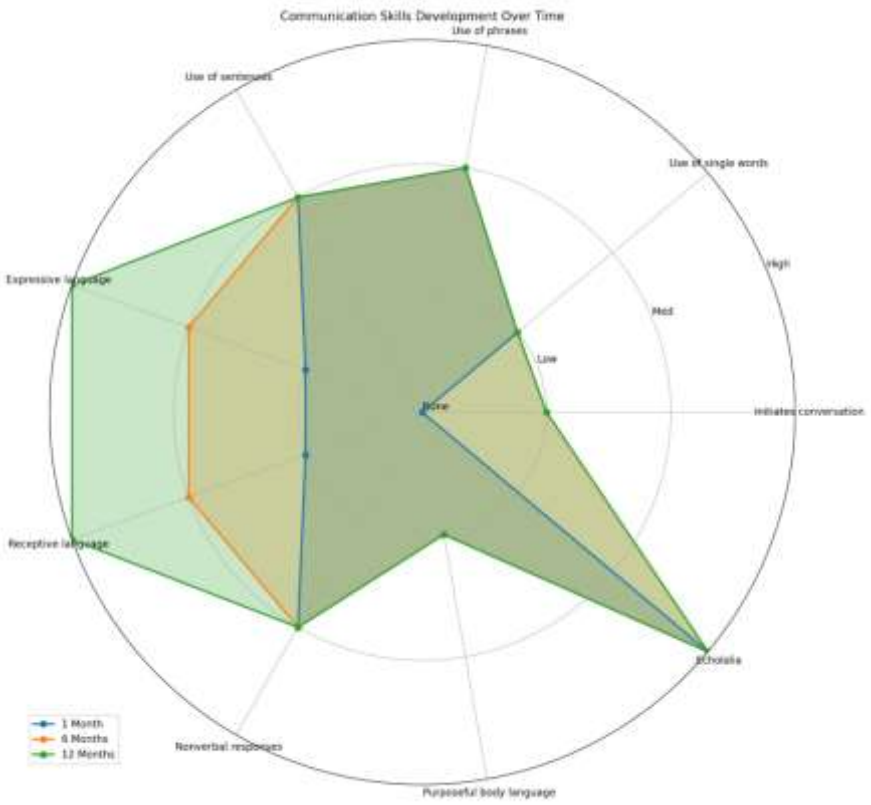
Communication

The communication domain included the following 10 response items for tracking

Initiates conversation, Use of single words, Use of phrases, Use of sentences, Expressive language, Receptive Language, Speech clarity/improvement in quality of need-based communication, Non-verbal responses, Purposeful body language, Echolalia

Based on the tracked responses the following radar chart was generated.

Figure 1: Radar graph indicating progress in the communication modality



The assessment reveals significant improvement in 'R's language processing skills, with both expressive and receptive language advancing steadily from low to medium and eventually reaching high levels. Notably, there was a slight improvement in initiating conversations, progressing from none to low, though this remained somewhat limited. Basic communication skills, such as the use of single words, phrases, and sentences, showed stability without notable progress, with single-word usage remaining low while phrases and sentences maintained moderate levels. Nonverbal responses remained consistently at a medium level, whereas purposeful body language stayed low throughout. Persistent high levels of echolalia and the lack of improvement in speech clarity highlighted areas of concern, as did the stagnant development in purposeful body language. However, the most positive trend was observed in language processing, while basic and higher-order communication skills remained stable, with potential for further enhancement.

He demonstrated an improved ability to understand simple sentences and follow basic instructions. He could also provide explanations for tardiness and displayed a considerable amount of imitation behavior. While his speech was sometimes confused, he maintained politeness in interactions. Over six months, noticeable improvements were observed in his comprehension and response to verbal communication, with him becoming more attuned to facial expressions and non-verbal cues. Researchers noted a deep-seated passion for learning music within him, contributing significantly to his progress. Overall, while language processing showed the most positive developments, other areas of communication demonstrated stability with opportunities for further growth.

