

Enhancing Joint Attention Skills in a Child with Tuberous Sclerosis Complex (TSC): A Single-Case Study of Using Music Therapy Intervention

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Abstract

Tuberous Sclerosis Complex (TSC) is a rare genetic disorder that causes benign tumors, or hamartomas, in various organs, including the brain. These tumors can lead to seizures and epilepsy, which impact the brain's neural circuits and are associated with neurodevelopmental disorders (TAND) such as autism spectrum disorder, intellectual disability, and various behavioral, academic, and psychosocial difficulties. Due to these neurodevelopmental challenges, children with TSC often experience social communication delays, particularly in joint attention skills. Music therapy has been found to improve joint attention in children with autism spectrum disorder (ASD), but its effectiveness in children with TSC has not been studied. This study aimed to investigate the effectiveness of music therapy on joint attention skills in an 8-year-old child with TSC, using an ABAB single-case design. The study involved six baseline sessions and eleven music intervention sessions, which included singing, instrumental playing, and movement with music. Joint attention skills were assessed using the SCERTS Model, specifically the SAP-Report Form (SAP-R) and SAP-Observation Form (SAP-O). The results showed that during the baseline phases, the child's joint attention skills had a mean score of 1.57 in the first baseline and 1.64 in the second. During the intervention phases, these scores increased to 1.85 and 1.93, respectively. The findings suggest that music therapy interventions effectively improve joint attention skills in children with TSC.

Keywords: joint attention skills, music therapy, Tuberous Sclerosis Complex (TSC)

Introduction

Tuberous Sclerosis Complex (TSC) is a rare genetic disease which causes benign tumours in various organ systems, including the brain, kidneys, heart, eyes, lungs, and skin. These tumours, referred to as hamartomas, consist of abnormal mixtures of cells and tissues (National Institute of Neurological Disorders and Stroke, 2023; National Health Service, 2021; and National Organization for Rare Disorders,

2021). Tuberous Sclerosis Complex can be diagnosed by using genetic diagnostic criteria and clinical criteria. Diagnosis of TSC involves genetic testing for mutations in the TSC1 and TSC2 genes, but 10% to 25% of cases may not show mutations, requiring clinical criteria for confirmation (National Institute of Neurological Disorders and Stroke, 2023; Northrup et al., 2021). Besides that, individuals who have suspected of having TSC must also include MRI of the brain to detect abnormalities and routine EEG due to the high likelihood of seizures, especially in infants. Due to the seizures or epileptic, the genetic mutation and the tumours that affected the neural circuit in central nervous system in the brain may lead TSC patient associated with neurodevelopmental disorders (TAND) like autism spectrum disorder, Intellectual disability, and various behavioural, academic, and psychosocial difficulties (de Vries et al., 2015; Northrup et al., 2021).

Research found that children with TSC had showed the level of cognitive impairment, from mild learning disabilities to severe intellectual disability (ID) were up to 80%. Besides that, 60% of children with TSC would also experience autism spectrum disorder (ASD) approach and more than 50% associated with Attention Deficit Hyperactive Disorder (ADHD) (Bolton et al., 2015; Kopp et al., 2008). Because of the neurological characteristics such as seizures, brain damaged by tumours, roughly 50% of TSC children showed ASD and ID symptoms or behaviours (de Vries et al., 2007) and 17-61% of TSC children had been diagnosed with autism (Jeste et al., 2008). One of the symptoms that showed in children with ASD is social communication impairments which included social interaction (verbal and nonverbal communication (American Psychiatric Association, 2013). As most of the TSC children may associated with the symptoms of ASD, they may cause to have difficulties in social interaction such as eye contact, imitate the people surrounded through verbal and nonverbal, and shared attention (Claudia & Lucia, 2022). Jeste et al. (2014) and McDonald et al. (2017) found that TSC children may demonstrated some characteristics that presented in autism spectrum disorder (ASD) or intellectual disorder (ID) such as lack of social communication skills and delays in nonverbal cognition, and infants with TSC by 9 months of age were later diagnosed with ASD from those without ASD. Hence, children with TSC would demonstrate social communication delay.

Joint attention is one of the important domains in social communication skills which the attention overtly focused by two or more people on the same object, person, or action at the same time, with each being aware of the other's interest, it also known as shared attention (American Psychological Association, 2023). Joint attention behaviours described into two categories which are: Responding Joint Attention (RJA) refers to the person who has the ability to follow the direction of gestures and gaze of others in order to share a common point of reference; and Initiating Joint Attention (IJA) refers to the person use his or her gestures and eye contact to direct other's attention to objects, events, and to themselves (Mundy & Newell, 2007). Both joint attention behaviours are important to develop the social communication skill. As children with TSC may associated with neuropsychiatric disorders (TAND), they may show delayed in social communication skill (Jeste et al., 2014; McDonald et al., 2020). Kasari et al. (2015) found that to improve social interaction and language in toddlers who are in high risk for ASD, parents or caregivers can use intervention that targeting nonverbal communication for their child. A nonverbal communication included the initiation of joint attention gestures such as pointing to share, coordinated eye gaze between objects and people. These skills are the fundamental of social communication which develop the relationship of the children with others. Therefore, it is important to provide intervention for children with TSC who presented delay in joint attention skills.

