The Effectiveness of Music Therapy for Children with Autism Spectrum Disorder:

A Meta-analysis

by

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ABSTRACT

About 1 in 68 children is diagnosed with Autism Spectrum Disorder (ASD) in the United States (Centers for Disease Control and Prevention [CDC], 2015). The prevalence of ASD within the population of all people with disabilities has increased, percentage changed from 1.8% to 7.1% in ten years (NCES, 2016). Music therapy, as a therapeutic intervention, has been used for children with autism since 1940s (Reschke-Hemandez, 2011). In the past 70 years' practice, music therapy research has explored the efficacy of music therapy in improving the multiple areas of functioning affected by the symptoms of autism. However, the results are varied. The objective of this study is to investigate the efficacy of music therapy on children with autism spectrum disorder using meta-analysis as the statistical analysis methodology to synthesis the research results from all the eligible studies in the field. After a comprehensive search of the literature and screening procedure, 11 studies were finally included in the meta-analysis. The results showed a medium to large effects (d = 0.73, CI [0.43-1.03]) of music therapy interventions for children with ASD. Subgroup analysis and meta-regression analysis are conducted for further exploration within the topic.

DEDICATION

谨以此文献给从小到大无私爱我的、在教育上对我无尽支持的父母。

以及所有在我成长过程中传授过我知识的、令人尊敬的老师们。

This work is dedicated to my parents for their altruistic love and their unwavering support to my education since I were young.

Along with all the respectful teachers who taught me knowledge during my growth.

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TABLE OF CONTENTS

Page

CHAPTER Page

APPENDIX Page

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

CHAPTER 1

INTRODUCTION

This study is a systematic review of the research investigating the effectiveness of music therapy on improving areas of functioning difficulty experienced by children with ASD. Meta-analysis, as a statistical methodology to synthesize the effect size from different studies (Borenstein, Hedges, Higgins, & Rothstein, 2009), is used in this research to examine the results obtained from all the selected studies. The purpose of this systematic review and meta-analysis is to quantify the strength of music therapy effectiveness in enhancing multiple delayed functions of children with ASD across the studies, as well as identify the possible factors that may affect the therapeutic outcomes. This chapter starts with a vignette of a music therapy session for children with autism, followed by a discussion of rationale for conducting a meta-analysis on the topic of music therapy's affects on children with autism and also introduces the main research questions. In the end, a brief description of the following chapter is provided.

Prevalence of Autism Spectrum Disorder

Vignette: *Client Zane walked into the music therapy room with his mother as he did every Monday morning for the past three weeks. His mother asked him, "Zane, can you say 'hello'?" Zane looked down to the floor and occasionally moved his head toward the window and the wall without any kind of verbal response to his mother. His mother said again, "Hey, Zane, look at me, say 'he-llo'". Zane looked at his mother briefly and then quickly moved away his eyes and turned his head to the floor and then to the wall. While he was moving his head, he moved his mouth slightly but then ended up with a small*

smile. Zane's mother tried again "Say hello, Zane". The words finally came out from Zane's mouth, but he said "hello, Zane".

Zane's mother left the music therapy room, which made Zane very upset to be alone with the therapist. He cried and threw the puppets and instruments around. The therapist brought Zane to the area in the left side corner of the room that is partitioned by an exercise mat where they usually do music therapy together. Zane's crying diminished when he heard the familiar melody of the "hello song" accompanied by guitar. He stared at the exercise mat without moving his eyes, which looked as if he was focused on listening to the music. After two phrases of repeat singing of "Hello, Zane", the therapist's singing stopped after "Hello" and left the blank in the lyrics where Zane's name should be. Zane didn't sing his name as was expected. The therapist sang again "Hello, Zane/ hello Zane/ hello, _"and waited. Zane still looked at the exercise mat for 3 to 4 seconds and finally he sang the word "Zane". "Zane, good job!", before he continued the therapist continued playing guitar Zane said his name, and verbally rewarded his verbal response in the song.

Client Zane is a 3 year old boy diagnosed with Autism Spectrum Disorder (ASD) one year ago. As it indicates in the vignette, Zane has difficulty in social interactions with people, especially strangers. He is also delayed in verbal functioning compared with his typical developed peers, and sometimes has echolalia behaviors as some of other ASD children do. In the music therapy session, he is engaged in various music activities aimed at improving his verbal skills and social skills.

Children who receive a diagnosis of Autism Spectrum Disorder (ASD) like Zane, are more and more prevalent. Per the latest updated data from the National Center for

Education Statistics website, more than 458,000 children and youth diagnosed with ASD are under the Individual Disabilities Education Act (IDEA) programs during the year 2011-2012. The percentage has increased from 1.8% to 7.1% of all diagnosed developmental disabilities comparing the data to ten years ago (NCES, 2016). In 2015, about 1 in 68 children were diagnosed as ASD in the United States (Centers for Disease Control and Prevention [CDC], 2015). All the data indicates there is a large demand for effective treatment to help children with ASD.

Autism Spectrum Disorder

Autism spectrum disorder, also referred to *early infantile autism, childhood autism, or Kanner's autism* in the past (APA, 2000), was first described in 1943 by the American physician, Leo Kanner (Kanner, 1943). After post-war, for a long time, autism was thought to be a psychogenic disorder among American psychiatry, meaning that the cause of autism is emotional or mental stress (Silverman, 2011). However, in late 20th century, the Functional Magnetic Resonance Imaging (fMRI) technique has been developed to show the neuronal activity in the picture that produced by the ferromagnetic difference of oxygenated and unoxygenated blood in the brain (Cohen and Bookheimer, 1994). Continuous research has been conducted to learn about autism, using fMRI is a strategic priority among many professionals. It was increasingly recognized that autism is caused by the brain's abnormal functioning (Baron-Cohen, Ring, Wheelwright, Bullmore, Brammer, Simmons, &Williams, 1999; Philip, Dauvermann, Whalley, Baynham, Lawrie, & Stanfield, 2012; Grelotti, Peretz, &Adolphs, 2005; Holt, Chura, Lai, Suckling, Von, & Calder, 2014; Kleinhans, Richards, Greenson, Dawson, & Aylward, 2015; Koshino, Kana, Keller, Cherkassky, Minshew, & Just, 2008; Masten, Colich, Rudie, Bookheimer,

Eisenberger, & Dapretto, 2011) and it is possibly caused by genetic problems (Devlin, 2012; Bourgeron, 2015). Philip and his colleagues (2011) conducted a meta-analysis comparing the fMRI results of 90 articles which reported the ASDs' activation regions in the brain while they were completing specific tasks. The results showed that both the ASD group and the control group (undiagnosed people) are at the same level of neural response and neural reaction time. However, the activation regions in the brain are different among the ASD group in comparison with the control group while they were completing the tasks, including motor, language and auditory, executive functioning, visual processing and basic social processing tasks. Another fMRI research study investigated the social brain network in a group of children with ASD with a controlled comparative group. Results from the study showed that the brain of the children diagnosed with ASD was activated in a different region when they viewed various pictures containing people's faces with various emotions. This result demonstrated that children with ASD have a different neural processing procedure for social and emotional experiences (Kim, Choi, Park, Oh, Yoon, Koh, & Lee, 2015).

Brain volume in high-risk populations, specifically siblings of children with ASD, has been investigated extensively in recent years. Researchers found increasing brain volume caused by extra-axial fluid among infants from 6 months to 2 years old who were at high-risk children for developing ASD. The severity of the ASD symptoms developing in later life could be predicted in advance as early as 6 months old by testing the extra-axial fluid (Shen, Nordahl, & Young, 2013). The amygdala volume was found to be enlarged from young children during 1 to 4 years old and 6 to 7 years old (Kim, Lyoo, & Estes, 2010; Nordahl, Scholz, & Yang, 2012; Poe et al., 2009). Gosselin, Peretz, Johnsen,

& Adolphs (2007) found that the amygdala performed an important role in emotional recognition, especially distinguishing "fear" in music as it does in visual stimulation. However, these findings are different from another study investigating the high functioning autistic adolescents' emotional perception in music (Quintin, Bhatara, Poisssant, Fombonne, & Levitin, 2011). Compared with a group of typically developed adolescents, the ASD group showed no difference in reporting the emotional intensity to the videos including "happy" "sad" "scared" and "peaceful" (Quintin et al., 2011). This finding corresponds to the result of another similar study conducted for a group of ASD adults (Allen, Davis & Hill, 2013). They tested the emotional response by both physical and verbal measurements, and suggested that autistic adults' emotional response to music is limited by their verbal ability, but not the emotional level.

The diagnosis of autism has been developed along with the update of the Diagnostic and Statistical Manual (DSM). There are five editions of DSM dating back to 1952. To provide a context for understanding how the diagnosis of autism and criteria has evolved, the following paragraphs give an overview of the diagnostic criteria for autism in the DSM-lV (APA, 2000) and the DSM-5 (APA, 2013). In the earlier version, DSM-lV, autism was presented under the category of *Pervasive Developmental Disorder* (PDD). According to the DSM-lV, four main criteria are used for the diagnosis of autism: 1) Autism is a disorder that has gross and sustained impairment in reciprocal social and emotional interaction that showed different forms of developmentally poor social behavior, missing various milestones in development when compared with their age-matched peers, 2) verbal and nonverbal communication functioning are impaired, 3)

presence of repetitive, stereotyped behaviors or interests must be identified, and 4) the onset before age 3(APA, 2000).

In the newest published version of *Diagnostic and Statistical Manual of Mental Disorders: DSM-5*, autistic disorder, Asperger's disorder, childhood disintegrative disorder, and pervasive developmental disorder not otherwise specified are all categorized into one diagnosis, which is now called Autistic Spectrum Disorder (ASD) (APA, 2013, p.51). This new categorization indicates that those four different diagnoses are actually the same condition but with different levels of severity. As defined in the DSM-5, ASD is a mental disorder that normally presents itself in the early developmental period with "persistent deficits in social communication and social interaction across multiple contexts" (criteria A) and "restricted, repetitive patterns of behavior, interests, or activities" (criteria B) (APA, 2013, p.50). Compared to DSM-IV, the criteria remained the same but the diagnosis age is not limited to 3 years old or younger but can be any time "in early developmental period (p. 51)." Comparisons and critiques between the two versions of DSM-lV and DSM-5 showed many concerns, one of them being the prevalence of people diagnosed with ASD has significantly increased after the publication of DSM-5 (Paris, 2013).