LaGasse (2017) highlighted the significant benefits of music therapy in fostering communication skills, enhancing peer interactions, and improving cognitive social abilities. Similarly, research by Lim has provided robust evidence supporting the effectiveness of music-based interventions in improving speech production in both children and adults with autism. In a landmark study, Lim (2010) demonstrated that music instruction played a pivotal role in advancing key elements of speech, including semantics (word meaning), phonology (sound patterns), pragmatics (social language use), and prosody (rhythm and intonation). These findings align with earlier studies, such as those by Geretsegger et al. (2014), which underscore the positive influence of music therapy on communication and social engagement among individuals with autism spectrum disorder. Moreover, research by Bhatara et al. (2011) has highlighted the role of musical rhythm and intonation in aiding emotional expression and comprehension, further emphasizing the multifaceted benefits of music interventions in speech and social communication.

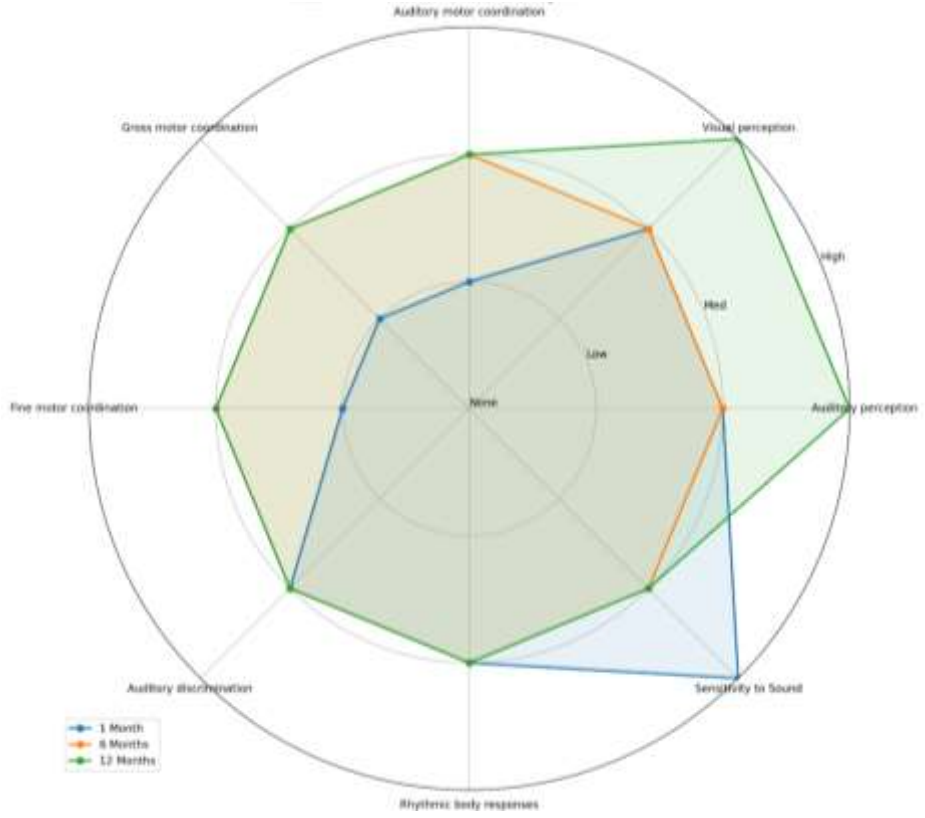
Sensory/Physical response

The Sensory/physical response domain included the following 12 response items for tracking

Self-expression, Range of affect, Anger, Frustration, Anxiety, Perceiving emotions, Understanding emotions, Managing emotions, Joy / Satisfaction, Sharing feelings, Self-esteem/confidence, Resilience.

Based on the tracked responses the following radar chart was generated.