Music therapy is clinical and evidence-based that provided by a credentialed professional who uses music elements and using clinical and evidence-based to create music interventions to accomplish individualized goals within a therapeutic relationship. Music therapy is suitable for individuals, groups, families, or communities who seek to optimize their quality of life and improve their physical, social, communicative, emotional, intellectual, and spiritual health and wellbeing (American Music Therapy Association, 2005; World Federation Music Therapy, 2011). Many studies had showed that music therapy effectively enhanced joint attention skills in various kinds of children, especially children with autism spectrum disorder (ASD). The benefits of music therapy are facilitating children who lack of joint attention to improve their acquiring language, social and communications skills by using music which can be playing the same instruments or improvise the music together in the session (Chiengchana & Trakarnrung, 2014; Davis, 2016; Ghasemtabar et al., 2015; Gross et al., 2010; Kim et al., 2008; LaGasse, 2014; Vaiouli et al., 2013). Music therapy had also found to increase eyes contact and improve on initiating and responding to communication for children with ASD by using music improvisation. It was because music therapist used improvised music to match with the child in the present to show the involvement of shared

contact for a therapeutic relationship between the child and the therapist (Geretsegger et al., 2012; Kim et al., 2008; Vaiouli et al., 2012). Therefore, the child could feel safe to communicate with therapist in the music therapy session, this also known as client-centred approach which the therapist will focus on the client during the session.

While most studies have discussed the effectiveness of music therapy on joint attention skills in children with Autism Spectrum Disorder (ASD), no studies have addressed music therapy interventions on joint attention skills in children with TSC. However, TSC children may also exhibit autism symptoms and intellectual disabilities, which means that joint attention skills may also be affected (Claudia & Lucia, 2022; Jeste et al. 2014; McDonald et al., 2017). Based on previous research on joint attention skills, the researcher hypothesized that music therapy may also show positive results in children with TSC who lack of joint attention skills.

Hence, the objective of this study was to investigate the effect of music therapy on joint attention skills which included shares attention, shares emotion, and shares intentions for social interaction in a child with TSC using single-case research design. The research questions of this study are:

1. Does music therapy increase joint attention skills in a child with tuberous sclerosis complex?
2. How music therapy interventions used to improve joint attention skills in a child with tuberous sclerosis complex?

Methodology

This study had received ethical approval from The Committee for Research Ethic (Social Sciences), Faculty of Social Sciences and Humanities, Mahidol University [MUSSIRB No. 2023/069 (B2)]. A single-case study design was employed in this study to investigate the effectiveness of music therapy interventions on the joint attention skills consisting of three areas: shares attention, shares emotion, and shares intention for social interaction of a child with TSC. The researcher used reversal A-B-A-B design to test the effectiveness of music intervention and compare the results between two baseline (A1 & A2) which was without music intervention and two intervention phase (B1 & B2) which was with music intervention. In this way, the researcher would be able to determine from the results of baseline and music intervention phase whether the music therapy interventions could help the child with TSC improve joint attention skills.

Participants

The participant of this study was an eight-year-old girl who had been diagnosed as having Tuberous Sclerosis Complex (TSC). The participant was referred from the lecturer and professor in Music Therapy Department, College of Music, Mahidol University who had the contact of the parents with TSC child. The selection of the participant based on the following criteria: (1) An eight-years-old child who had diagnosed as Tuberous Sclerosis Complex from doctor; (2) The child had occurred seizures onset before age of two; (3) The child had presented difficulties in joint attention skills such as no responds or no initiative interaction with others, low eye contacts or low gaze shifts between people and objects, lack of sharing emotion by using facial expression or vocalizations, lack of request and/or protests behaviours, lack of turn-taking; (4) The child was determined as Language Partner stage by using SCERTS Model; (5) The child could communicate in Thai or English language; (6) The child had never attended any music therapy for joint attention skills before; and (7) The child should be allowed to attend this study by the parents and asked to complete and sign the consent form for their child's participation to attend in this study.

Dependent Measures

1. Participant's Background Interview

SAP-Report Form (SAP-R) in The SCERT Model was used to interview the parents of the participant in order to collect the participant's background information which included: (1) background information of the participant; (2) joint attention behaviour of the participant at home; and (3) musical background of the participant such as musical skills and music preferences at home. The data from this semi-structured interview were used to design appropriate music therapy interventions to meet the needs of the participant.

2. Assessment of joint attention skills

The SCERT Model was applied in this study for conducting assessment for joint attention skills in each activity. It is an ongoing assessment process which used to determine the basis of a child's overall developmental level, functional needs and preliminary assessment outcomes. SCERTS Model assessment addresses three domains: social communication (such as joint attention and symbol use), emotional regulation (such as mutual and self-regulation), and transactional support (such as interpersonal and learning support). Each domain will be assessed in the three major stage developmental continuum: Social Partner, Language Partner, and Conversational Partner (Prizant et al., 2006). In this study, the researcher would focus only the joint attention behaviours in social communication domain.

