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REVIEW PAPER

Music Therapy for Individuals with Autism Spectrum Disorder: a Systematic Review

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Abstract We identified, summarized, and appraised the certainty of evidence for 12 studies investigating the use of music therapy for individuals with autism spectrum disorder (ASD). The studies were summarized in terms of (a) participant characteristics, (b) dependent variables, (c) procedures, (d) results, and (e) certainty of evidence. A total of 147 participants aged 3 to 38 years were included in the 12 studies. Dependent variables included: (a) decreasing undesirable behavior, (b) promoting social interaction, (c) improving independent functioning, (d) enhancing understanding of emotions, and (e) increasing communication. Music therapy included the use of specific songs with lyrics related to target skills as well as musical improvisation. Outcomes were positive for 58 % of the studies and mixed for 42 % of the studies. Certainty of evidence was rated as conclusive for 58 % of the studies. The existing literature suggests that music therapy is a promising practice for individuals with ASD, but additional research is warranted to further establish its generality and the mechanisms responsible for behavior change.

Keywords Autism spectrum disorder · Music therapy · Systematic review

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Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by persistent deficits in social communication, social interaction, and restricted and repetitive behaviors, interests, or activities (American Psychiatric Association 2013). The symptoms of ASD are identifiable in early development and cause a significant impairment in social, occupational, and/or daily functioning (Horovitz et al. 2011; Lang et al. 2010). The symptoms of ASD can vary in terms of severity. For example, it has been estimated that between 25 to 61 % of individuals with ASD do not develop functional speech. While others might develop speech, it is often used in restrictive or stereotyped ways (Prizant 1996; Schlosser and Wendt 2008). Additionally, severe intellectual disability (i.e., IQ <50) appears to be evident in about 25 to 50 % of ASD cases, but average and even above average IQ scores have been identified in some people with ASD (Edelson 2006; Geschwind 2009; Mirenda 2008). Given this range in severity, it is perhaps not surprising that a range of treatment options have been investigated (Green et al. 2006).

Music therapy is one treatment that has been used for children with ASD (Green et al. 2006; Reschke-Hernández 2011). Music therapy has been defined as "a systematic

process of intervention wherein the therapist helps the client to promote health using musical experiences and relationships that develop through them as dynamic forces of change" (Bruscia 1998, p. 20). A more recent definition has been provided by the World Federation of Music Therapy (WFMT):

> Music therapy is the professional use of music and its elements as an intervention in medical, educational, and everyday environments with individuals, groups, families, or communities who seek to optimize their quality of life and improve their physical, social, communicative, emotional, intellectual, and spiritual health and wellbeing. Research, practice, education, and clinical training in music therapy are based on professional standards according to cultural, social, and political contexts (WFMT 2011).

As the number of children diagnosed with ASD has increased, there also appears to have been an increased demand for music therapy services for this population (Reschke-Hernández 2011). Wigram et al. (2002) discussed music therapy in special education settings, where music therapists work with individuals with learning disabilities, challenging behavior, social skill deficits, and comorbid psychological conditions. They asserted that music therapists use music as a tool by which to meet the needs of the clients.

The American Music Therapy Association (AMTA) emphasizes that music therapy should only be implemented by individuals trained in music therapy. Within the USA, this involves a bachelor's degree or higher in music therapy, including 1200 h of clinical training and board certification (AMTA 2014). Requirements elsewhere (including Great Britain, Germany, Scandinavia, Canada, South America, Australia, and New Zealand) involve clinical training programs at the undergraduate or graduate level. Additionally, many countries require music therapists to be registered with the appropriate authorities in order to practice (Grocke and Wheeler 2001).

Music therapy can involve one or more of the following techniques: (a) free improvisation (i.e., without any stated boundaries for the music), (b) structured improvisation (i.e., some established parameters for the music), (c) performing or recreating pre-composed music, songs, and associated activities, (d) composing songs and instrumental music, and/or (e) engaging in listening experiences (Wheeler et al. 2005). Wheeler et al. (2005) argued for the usefulness of improvisation and pre-composed music and activities for working with children with special needs. They noted that songwriting might not be appropriate for younger children who lack the required literacy skills, but that this might be an enjoyable experience and a potential learning tool for adolescents. In contrast, isolated receptive listening experiences appear to be used less commonly (Wheeler et al. 2005).