Figure 2: Radar graph indicating progress in the Sensory-physical response modality



The initial assessment at 1 month revealed that most areas began at a medium level, with auditory motor coordination, gross motor coordination, and fine motor coordination starting at low, while sensitivity to sound was notably high. By the 6-month mark, all areas stabilized at a medium level, indicating significant progress in motor coordination, which improved from low to medium, while sensitivity to sound moderated from high to medium. The final assessment at 12

months showed auditory perception and visual perception reaching high levels, while other areas maintained medium levels. Additionally, it was observed that 'R' responded more effectively during individual sessions than in group settings. He displayed heightened sensitivity to others singing off-pitch or out of tune, often reacting with continuous laughter or by tapping and touching his face. Group interventions sometimes triggered restlessness, likely due to sensory overload and increased sensitivity to sound. Despite these challenges, his innate sense of rhythm and melody enhanced his engagement with music, leading to notable improvements in auditory-motor coordination and discrimination skills.

Research shows that both receptive and active music-making activate the superior temporal lobe and inferior frontal regions of the brain, facilitating enhanced communication between these areas. This interaction strengthens sensory integration by engaging cognitive, sensorimotor, and perception-action processes (Koelsch, 2009; Altenmüller & Schlaug, 2015). Rhythm, a fundamental element of music, plays a critical role in organizing timing and movement, making it particularly beneficial for individuals undergoing physical rehabilitation through auditory-motor synchronization (LaGasse & Thaut, 2013; Thaut et al., 2009). Beyond motor and sensory benefits, rhythmic stimuli also enhance non-motor functions, such as sustaining attention over time and improving cognitive flexibility (Bolger et al., 2013; Escoffier et al., 2015).

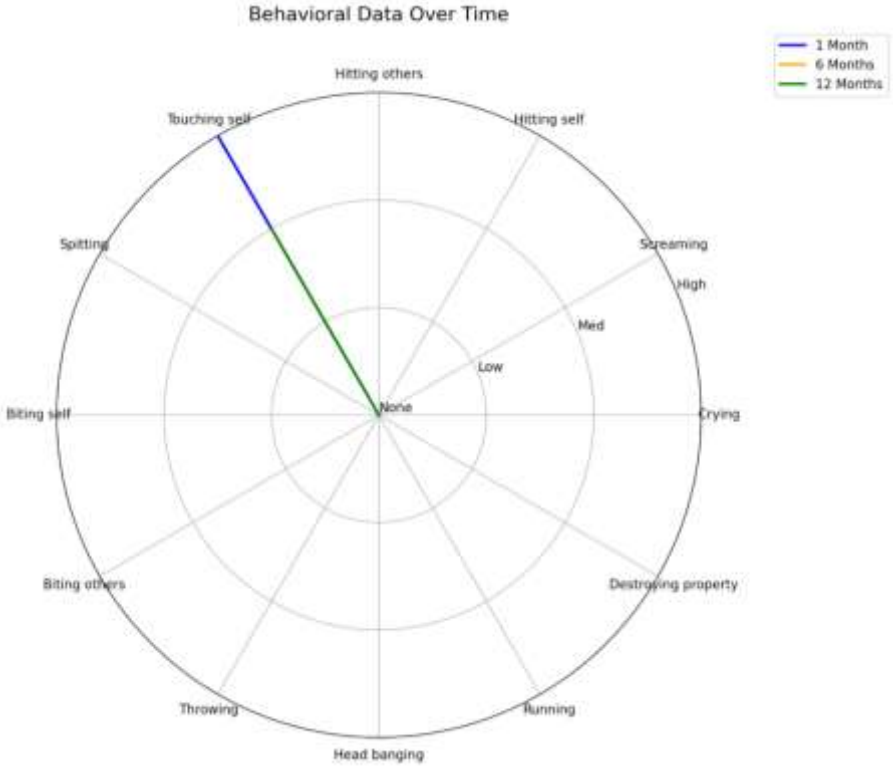
Behavior

The behavior domain included the following 12 response items for tracking

Crying, Screaming, Hitting self, Hitting others, Touching self, Spitting, Biting self, Biting others, Throwing, Head banging, Running, Destroying property.

Based on the tracked responses the following radar chart was generated.