Music Therapy

Music therapy, as a therapeutic intervention, has been used for children with autism since 1940s (Reschke-Hernández, 2011). The American Music Therapy Association (2005) defined music therapy as "the clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship by a credentialed professional who has completed an approved music therapy program

(AMTA, 2005)." The definition indicates that music therapy is a musical treatment incorporating various models of musical approaches and different formats in a therapy process. An online survey posed to the music therapists who worked with individuals with ASD reported that music therapy is needed by an increasing number of clients and is requested by a widening range of ages. The music therapists prefer to choose evidence-based practices in their clinical sessions (Kern, 2013). In the past 70 years' practice, a lot of research has explored the effectiveness of music therapy in improving autistic children's different functioning (Geretsegger, Elephant, Mossler, & Gold, 2014; Reschke-Hernández, 2011; Simpson & Keen, 2011; Whipple, 2004; Wigram & Gold, 2006). The American Music Therapy Association website states:

> *Music Therapy is an established health profession in which music is used within a therapeutic relationship to address physical, emotional, cognitive, and social needs of individuals. After assessing the strengths and needs of each client, the qualified music therapist provides the indicated treatment including creating, singing, moving to, and/or listening to music. Through musical involvement in the therapeutic context, clients' abilities are strengthened and transferred to other areas of their lives (AMTA, 2005).*

This demonstrates that music therapy as a treatment incorporates various models of musical approaches in the therapy process, including song singing, improvisation, musical composition, listening to music, instrument playing, movement to the music, music story, etc. In addition, various session formats are employed as needed based on the therapeutic objectives. For instance, group format of music therapy creates opportunities for social interaction (Ghasemtabar, Hosseini, Fayyaz, Arab, Naghashian, & Poudineh, 2015; Jemison, 2010; LaGasse, 2014); Family-centered music therapy, which involves clients' family members in the session, has the advantage for parent-children relationship construction (Thompson, McFerran, & Gold, 2014; Thompson &

McFerran, 2015). An individual session format enables therapists to focus on the client themselves to work on various specific deficits in functioning (Lanovaz, Rapp, Maciw, Pregent-Pelletier, Dorion, Ferguson, & Saade, 2014; Vaiouli, Grimmet, & Ruich, 2015; Simpson, 2010).

However, the research results of music therapy effects for ASD are inconsistent. Some research has shown that music therapy is effective for children with autism, but other research found the evidence is insufficient to make that conclusion. For instance, LaGasse (2014) conducted research investigating the effects of music therapy in increasing social responses in children with autism. She found the social response ability is increased significantly in the music therapy treatment group compared to the control group. Another researcher, Ghasemtabar (2015), also investigated the effects of music therapy on enhancing the social skills among autistic children. His findings corresponded to LaGasse (2014)'s conclusion. In contrast, Schwartzberg and Silverman (2013) didn't find the same significance of music therapy in improving autistic children's social skills, postulating that the insignificant treatment results are attributed to the insufficient treatment dose. However, the three different studies have found inconsistent results, and it is unclear whether or not music therapy is effective in improving autistic children's social skills. In LaGasse's (2014) research, she examined the outcome of eye gaze, joint attention (both parties have shared attention on same object), and initiative behaviors. No significant differences were observed between the music therapy group and control group in regard to these aspects of functioning in the subjects, and were not consistent with findings from other researches. Kalas (2012) examined the effects of both complex and simplified music in facilitating autistic children's joint attention, she found using the

music with careful manipulation of the musical elements can help with joint attention of children with ASD. Yoo (2010) also found using musical cues in the therapy can significantly increase the response to joint attention among children with ASD.

As the review of past research suggests, there is dispersion of outcome results existing across the studies on the topic of music therapy and children with autism. None of the individual study findings can be a representative result of music therapy effects for children with autism. In order to find out whether or not music therapy is an effective treatment in improving different functions for children with ASD, what factors moderates the outcome, and what elements contribute to the outcomes, a collaborative way to compare and analyze all the relevant studies in the field is necessary.

What is Meta-analysis

The first meta-analysis research was performed by the statistician Karl Pearson in 1904 to analyze the infection and mortality relevance among soldiers (O'Rourke, 2007). It was the first time that a researcher used combined data from several studies to do research, therefore, it was recognized as the earliest meta-analysis. However, the systematic review and meta-analysis was developed for several decades before it was widely applied in research. Prior to the emergence of meta-analysis, researchers found traditional *narrative review* had more and more limitations as the quantity of literature was increasing rapidly. For instance, when there are a small number of articles to review, the reviewers can synthesize data by memory. An example is shown in an article that investigated the effectiveness of the music interventions used for children with Attention-Deficit/Hyperactive Disorder (ADHD). The article included only five articles with three of them used for statistical analysis. The major part of the review compared the different

variables in the five articles using narrative descriptions (Maloy & Peterson, 2014). However, the approach becomes more and more difficult as the number of available articles increases. For example, Standley (1996) did meta-analysis research including 98 studies where she extracted 208 variables for meta-analysis. Another complication is that narrative reviewers summarize the research results by simply using "effective" or "not effective" and assigning them levels of importance by impression. However, different reviewers have different criteria in choosing articles and giving credence to the results, which may have individual bias. In addition, the researcher found that the study-level covariates like the population, intervention, measurement, outcome variable, and other factors are different from one study to another, making the treatment effects from different studies varied and hard to summarize accurately by using qualitative description (Borenstein et. al, 2009).

Due to the limitations and problems mentioned above, researchers started to use systematic review and meta-analysis. A systematic review, as it named, is a comprehensive way of reviewing and summarizing the literature. Meta-analysis is a statistical approach that is usually used in systematic review. It is "statistical formulas and methods used to synthesize data from a set of studies" (Borenstein et. al, 2009, p. xxvii). In other words, meta-analysis is one method of, and is based on, systematic review. It could be used or not used in systematic review depending on whether the study focus is on the statistical data parts or not. The advantage of this new research method can commendably resolve problems in narrative review. First, systematic review clearly sets up a group of criteria for searching, and screening for, including and excluding the studies for analysis. In addition, meta-analysis assigns credence to the studies based on

mathematical criterion providing “a transparent, objective, and replicable framework” for the results’ interpretation (Borenstein et. al, 2009, p. xxiiii).

Summary

In this chapter, the concept of Autism Spectrum Disorder, music therapy intervention and meta-analysis was introduced. Also, the necessity to conduct a meta-analysis to investigate the research within the music therapy literature to measure the effectiveness of this specialized treatment for children with ASD was discussed. In the following chapter, a review of the relevant literature is presented in the area of music therapy regarding its effectiveness for children with ASD through a meta-analysis, and identifying possible research questions and null hypotheses. The third chapter introduces the process in meta-analysis, followed by a step-by-step explanation in detail of the meta-analysis methodology and how it works to answer the study questions. Chapter Four presents the research results in each step of the research process. A discussion of the research findings, research limitations and future research suggestions are provided in the last chapter.

CHAPTER 2

LITERATURE REVIEW

Introduction

In the first chapter, a rationale of conducting meta-analysis for music therapy effects on autistic symptoms was discussed. Since a large need has been found among ASD populations, effects of music therapy treatment should be identified so that it can be better applied in clinical practice. However, individual study findings can hardly represent the overall efficacy of music therapy treatment. Therefore, the eligible study outcomes need to be synthesized to find out the effects and factors that affect treatment outcome in music therapy treatment. In this chapter, research studies that were conducted on the topic of music therapy intervention for the ASD population are reviewed by variables including: social skills, verbal and nonverbal communication skills, and secondary skills including cognition, emotion, and parent-child relationship. In addition, other meta-analyses done in music therapy discipline are also reviewed and summarized to provide a clear background for the further research in this study.

Music Therapy for Social Skills

The research investigating the effects of music therapy on the social skills of children with ASD used a variety of music therapy models. Most of them use guardian rated standardized scales (Gattino, Riesgo, Longo, Leite, & Faccini, 2011; Ghasemtabar, Hosseini, Fayyaz, Arab, Naghashian, & Poudineh, 2015; LaGasse, 2014; Schwartzberg & Silverman, 2013; Thompson, McFerran, & Gold, 2014). Some studies used clinical observation and coding as the main measurement tool (Kim, Wigram, & Gold, 2009) or

in addition to the standardized instrument (Thompson et al., 2014). However, the results are inconsistent across the research.

Ghasemtabar et al. (2015) measured the effects of music therapy within Orff-Schulwerk model in enhancing social skills. Twenty-Seven children with ASD were divided into two groups of experimental and control and matched by age and gender. The experimental group received two sessions of Orff music therapy treatment weekly. In the music therapy session, a variety of musical activities based on the Orff-Schulwerk model were adopted in the intervention including: music listening, singing and chanting, music drama of the Orff-Schulwerk method and Orff instrument playing (for example: xylophone, triangle, tambourine, maraca, woodblock, etc.). The control group received no treatment but only finished the assessment in the same time frame. The assessment tool, Social Skills Rating System (SSRS), has been used in the pre, post and follow-up period (after two months) and rated by participants' parents. The SSRS has 38 items in total and measures four social related abilities: cooperation, assertion, self-control, and responsibility. The total score ranged from 0 to 80 with the higher score indicating a higher level of social skills and vice versa. A covariance test showed a significant positive result in the experimental group compared to the control group. There was no difference in outcome between posttest and follow-up, indicating the effects of music therapy remained the same during follow-up period.

LaGasse (2014) investigated the impact of music therapy on enhancing social skills of children with ASD using a non-blinded, randomized control trial design (*n*-17). In the twice weekly 50-minutes neurologic music therapy session, musical activities, like body movement to music, instrument playing, and music accompanied sensory stimulation,

were used to promote social experiences, like eye gaze, communication, and joint attention. Three different measurements were used to examine outcomes. The first is the Social Responsiveness Scale (SRS) which was used for measuring social skills, having 65 items and rated by the parents or caregivers. A lower score from SRS indicates higher level of social skills. The second is Autism Treatment Evaluation Checklist (ATEC) which was also used in the research to track the progress across the treatment procedure. It covers four different areas including verbal, social, cognitive/sensory and physical abilities with a total of 77 items. A lower score indicates higher level of functioning and was rated by parents/caregiver at six time points (pre, after session 2, 4, 6, 3days, and 3 weeks) and the therapist at four time points (session 2, 4, 8, and 10). The reliability of these two scales was not reported in the article. In addition to the two standardized measurement tools, social skills were also measured by clinical observations. Two trained assistants performed coding with concealed session order. The frequency of eye gaze, joint attention and communication behaviors were quantified by coding of video recordings in the 3th and 10th session. LaGasse (2014)'s research result corresponded to Ghasemtabar et al. (2015)'s findings. The SRS score was significantly higher in the music therapy intervention group than social skills group. However, no significance was found in ATEC scores for initiation, response to communication and withdrawal behaviors.

Kim et al. (2009) also found a positive impact of music therapy in improving social skills of children with ASD. They compared the effects between improvisational music therapy and toy play in improving emotional, motivational and social responses. A within-subject comparison design was used to avoid bias of varied levels of language

functioning in the sample. Ten boys, who ranged from age 3 to 5 and had ASD, were selected to participate in the study. They were randomly assigned to either have 30 minutes' weekly music therapy session first or the toy play session first. After 12 weeks, each group took one week break of wash out and then started to participate in the other experimental condition for 12 weeks. Each session consisted of two 15-minute time frames, one child-directed and the other therapist-directed. In the first 15 minutes, children freely played whatever instruments/toys they wanted with therapist's participation and assistance during the process. In the second 15-minutes, therapist structured the session by directing the children with modeling and turn-taking activities. In the music therapy group, singing and instrument playing were used as the main media to interact with the child, whereas in the toy play condition the therapist used any means of interaction but avoid any kind of music or rhythmic interaction. Video and sound are recorded in each session for the coding process of the target behaviors. Results showed a positive effect of music therapy on improving social skills.