Music therapy goals also vary widely and are determined by the needs of the client. Kaplan and Steele (2005) analyzed music therapy goals and outcomes for 40 music therapy clients with ASD over a two-year period. The analysis involved synthesis of data provided by an agency-wide computerized music therapy outcomes-based measurement program that tracked data for each individual who received music therapy services in a community-based music therapy program over the two-year time period. Participants ranged from 2 to 49 years of age (M=13.9 years) and the sample included more males (70 %) than females (30 %). Participants received either individual or group music therapy sessions. Results suggested that music therapy goals focused primarily on improving communication and language as well as promoting behavioral and social skills.

In addition to examining goals, Gold et al. (2006) reviewed the efficacy of music therapy for individuals with ASD. They reviewed research up to July 2004 and included only studies involving a randomized control trial or controlled clinical trial design. Three studies met their inclusion criteria. The participants in these three studies were between 2 and 9 years of age, had been diagnosed with ASD, and received individual music therapy sessions. A summary of the outcomes suggested that music therapy had positive effects on nonverbal communication, gestural communication, and verbal communication. However, these three studies were limited in three ways. First, music therapy was provided for 1 week only in each of the three studies. Second, sample sizes were fairly small (4 to 10 participants). Third, only one study included active music making, which appears to be the more typical clinical practice (Wigram and Gold 2006).

In contrast to Gold et al.'s (2006) review, Accordino et al. (2007) undertook a narrative review of the literature. They identified 20 studies, published between 1973 and 2000. Eleven were case studies. The participants ranged from 3 to 41 years of age and, at least one participant in each study had an ASD diagnosis. They classified therapy approaches in the following categories: (a) improvisational music therapy, (b) receptive music therapy, (c) activity music therapy, (d) melodic intonation therapy, (e) rhythmic entrainment, (f) musical synchronization, (g) behavioral therapy, (h) musical interaction therapy, and (i) auditory integration training (AIT). The most common approaches were AIT (seven studies), improvised music therapy (seven studies), and activity music therapy (five studies). Therapy outcomes were categorized as communicative, social, or behavioral. Seventeen studies focused on communication, 15 focused on social skills, and 12 focused on challenging behavior. Many of the studies addressed more than one of these outcomes. Based on their review of these studies, Accordino et al. (2007) concluded that there was limited empirical support for music therapy.

However, it is important to note that seven of the 20 studies in Accordino et al.'s (2007) review used AIT. The inclusion of AIT could have negatively skewed the overall analysis of the effects of music therapy because AIT has been repeatedly demonstrated to be ineffective (Mudford and Cullen 2005). Unlike music therapy, AIT is a form of sound or listening therapy predicated on an entirely different hypothesized mechanism of action (physiologically-oriented) to music therapy.

The inclusion of AIT in the narrative review by Accordino et al. (2007) and the omission of single-case research studies and the elapsed time since Gold et al.'s (2006) review would therefore seem to justify a further examination of the literature on music therapy for the treatment of individuals with ASD. The aim of the present review was to provide an updated review of both group and single-case studies that have evaluated music therapy for individuals with ASD. A review of this type was considered necessary to determine whether music therapy could be considered an evidence-based practice. Such information would be useful in the selection of treatment options for children with ASD. Our review was also intended to identify directions for future research.

Method

Inclusion and Exclusion Criteria

Studies included in this systematic review had to involve experimental (randomized control trials, multiple-baseline designs) or quasi-experimental (e.g., A-B design) designs. The studies also had to have investigated the effects of music therapy on the behavior of at least one individual with ASD. Music therapy interventions were defined by the following criteria: (a) the use of music as a tool to address nonmusical goals, and (b) at least one of the researchers was a qualified music therapist or the study stated that music therapy sessions were conducted by a music therapist. Descriptive studies and studies on assessment of skills were excluded, as were other reviews and theoretical papers.

Search Procedures

Four electronic databases were searched: (a) PsycINFO, (b) MEDLINE, (c) Cumulative Index of Nursing and Allied Health Literatures (CINAHL), and (d) Education Resources Information Center (ERIC). Publication years were from 2004 until September 2013, as previous studies have reviewed the literature on music therapy and ASD up to 2004 (see Accordino et al. 2007; Gold et al. 2006). The search was also limited to English-language journal articles. In all database searches, the search terms *music therapy* and *autism* (with relevant BOOLEAN operators) were used.