Figure 3: *Radar graph indicating progress in the behavior modality*



Research demonstrates that music therapy is effective in reducing anxiety and mitigating aggressive behaviors in various populations (Starr et al., 1998; Erkkilä et al., 2011). Vibroacoustic music, specifically, has shown promise in addressing behavioral challenges in individuals with autism. Lundqvist et al. (2009) observed significant reductions in self-injurious and challenging behaviors in children with autism following vibroacoustic therapy, highlighting its therapeutic value. A comprehensive review by Kalas (2012) examining the effects of music therapy on adults with autism reported notable reductions in challenging behaviors and significant improvements in social skills compared to control groups. This aligns with findings by Gold et al. (2006), who noted that music therapy interventions enhanced emotional expression and social interaction in individuals with autism spectrum disorder,thereby reducing behavioral symptoms considerably. Additionally, Wigram and Gold (2006) emphasized the role of music therapy in fostering communication and engagement, further reinforcing its multifaceted benefits.

The overall behavior profile revealed that out of 12 tracked behaviors, 11 were consistently absent (none) across all time periods, indicating no occurrence of aggressive behaviors (e.g., hitting, biting, throwing), self-injurious behaviors (e.g., headbanging, self-biting), destructive behaviors (e.g., property damage), or disruptive behaviors (e.g., crying, screaming, running). However, the behavior of touching himself was noted and demonstrated changes over time. In certain instances, attention-seeking or self-stimulatory behaviors were observed. To address this, social stories and visual aids depicting acceptable behavior were introduced to help him understand appropriate social conduct, particularly during one-on-one sessions where this behavior was more pronounced. Music interventions were strategically employed to redirect his focus and attention, utilizing logical sequences of notes (*svara prasthārās*) presented at varying speeds to engage his spatial reasoning skills and foster active learning.

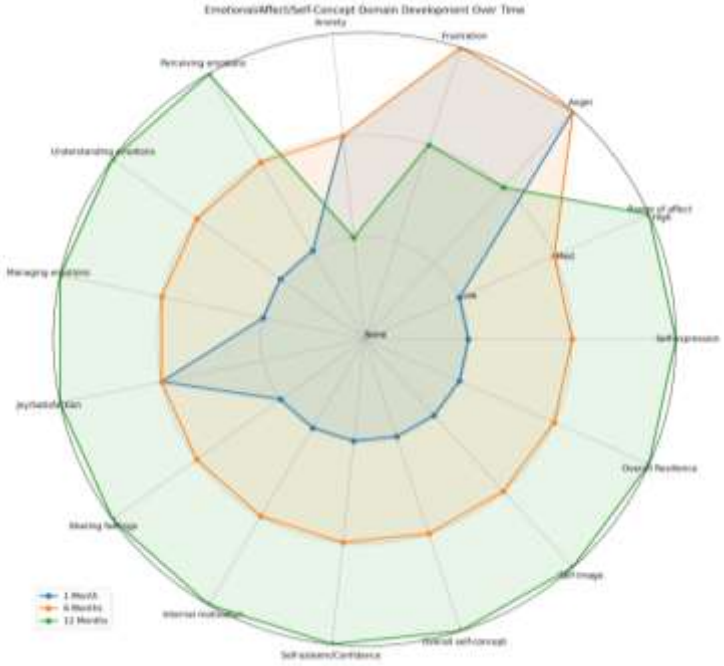
Emotional/Affect

The emotional / affect domain included the following 12 response items for tracking

Self-expression, Range of affect, Anger, Frustration, Anxiety, Perceiving emotions, understanding emotions, Managing emotions, Joy / Satisfaction, Sharing feelings, Self-esteem/confidence, Resilience

Based on the tracked responses the following radar chart was generated.

Figure 4: *Radar graph indicating progress in the Emotional/Affect modality*



In music therapy, musical and emotional attunement plays a crucial role in promoting synchronization between individuals. This process supports sensory integration, enhances emotional regulation, and fosters meaningful moments of emotional connection and shared experiences, ultimately contributing to the development of a shared narrative (Mössler et al., 2020). Kim et al. (2009) explored the social and motivational benefits of improvisational music therapy in individuals with autism. Their study analyzed participants' emotional, motivational, and interpersonal responses during therapy sessions. The findings revealed that music therapy significantly increased the frequency and duration of joyful interactions, emotional synchronicity, and instances where participants initiated engagement, highlighting its potential to strengthen social and emotional connections.