The reason of choosing only joint attention skill in this study is because joint attention skill is very important in daily life for a child. It is the skill to develop social learning by sharing the attention with others. Joint attention also serves as a self-organizing role in social information processing in early and in unstructured social-learning situations. However, children with TSC are likely facing the difficulties in joint attention as TSC is the rare genetic disorder that associated with a variety of neurodevelopmental issues collectively known as TSC-associated neuropsychiatric disorders (TAND), up to 90% of individuals with TSC experience TAND (Curatolo et al., 2015; de Veries et al., 2015). 72-85% of individuals with TSC will have a history of seizures, and more than 80% of cases epilepsy begins in the first 3 years of life. Apart from that, individuals with TSC will associate with autism spectrum disorders (ASD) (40-50%), attention deficit hypertension disorder (ADHD) (30-50%) and intellectual disability (about 50% range from mild to profound) skill (Bolton et al., 2015; Curatolo et al., 2015; Leclezio et al., 2015; Schoenberger et al., 2020). Half of the children with TSC (50%) had found to develop intellectual disability from mild to severe intelligence ($IQ > 70$) and developed the similar symptoms of ASD which would has difficulties in social communication (Bolton et al., 2015). Research also found that infants with TSC showed early delays in nonverbal cognition and social communication skills which slowly developed into ASD (McDonald et al., 2020). Hence, this study focused on only joint attention skills.

The assessment tool that used to assess the joint attention behaviours of the child is using SAP-Observation (SAP-O) form in The SCERTS Model. The SAP-O form used to collect the data then rate the score by using a scoring system (0,1 or 2) shown as below:

- 0- Child is learning this skill and criterion is not met without partner support.
- 1- Child is practicing this skill and criterion is met inconsistently.
- 2- Child is using this skill independently and criterion is met consistently.

In this study, the scores of the joint attention behavior that the researcher and the inter-observer (another music therapist) in treatment phase; the researcher and two of the child's parents in baseline phase were calculated by using Pearson product-moment correlation to evaluate the consistency between the two observer's score (the researcher and inter-observer; the researcher and the parents) (Bland & Altman, 2003). The inter-observer reliability of SCERT Model observation form (SAP-O) test shown strong positive correlation ($r=0.75$, $p<.01$) for the researcher and the two of the child's parents (in baseline phase) and strong positive correlation ($r=0.94$, $p<.01$) for music therapist as inter-observer (in treatment phase). Therefore, the result showed the high relation ($r=.70-.90$) between the researcher and both child's parents (in baseline phase) and music therapist as another observer (in treatment phase).

3. Observational note

Observational note was a separated tool from the SCERT model assessment. It was used to collect the participant's joint attention skills, behaviours, and musical preference and ability in every session. The researcher would observe the recorded session and used observational note to write down the joint attention behaviour of the participant that showed in the music therapy sessions. The purpose of observational note is to record and get the information from the experimental activities by observing the joint attention skill included (1) shares attention; (2) shares emotion; and (3) shares interaction for social interaction. The observational note would also record the information about the effective of the music interventions that conducted in the session and to help the researcher to prepare for the next music therapy session.

Data Collection

Based on the previous studies, most of the research conducted roughly nine to twelve music therapy session and all the results showed positive (Carpente et al., 2022; Davis, 2016; Kim et al., 2008; Gim et al., 2009; Oldfield, 1991). Therefore, the data collection in this study was applied from previous studies and

conducted in total of 17 sessions which were 6 sessions for baseline (A1, A2) and 11 sessions for music interventions (B1, B2). The sessions were conducted in three consecutive days per week.

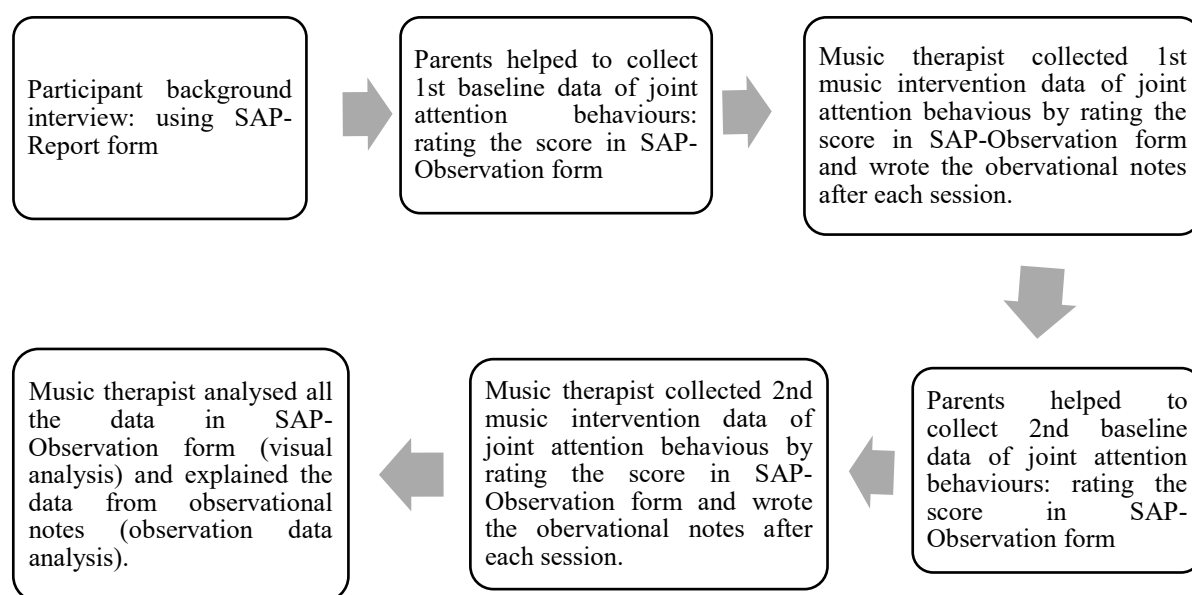
1. Baseline data collection (A1 & A2)