A review of the abstracts of identified studies was utilized to determine inclusion in the review. The reference lists of the included studies were examined to identify any further possible studies for inclusion. Hand searches were completed for all of the journals in which the identified studies were published, and additional hand searches were conducted in the *New Zealand Journal of Music Therapy*, *Australian Journal of Music Therapy*, *Canadian Journal of Music Therapy*, and musictherapyworld.net (which contains an online journal and other archives). An author search for additional publications from each of the authors identified in the included studies was conducted in the four electronic databases. As a result of these search procedures, 19 studies were identified for possible inclusion in this systematic review. Each of these 19 studies was then assessed to determine whether it met the inclusion criteria (see "Inter-rater Agreement").

Data Extraction

A summary of each study was generated in terms of (a) participants, (b) target skills for therapy (dependent variables), (c) music therapy intervention procedures, (d) intervention outcomes, and (e) certainty of evidence.

Intervention outcomes were rated as positive, negative, or mixed, in accordance with the definitions provided by Lang et al. (2012). Positive outcomes in single-case research were determined by visual analysis of data suggesting improvement in all dependent variables for all participants. Positive outcomes from studies involving a group design were determined by a statistically significant improvement in the music therapy treatment group compared with the control group. Negative outcomes in single-case research were determined by visual analysis of data suggesting no improvement for any of the participants on any of the dependent variables, while negative outcomes in group research were determined by the absence of statistically significant improvement in the treatment group. Mixed outcomes in single-case research showed some improvements for some dependent variables or for some participants, while mixed outcomes from studies involving a group design showed statistically significant improvements for some of the dependent variables in the experimental group.

The certainty of evidence of each study was rated as insufficient, preponderant, or conclusive based on the definitions provided by Davis et al. (2013). Studies using quasi-experimental designs were rated as capable of providing only insufficient certainty of evidence. For studies to be rated at the preponderant level, they were required to have (a) an experimental design, (b) inter-observer agreement (IOA) data collected in at least 20 % of the sessions, and with the resulting agreement of 80 % or higher, (c) operationally-defined dependent variables, and (d) sufficient methodological detail to replicate the study. However, these studies were limited in some way with confounds that affected their ability to control

for alternative explanations for intervention effects. For example, confounds related to attrition, carry-over, or blinding may have been present. Studies rated as having conclusive evidence possessed all the features described at the preponderant level and attempted to control for alternative explanations for intervention effects and may have also included measures for treatment fidelity.

Inter-rater Agreement

The first author examined the initial set of 19 studies to determine whether each met the inclusion criteria. The ninth author independently assessed these 19 studies against the inclusion and exclusion criteria. Agreement on inclusion and exclusion of studies was initially obtained for 16 of the 19 studies (84 %). After discussion to clarify the criteria, consensus was reached to exclude 7 studies and include 12 studies in this systematic review.

Guided by the procedures outlined in Sigafoos et al. (2009), the first author produced summaries of each of the 12 included studies, which were assessed by the eighth author for accuracy and generate a measure of inter-rater agreement for data extraction and analysis. Each summary was read and checked against the original study, and a checklist of five questions was completed to indicate the accuracy of the summary with regard to participants, target skills, interventions, outcomes, and certainty of evidence. There were 60 items for which there could be inter-rater agreement or disagreement, as there were 12 studies with 5 questions each. There was agreement on 59 of the 60 items (98 %).

Results

From a pool of 19 studies, 7 were excluded, leaving 12 studies for summary and analysis. The appendix provides the details of excluded studies, while included studies are indicated in the reference list with an asterisk. Table 1 provides summaries of the participants, target skills, procedures, main findings, and certainty of evidence for each of the 12 included studies.

Participants

Within these 12 studies, a total of 147 participants received music therapy. Two studies did not report the participants' genders, but the other studies had a collective total of 77 males and 8 females. Participant ages ranged from 3 to 38 years (M= 6.97 years). In a majority of studies, participants were between 3 and 5 years of age.