Thompson et al., (2014) investigated the effects of family-centered music therapy (FCMT) in improving ASD children's social functioning, by comparing the normal family-centered early childhood intervention and family-centered music therapy. In FCMT, the client's parent was invited to participate in the session. The therapist created ways to encourage and support the engagement of parent with children in various versions of activities. The study intervention used mixed music therapy methods including singing, improvisation, and movement to music. Sessions were conducted in the client's home every week for 30 to 40 minutes and lasted over 16 weeks. Three standardized measurement instruments that measures social-related skills were rated by

the parent in pre- and post-tests; (a)Vineland Social-Emotional Early Childhood Scales (VSEEC) was used to assess the client's social and emotional functioning, (b) The Music Therapy Diagnostic Assessment (MTDA) was used to measure engagement in the session, and (C) The Social Responsiveness Scale Preschool Version for 3-Year-Olds (SRS-PS) was used to measure the children's social behavior related IQ in social settings. The three measurements used in this study showed reliability and validity (Constantino & Gruber, 2005; Oldfield, 2006; Sparrow et al., 1998). The results showed a large significance of the social engagement improvement (d = 1.96) and a medium effect in social responsiveness (d = 0.42) for the music therapy interventions. These finding are consistent with the results from Kim (2009) and Ghasemtabar et al. (2015).

Schwartzberg & Silverman (2013) conducted research on the same topic of music therapy to improve social skills of children with ASD, and his results were different. The Autism Social Skills Profile (ASSP) was used in this research to measure the generalization of children's targeted social behaviors. Research showed the reliability, validity, and internal consistency of ASSP (Bellini and Hopf's, 2007). ASSP is a parent-rated standardized scale that had been used before and after the intervention. In addition, the researcher also had all the participants answer the Comprehension Checks (CCs) during pretest, posttest, and after every session to evaluate the participants' different comprehension ability of the story. The ASSP has three different sections that measure different aspects of social skills, including: social reciprocity (SR), social participation (SP), and detrimental social behaviors (DSB). Therefore, the researcher used 6-group randomized design to randomly divide the sample into 6 different groups: SR group, SP group and DSB group separately under either experimental condition or control condition.

Thirty participants age ranged from 9 to 21 with ASD finished the overall experimental process. In the experimental condition, the participants listened and/or sang along to the social stories sung by the therapist with guitar accompaniment. In addition to the main intervention (music story), a variety of music activities were also used in the session, including: movement and music, instrument playing, and music and relaxation. In the control condition, participants listened to the same story read (instead of sung) by the session conductor. Regardless of which of the three social skills group the participants were in, they received the same intervention within the same condition but were assessed separately by different subcategory questions. The intervention lasted 50-minutes' daily for three consecutive days. The results showed insignificance of the music therapy treatment effect in ASSP scores between groups. The inconsistent results may be due to the minimal amount of intervention (only 3 daily sessions finished in one week).

Gattino et al., (2011) assessed the effectiveness of relational music therapy (RMT) on children's verbal, nonverbal and social communication skills. Outcome from this research also failed to demonstrate the efficacy of music therapy for improving social skills. Twenty four boys with ASD diagnosis were divided equally into experimental and control group. The control group only accepted clinical routine activities like medical, psychological and/or neurological treatment. RMT group received weekly 30 minutes music therapy intervention in addition to the clinical routine activities. The character of RMT is that it doesn't have a structured session protocol but is based on the therapist's observation of clients' reaction in the moment. Therefore, it incorporates a lot of improvisational activities. The research used a Brazilian version of the Childhood Autism Rating Scale (CARS-BR) to measure the social communication skills which was

normally used as diagnosis tool of ASD and determines the level of severity. The research result showed no significant difference between the two groups.

Music Therapy for Verbal and Nonverbal Communication Skills

Lim (2010) investigated the effects of neurological music therapy in improving the language skills in children with autism. Fifty children diagnosed with ASD were divided into three groups; the music therapy group, the speech therapy group, and the non-intervention group. For the two experimental groups, 6 sessions were conducted 2 times a day over 3 days. In the music session, 36 target words were applied in 6 pre-created songs. Children were required to fill-in the blanks of the lyrics with one of those 36 target words with the picture cues. In the speech condition, the same 36 target words were used in the story and the same pictures were used for cues. Verbal Production Evaluation scale (VPES) designed by the researcher was used for the coding process. Two speech pathologists coded the data based on recorded video tapes. The researcher reported a .999 level of interrater reliability on VPES. The results showed a significant improvement of verbal skills in MT group compared to the nonintervention group. The improvement was also higher than the speech therapy group. It demonstrated a valuable use of music therapy treatment for verbal skills in children with ASD (Lim, 2010).

Lim & Draper (2011) compared the effectiveness of Applied Behavior Analysis Verbal Behavior (ABA VB) and music therapy incorporated with ABA in improving speech and language skills of children with ASD. ABA is an approach that uses reinforcement to shape and improve behavior. Twenty two children age ranged between 3-5 years old were involved in this study. A within subject comparison design was used. Each child separately participated in all the three different experiment conditions in a

random sequence. Treatment conditions included: the music therapy condition, the ABA VA condition, and no treatment condition. Each condition lasted over 3 days each week for over two weeks. In the ABA VA training, therapist used four categories of verbal operant including: mand, tact, echoic, and intra-verbal operant. Target words and phrases were designed to be practiced by questions and answers. In the music therapy condition, singing techniques incorporated the target words and phrases were used. However, target verbal behaviors were modified to be musical behaviors in order to make music elements as a main stimulation. The measurement in this study was also VPES that used in pre and post tests. The result showed there was no statistical between-group difference. But the within-group test showed music therapy was effective as well as ABA model without music in improving verbal production.

In one of the formerly introduced studies, LaGasse (2014) also measured the nonverbal communication outcomes of eye gaze and joint attention by video recording the research. The results demonstrated significant effects of music therapy in increasing non-verbal communication of eye gaze and joint attention.

However, some other researchers didn't find the significance in this variable. Thompson (2014) also measured the improvement of language and gesture communication ability in his research using the MacArthur-Bates Communicative Development Inventories, Words and Gestures (MBCDI-W&G). No significant treatment effects were found in both the experimental and control groups. Gattino et al., (2011) also found no significant effects on verbal and non-verbal communication skills in his CARS-BR measurement. The dispersion of the outcomes among those studies in the same topic

makes the effects of music therapy on verbal and nonverbal skills for ASD population inconclusive.

Music Therapy for Secondary Outcomes

In the spectrum of autism disorder, some clients have impairment in cognition, or emotional function, but some do not (DSM-5, 2013). Therefore, the cognitive skill, emotional functioning and other non autistic symptoms fall into the secondary outcome category. There are limited amounts of research that measure the impact of music therapy effects on the cognitive outcomes among the ASD population. One of the studies mentioned before (Schwartzberg & Silverman 2013) found a significant impact of music therapy on comprehension ability while conducting a musical story intervention.

Kim et al. (2009) measured emotional related dependent variables, including joy significant, emotional synchronicity. The first two variables were measured by duration and frequency and the latter one was only measured only by the frequency. The coder repeatedly watched the session video three to five times to get the result. Results of all the three emotional related functions were significantly positive, which means music therapy had a positive impact on the clients' emotional functioning. Thompson et al. (2014) measured a similar variable in the research. They used the Parent–Child Relationship Inventory (PCRI) (Gerard, 2005), a parent rated scale, to report quality of parent-child relationships and to measure the relationship between client and their parents. In addition to the standardized instruments, a parent interview was also conducted after the treatment, investigating the parents' notice of any change in parent-child relationship. However, results showed no statistical significance of music therapy intervention in

improving parent-child relationship, but the qualitative results suggested a positive change.

Based on the literature, the research investigating efficacy of music therapy treatment on various autistic-related symptoms remains unclear due to a wide dispersion of the study results. Within the same functioning, some research reported significant positive impact of the music therapy interventions, while others did not. Even within the studies that reported positive results, there are still differences among statistical significance. Therefore, an effective way to synthesize these study findings is necessary.

Meta-analysis in Music Therapy

Meta-analysis has been used in music therapy research since 1986, when the music therapy researcher, Jayne Standley, examined the effects of musical interventions on medical and dental health. She did several research updates later on the same topic to include newly published literature as the literature database increased (Standley, 1992, 1996, 2000). In the mean time, music therapy meta-analysis was adopted for the purpose of research on a variety of diagnoses represented in the field of music therapy. For example, in the area of music therapy for mental health, Maloy and Peterson (2014) used 5 studies to do a meta-analysis, and found a minimal effect of music therapy to increase task performance of children and adolescents diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD). Gold, Solli, Kruger, & Lie (2009) examined if the dose of music therapy intervention affected the outcome of severe mental disorders. It suggested that music therapy is effective in improving global state, symptoms and functioning for the population with serious mental problems. Long-term studies with higher frequency of music therapy interventions are needed to get more substantial

benefits. Cercone (2007) also did research on the same topic. It showed a medium to large effect of music therapy on general mental symptoms that was also affected by the duration of treatment. Chang, Chu, Yang, Tsai, Chung, Liao, & Chou, (2015) and Vasionyte and Madison (2012) investigated the music therapy/music interventions for the dementia population. They found large effects of music therapy in changing behaviors of people with dementia. However, Chang et al., (2015) found larger effects in the area of cognition too, which is different from Vasionyte and Madison's result of minimal effects. Three articles explored the music therapy efficacy for patients with cancer using meta-analysis (Nightingale, Rodriguez, & Carnaby, 2013; Tsai, Chen, Chung, Liao, Chi, Chang, & Chou, 2014; Zhang, Wang, Yao, Zhao, Davis, Walsh, & Yue, 2012). Zhang et al. (2012) and Tsai et al. (2014) indicated that music therapy was beneficial in reducing anxiety and pain management. However, Nightingale et al. (2013) didn't find the same outcome, which may be attributed to her small amount of studies (N = 4) included in the analysis. The findings of music therapy on reducing depression and fatigue were inconsistent from Zhang et al. (2012) and Nightingale et al. (2013) as Zhang found positive effects in these two areas but Nightingale found negative effects. The true effects of music therapy in reducing the depression and fatigue symptoms in cancer patients needs further research.

For the population of autism spectrum disorder, 2 meta-analysis studies included ASD in the sample (Geretsegger, Elefant, Mossler, & Gold, 2014; Gold, Voracek & Wigram, 2004; Gitman, 2009) and 3 studies (Whipple, 2004; Gold et al., 2009) conducted the meta-analysis research specifically for ASD. Gold et al. (2004) did a meta-analysis of music therapy efficiency on children and adolescents with psychopathology

including autism. After eliminating one study that has extreme outlying value, 10 studies were used to yield a homogeneous final result. A significant medium effect size (ES = 0.61) demonstrated the valuable use of music therapy treatment for the population with psychopathology. By testing the moderator variables (study variables except sample size that affect the outcome), they found the subject groups with mixed diagnosis (more than one diagnosis), or with developmental and behavioral problems had a larger effect size in the result. A minimal effect size (d = 0.16) was found in the emotional problems group. They found no difference of the treatment effects between the children and adolescents group. Gitman (2009) examined the pediatric population with both medical and mental symptoms. In her research, a total number of 187 subjects from 12 studies were diagnosed with mental illness including the diagnosis of ASD. The result showed a significant homogeneous medium effect (*d = 0.52)* of music therapy treatment on children with mental disorders. She also explored the moderator variables and found that better effects were yielded in the mixed age group, random study design group, and the group that used objective measurements rather than self-reports. Both of Gitman (2009) and Gold et al.'s (2004) research showed a significant medium efficacy of music therapy for the psychological population. However, they both didn't find the dispersion of effects in different aged group.