The baseline data were collected on sessions 1st to 3rd and sessions 10th to 12th. Music therapist explained to the parents about the protocol of SCERT Model assessment tool to assess the child's joint attention skills and behaviour at home. The parents would observe the child's joint attention skills and behaviour during daily activities at home such as playing ABC puzzle, fixing and building with screwdrivers and building blocks. During the activities, the child would play with the parents and the little sister at home. Then, the parents were assisted to collect the joint attention behaviour during the daily activities in home setting without any music intervention by using the SAP-Observation form which taken from SCERT Model assessment.

2. Music therapy intervention data collection (B1 & B2)

The music therapy intervention data were collected on sessions 4th to 9th and sessions 13th to 17th which were after each baseline session. All the music therapy sessions were used video recording to record for the visual analysis and observation analysis on the participant's joint attention behaviour by researcher and inter-observer. The researcher watched the video recording after each music therapy session and discuss the treatment process with the advisor who was observing the session in another room to provide helps when needed. The researcher was using the SAP-Observation form which taken from SCERT Model assessment to rate the score on joint attention behaviour and also used observational note to record all the joint attention behaviour that happened in the music therapy session. The music therapy intervention data would be analysed in two ways of analysis: visual analysis and observation data analysis. Each session took 30-40 minutes long.

Table 1. *Procedures in data collection*



Music Therapy Intervention strategies

Music therapy interventions of this study were developed according to applied behavioural analysis approach and humanistic approach to improve the joint attention skills.

Applied Behavioral Analysis (ABA) is a scientifically based method focused on modifying socially beneficial behaviours. It utilizes established learning principles, collecting data on targeted behaviours to assess intervention effects. ABA employs positive reinforcement to encourage individuals to repeat specific behaviours, increasing the likelihood of their recurrence (Kearney, 2015).

Humanistic approach emphasizes viewing individuals holistically, valuing their uniqueness and believing in human free will. Applied in client-centred therapy, this approach involves therapists fostering a healing relationship marked by empathy, unconditional positive regard, and transparency. Clients are

expected to actively participate, with therapists adopting a supportive role. In a study utilizing the client-centred technique from the humanistic approach, the therapist aimed to establish a positive therapeutic relationship, enabling clients to engage in music therapy interventions and freely express their inner experiences through music without fixed rules or structures (Corey, 2009; Corsini & Wedding, 1995; Mcleod, 2023; Wheeler, 2017).

ABA and humanistic approach combined together to plan the music interventions and also applied during the music therapy session. It was because music could be the rewards, positive reinforcement or prompts to cue the participant to build the joint attention skills with music therapist in the session which related to Applied Behavioral Analysis (ABA). Humanistic approach helps to provide a positive therapeutic relationship which encouraged the participant to engage with music therapist in the session. The participant could feel safe in the session when the music therapist let the participant decided what musical instruments she wanted to play or what songs she wanted to sing. But at the same time, music therapist was still taking the control of whole music therapy session in order to help the participant to develop the joint attention skill while doing the music activities.

In this study, the 30-40 minutes music therapy session was started with greeting song to create an atmosphere to inform the participant that the session has begun. Then followed by the music activities which consist of singing, movement with music activity and musical instrumental improvisation. The last part was singing goodbye song to inform the participant that the session had finished. The therapeutic function of the music therapy interventions was shown as follows:

1) Singing. The primary objective of incorporating singing activities in music lessons for young children is to promote social development and enhance social skills (Lau, 2005). The child selected favourite songs and sings alongside the music therapist, who follows the child's lead. Using familiar songs encourages the child's engagement and communication with the therapist, fostering eye contact, body language, and verbal responses to express emotions. Familiar songs can enhance the communication such as eye contact and body language and/or verbal responses to express their feelings of this song and telling others that they are engaged. It also facilitated turn-taking, promoting joint attention (Initiative JA & Respond JA) skills (Chiengchana & Trakarnrung, 2014; Scholtens, 2019). In this study, the researcher as music therapist allowed the child to request specific songs during sessions, and the researcher can use songs as reinforcement for the child's participation.