Sample size of individuals in studies ranged from 1 to 50 participants (M=12.25). Two studies included only 1 participant [Studies 4 and 9], three studies had 2 to 4 participants [Studies 1, 2, and 5], and four studies had 8 to 12 participants [Studies 3, 6, 7, and 8]. The remaining three studies had sample sizes of 22, 24, and 50 participants, respectively [Studies 10, 11, and 12]. All of the participants had been diagnosed with a type of ASD. One study specified that, of the 24 participants included, 10 had diagnoses of autistic disorder, while 12 had diagnoses of pervasive developmental disorder, not otherwise specified (PDD-NOS), and two had diagnoses of Asperger's disorder [Study 11]. Four studies used the Childhood Autism Rating Scale (CARS; Schopler et al. 1988, 1998) to identify the severity of ASD for each participant [Studies 2, 5, 9 and 10]. From the 57 participants in these four studies, 25 were categorized as having mild symptoms of autism, five were categorized as having mild/moderate symptoms, 26 were categorized as having moderate/severe symptoms, and one was categorized as having severe symptoms.

Settings

Intervention settings were described for 7 of the 12 studies [Studies 1, 2, 4, 5, 6, 9, and 11]. Of these, one study was conducted at a private practice clinic [Study 6], one was conducted in a hospital [Study 11], one was conducted in participants' homes [Study 1], three were conducted in a preschool [Studies 2, 4, and 5], and one was split between the participant's home and a preschool [Study 9]. The research took place in a range of countries, including the USA, Canada, South Korea, Italy, Japan, and Brazil.

Dependent Variables

Target skills for intervention were coded into five categories: (a) decreasing undesirable behavior, (b) promoting social interaction and social communication, (c) improving independent functioning, (d) enhancing understanding of emotions, and (e) increasing verbal communication. Two studies, involving 11 participants [Studies 1 and 3] targeted decreasing undesirable behaviors, such as aberrant vocalizations, rewinding/fast forwarding video tapes, rummaging in the kitchen, or psychomotor agitation (although the authors did not operationally define psychomotor agitation). Social interaction and social communication were the broad foci for five studies, involving 49 participants [Studies 2, 6, 8, 9, and 11]. Specific targets in this category included increasing peer interaction and participation; facilitating joint attention behaviors and nonverbal communication skills; and increasing emotional, motivational, and interpersonal responsiveness in joint engagement.

Independent functioning featured in two studies, involving three participants [Studies 4 and 5]. The target skills involved increasing independent completion of multi-step tasks, such

Table 1 Summary of 12 music therapy studies involving participants with ASD

Study	Participants	Dependent variables	Procedures	Results	Certainty of evidence
Number 1: Pasiali (2004).	Two boys aged 7 (P1) and 9 (P2) years and one girl aged 8 years (P3) with ASD. Participants were required to have no hearing loss and exhibit attention and positive response to music. Participants had no prior music therapy intervention to address target behavior.	Promoting social skills acquisition and decreasing undesirable behaviors.	Three case studies utilizing an ABAB reversal design—baseline (A), treatment (B), baseline (A), treatment (B). A prescriptive song protocol was used, where the music therapist adapted one of the child's preferred songs to incorporate original lyrics about the target behavior, based on the guidelines for writing social stories (Gray and Garand 1993). A 15-min music therapy session was implemented with three activities using the adapted song: listening, playing rhythmic instruments, and singing. Data on the frequency of target behaviors were recorded for 30 to 60 min following the music therapy session.	Results were mixed. The graphed results for each participant showed changes between the first baseline and treatment phases for P1 and P2, but not for P3. Differences between baseline and treatment phases provided some evidence of an intervention effect.	The certainty of evidence is preponderant because of potential confounding variables, such as changes to dinnertime routines for P1 and changes to schedule for P2. There was also a possible carry-over effect that may have confounded the results. Mean inter-rater agreements across the four treatment phases ranged from 91.59 to 98.95 % across participants. There were no reported data for treatment integrity.
Number 2: Kern and Aldridge (2006).	Four boys aged 3:4 (years:months; P1), 4:0 (P2), 4:9 (P3), and 3:9 (P4) with diagnoses of ASD. Participants were required to have an interest and positive response to music and have no specific peer-related interventions on the playground. Selection for the study was also based on consideration of each child's individual education plan (IEP) goals.	Peer interaction and participation in playground activities.	A multiple-baseline design across participants was used. There were four phases: baseline, adaptation of the playground, teacher-mediated intervention, and peer-mediated intervention. The playground was adapted to include a "music hut," which included a range of drums, percussion instruments, and a CD player. In the teacher-mediated intervention phase, teachers were trained to initiate play, sing a song specifically composed for the child and model the content of the song in the music hut with the child and a buddy. The final intervention phase involved the child and peer buddy interacting in the music hut independently. Each playground observation was 10 min, and occurred daily over an 8-month period.	Results were positive. Visual inspection of graphed results indicates an increase in peer interactions in the teacher-mediated intervention and peer-mediated intervention phases, compared with the initial baseline and second baseline phases where the playground was adapted to include the music hut. These results suggest that the combination of environmental adaptations and individualized interventions were necessary for participants to increase their interaction with peers. Additionally, the data suggest that songs uniquely composed for each participant to incorporate their specific therapy goals were successful and that a collaborative consultation approach was effective in enabling teachers to facilitate the interventions in the playground.	The certainty of evidence can be considered conclusive, as there was a clear experimental design, adequate inter-observer agreement, operationally defined dependent variables, sufficient detail to replicate the study, and good treatment fidelity. Inter-rater agreements checks were carried out on an average of 36.8 % of the total observations, and agreement ranged from 93.8 % to 99.8 %. Treatment integrity data were collected for teacher- and peer-mediated interventions. The fidelity varied, all teachers but one demonstrated a high level, and all peers but one demonstrated consistently high levels of treatment integrity. The study may have provided further evidence for the intervention if maintenance and generalization phases were included.