In Whipple (2004)'s research, 9 articles with a total of 76 children or adolescents were included for meta-analysis. She found a large effect (d = 0.77) with a homogeneity (p = *.8262*) in the result. However, when screening for the studies, her inclusion criteria of the independent variable was not limited to the music therapy profession, but all the musical interventions were included. The heterogeneous interventions made it hard to

make the conclusion of the positive effects within music therapy treatment. Gold et al. did a similar meta-analysis in 2004, only three studies 9 (N = 24) were included in the research. However, all three studies employed high quality of study designs (either Randomized Controlled Trials or Controlled Clinical Trials). A small effect of short-term music therapy (daily intervention for one week) on verbal communication skills (SMD = 0.36) and a medium effect on gestural communication skills (SMD = 0.50) was found with no significant effects on behavioral problem, which is inconsistent with the meta-analysis result from Whipple (2004). However, it showed that music therapy was beneficial in enhancing communication skills. Due to the limited study sample size, Geretsegger et al. (2014) updated the results in 2014 using a relatively large size of sample, 10 studies (N = 165) with RCT or CCT designs. They grouped the studies by different types of measured outcomes including: social interaction, nonverbal and verbal communication, initiating behavior, and social-emotional reciprocity as the primary outcome. Secondary outcomes of social adaptation, joy, and parent-child relationship were also found. There was a large effect of music therapy for improving "joy" (SMD = 0.96) and "parent-child relationship" (N = 0.82); a medium effect of music therapy on generalized social interaction (SMD = 0.71), initiation behavior (SMD = 0.73), social adaptation (N = 0.41), and non-verbal behavior both within and outside the therapy (SMD = 0.57, SMD = 0.48). Small effect sizes were found in the area of social interaction within the therapy context, verbal communication skills, and social emotional skill. All the outcomes in this research were homogeneous. This comprehensive research extensively explored music therapy efficacy on different functioning areas of children with autism. The results strongly supported the conclusion of valuable use of music

therapy treatment for autism population. However, it didn't test the effects of moderator variables to further explore what factors affect the clinical treatment outcomes.

Summary

This chapter reviewed the relevant literature on the topic of the effectiveness of music therapy in improving autistic symptoms. The results were highly inconsistent from one study to another. Therefore a meta-analysis was conducted to synthesize the outcomes from different studies and, therefore explore the combined effects of music therapy intervention on the ASD population. The meta-analyses done within the music therapy field were also reviewed. This section provides, (a) a clear concept of the use of meta-analysis methodology in the music therapy discipline, and also (b) a background of what has been investigated and what needs a further inquiry on the same topic of music therapy treatment and ASD. Based on the literature review discussion above, following study questions are presented in this research and are explored in the coming chapters.

1. Is music therapy in general an effective treatment for children with a diagnosis of Autism Spectrum Disorder?
2. If so, is music therapy especially beneficial to any specific skill areas, including social skill, verbal skill, nonverbal skill, social adaptation, initiation behavior, cognition, parent-child relationship, or emotion?
3. What variables have impacted the effectiveness of music therapy treatment for children with ASD?

CHAPTER 3

METHODS

Research Objectives

The research objectives for this study are to investigate the effectiveness of music therapy treatment for children with ASD in improving different aspects of delayed functions (social skills, communication skills, speech skills, etc.) to provide information for practical application. Searching in the literature database, many studies reported the effectiveness of music or music therapy for children with autism (Geretsegger, Elephant, Mossler, & Gold, 2014; Simpson & Keen, 2011; Wigram & Gold, 2006; Whipple, 2004). However, the specific research findings were only validated within that research instead of being representative as the overall outcome in the field, due to the study bias from one study to another. For instance, Ghasemtarber (2015) found a significant effectiveness of music therapy in enhancing autistic children's social skill, however, LaGasse (2014) didn't find the same significance in similar research. The reason is that some study moderators made the research results varied across the studies when measuring the effectiveness of music therapy treatment for ASD. For example, the difference of client's characters, therapist's level of music skills, the session environment and etc will generate different intervention result.

Based on the discussion above, this study was to explore the answer to the following research questions:

1. Is music therapy in general an effective treatment for children with a diagnosis of Autism Spectrum Disorder?

2. If so, is music therapy especially beneficial to any specific skill areas, including social skill, verbal skill, nonverbal skill, social adaptation, initiation behavior, cognition, parent-child relationship, emotion?
3. What variables have impacted the effectiveness of music therapy treatment for children with ASD?

Hypotheses were made in response to the study questions:

1. Music therapy is an effective treatment for children with ASD.

2. Music therapy has an equal impact to the different functions of children with ASD.

3. In addition to the sample size, the sample age, gender, study design, types of musical intervention, outcome measurement type, comparison group, session modality, and duration of treatment all have an impact on the intervention.

To answer the first and second questions, a meta-analysis is conducted. To answer the last question some possible factors are examined. The "factors" are named as moderator variables in meta-analysis. It refers to the factors, except the sample size, affect the research outcome. Possible moderator variables examined in the meta-regression are: participants' age, participants' gender, study design, musical intervention, outcome measurement type, comparison group, session modality, experiment setting, and duration of treatment.

Overview of Meta-analysis

All research starts with a research question, including meta-analysis research. In this study the question was: Is music therapy an effective treatment for children with Autism Spectrum Disorder? Four basic steps were used to answer this question. First, a comprehensive search for all the relevant studies based on a list of pre-determined

criterions. Second, all the studies were identified and the data and variables were extracted, reviewed, coded, and categorized. Third, the effect sizes were computed and converted into the same statistical metrics for analysis. And finally, the statistical analysis was performed and the results interpreted (Lipsey & Wilson, 2001).

Study Retrieval Criterion

As introduced in the former chapter, the first step for a meta-analysis is to identify all the eligible articles that meet the criteria for this study. Therefore, a list of criterion was determined before the search process:

1. The paper is a published article or dissertation.
2. The study investigated the effectiveness of music therapy treatment for the diagnosis of ASD. Based on the definition from the American Music Therapy Association website, "Music Therapy is the clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship by a credentialed professional who has completed an approved music therapy program." (AMTA, 2005). Therefore, the studies used for this research must present that the experimental group intervention is conducted by a Board-Certified Music Therapist (MTBC). Studies that used musical interventions but not conducted by MTBC are excluded (for instance, music educator, special education teacher, etc.).
3. The study samples recruit the subjects that are diagnosed as Autism Spectrum Disorder according to DSM-5, DSM-IV, or ICD-10. Studies are excluded for the diagnosis if: 1.) It includes other diagnosis (for example other kinds of developmental delay like Rett Syndrome) in the sample, 2.) The subject's

diagnosis is made by the self-rating scale instead of professionals, and 3.) The subjects are at-risk instead of diagnosed with ASD.

4. The dependent variable must be delayed functions that relate to the diagnosis of ASD. Possible dependent variables could be: social skills, verbal or nonverbal communication skills, cognitive skills, stereotypical behaviors, echolalia, and etc.
5. The subjects are all children, in other words, their age should be under 12 years old. There is one study that included adults in the sample, but was not excluded (age range 9 – 21, *mean* = 15) from this research (Schwartzberg, 2013), because the total amount of eligible studies were limited.
6. The study must have a control group with the same diagnosis, or the studies use a within-subject crossover design with subjects randomly assigned to receive the interventions in a different sequence. Studies that use typically developed (TD) children or siblings as the comparison group are excluded.
7. The study must be quantitative experimental research that provides sufficient data and interpretation of the data in the article so that data can be used in the statistical analysis (For example: the *mean* and *sd*).
8. Since the study is further research of the article: *Music in Intervention for Children and Adolescents with Autism: A Meta-Analysis* (Whipple, 2004), articles published from 2004 (January) to 2016 (February) were searched. Articles published before 2004 were searched from relevant study reference lists (Geretsegger et al., 2014; Whipple, 2004).

Searching Procedure

A comprehensive search of the articles published in the time period of 2004–2016 was conducted using the following databases: *PsycINFO, ProQuest, Eric, PubMed(Medline), Academic Search Premier, ASU Dissertations & Thesis database, International Index to Music Periodicals Full Text, and Google Scholar*. In addition to the first search of the database, a second search of the typical journal publications in the music therapy field in the same time period of 2004–2016, was conducted including: *Journal of Music Therapy, Music Therapy Perspectives, Australian Journal of Music Therapy, Canadian Journal of Music Therapy, and Nordic Journal of Music Therapy*. During the search process, a combination of the keywords was used: music, music therapy, autistic, autism, ASD, Asperger's disorder, pervasive developmental disorder, PDD.

When the keywords were chosen, Asperger's disorder was included, because in the DSM-5(APA, 2013), Asperger's disorder is no longer an independent diagnosis, but is categorized to be the high functioning end of the autism spectrum. The term Pervasive Developmental Disorder (PDD) because the diagnosis was included, ASD is under this category in DSM-IV. Since the meta-analysis in this study includes research conducted before the publication of DSM-5(APA, 2013), PDD is used as a keyword in order to avoid missing any eligible studies. In addition, the relevant meta-analysis studies' reference lists were reviewed to avoid missing studies during database search (Geretsegger et al., 2014; Whipple, 2004).

Coding Procedure

According to Lipsey and Wilson (2001), the variables in research can fall into two different categories, the study characters and the empirical findings. Two coding forms

were created to organize the information from all the studies that may be used for the analysis, the study variables coding form (Appendix A) and the effect size coding form (Appendix B). The study variables coding form was used to record possible study moderators (study characters) that may affect the empirical outcome. For example, the participants' mean age, the treatment settings, the approach of music therapy intervention, the duration of the treatment, the dependent variable type, measurement tool. The effect size form is created to extract the statistical data reported and was imported into the meta-analysis software (R 3.2.3) in a later research step.

Effect Size Selection

The *effect size* in meta-analysis, sometimes named *treatment effects,* means the strength of relationship between two variables (Borenstein, Hedges, Higgins, & Rothstein, 2009). There are three typical kinds of effect sizes that are used in meta-analysis, *Cohen's d, odds ratio*, and Pearson's *r*. Researcher computes the effect size using statistical variables from each included study and assesses the consistency of the effects for all of those studies to reach a summary effect. Different kinds of effect size are chose for different types of data. If the study reports continuous data (numerical quantity) with means and standard deviations, *Cohen's d* (Standardized Mean Difference) should be computed; if the study presents binary data (or dichotomous data), where the individual outcome is from one of two possibilities (example could be: yes or no, 0 or 1.), odds ratio should be computed. If the data type is correlation between two continuous variables, for instance, the increase of verbal communication level related to the repeated words in the lyrics, the correlation coefficient Pearson *r* can be used as the effect size, which requires no further computation as there might be varied types of data across the studies allocated

in meta-analysis. As a meta-analysis expert, Borenstein (2009) introduced the three commonly used effect sizes, *Cohen's d, odds ratio* and *r*, can be converted to each other as long as the measurements are relevant and comparable to each other. Therefore, all the varied data from different studies, despite the methodology or data type, can all be transformed to the common statistic metric. In this study, *Cohen's d* as the meta-analysis effect size was used, since the studies in this topic usually reports continuous data, and also *Cohen's d* is the most commonly used effect size in the field (Cercone, 2007; Gitman, 2009).