2) Movement with music. Movement accompanied by music served as a means to cultivate the child's initiative in social interactions with the therapist, contributing to the development of social and communication skills (Oldfield, 2011). Rhythmic cues and music structure were used to help the child to understand the correct response and follow the response. For example, a stopped music/rhythm to signal that the child should respond stop with the music (LaGasse, 2014). The researcher as music therapist utilized equipment like a parachute and yoga ball, encouraging the child to move in sync with the music and incorporating musical elements such as tempo, dynamics, and melody to promote joint attention between the participant and therapist. Additionally, music was employed as reinforcement to motivate the child to respond correctly and follow cues. When the child showed joint attention behaviour, music therapist would play the music and move together with the parachute or yoga ball, on the contrary, if the child stop showing the joint attention behaviour, music therapist would stop the music.

3) Musical instrumental improvisation. Improvisation, defined as creating and performing spontaneously without preparation, allows for the production of music from whatever is available. Engaging in improvised music-making with instruments can enhance social skills such as turn-taking, imitation, joint attention, and verbal communication (Chiengchana & Trakarnrung, 2014; Kim et al., 2008). Shared intentionality enables the child to better learn from each other and collaborate in collective activities (Tomasello & Carpenter, 2007). According to Oxford Languages, "improvise" defined as to create and perform spontaneously or without preparation. It can produce or make anything from whatever is available. The researcher as music therapist applied an improvisational music therapy approach, involving improvised, shared music-making experiences aligned with the child's musical and non-musical non-verbal behaviours. This intervention, rooted in the humanistic perspective, grants the child the freedom to spontaneously create and improvise music on various instruments.

Table 2. *Interventions that used in the music therapy session*

Intervention	Function of interventions
Greeting	Starting with greeting song also help the researcher to create therapeutic relationship with the participant and informed the participant that the session has begun. Greeting song can cue the child to say "Hello".
Singing	The researcher will use the songs that the child is familiar to encourage the child to engage and communicate with the music therapist in the activity.
Musical Instrument improvisation	The researcher adapted improvisational music therapy approach by using improvised, shared music-making experiences to match with the patient's musical and non-musical non-verbal behaviors.
Movement with music	The researcher facilitated the child by using the equipment such as parachute and scarfs and let the child move with the music and use the elements of music such as tempo, dynamics, melody to encourage the joint attention between participant and therapist.
Farewell	Researcher sang goodbye song to inform the participant that it's time to go home and finished the session.

Data Analysis

1. Visual analysis was used to analyse the quantitative result by observing the joint attention skills during the baseline phases (A1 & A2) and the music intervention phases (B1 & B2). The data for both phases (baseline and music intervention) were collected by using SAP-Observation form which taken from SCERT Model assessment and analysed by using the scoring system (0, 1, 2) that provided in SCERT Model assessment on joint attention behaviour. After finished collecting all the data in both baseline and music intervention phases, the researcher used Microsoft Excel to analyse the data and present the results between baseline phases (A1 & A2) and music intervention phases (B1 & B2) in the linear graph by displaying the levels of changes and trend of joint attention skills. However, the researcher would not use the scores of joint attention behaviour that collected from the inter-observer (another music therapist who observe the video recording) as the scores were only used to reduce the bias and calculate the reliability of this study.

2. Observation data analysis was used to analyse the qualitative result of the participant's joint attention skills during the session from video recording. The researcher would record all the joint attention behaviour by writing the observational note after every music therapy session. After that, the result would be presented as narrative by describing the joint attention behaviours that the child showed in the sessions. Besides that, the observation data would also use to describe the result that showed in the visual analysis. However, the results of two baseline phase (A1 & A2) would not present in observation data analysis part as the activities were conducted at home and collected by the parents in home setting. All the sensitive information of the participant such as name, address, school, and specific personal information will be removed due to keep the confidentiality of the participant.

Results

The results were divided into three parts: (1) background of the participant; (2) results of visual analysis of joint attention skills; and (3) results of the observation.

1. Background of the participant

The participant of this study was an eight-year-old girl with TSC. According to the interview protocol, she faces challenges in joint attention skills, a component of social communication and unable to attend school due to seizures related to her disorder. The child expresses her desire and dislikes in nonverbally such as pushing or grab, using words sparingly. She struggles with turn-taking and often

unable to wait for her younger sister during activities with her mother. Difficulty comprehending and following instructions leads her to walk away, whether misunderstood or when she doesn't understand. The child struggles to express her emotions but aligns her feelings with her parents'. Physically, she runs despite weakness in her hips, occasionally sitting or lying down after a few minutes. Proficient in motor skills, she can draw, write, feed herself, and put on shoes. In terms of music preference, she demonstrates a keen interest, requesting songs on YouTube, playing musical toy instruments at home, and singing along loudly.