The assessment as shown in the graph above, reveals a clear trajectory of emotional and affective development over 12 months. At the initial stage (1 month), most categories were rated as low, with pronounced challenges in managing anger and frustration, which were rated as high, and moderate concerns with anxiety, rated as medium. By the midpoint (6 months), a general improvement was evident, with most categories progressing to medium, although anger and frustration remained consistently high. Notably, no areas showed regression, indicating steady and positive progress. By the final stage (12 months), significant advancements were observed across all areas, with most categories reaching high levels. Anger and frustration reduced to medium, and anxiety declined to low, demonstrating substantial progress in emotional regulation and an overall reduction in emotional concerns.

It was further observed that 'R' developed the ability to discern emotions in others during music therapy sessions. He exhibited a sharp sense of observation, especially in recognizing facial expressions, and often engaged in self-talk or self-instruction when encountering distressing emotions or expressions from the therapist. However, he displayed heightened anxiety in response to negative expressions and would often internalize blame. Reflecting the impact of past experiences, including mishandling at home and academic pressures despite repeated failures, music therapy sessions were designed to incorporate emotions such as *Śṛṅgāra* (joy) and *Vīra* (valor) to promote relaxation and sustained focus.

Initially, 'R' struggled to initiate or share his emotions. Over time, however, he began translating his vocal lessons onto the keyboard, which became a constructive emotional outlet, reducing conflicts at home. Before commencing music therapy, 'R' exhibited indications of low self-esteem, loneliness, and heightened social anxiety. However, after 12 months of individualized and group music therapy interventions, notable improvements were observed in his self-image, self-esteem, and ability to manage emotional challenges, reflecting the transformative impact of the therapy process.

Cognition

The cognition domain included the following 10 response items for tracking

Attention span, Reasoning, Focus, Sharing, Overall memory, Understanding simple instructions, Understanding visual cues, Understanding visuals, Body awareness, Ability to learn new things.

Based on the tracked responses the following radar chart was generated.

Figure 5: Radar graph indicating progress in the Cognition modality

The cognitive assessment conducted over 12 months reveals significant trends and progress. At the initial stage (1 month), most categories, including attention span, reasoning, focus, and understanding simple instructions, were rated as low. However, overall memory and the ability to learn new concepts were rated high, indicating strong baseline cognitive abilities. Understanding visual cues and visuals was assessed at a medium level, reflecting moderate initial performance. By 6 months, noticeable improvements were observed in attention span, focus, and understanding simple instructions, which progressed to medium levels, while overall memory and learning ability remained consistently high. Despite these advancements, reasoning, body awareness, and understanding visual cues showed no significant changes.

In examining his cognitive profile, it became apparent that 'R' initially exhibited a relatively short attention span for his age, likely due to the challenges of acclimating to a new environment. Nevertheless, he displayed a strong enthusiasm for learning and a rapid understanding of melody and rhythm, which facilitated his engagement in therapy. His auditory memory retention stood out as exceptional from the beginning, enabling him to quickly grasp and retain new musical compositions. During the initial phase (1–6 months), interventions centered on compositions such as Sri Muthuswamy Dikshitar's *Nōṭṭusvaras*, which served as effective tools for building connection and engagement. As the therapy progressed, the introduction of *dāsarapadas* in rāgas like *Peelu* and *Tilang* further enhanced his ability to maintain focused attention, thereby contributing to his overall cognitive development and sustained interest in learning.

Prolonged engagement with music leads to notable structural changes in the brain,

particularly in the cortex and cerebellum, manifesting as increases in both volume and density (Halwani et al., 2011; Schlaug, 2015). These neural adaptations are closely associated with enhanced cognitive functions. Evidence suggests that music-based interventions significantly improve key cognitive abilities, including memory, sustained attention, and verbal communication skills (Thaut et al., 2009; Simpson et al., 2013). Furthermore, Simpson et al. (2013) highlighted the transformative potential of music therapy in positively influencing these domains, providing compelling support for its application in therapeutic settings.