The formula of *Cohen's d* is the difference of two means divided by the pooled standard deviation (Cohen, 1988, p. 20):

$$d = \frac{\bar{x}_1 - \bar{x}_2}{s}.$$

Where the "x1" and "x2" are the means from two groups, the "s" is pooled standard deviation. Cohen (1988) defined the statistical power of SMD by three levels of strength. If d = 0.2 – 0.4, that indicates a "small" effects; if d = 0.5 – 0.7 means "medium" effect; and if d = 0.8 or above, it indicates a "large" effect.

After all the effect sizes were computed, whether the effect size is consistent or not was determined. If the results were consistent, the focus was on the summary effects. If the effect size was moderately varied, the true effect incline was lower or higher to the value of summary effect and was conferred. However, if the effect size significantly

varied from one to the other, the dispersion of the effect sizes rather than the summary effect was determined (Borenstein et. al, 2009).

Statistical Model

As it was introduced in the former chapter, different studies should not have equal weight in meta-analysis because of the varied study precisions. In other words, studies that have relatively better precision should get more weight in the analysis compared with studies that have poorer precision. In general, the study precision is mainly affected by the sample size. However, other factors in some types of experiments also have an impact on the study precision. For instance, if the researcher use standardized computer equipment to test the drug effects in increasing the blood pressure, the study precision is possibly only changed by the experiment sample size. However, if another researcher used observational recordings to measure the effects of music therapy intervention in improving children's social behaviors, the study precision is still affected by the sample size, but in addition, it will also be affected by other elements in the experiment like the observation bias, the intervention conductors' individual difference, the experimental environment, the client's character and mood in the session, etc. Meta-analysis research is based on different statistical models which related to the weight assigned to each study. Two effect models, the fixed-effect model and the random-effects model are most commonly used (Borenstein et al., 2009). Under the fixed-effect model, it assumes that the true effect size is the same across the studies, difference in observed effects is due to sample error alone. However, under the random- effects model, it assumes that the true effects are different from one study to another (Borenstein et al., 2009). Hunter and Schimdt (2000) did a research comparing these two different models. They found the

fixed effects model has a high risk of yielding bias in significance tests for mean effect sizes and for moderator variables that will mislead the outcomes. Since music therapy treatment quality and effectiveness are highly affected by the individual session factors, results from the random-effects model are more reliable.

Heterogeneity in Effect Sizes

As it was discussed above, the true effects under the random-effects model are varied from one study to another. The goal of the heterogeneity test is to quantify the dispersion of true effect size between the studies, in other words, if there is no dispersion of true effect size in studies, a fixed model will be chosen. Otherwise, the random-effects model should be used. However, it is more complicated than testing the variables between the scores (which can use the standard deviation), because besides the between study dispersion, the within-study error exists due to the sample error. Therefore, the *Q* test, a heterogeneity assessment suggested by Cochrane (1954), was used for this study. The *Q* statistic can isolate the within-study error (in other words, the sample error) by comparing the ratio between observed effect size and the within-study error (sample size) (Borenstein et al., 2009).

The *Q* statistic hypothesizes that the true effect sizes from all the studies are homogenous, and that the variation between the true effect sizes is only driven by the sample error. A significant *p*-value yielded from *Q* statistic rejects this hypothesis which means the true effect size is not only affected by the sample error but also affected by the covariance (moderators). Therefore, a random-effects model was chosen and the moderators were analyzed.

Statistical software: R

In order to make the meta-analysis process easy and convenient, the software R (version 3.2.3) and RStudio were both downloaded. R is program language software designed for statistical computing and graphing (The R foundation, 2015). The RStudio is an integrated development environment (IDE) that has optimized interface for the users to manage and manipulate their data (RStudio, 2015). During the computing process, users type in the commands in lines using the "R program language" and press the key of "Control + R" to run the line, and the command is then processed with the result showing in the "Console" window. The main features include: directly importing the data from excel, statistical computing, various statistical formulas, transforming of the statistics from studies to effect sizes, computation of the heterogeneity test, and finally presenting the results in forest plots. This program was used in this study.

Summary

In this chapter, the main procedures for a meta-analysis research as well as the statistical methods involved in this methodology were reviewed. To do a meta-analysis a comprehensive search of the database using a set of predetermined inclusion criteria was developed. The studies that met the inclusion criteria and list of reasons for the excluded studies were carefully reviewed. The next step was to extract the variable data from all the included studies using created and modified coding forms. Software was used to compute effect sizes and complete all the relevant statistical tests including Q test, heterogeneity test, and meta-regression. In the next chapter, the research results from all the steps in the meta-analysis will be presented in a variety of ways, including tables, pictures, forest plots, qualitative descriptions, and others.

CHAPTER 4

RESULTS

The purpose of this study was to examine the research regarding effectiveness of music therapy treatment in improving multiple functions of children with autism. The first chapter provided the rationale to conduct this research and introduced the concepts of music therapy, autism spectrum disorder and meta-analysis. The second chapter reviewed the relevant literature of music therapy interventions for the ASD population in improving a variety of symptoms experienced by children with ASD. It presented meta-analyses done within the music therapy discipline for a variety of populations, including medical conditions, mental health, as well as specifically ASD populations. The third chapter introduced the process in conducting a music therapy meta-analysis, including: study search and selection, data coding, effect size selection and computing, heterogeneity test, including the tools, software, and statistics that are needed to use during the process. This chapter is going to present the results for each step.

Study Retrieval

All the studies with an independent variable of music therapy intervention and a dependent variable of developmental functions of children with ASD were retrieved by searching databases (N = 40) and the relevant articles (N = 13). A total number of 53 articles were allocated and downloaded with full text for detailed review. Figure 1 is the flow chart indicating study inclusion and exclusion. As it shows in the Figure 1, after the first screening process, 12 articles were excluded that were either not quantitative research or didn't meet the searching criterion. The remaining 41 articles were used for

further analysis of study characters and variables. In this process, 30 articles were excluded due to a variety of factors. These included: the study design, lack of enough data, sample issue, music intervention issue and etc. (See Appendix D for reasons of excluded articles). Therefore, 11 articles were finally included in the meta-analysis. Table 1 (see page 39) presents the descriptions of the included articles:

Figure 1: Study Retrieve Flow Diagram.

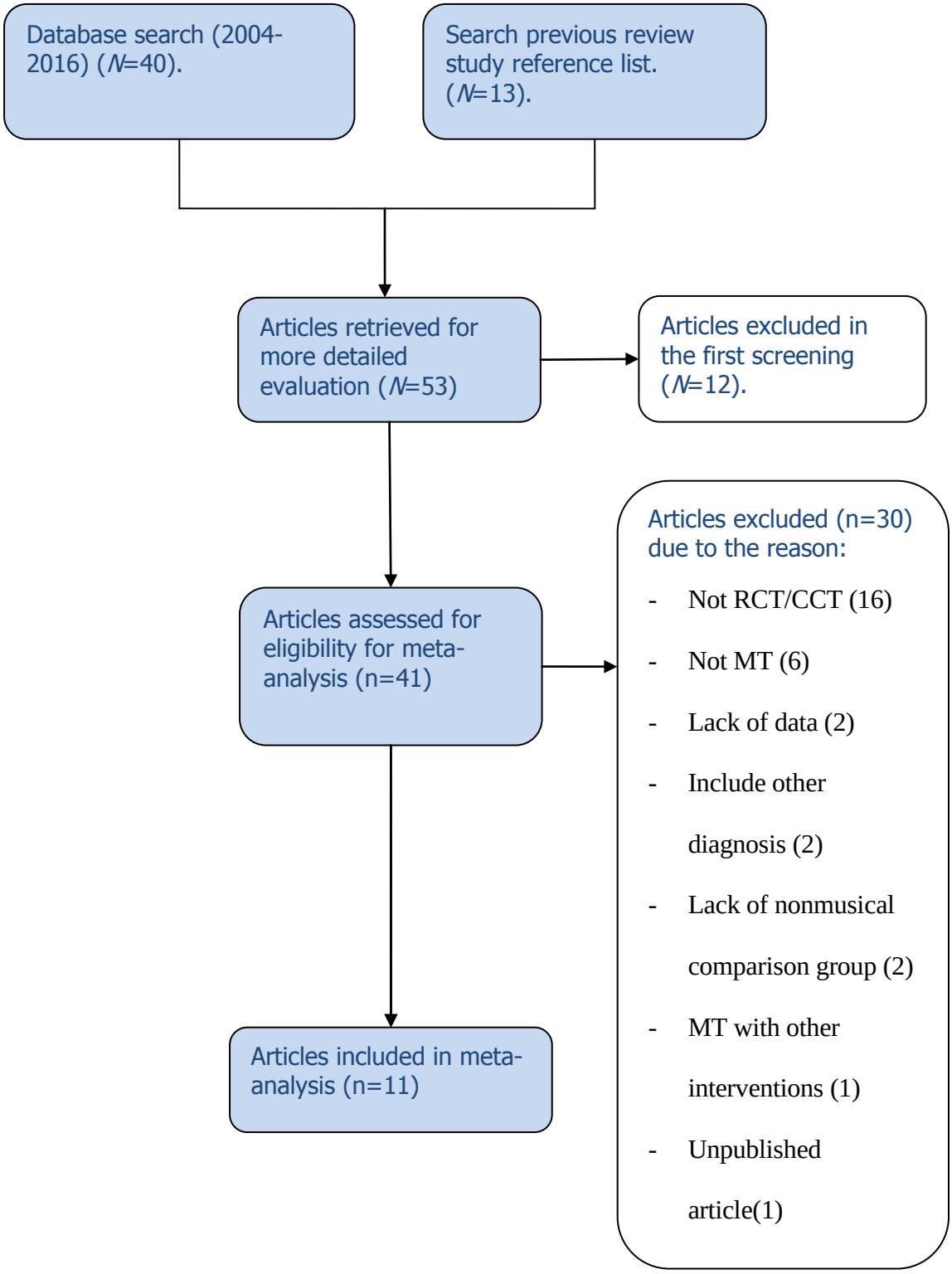


Table1. Characteristics within the Studies in Meta-analysis.