Table 1 (continued)

Study	Participants	Dependent variables	Procedures	Results	Certainty of evidence
Number 3: Boso et al. (2007).	Seven male and one female from 23 to 38 years of age, with a mean age of 30.2 years, recruited from a single farm community for individuals with ASD. None of the participants had previous musical training.	Facilitating social engagement, improving problem behavior, and enhancing creative music making.	Clinical and musical ratings were administered at 0 weeks (T1), 26 weeks (T2), and 52 weeks (T3). Clinical ratings included the Brief Psychiatric Rating Scale (BPRS; Ventura et al. 1993, Clinical Global Impressions-Severity (CFGI-S) scale and the Clinical Global Impressions-Improvement (CGI-I; Guy 1976) scale. An external rater administered a musical skills questionnaire. Weekly 1-hour group music therapy sessions took place over 52 weeks. Sessions involved three active music-making activities: drumming, singing, and piano playing.	Results were mixed. There was a significant improvement in BPRS from T1 to T2 and T3. BPRS score differences were not significant between T2 and T3. 87.5 % of participants were rated as much improved or minimally improved from T1 to T2 on the CGI-I while 75 % of participants were rated as minimally improved from T2 to T3 on the CGI-I. All music skills improved from T1 to T2, but not from T2 to T3, with the exception of executing complex rhythms, which did not improve between T1 and T2, but improved significantly between T2 and T3.	The certainty of evidence is suggestive because the effects of the intervention were measured in a pre-post-test design without a control group. There were no reported data for inter-rater agreement for clinical and musical rating scores, and no data for treatment integrity.
Number 4: Kern et al. (2007a).	A 3:2 (years:months) boy with ASD at a university-affiliated childcare program.	Increasing independence in completion of three multi-step self-care tasks: hand washing, toileting, and cleaning up.	Songs were provided for each of the self-care tasks. Transitional objects were used to prompt initiation of tasks, and least-to-most prompting was used to teach the steps of the tasks. For hand washing, new lyrics appropriate to hand washing were sung to the familiar tune of "Row, row, row your boat." For toileting, an original song was composed, which outlined the 10 steps involved. The pre-composed song "Clean Up!" by Barney and Friends was used for the cleaning up task. An alternating treatment design was used to compare the use of the songs with a lyric condition, using only the words from the songs. Six categories of behaviors related to completion of each step of each task were coded. Data were recorded once per day for each of the tasks over a period of 10–17 days.	Results were mixed as they do not show one condition as consistently more effective than the other. The song intervention tended to be more effective than the lyric condition for hand washing and cleaning up, while the lyric-only condition appeared to be more effective than the song condition for toileting. There was an overlap of data for song and lyric conditions in hand washing and toileting, while for cleaning up, the song condition consistently provided equal or higher frequency of steps completed than the lyric-only condition. The authors claim that completion of steps for each self-care task increased in both the song and lyric-only conditions, but there is an absence of baseline data to verify this.	The certainty of evidence is suggestive, as the study did not employ an experimental design. There was a description of the participant's abilities prior to the implementation of the intervention, but no baseline data were reported. The authors also acknowledge that the teacher had already implemented aspects of the intervention prior to the commencement of the study. Inter-rater reliability was reported as ranging from 79.2 % to 100 %, with a mean rate of 96 %, collected for 44.7 % of total observations. No treatment integrity data were provided.
Number 5: Kern et al. (2007b)	Two boys with ASD aged 3:5 (years:months; P1) and 3:2 (P2), with	Improving the morning arrival transition to a university-affiliated childcare program,	Single-subject research designs were used with an A-B-A-B design for P1, and an A-B-C-	Results were positive. Visual analysis of the data indicates that for P1, independent	The certainty of evidence is conclusive as there was evidence of an experimental