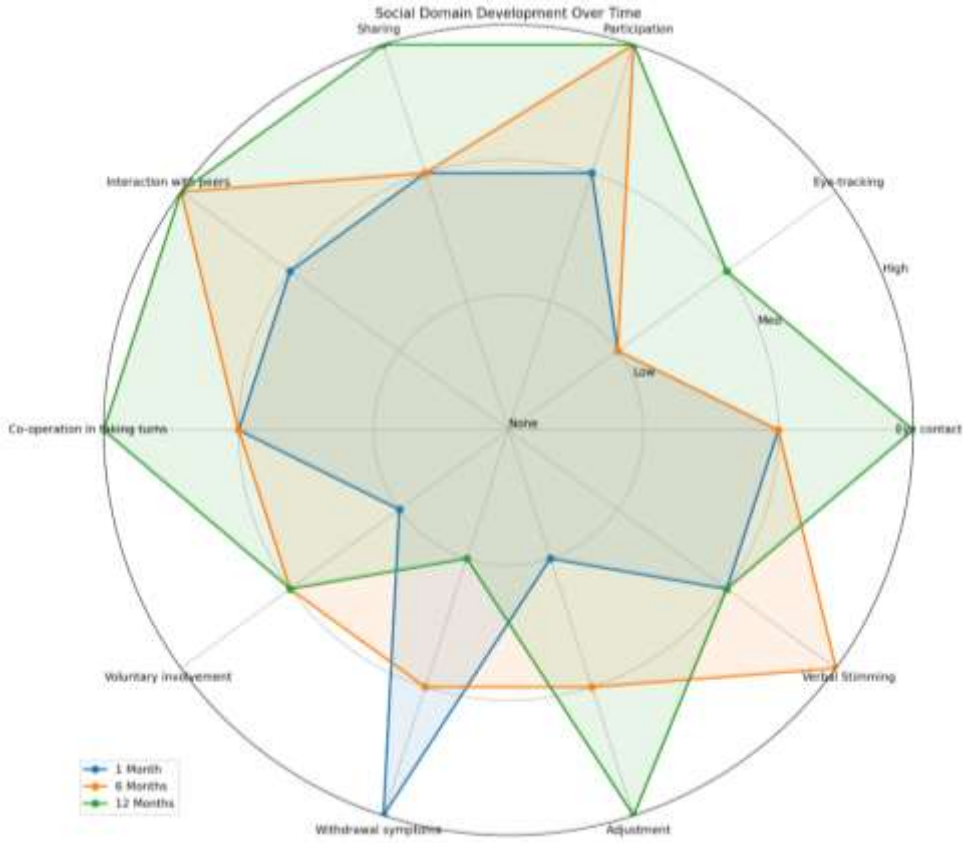
Social

The social domain included the following 10 response items for tracking

Eye contact, Eye-tracking, Participation, Sharing, Interaction with peers, Co-operation in taking turns, Voluntary involvement, Withdrawal symptoms, Adjustment.

Based on the tracked responses the following radar chart was generated.

Figure 6: Radar graph indicating progress in the Social modality



Music serves as a powerful medium for fostering connections between movement and emotion in individuals with autism, thereby enhancing their motivation to engage socially (Daniel, 2019). Emotionally, collaborative music-making can positively influence how individuals perceive and interact with one another, promoting deeper social bonds (Shamay-Tsoory et al., 2019). Recent research by Yoo (2023) observed that autistic adolescents exhibited increased attention to faces while watching videos of tapping activities, particularly when accompanied by music. This suggests that music engagement heightens social awareness and interaction, making it a valuable intervention for improving social engagement in individuals with autism (Stupacher et al., 2017).

The results indicated in the above graph show significant positive progress across multiple areas. Eye contact improved notably from medium to

high, as did participation, sharing, peer interaction, and cooperation in turn-taking, highlighting enhanced social engagement and collaborative abilities. Mixed progress was observed in areas like eye-tracking, which advanced from low to medium, and voluntary involvement, which also improved from low to medium but plateaued at that level.