Modality	Measurement Type	Experiment Setting	Duration/times/week
group	other rated score	Childcare Center	30m/2/6.5
group	other rated score, clinical observations	large treatment room	50m/ 2/ 5
group	Other rated, self-answered	NG	50m/3/1
individual	other rated score	local treatment facilities	9m(music) 5m40s(speech)/2/3(day)
Individual	other rated score	Hospital	30m/1/20
individual	family rated score, clinical observations	Home	30-40m/1/16
group	clinical observations	Adolescent Psychiatry at Seoul	30m/1/12
individual	other rated	NG	NG/3/2
individual	clinical observations	outpatient therapy center	10m/3 to4/5
individual/group	Clinical observations	home	20m/5
individual	clinical observations	school	NG/5/4(day)

outcome measurement	control group intervention	type of dependent variable
Social Skill Rating System(SSRS)	no intervention	social skill
The Social Responsiveness Scale(SRS), The Autism Treatment Evaluation Checklist(ATEC);Video analysis of social-related behaviors.	social skill group	social skill
Autism Social Skills Profile(ASSP), Comprehension Checks(CCs)	social story listening	social skill
Verbal Production Evaluation Scale(VPES)	no intervention	speech skill
Brazilian version of Childhood Autism Rating Scale(CARS-BR)	clinical routine	Social Skill
Vineland Social-Emotional Early Childhood Scales (VSEEC), The Social Responsiveness Scale (SRS), The MacArthur-Bates Communicative Development Inventories, Words and Gestures(MBCDI-W&G), The Parent–Child Relationship Inventory (PCRI), Child engagement in the music therapy sessions: The Music Therapy Diagnostic Assessment(MTDA), clinician observation measure	early intervention program	Social skill
Clinical observation	toy play session	social and emotional skill
Verbal Production Evaluation Scale(VPES)	ABA	speech skill
interaction, requesting, (15 second-partial interval)	interactive play/independent	joint attention
Verbal Responses, Guesture Responses	nonmusic group	verbal and nonverbal communication
signs imitation, speech imitation(frequency)	rhythmic speaking	verbal and nonverbal communication

Year	Author	study type	sample size(E/C)	Age Range	Gender	Study Design	musical intervention	musical activities
2015	Ghasemtabar	article	27(13/14)	7 to 11	m = 14, f = 13	CCT	Orff–schulwerk method	mixed
2014	LaGasse	article	17	6 to 9	m = 13, f = 4	RCT	Neurologic MT	mixed
2013	Schwartzberg	article	30(16/14)	9 to 21	m = 29, f = 1	RCT	Music-based story	mixed
2010/2007	Lim	article/DISS	50(18/14)	3 to 5	m = 44, f = 6	RCT	Song singing MT	song singing
2011	Gattino	article	24(12/12)	7 to 12	m = 24, f = 0	RCT	relational MT	instrument
2014/2012	Thompson	article/DISS	23(12/11)	3 to 6	m = 19,f = 4	RCT	Family-centered MT	Mixed
2009/2006	Kim	article/DISS	10	3 to 5	m = 10, f = 0	CCT	Improvisational	mixed
2011	Lim	article	22	3 to 5	m = 17,f = 5	CCT	ABA with music	song singing
2012	Arezina	DISS	6	3 to 5	m = 5, f = 1	CCT	eclectic	mixed
2003	Farmer	thesis	10(5/5)	2 to 5	m = 9,f = 1	RCT	eclectic	mixed
1995	Buday	article	10	4.3 to 9	m = 8, f = 2	CCT	Music singing	song singing

Coding Procedure

Two coding forms were created for different types of data (Lipsey & Wilson, 2001). The study variables coding form indicated the general information related to the study design, experimental conditions, participants' information and background, etc. (see Appendix A). The effect size coding form records the statistical data from studies, including the pre and post mean and standard deviation from both experimental and control group (if applicable) as well as the statistical test used in the study (Appendix B). A categorized description of the variables is provided below.

There were a total of 229 participants from the 11 studies included in the meta-analysis. Lim's (2010) research had the largest sample size among all the 11 studies with 50 participants. Five studies had a medium sample size ranging from 22 to 30 subjects (Gattino, Riesgo, Longo, Leite, & Faccini, 2011; Ghasemtabar, Hosseini, Fayyaz, Arab, Naghashian, & Poudineh, 2015; Lim & Draper, 2011; Schwartzberg & Silverman, 2013; Thompson, McFerran, & Gold, 2014). LaGasse (2014) had a 17 subjects' sample size, which is relatively small. Four studies had a very small sample size starting from 6 participants (Arezina, 2012) to 10 participants (Budday, 1995; Farmer; 2003; Kim, 2009).

The client's age was coded by the age range and the mean age. In the 11 included studies, the participants' age was between 2 to 21. The mean age could not be calculated because of the missing data of mean age from one of the included studies (Farmer, 2003). However, in the meta-regression, studies that didn't provide mean age of sample were not considered into the moderator test (See the section of meta-regression in chapter 4).

Participants' gender was considered to be the moderator variable, the factors excepted sample error that affect outcome, and therefore was coded by the percentage of

males in the total sample size. Eighty four percent of the total subjects were males, individual study's male percentage ranging from 52% (Ghasemtabar et al., 2015) to 100% (Gattino et al., 2011; Kim & Gold, 2009). All of them received a diagnosis of Autism Spectrum Disorder.

Nine studies were published in peer reviewed articles (Buday, 1995; Gattino et al., 2011; Ghasemtabar et al., 2015; Kim & Gold, 2009; LaGasse, 2014; Lim, 2010; Lim & Draper, 2011;Schwartzberg & Silverman, 2013; Thompson et al., 2014). Three of them were also published as an academic thesis or dissertation (Kim, 2006; Lim, 2007; Thompson, 2012). However, in this research the most recently published version were used for analysis. Farmer (2003) and Arezina's (2012) research were published only as a thesis and dissertation.

In five studies the music therapy session was conducted in either hospital or professional treatment settings (Arezina, 2012; Gattino, 2011; Kim, 2009; LaGasse, 2014; Lim, 2010). Thompson (2014) and Farmer (2003) held the sessions at participants' homes, Ghasemtabar (2015) and Buday (1995) did their research in a childcare center and a school. Three other studies didn't report the experiment settings (Lim & Draper, 2011; Schwartzberg & Silverman, 2013).

The length of experimental intervention time varied, ranging from three days to twenty weeks. Some studies used within-subject design (two groups received both the music therapy intervention and the nonmusical intervention but in a different sequence) that took longer period of the overall experiment, including the music therapy intervention and comparison intervention (Arezina, 2012; Budday, 1995; Ghasemtabar et al., 2015; Kim, 2009; Lim & Draper, 2011). However, in this section only the time period

of music therapy intervention was counted. Four studies finished all the music therapy sessions within one week (Buday, 1995; Farmer, 2003; Lim, 2010; Schwartzberg & Silverman, 2013) and one study used two weeks (Lim & Draper, 2011) with short-term intense frequency interventions. Three studies conducted intervention over 5 weeks (Arezina, 2012; LaGasse, 2014;) and one study lasted over 6.5 weeks (Ghasemtabar et al., 2015). Participants in the other three studies received the music therapy session once a week and each of them lasted either12 weeks, 16 weeks or 20 weeks (Gattino et al., 2011; Kim, 2009; Thompson, 2014). In the meta-regression, the duration of treatment were categorized by long-term (longer than one week) and short-term (within one week).

Music activities were considered to be moderator variables. Coding of category was by number of interventions used, which means if the study employed more than one music activity (singing, instrument playing, movement, etc.), it was coded as "MIX". If the study mainly used one intervention (singing), it was coded as "SINGLE". Of the 11included studies, 7 studies used more than two mixed musical activities (Arezina, 2012; Farmer, 2003; Ghasemtabar et al., 2015; Kim, 2009; LaGasse, 2014; Schwartzberg & Silverman, 2013; Thompson, 2014;). The activities used in the studies include general music activities, for example, music listening, song singing, body movement to music, instrument playing, and improvisation, as well as some special approaches, for example, music relaxation, music accompanied sensory stimulation, musical book reading, blowing bubbles to the music. Four studies used one of the single music activities mentioned above (Buday, 1995; Gattino et a., 2011; Lim, 2010; Lim & Draper, 2011).

The non-music therapy comparison group intervention was also considered to be a factor that affected outcome. Some of the interventions in the comparison groups were

targeting similar skills to the music therapy intervention like social skills. Other studies had a control group with no intervention except normal clinical routines. The presence of two types of comparison groups (groups working on targeted skills and those with no interventions) may affect the results of this study, because the studies working on a skill without music therapy intervention shows less significant efficacy of the music therapy intervention. There was one study that used a three-group experimental design, the music therapy group, the social skill group and the non intervention group. The music therapy group effect size and the non intervention group effect size were chosen for meta-analysis (Lim, 2010). Therefore, a total of five studies in the meta-analysis used a non-intervention group as a comparison group. The other six studies used a "placebo" therapy intervention as a comparison group. They are the social skill group (LaGasse, 2014), the toy play group (Kim, 2009), the ABA speech therapy group (Lim & Draper, 2011), non-musical interactive play (Arezina, 2012), and rhythmic speaking group (Buday, 1995)

Study design was also coded as a moderator variable because randomized controlled trial is recognized as higher quality study design than other experimental study designs. In the section of study selection criteria (chapter 3), only studies with either randomized control trial (RCT) or clinical control trial (CCT) with randomization were selected for this meta-analysis. In the 11 studies, 6 of them are RCTs (Farmer, 2003; Gattino et al., 2011; LaGasse, 2014; Lim, 2010; Schwartzberg & Silverman, 2013; Thompson, 2014;). The other five studies were CCTs that employed randomization for the within subject cross-over design (Arezina, 2012; Buday, 2003; Ghasemtabar et al., 2015; Kim, 2009; Lim & Draper, 2011).

The first step for the meta-analysis was to have all the effect sizes coded into an independent form (Lipsey & Wilson 2001). However, some studies reported more than one outcome (Kim, 2009; LaGasse, 2014; Schwartzberg & Silverman, 2013; Thompson et al., 2014). According to Borenstein et al. (2009), it is not appropriate to treat different outcomes from the same sample as separate studies for two reasons: (a) studies with more than one outcome reported separately will get more weight in the summary effect across studies, which will affect the final result, and (b) the outcomes reported separately will mislead the estimate of the precision of the summary effect, because the independent outcomes will be treated separately however the sample is the same instead of independent to each other. (Borenstein et al., 2009).

To resolve this problem, a decision was made to combine the outcomes from the same study by combing the *mean* and *sd*. "Formula 4.1" was used for combined variance and then the combined *sd* was computed:

Formula 4.1:

$$V_{\bar{Y}} = \frac{1}{4}\left(V_{Y_1} + V_{Y_2} + 2r\sqrt{V_{Y_1}}\sqrt{V_{Y_2}}\right)$$

Formula 4.1 is used for synthesizing outcome variance from one study. The rooted variance is the combined *sd*.