Table 1 (continued)

Study	Participants	Dependent variables	Procedures	Results	Certainty of evidence
	limited speech and some picture exchange use.	increasing independent functioning of the five-step morning greeting routine, and supporting peer interaction by engaging in greeting peers.	A-C design for P2, where A was baseline, B was intervention, and C was a modified intervention. A system of least prompts was used to help the child complete each step of the greeting routine. In the intervention, an individual greeting song was composed for each child, which outlined the steps of the greeting routine. The modified intervention phase for P2 involved eliminating step four of the greeting sequence (saying goodbye to caregiver) as it was determined that P2 became upset when separating from his caregiver. Data were collected daily over a period of 2 months for P1 and 3 months for P2.	performance of morning greeting steps increased in intervention. In the second baseline, frequencies returned to baseline levels, and again increased with the reintroduction of the intervention. For P2, the implementation of the initial intervention did not show an increase in performance. The implementation of the modified intervention showed an increase in independent performance, while the second baseline showed a decline. The final modified intervention phase showed an immediate increase in independent performance frequencies.	design including baseline measures. Inter-rater reliability ranged from 75 % to 100 %, with a mean of 94 %, collected for 22 % of the observations for each condition and child. There were no reported measures of treatment integrity; however, there was a description of staff training for implementation of song interventions.
Number 6: Kim, et al. (2008).	Thirteen boys and 2 girls with ASD, aged 3 to 5 years old, with no prior experience of music therapy or play sessions. During the study, 5 children dropped out; the 10 remaining participants were all boys. The mean age of participants was 51.20 months.	Facilitation of joint attention behaviors and nonverbal social communication skills.	The design was a randomized control study using repeated-measures comparison between conditions and within subjects for 2 conditions, improvisational music therapy and play sessions with toys. Each participant had 12 weekly 30-min music therapy sessions and 12 weekly 30-min play sessions. Each session was divided into two 15-min parts: the first part was child-led play; the second part was therapist-directed. The Pervasive Developmental Disorder Behavior Inventory-C social approach subscale (PDDBI; Cohen and Sudhalter 1999) and the Early Social Communication Scales (ESCS; Mundy et al. 2003) were used for pre-test, in between, and post-test measures of joint attention and pro-social behaviors. DVD excerpts of therapy sessions were sampled to measure	Results were positive. Improvement in joint attention behaviors was greater in music therapy than in the toy play condition, based on results from standardized measures and session analysis. Eye-contact duration was significantly longer in music therapy than in play. Turn-taking duration was longer in the therapist-directed part of both the music therapy and play sessions, and turn-taking duration was longer in both child-led and therapist-directed music therapy than in either part of the play sessions. The PDDBI revealed that parents and therapists perceived improvements in both the music therapy and play conditions. Professionals, who were blinded to treatment order, scored greater has reported that a single ERF gene from improvements after music therapy, while parent	The certainty of evidence is conclusive, with an experimental design, operationally defined dependent variables and replicable procedures. Inter-rater reliability across the various measures was generally rated as good or excellent. Treatment integrity data were not provided; however, the authors state that a semi-flexible treatment manual was developed to ensure consistency and reliability of intervention. They also note that the differences between the first and second parts of the sessions indicate that therapists followed the treatment protocol. There was a relatively high attrition rate. Three participants dropped out due to hospitalization for health problems and two dropped out due to the long distances required to travel.