Importantly, substantial improvements were seen in key areas of concern: withdrawal symptoms decreased markedly from high to low, and adjustment showed steady progress from low to high, reflecting enhanced adaptability and emotional regulation. Regarding social interactions, it was observed that R finds joy in engaging and socializing within a group of adult students, often initiating greetings independently. However, during music sessions, he occasionally becomes hyperacute, displaying restlessness and anxiety, especially when the group deviates from the correct pitch or rhythm. To address sensory overload and foster connections with peers, artwork was introduced as a parallel activity. Initially, R found turn-taking challenging, but with time, he demonstrated gradual improvement by responding musically only when his name was called out, indicating increased ability to engage and participate with the group.

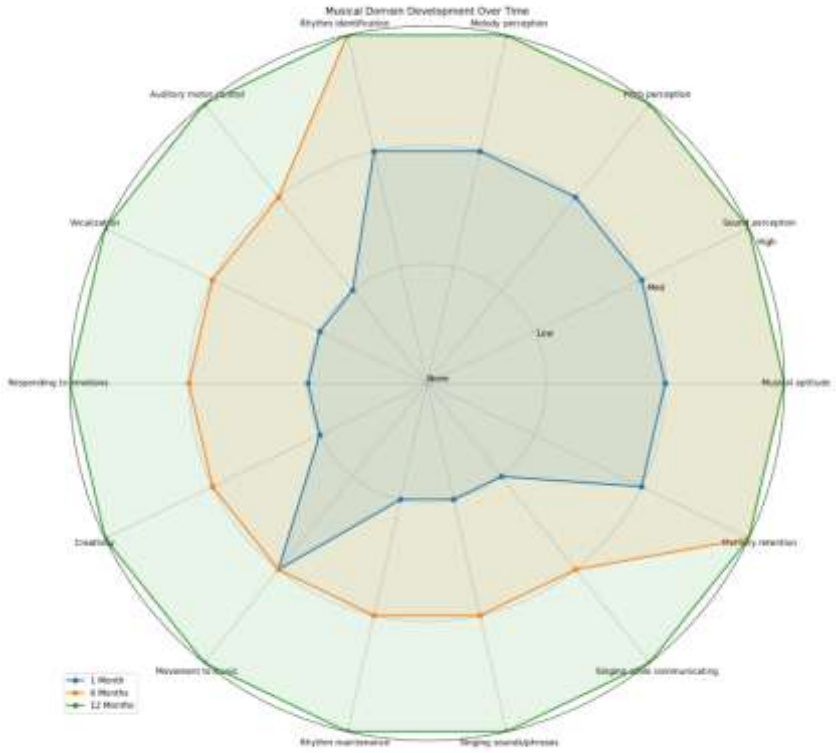
Musical

The musical domain included the following 14 response items for tracking

Musical aptitude, Sound perception, Pitch perception, Melody Perception, Rhythm identification and processing, Auditory Motor Control, Vocalization, Responding to emotions in music, Creativity and improvisation, Movement to music, Rhythm on instruments, Singing words / Phrases, Singing/playing whole compositions, Memory Retention and recall

Based on the tracked responses the following radar chart was generated.

Figure 7: Radar graph indicating progress in the Musical modality



Research indicates that individuals with autism spectrum disorder (ASD) tend to prefer music over verbal stimuli when exposed to auditory inputs (Blackstock, 1978; Buday, 1995). Autistic individuals frequently exhibit exceptional abilities, with one study reporting that about one-third of adults with autism demonstrate superior skills in specific areas, as assessed through psychometric testing and parental reports (Howlin et al., 2009). In the realm of music, autistic savants often display extraordinary talent. Early research by Applebaum et al. (1979) revealed that autistic children surpassed neurotypical peers with greater musical experience in reproducing complex atonal melodies, highlighting their unique musical capabilities (Heaton, 2009).