2. Result of visual analysis of joint attention skills

Visual analysis of graphed data was employed to analyse the scores from the SCERTS Model in all sessions and covers joint attention skills in three areas which are Shares attention, Shares emotion, and Shares intentions of social interaction. The score in each session was assessed by two parents (in baseline phase) and one music therapists (in treatment phase). The researcher would not include the scores from the inter-observer which was observe the same recording of the treatment sessions in this study; however, inter-observer reliability had been done in this study. Changes in level, slope, and trend of the scores were presented by graphing lines between points. Results from the first baseline session to the last treatment session were shown below as line graphs.

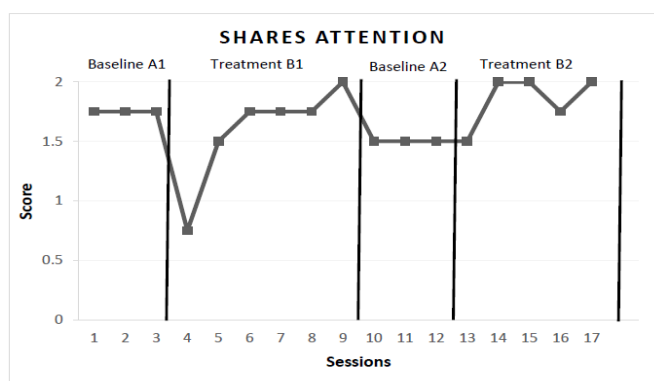


Figure 1. Overall mean scores of joint attention skills in shares attention area during baseline phase and treatment phase.

For shares attention area that showed in Figure 1, the mean score for each three sessions was shown stable in the graph which was 1.75 during baseline phase A1. After the first treatment phase (B1), the mean score dramatically decreased to 0.75 in the first session but again dramatically increased to 1.5. From session three onwards, the mean score showed consistently in 1.75 and increased to the peak on the graph in the sixth treatment session which was 2. During baseline phase A2, the mean score had decreased to 1.5 and remained consistent. After the second treatment phase (B2), the mean score rose to the peak on the graph in session 14 and session 15 again from the second session but fell to 1.75 in session 16 and back to the peak on the graph which was score of 2.

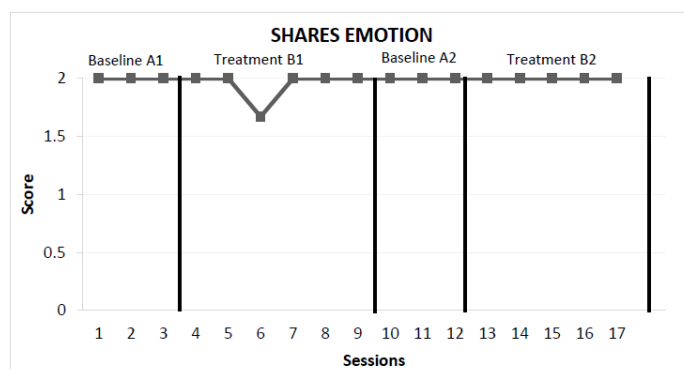


Figure 2. Overall mean scores of joint attention skills in shares emotion area during baseline phase and treatment phase.

For shares emotion area that showed in Figure 2, the mean score remained consistently in score of 2 during baseline phase A1. After the first treatment B1 session, the mean score dropped to score 1.67 but increased again to the peak of the score which was 2 until the end of this treatment phase. During baseline phase A2, the mean score dramatically remained consistently in score of 2. In the treatment phase B2, the mean score also remained the same until the end of the treatment phase.

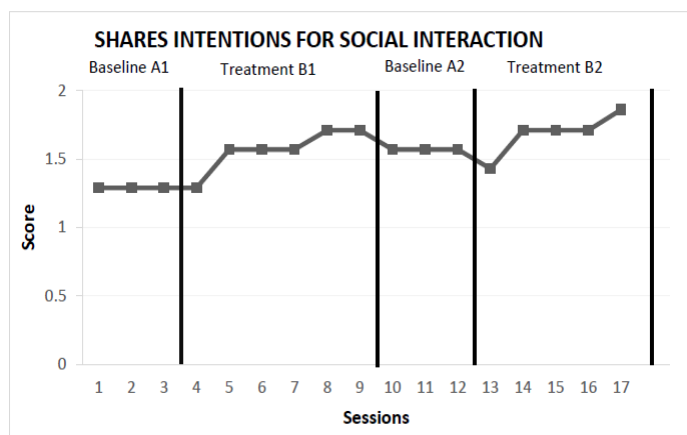


Figure 3. Overall mean scores of joint attention skills in shares intentions for social interaction area during baseline phase and treatment phase.

For shares intentions for social interaction area that showed in Figure 3, the mean score showed 1.29 for the whole baseline phase A1. In the treatment phase B1, the mean score gradually increased to score of 1.71 in session 8 and session 9. The mean score performed stable in score of 1.57 in session 5 to session 7. During the baseline phase A2, the mean score dropped to score of 1.57 throughout the whole baseline phase. In the treatment phase B2, the mean score dropped again to score of 1.43 in session 13. However, the mean score slowly increased to the highest score in session 17 which was score of 1.86.

3. Results of the observation

During the intervention phases, the child had showed a positive therapeutic relationship with the music therapist and engaged with the music therapist throughout all the treatment sessions. The child followed the instructions of the music therapist and requested social games with the music therapist. However, the child still needs some prompts either verbal or nonverbal on turns taking, greeting and request permission skill from the music therapist.