Table 1 (continued)

Study	Participants	Dependent variables	Procedures	Results	Certainty of evidence
			frequency and duration of pre-defined target behaviors.	perceptions were less consistent.	
Number 7: Katagiri (2009).	Twelve students with ASD aged 9 to 15 years, who attended schools in Japan. Selection criteria included difficulty in decoding and encoding nonverbal emotional expressions, although the study does not specify how this was determined.	Improving decoding and encoding of four specific emotions: happiness, sadness, anger, and fear.	Participants were randomly allocated to groups that were counterbalanced for four treatment conditions across the four emotions. The four treatment conditions were no-contact control (NCC), contact control (CC), background music (BM), and singing songs (SS). In NCC, there was no teaching of the emotion, while in CC, the emotion was taught using verbal instruction. In BM, piano music was improvised to reference the four specific emotions, and was played during the verbal instruction for each emotion. In SS, song lyrics were written to match the scenario of the text for the emotions and set to original melodies. The study involved eight individual 30-min sessions, which took place bi-weekly. A pre-test and post-test were administered to assess skills in encoding and decoding emotional expressions.	Results were mixed. While they indicated gains, there was no clear indication that the treatment conditions were superior to control conditions. Participants' emotional understanding improved from pre-test to post-test in all conditions. The authors argue that the students could determine the fourth emotion (from the NCC condition) via a process of elimination, having learned the other three emotions in the other three conditions. When participants' pre-test scores were taken into account, an ANCOVA revealed that the BM condition was most effective at teaching emotional understanding, followed by the SS condition, and the conversational CC condition.	The certainty of evidence is preponderant. While the study was experimental, it is unclear whether inter-rater reliability data were collected. It reported that the researcher and 3 reliability observers matched the 4 photographs to the 4 emotions in subtest 4, with a criterion for a correct response set at .75. There were no measures of treatment fidelity reported.
Number 8: Kim et al. (2009).	Thirteen boys and 2 girls with ASD, aged 3 to 5 years old, with no prior experience of music therapy or play sessions. During the study, 5 children dropped out, the 10 remaining participants were all boys. The mean age of these participants was 51.20 months.	Increasing emotional, motivational and interpersonal responsiveness in joint engagement.	A randomized control study using repeated-measures comparison between conditions and within subjects for 2 conditions, improvisational music therapy, and play sessions with toys. Each participant had 12 sessions of music therapy and 12 sessions of toy play. Each 30-min session took place on a weekly basis. Each session was divided into two 15-min parts: the first part was child-led play, the second part was therapist-directed. DVD excerpts of therapy sessions were sampled to measure frequency and duration of pre-defined target behaviors	Results were positive. Frequency and duration data were very similar, so only frequency data were reported. A significantly greater effect was found for music therapy for all categories of emotional and motivational responsiveness, and for initiation of interaction by the therapist and compliant response in the "effects of interpersonal responsiveness" category. "No response" behavior was more frequent in the toy play condition than in music therapy. The child-led part of the music therapy sessions yielded higher frequencies for measures of emotional	The certainty of evidence is conclusive. Inter-rater reliability measures were completed for 30 % of the DVD recordings with a second coder who was blind to the order of the sessions. Inter-rater reliability ranged from 86 % to 98 % except for compliant response and no response categories, where interpretation of behaviors was required and disagreement was potentially greater. Overall ratings were between fair and excellent. Specific procedural integrity data were not collected. There was a relatively high attrition rate. Three participants

Table 1 (continued)