The results with reference to the current case study reveals consistent improvement across most areas, with significant progress observed from initial low or medium levels at the 1-month mark to high levels by the 12th month. Notable areas of steady development include auditory-motor control, vocalization, emotional responsiveness to music, and creativity. Furthermore, categories with a strong baseline—musical aptitude, sound perception, pitch perception, and melody perception—demonstrated rapid progression from medium to high levels within the first six months, underscoring initial strengths and sustained growth.

Thanks to his exceptional musical abilities and innate affinity for music, engaging with him through musical activities was seamless. He exhibited the capacity to grasp substantial portions of music in a single session, requiring minimal prompts in subsequent sessions due to his excellent recall skills. By the end of the 12-month period, he successfully showcased his musical talents across three different platforms, fully utilizing his abilities and demonstrating his remarkable growth and potential.

Impressions and recommendation

During the intervention phase, it was evident that he required substantial encouragement from parents and mentors to effectively navigate the challenges of adulthood. A less stressful learning environment, emphasizing practical and experience-based subjects over high-level reasoning and abstract thinking, proved beneficial. Consistent engagement in music and art emerged as a vital strategy to reduce socially inappropriate behaviors.

Prior to the commencement of music therapy sessions, assessments revealed low self-esteem, loneliness, and heightened anxiety in social interactions. However, after twelve months of structured individual and group music therapy, marked improvements were observed in his self-image and self-esteem. These changes fostered greater confidence in interacting with peers, therapists, and others in his environment.

His focus and attention showed significant development, evolving from an ability to recite simple two-line shlokas to performing entire compositions and reading pages of musical scripts. His retention abilities were particularly noteworthy, enabling him to recall information effortlessly, even after extended periods of non-practice. He demonstrated effective transfer of learning across domains, integrating music as a leisure activity and a tool for conflict resolution at home. For example, he applied vocal lessons to playing musical instruments and engaged in painting and math activities while passively listening to music.

With his keen perception of sound, pitch, melody, and rhythm, combined with his natural musical aptitude, he responded proficiently to diverse compositions, including shlokas, swara patterns, rhythmic sequences, and both classical and Western pieces. He actively participated in musical activities for extended durations without distraction and required minimal verbal prompting. Towards the end of the study period, he exhibited the capacity to participate in individual and group music sessions with reduced occurrences of repetitive physical movements,

sounds, words, or other self-stimulatory behaviors.

Conclusion

The present study underscores how engaging with music can leverage cognitive processes to address various aspects such as managing sensory sensitivities, facilitating emotional expression and regulation, enhancing memory and learning, promoting social engagement, improving speech, and regulating mood, among other benefits. A specific study by LaGasse (2014) highlights the potential of music therapy to improve social behaviors and enhance joint attention in children with Autism Spectrum Disorder (ASD). Similarly, Vaiouli et al. (2015) conducted a study demonstrating the efficacy of music-based intervention in improving joint attention and social engagement, with input from teachers and parents on the role of the social environment in supporting social communication skills. In the current study, MT intervention showed notable progress in various domains, including understanding emotions, initiating interactions, responding, managing self-stimulation, and engaging in social interaction with reciprocity. Additionally, Heaton (2009) and Bhatara et al. (2013) suggest that individuals with ASD often exhibit strengths in music perception and ability, with adolescents and adults showing similar levels of interest in music as their neurotypical peers. Moreover, music listening has been found to activate the dopaminergic response system in individuals with ASD, contributing to its rewarding nature and its impact on emotions and mood regulation (Allen et al., 2009). Individuals with ASD also demonstrate the ability to associate emotions with corresponding musical excerpts (Heaton et al., 2008).

Music-based interventions can be promising for improving interpersonal skills, behavior, affect, sensory processing, cognition, and communication in adults with autism. It highlights the positive impact of individualized intervention plans tailored to specific goals and the importance of proper assessment and multimodal problem analysis in MT implementation. Indian classical music therapy, when applied effectively, can contribute positively to the well-being of individuals with autism, with the potential for systematic tracking of intervention progress through response tracking and subjective analysis. Overall, systematic tracking of intervention progress is essential in Indian classical music therapy for individuals with autism to optimize outcomes, personalize treatment plans, and ensure the delivery of effective and evidence-based care.

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