In Shares attention area, the child had eyes contact with the music therapist when the music therapist was singing her preferred songs such as “Twinkle Twinkle Little Star” or “Hockey Pockey”. Besides that, the child also will look at the speaker when the music therapist played her preferred songs. When the music therapist was playing the xylophone, the child would look at the music therapist and the xylophone happily by flipping and moving her hands and legs. The child also started to express her intentions from nonverbal (grabbing, pulling) to verbal such as “I want this” and “Please open” when the music therapist used her preferred and familiar songs and instruments in the session.

In Shares emotion area, the child consistently showed positive emotions, such as happiness and excitement, throughout all treatment sessions. The child expressed her joyfulness using gestures such as flipping and moving her hands and legs. Additionally, when feeling comfortable and relaxed, the child hugged the music therapist or leaned her head against the therapist's head. This positive emotional response was attributed to the music therapist's use of the child's favourite songs and instruments, such as the xylophone, triangle, and handbells, creating a strong bond between them.

In Shares intentions for social interaction area, the child started to use verbal to request her needs such as “I want”, “Please open” and “Want this” in the session. The child also started to share the musical instruments with the music therapist by giving the mallet to the music therapist to request social games such as play the xylophone together. Although the music therapist needs to prompt the child to do the turn taking by holding her hands or prompt in verbal (“Wait first.”), the child could understand and learned to wait while the music therapist was playing the xylophone. Sometimes, the child will learn to say “Wait

first” while the music therapist was teaching the turn taking skill with her. Although the child needs prompt to greet the music therapist, she still greets by saying “Hello” in the beginning of the session then the music therapist used musical instruments as a positive reinforcement for her.

In the musical response, the child responded very well on the songs that she familiar with such as “Twinkle Twinkle Little Star”, “Walking in the Jungle”, “Hockey Pockey”. The child sang the lyrics together with the songs that played from the YouTube. The child also responded well in the musical instruments such as xylophone, handbells, triangle and lollipop drum. She could play the musical instruments with either live music (music therapist played guitar and sing) or recording music (from YouTube). From those response, the child showed more social interaction and attentions such as requesting needs, sharing musical instruments in the treatment sessions.

The results of visual analysis and parents’ interviews suggested a positive outcome for the child following participation in the music therapy intervention sessions. The child showed improvement on her joint attention skills in those three areas: (1) shares attention, (2) shares emotion and (3) shares social interaction.

Discussion

According to the result of Shares attention area in Figure 1, the child had showed improvement which the mean score increased from 0.75 to the highest score (2 out of 2) in both treatment phase because the researcher as music therapist used preferred songs to build the therapeutic relationship with the child. Preferred song means that the child was familiar with the melody, hence, the child was able to have eyes contact with the music therapist when singing her favourite song and shift her gaze between the speaker (used to play song) and the music therapist. However, some of the music therapy session had a low mean score which was 0.75 out of 2 because the child had a seizure before starting the session. Seizure is one of the symptoms that will happen in a child with TSC (National Institute of Neurological Disorders and Stroke, 2023). When the child had a seizure, she became sleepy and had low energy, therefore, the music therapist matched with her condition to provide music therapy. The music therapist used soft and slow music such as “Twinkle little star” which is also the child’s preferred song to attune the child’s emotions. This is one of the techniques in music therapy which so called Iso-principle. Iso-principle is a process where the music or songs were selected to match with the client’s current mood, emotion, and condition (Wigram et al., 2002). Hence, the child could still have eyes contact with the music therapist in that session although she was showing low energy.

According to the result in Figure 2, the child showed consistent in Shares emotion area at both treatment phase. The mean score remained in the highest score 2 from session 4 until the last treatment session. However, the child showed less shares emotion in session 6 because she was not ready to do the activity, hence, the child could not attune her emotions with the changes of the music therapist’s expression of emotion. Although the seizure had caused the child lack of energy and less sharing of emotions, but she could still share her emotions most of the time in the sessions by using gestures and facial expression with music therapist. It was because music therapist was using musical attunement with the child in the session which is the process that therapist was matching with the child’s emotional, behavioural through musical engagement. This process had encouraged the child to respond and show joint attention with the therapist in the session. This method had matched with the studied by Holck (2007) and Wigram and Elefant (2008), and they mentioned this “musical attunement” process is often likened to early mother-infant interaction. Throughout the whole treatment session, the child showed only positive emotions because the music therapist had built a good therapeutic relationship with her and created a safe and freely environment for the child to engage in the session.

According to the result in Figure 3, the child showed improvement in Shares intentions for social interaction area at both treatment phase. The mean score was slowly increase from 1.29 and reached to 1.86 at the last treatment session. As the music therapist adapted child-centred approach in the music therapy session, the child was able to have a good therapeutic relationship with the music therapist. Therefore, the child was willing to follow the instructions of the music therapist in the activity. At the beginning of treatment session, the child preferred playing the xylophone alone and she resisted to play with the music therapist. Adapting improvisational music therapy interventions which was created a flexible structure for the child who is not ready to learn any skills (Kim et al., 2008), the therapist mirrored the child’s play and let the child lead the activity. As a positive therapeutic relationship developed, the therapist introduced turn-taking and resulting positive progress on the graph at the end.