Another problem before the effect size was determined involved Schwartzberg & Silverman (2013) that used a six-group randomized control design in his research. He divided both experimental and control group into to three social skill subgroups: the social response, social reciprocity, and the social detrimental behavior group separately, which compromised the total of six groups. This design brought up a complex data

structure in the result. In each outcome type he had three groups presented both in experimental and control. This led to a two-step combination of the outcomes. In the first step, the subgroups from the same outcomes were combined. For example, in the result of social response, three groups in the experimental condition were combined into one group with one presented sample size. In this step, the combined sample size was simply to add the number of subjects from each of the three groups and get the total number of the final sample size. For combing the mean "Formula 4.2" was used and for *sd* from different subgroups, "Formula 4.3" (Higgins & Green, 2011):

Formula 4.2:

$$\frac{N_1M_1 + N_2M_2}{N_1 + N_2}$$

Formula 4.3:

$$\sqrt{\frac{(N_1 - 1)SD_1^2 + (N_2 - 1)SD_2^2 + \frac{N_1N_2}{N_1 + N_2}(M_1^2 + M_2^2 - 2M_1M_2)}{N_1 + N_2 - 1}}$$

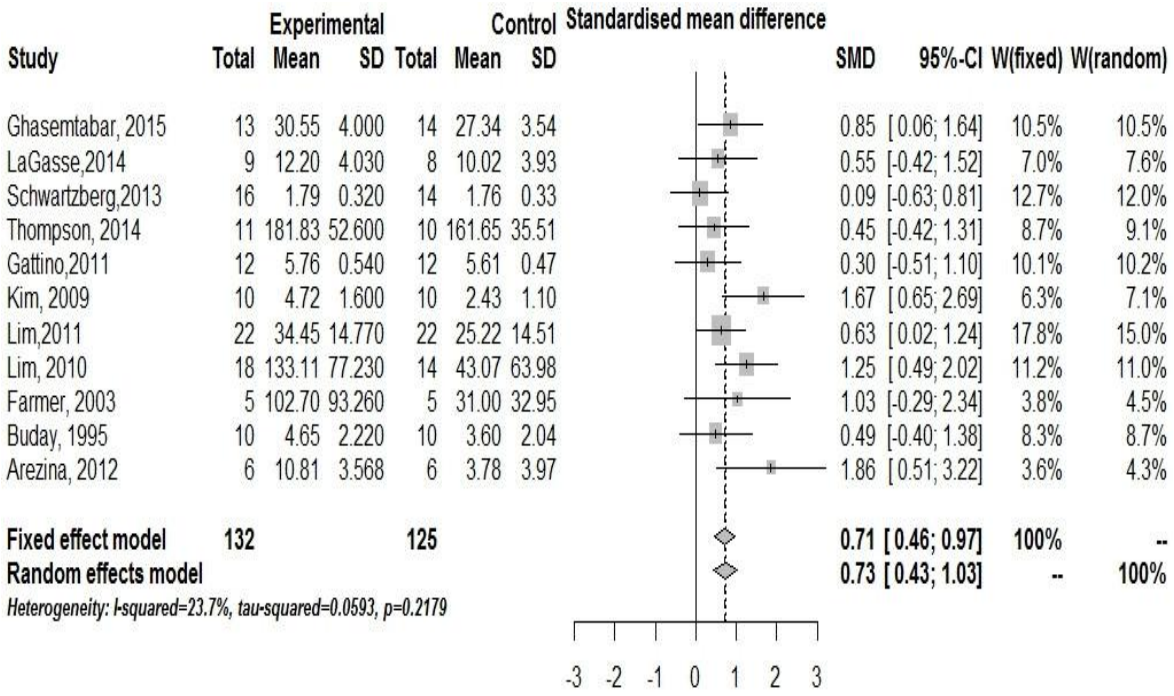
(Higgins & Green, 16.6.3)

In "Formula 4.1 and 4.2", N1 and N2 represent the sample size from each group. The M1 and M2 represent the mean from each group, The SD1 and SD2 means the standard deviation from the two subgroups. After two groups were combined into one group, then the same process was repeated to combine group 1 and 2 (combined) with group 3, and so on. After the different sampled groups were combined in the first step, all the different sampled groups were combined, and then only different outcomes for the same

experimental and control group remain. To combine the outcomes from the same sample, the process introduced before was repeated.

After the outcomes and the subgroups from the same studies were combined, the result of the meta-analysis are displayed in the forest plot (Table 2)：

Table 2. Meta-analysis Result
Overall Effect of Music Therapy for Children with Autism Spectrum Disorder.



Meta-analysis employs the homogeneity statistic (*Q*). It is automatically computed in R during the meta-analysis. A significant *p* value yielded from *Q* statistic rejects the null hypothesis that "all the effect size variability is only caused by the sample size". As it is shown in the Table 2, the heterogeneity test shows no significance ($Q = 13.1$, $df = 10$, $p = 0.22$), which indicates that the sampling error alone can explain the variance among the effect size. In other words, the effect size was consistent from one study to the other, and it was representative for the same population. Therefore, the overall mean effect size was interpretable.

The overall effect size under random effect model in was $d = 0.73$ in the meta-analysis. According to Cohen's (1988) definition of the three level strength, an effect size interval of 0.2-0.4, 0.5-0.7, and 0.8 or above, separately indicate "small," "medium," "large," effects of the independent variable on the dependent variable. Therefore, the result of $d = 0.73$ indicated a medium to large effects of music therapy intervention for improving autistic symptoms. The confidence interval doesn't include a "0" that shows the significance of the result. The confidence interval is [0.43, 1.03], which means under the 95% of possibilities, the true effect size should be no smaller than 0.43 and no larger than 1.03. Based on the confidence interval, a conclusion can be made that in 95% of possibility, the true effect size of music therapy treatment in improving autistic symptoms was between medium to large.

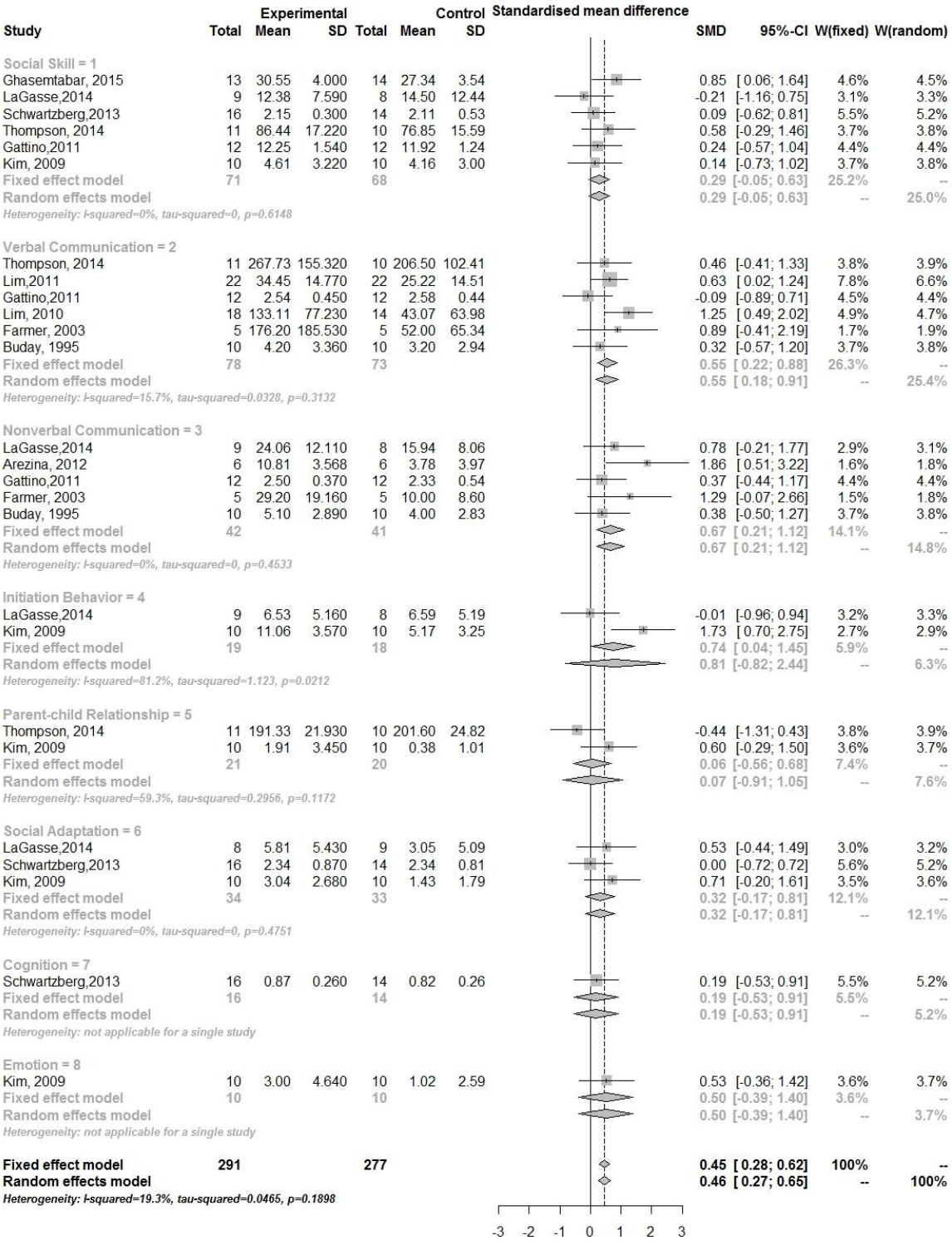
Subgroup Analysis

A subgroup analysis was conducted to explore the effectiveness of music therapy in improving specific aspects of autism spectrum deficits. The effect size coding form was regrouped by the dependent variable categories. The same procedure of combing the variables from subgroups or outcomes in one study was conducted again. However, the only difference was, when the outcomes from one study were conferred, it was done within the subgroup category, instead of in the overall studies. For example, both "social reciprocity" and "social response" from one study were categorized into the social skill subgroup. These two variables were combined because they were from the same study (Schwartzberg & Silverman, 2013) and they were under the same subgroup. However, the "social detrimental behavior" was not combined with the first outcome even if it was from the same study, because it was under the social adaptation subgroup, therefore it

remained independently in the subgroup. After regrouping all the variables, eight subgroups were generated including, social skill (*N* = 6), verbal communication (*N* = 6), nonverbal communication (*N* = 5), initiation behavior (*N* = 2), parent-child relationship (*N = 2)*, social adaptation (*N = 3)*, cognition (*N = 1)*, and emotion (*N* = 1).

The result found two subgroup categories yielded a significant effect size, the verbal and the nonverbal subgroups. The verbal subgroup effect size was medium (*d* = 0.55), with a confidence interval from 0.18 to 0.91. The nonverbal subgroup also had a significant medium effect size (*d* = 0.67) with confidence interval of 0.21 to 1.12. For the overall meta-analysis result for each subgroup, see Table 3:

Table 3. Subgroup Analysis



The subgroup analysis showed that music therapy treatment was very beneficial to the nonverbal and verbal functioning for children with ASD. However, the data from subgroups with less than 4 studies should be interpreted by caution due to the limited sample size.

Meta-Regression

Although the heterogeneity test showed no significance, which means the variable among effect size can be explained by the sampling error alone, a meta-regression was still performed to examine if the impact of other moderator variables showed a consistence to the result from the heterogeneity test. Eight moderator variables were examined in the meta-regression, including sample age, gender, study design, musical intervention, outcome measurement type, comparison group, session modality, and duration of treatment. The result showed that only the variable of the participant's age had impact on the outcome ($Q = 4.51$, $df = 1$, $p = 0.03$, *estimate* = -0.07). The negative *estimate* indicated that the outcome effect size decreased by 7% with the increase of every 1 year of age. This means the younger the participant is the better the outcome will be. The test result of other moderator variables showed no significant impact to the effect size, which means there was no relationship between the treatment outcome with study design, musical intervention, outcome measurement, comparison group, session modality, or duration of treatment. For the result of meta-regression for all the moderators, see Table 4.

Table 4. Meta-regression Result.