In the treatment session, the music therapist mainly used three music interventions which were singing, playing musical instrument and movement with music to encourage the child to have joint attention with the music therapist.

For singing, the music therapist used the child's preferred or familiar songs because it could help the child to engage with therapist by singing together and had eyes contact when the child was feeling happy (Adamek & Darrow, 2010; Davis et al., 2008). The child also had the chance to choose her own song in the session which showed the engagement and the attention with music therapist in the session. This had reaffirmed that humanistic approach was benefit to the child in the session because it treats the child as a whole person and let the child had the free will to choose and decide her own song (Corey, 2009; Corsini & Wedding, 1995; Mcleod. 2023; Wheeler, 2017). The child had showed more requesting skill (one of the joint attention skills) in verbally during singing intervention. It was because the music therapist encouraged the child to say "Please" or "Open again" and used the preferred songs as a positive reinforcement as a reward for the child to achieve the requesting behaviour. This intervention had matched with Chiengchana & Trakarnrung (2014) that singing songs used in music therapy intervention can help the child to improve social interaction effectively.

For playing musical instrument, the music therapist had used improvisational music therapy with the child during the session. Improvisational music therapy is one of the interventions where the music therapist musically matched the instrumental playing with the child's musical and non-musical expression in order to "tune in" empathically. The music therapist based on client-centred principle which adapted from the humanistic approach to create a safe and free environment together with the improvisational music therapy intervention in the session. The child was able to choose any instrument freely and play it freely and music therapist followed the child's lead. The child showed eyes contact when music therapist played the same musical instrument with her. The moment of playing the same musical instrument created a therapeutic relationship with the child as the child can see the similarity between herself and the music therapist. This similarity could create a safe place for the child to invite the music therapist into her space to play together (Kim et al., 2008).

For movement with music, the music therapist used YouTube to play the child's preferred songs so the music therapist could move together with child. The child showed eyes contact and engagement when the music therapist followed and copied the movement that the child was doing in the session. This result had matched with the previous study that showed that music and movement can activate the similar "mirror" networks in the brains which formed the basis for connections between social, emotional, and motoric (Amonkar et al., 2021). Creative movement with music activity could also improve the social skills such as eyes contact and engagement (Eren, 2015), hence, the music therapist let the child did her movement freely with the music. Besides that, music therapist also extended the equipment to non-musical material such as yoga ball in the session. Yoga ball in this study could provide an opportunity for playful exercise and improve gross and fine motor development as child with TSC may have weak gross motor skills due to the seizure. The music therapist added in music with throwing or pushing the yoga ball to the child, then the child would need to look at the ball and throwing back to the music therapist. Hence, it needed joint attention skill while playing the yoga ball.

Limitations

This study was focused on just one individual because Tuberous sclerosis complex (TSC) is a rare genetic which the estimated frequency is 1:6,000 to 1:10,000 live births (Northrup et al., 2013). So, it is hard to find the participant in Thailand. Besides that, children with TSC will occur seizures and epileptic spasms too which means they may show different neurodevelopmental disorders depends on their TSC symptoms and their severity. A single case study can used to focus on the specific symptoms that the researcher would like to work with, therefore, the researcher chose to focus on joint attention skills in this study and work with the music therapy interventions. On the other hand, single case study can help the music therapist to develop individualised music therapy interventions based on the goal and help provide in-depth findings specific to the child and music therapy. However, the child can also be introduced to a small group music therapy session with same background and condition after showed improvement in individual music therapy sessions.

Conclusion

Music therapy can help to enhance joint attention skills of the child with Tuberous Sclerosis Complex (TSC). The child had improved the joint attention skills through music activities, including singing

activity, playing musical instrument and movement with music. Using preferred songs and preferred musical instruments can encourage the child to engage with the music therapist and showed joint attention skills such as requesting, turn-taking, eyes contact and shares emotions. Therefore, music therapist must know the preferred songs of the child or introduce the songs that the child may like it in the session. Besides that, music therapist can apply humanistic approach in every session to create a safe place in order to make the child feels safe and freely to engage with the therapist. Therefore, a good therapeutic relationship is important in the session between the child and the therapist.

In this research study, the researcher only focused on three areas of joint attention skill (shares attention, shares emotions and shares intention of social interaction). According to SCERT Model, joint attention skill included many areas which involved both nonverbal and verbal communication skill. Hence, future study can conduct the research about music therapy interventions with other area of joint attention skill based on the SCERT Model. Joint attention is one of the skills which is important in social communication. Future study can conduct the research about music therapy interventions with other skills of social communication.

Besides that, music therapist who work with the child with TSC must understand the symptoms of seizures and observe the child while providing music therapy session. So, the environment or the location of the session must be safe for the child with TSC to prevent accident that caused by seizure.

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