Variable	*Q*	*df*	*p*-value	*estimate*	*Se*
Age	4.51	1	0.03	-0.07	0.03
Gender	0.03	1	0.85	-0.22	1.17
Study Design	1.45	1	0.23	-0.36	0.3
Musical Activity	1.85	1	0.17	-0.4	0.3
Outcome Measurement	2.92	1	0.09	-0.56	0.33
Comparison Group	0.01	1	0.91	-0.04	0.32
Session Modality	0	1	0.98	0	0.33
Duration of Treatment	0.01	1	0.94	-0.02	0.32

Summary

This chapter presented the results of a meta-analysis, subgroup analysis, and meta-regression. Forty two studies are excluded due to the following reasons: the study design was not randomized controlled or clinical controlled trial; the independent variable didn't not meet the definition of music therapy; the data provided in the article was not sufficient for meta-analysis; the samples were not purely ASD; there was no non-musical intervention group for comparison; music therapy was used combined with other interventions and could not be isolated; or the article was not published and it could not be accessed through the database. Finally, a total of 11 studies were included for the meta-analysis with total 229 participants. The overall effect size is $d = 0.73$, which indicates a medium to large effect size of music therapy treatment for improving the autistic symptoms.

The heterogeneity test showed homogeneous of the effect sizes across studies ($p = 2.2$) meaning the variables among effect sizes could be explained solely by sample error. A further exploration of moderator variable impact was done through meta-regression. The participants' age identified had an impact on the outcomes ($p = 0.03$). Subgroup

analysis showed that music therapy had significant effects in improving the verbal and nonverbal skills for children with ASD.

CHAPTER 5

DISCUSSION

The purpose of this study was to examine the research regarding the efficacy of music therapy on children with autism spectrum disorder though a meta-analysis of research. In addition, possible factors that may have impact on the outcome of music therapy treatment for this population were determined. Further, the hope was to have indications for using the music therapy intervention more effectively in the clinical practice for client with ASD. The study questions were:

1. Is music therapy an effective treatment for children with a diagnosis of Autism Spectrum Disorder?

2. If so, music therapy is especially beneficial to what one or more specific type of skills?

3. What factors will have impact on the outcome of music therapy intervention for children with ASD?

Hypotheses were made in response to the study questions:

1. Music therapy is an effective treatment for children with ASD.

2. Music therapy has the equal impact to the different functions of children with ASD.

3. In addition to the sample size, the sample age, gender, study design, types of musical intervention, outcome measurement type, comparison group, session modality, and duration of treatment also have an impact to the intervention outcome. To answer these study questions, several steps have been taken during the overall research process.

In the first chapter, a summarized the background of the research was completed by introducing the prevalence, definition, diagnosis, behavioral, and brain characteristics of autism spectrum disorder. Also, the concept of "what is music therapy" and "what is meta-analysis" were formed by giving vignettes, examples, and reviewing the development procedure of the discipline. Therefore, the rationale to conduct this research was provided. In the second chapter, literature with topic of music therapy for children with ASD and music therapy meta-analysis related field were reviewed, compared, and discussed. By reviewing the literature, a research gap was identified which led to the research question and hypothesis. In the third chapter, the step by step of the meta-analysis methodology was introduced in detail, including the comprehensive search process, the screening procedure, the coding tools, the formulas involved, and the software R that are used as the meta-analysis tool in this study. Therefore, chapter 3 was a detailed plan with notes of the methodology and procedure. The fourth chapter presented the results of meta-analysis in various ways, including description of the results, tables, figures and etc. In chapter 4, studies were analyzed using the combined effect sizes based on the individual studies. Also, subgroup analysis based on the different aspects of functioning was done to explore the effects of music therapy on more specific functioning of children with ASD. The main objective included computing pooled effect size for all the studies included, as well as identifying possible moderator variables. Eleven studies investigated the music therapy efficacy on different functions of ASD were included in the meta-analysis. The current chapter discusses the research results, and explores the possible reasons to support

these findings. Also, limitation of the research and suggestion for future research are provided at the end of the chapter.

Summary

The research result supported the hypothesis that music therapy is an effective treatment for children with autism spectrum disorder. The data showed medium to large effects (d = 0.73), which indicates a plausible intervention of music therapy for children with ASD. This finding corresponded to the meta-analysis result from Whipple's research on the same topic in 2004 (d = 0.77). In order to answer the second study question, the effect sizes from all the studies were regrouped into a specific functioning category based on the different kinds of outcomes measured in various ways within or between studies. Finally, eight subgroups were divided from all 10 studies, including social skills, verbal and nonverbal communication skills, social adaptation, initiation behavior, emotion, cognition, and parent-child relationship. The result of the subgroup analysis indicates that music therapy is especially beneficial for improving nonverbal communication skills with a significant medium effect size (d = 0.67) compared to pooled effect size from other functions. The result from verbal communication group was closely followed to the nonverbal communication group. It also had a significant medium effect size (d = 0.55), which indicates that music therapy is valuable treatment in improving nonverbal communication for children with ASD as well. The largest effect size was yielded from the initiation behavior group (d = 0.81). However, because the confidence interval included "0", the result is not significant. Looking at the pooled effect size under fixed effect model, the result is also medium to large and with significance (d = 0.74, CI [0.04, 1.45]). Even though, other groups do not have statistically significant result, the pooled

effect sizes from them are all consistently positive, which means music therapy is possibly an effective treatment for the other functions. However, further research is needed to clarify these results. The possible reason that subgroup analysis found the efficacy of music therapy intervention on the verbal, nonverbal, and initiation behaviors (under fixed effect) could be because those are the primary outcomes referring to the diagnosis of autism spectrum disorder (criteria A.). The insignificance of other groups may result from the small amount of studies, since the studies categorized into each subgroup was from 1 to 3 studies, which is not sufficient to yield a meaningful pooled effect size due to the bias. Only the social skills group in the subgroup analysis had more than one studies (N = 6) included that did not generate a significant result. The possible reason could be five of the six studies had a confidence interval including "0" which made the pooled result insignificant. To answer the last study question, a meta-regression to examine the relationship between the study result and the moderator variables was done including age, gender, study design, music intervention, measurement type, comparison group, session modality, and duration of the treatment. The result showed participant's age had an impact on the outcomes. The younger the participants, the more significant the outcome was. Other factors were not identified as having an impact on the outcomes regardless of if the session was group or individual, the music intervention employed various or single activity, the measurement was standardized scale or clinical observation, the treatment was short-term with high frequency or long-term with low frequency, the percentage of males in the sample, or, the study used randomized controlled trial or not.

Limitation of Current Study

The quality of a meta-analysis is highly dependent on the studies retrieved for the analysis (Lipsey & Wilson, 2001). That is the reason why the criteria of randomize control or clinical control trial with randomization was set. However, even within randomized control design, the sample bias could be still exists. For example, in LaGasse's study (2014), the sample in both the experimental and control groups may not have been the same level of functioning prior to the start of the intervention. Because the music therapy experimental group subjects' joint attention pretest *mean* and *sd* were (*mean* = 8.83, *sd* = 10.17), whereas the social skills group (comparison group) pretest *mean* and *sd* is (15.06, 13.74) which indicated a significantly different baseline. This kind of difference can be found in other included studies as well. In addition, for the subgroup analysis, grouping by specific different function category is hard due to the overlap of some skills. For instance, eye gaze, joint attention can both fall into nonverbal communication and social skill group. The last limitation is about the sample size. Even though, there are 11 studies involved, it is still a small amount for a meta-analysis. More research on the same topic should be done to contribute to updating the data in the future.

Recommendation for Future Research

More research is needed with the following suggestions:

1) Use a bigger sample.

2) Use high quality study design, such as randomized controlled study.

3) Use a pure diagnosis instead of mixed diagnosis.

4) Use a standardized evaluation tool. So the outcome measurement could have a greater contribution to the meta-analysis of music therapy's effectiveness with children with ASD.

One of the most prominent need areas of children with ASD is in verbal and nonverbal communication. By comparing these various experiments, the research data clearly shows the effectiveness of music therapy interventions for improving verbal and nonverbal communication for children with ASD. In addition, it shows how the measurement tools can impact the research results. By increasing the standardization of measurement tools in music therapy clinical work and research, more specific results detailing treatment methods pertaining to clinical practice can be achieved.

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APPENDIX A

STUDY VARIABLES CODING FORM

Author_____

Publication Year_____

Study Type_____

Sample Size (Experimental/Control) _____

Age Range_____

Gender_____

Study Design_____

Musical Intervention_____

Outcome Measurement Name_____

Measurement Type

Control Group Intervention_____

Type of Dependent variable_____

Modality_____

Experiment Setting_____

Duration/Frequency/Week_____

APPENDIX B

EFFECT SIZE CODING FORM

Author_____

Dependent Variable_____

Ex. Sample _____

Ex. Pre mean_____

Ex. Pre *sd* _____

Ex. Post mean_____

Ex. Post *sd* _____

Ctrl. Sample _____

Ctrl. Pre mean_____

Ctrl. Pre *sd* _____

Ctrl. Post mean_____

Ctrl. Post *sd* _____

Subgroup _____

APPENDIX C

PROGRAM LANGUAGE USED IN R

```
library (meta)

library(metafor)

#metaanalysis

mydata<-read.csv("C:/Users/Administrator/Desktop/meta-analysis effect

size.csv",as.is=TRUE)[1:26,2:15]

mydata$mean.age<- as.numeric(mydata$mean.age)

#mydata$Post.Mean<- as.numeric(mydata$Post.Mean)

metaresult<-metacont(n,Post.Mean,Post.SD,n.1,Post.Mean.1,Post.SD.1,

data=mydata,sm="SMD",method.smd =

"Cohen",pooledvar=TRUE,byvar=Group.1)

summary(metaresult)

forest(metaresult)

metareg<-(mydata,metaresult.tau=x$mean.age)
```


76

APPENDIX D

EXCLUDED STUDIES

Author	Reason for exclusion
Bhatara et al., 2009	Not MT(musical animation stimulus)
Brownell, 2002	Lack of adequate data for statistical analysis
Carnahan et al., 2009	Not RCT(case study, reversal design)
Carroll, 1983	Not MT(singing instructions)
Clauss, 1994	Not RCT(case series)
Fees et al., 2014	Sample includes other Developmental Delays
Finigan & Starr, 2010	Not RCT(case study, multi-element design)
Geretsegger et al., 20	Lack of adequate data for statistical analysis
Hillier et al., 2012	Not MT(session led by music education student)
Jemison, 2010	No nonmusical comparison group
Kalas, 2012	No nonmusical comparison group
Kern et al., 2007	Not RCT(case study, withdrawal design)
Laird, 1997	Not RCT(not controlled)
Lanovaz et al., 2014	Not RCT(case study, reversal design)
Lanovaz et al., 2011	Not RCT(case study, reversal design)
Lanovaz et al., 2012	Not RCT(case study, multi-element design)
Litchman, 1976	Not MT(recorded music)
Mateos-Moreno, 2013	Can't isolate MT from Dance Music Therapy
O'Loughlin, 2000	Not RCT(case series, reversal design)
Parker, 2015	Not RCT(Typical Developmental comparison group)
Pasiali, 2004	Not RCT(case series, reversal design)
Saylor et al., 2012	Not RCT(case study, reversal design)

Simpson, 2010	Not RCT(case study, multiple baseline design)
Simpson, 2013	Not MT(audio recording)
Thomas., 2003	Unpublished article
Vaiouli et al., 2015	Not RCT(case study, multiple baseline design)
Watson, 1979	Not RCT(case series, reversal design)
Wimpory, 1995	Not RCT(case study)
Wood, 1991	Not MT(listen to the music)