Study	Participants	Dependent variables	Procedures	Results	Certainty of evidence
			during joint engagement episodes. Two categories were used to code behavior: emotional and motivational responsiveness and responsiveness to the therapist's initiation of interaction.	and motivation responsiveness than the therapist-directed part.	dropped out due to hospitalization for health problems, and two dropped out due to the long distances required to travel.
Number 9: Finnigan and Starr (2010).	A 3:8 (years:months) girl with ASD, with no prior experience of ongoing music therapy.	Increasing social responsiveness.	A single-subject alternating treatment design was used, comparing two interventions. The child attended four 15-min sessions per week for 29 sessions over 2 months. There were four phases: baseline (Phase A), alternating treatments phase (Phase B), a second treatment phase using the most successful treatment from Phase B (Phase C) and follow-up (Phase D). Both intervention conditions involved turn-taking play with three toys, but one also had the therapist interacting with the child through singing songs and playing guitar. Phase C involved only the music-added condition but used the toys that had been in the play condition. Follow-up was similar to baseline. The child was presented with the six toys with no instruction or prompting from the therapist. Social responsive behavior measures included eye contact, imitation and turn taking. Avoidant behavior included gaze aversion, pushing toys away, pushing adult away, or moving away.	Results were positive for the effect of music therapy on increasing all measures of social responsiveness to a higher extent than any gains seen in the no-music condition. Avoidant behaviors were infrequent but when they occurred, they only occurred in baseline or no-music conditions, suggesting that the child preferred the music condition. When the toys from the no-music condition were used in Phase C, the child continued to show a higher frequency of social responsive behaviors. Follow-up did not reveal maintenance of social responsive behaviors, although turn-taking frequencies remained higher than they were in the no-music condition. Additionally, avoidant behaviors did not return in follow-up. These results suggest that a longer period of intervention may be necessary for maintenance of social responsive behaviors.	The certainty of evidence is conclusive, with randomization of music and no-music interventions and toys, operationally defined dependent variables, and detailed procedures. An observer blind to the purpose of the study completed inter-rater reliability measures. 20 % of the sessions were randomly selected for inter-rater agreement. Agreement for social responsive behaviors ranged from 85 % to 96 %, and agreement for avoidant behaviors ranged from 85 % to 86 %, with an overall collective agreement of 87 %. No treatment integrity data were reported.
Number 10: Lim (2010a).	Fifty participants with ASD, aged 3 to 5 years, with a mean age of 4:8 (years:months), 25 were rated at a high functioning level and 25 were rated at a low functioning level based on scores from the Childhood Autism Rating Scale (CARS; Schopler et al. 1988) or the Autism Diagnostic Interview Revised (ADI-R; Rutter et al. 1994). Language age was determined	Increasing verbal production.	Participants were randomly assigned to one of 3 treatment conditions: music, speech, or a no-training control group. Participants in the music group watched a Developmental Speech and Language Training through Music (DSLM; Thaut 2005) video for 3 days. Participants in the	Results were positive for effects of both music training and speech training on increasing speech production in children with ASD. Additionally, there was a nonsignificant trend (p=.053) that suggested that the increases in speech production were higher for low-functioning children in	The certainty of evidence is conclusive. Inter-rater reliability was collected for 100 % of the VPES data and was carried out by two raters who were blind to the purpose of the study. Agreement was reported as 99 %. Treatment integrity data were not reported.

Table 1 (continued)

Study	Participants	Dependent variables	Procedures	Results	Certainty of evidence
	from previously administered tests including the Preschool Language Scale (Zimmerman et al. 2006), the Peabody Picture Vocabulary Test (Dunn and Dunn 1997), the Expressive One Word Picture Vocabulary Test (Gardner 2000a), and the Receptive One Word Picture Vocabulary Test (Gardner 2000b). Language ages ranged from 1 year to 4 years, and 32 participants produced echolalia.		speech group watched a speech video for 3 days. Six songs were composed, which included 36 target words. Each line of lyrics ended with a target word and appropriate musical cadence. Pictures for the target words were shown as the corresponding word was sung. In the speech video, the same texts from the songs were used, but they were presented as stories. Pictures for the target words were shown as the corresponding word was spoken. Pre-test and post-test were administered to each participant before and after the intervention respectively. Participants' production of target words was evaluated using a verbal production evaluation scale (VPES) designed by the author, which measured semantics, phonology, pragmatics, and prosody.	the music condition than in the speech condition.	
Number 11: Gattino et al. (2011).	24 boys with ASD, aged 7 to 12 years with a mean age of 9.75 years. 10 participants were diagnosed with autistic disorder, 12 were diagnosed with PDD-NOS, and two were diagnosed with Asperger's disorder. Participants had no previous experience of music therapy and no intolerance to sound or profound hearing loss.	Increasing verbal, nonverbal, and social communication.	The design was a parallel randomized controlled trial, with balanced randomization (1:1). Participants were randomly assigned to music therapy plus clinical routine activities or a control group involving just clinical routine activities. Each 30-min music therapy session involved the use of a keyboard, guitar, stereo system, drums, and a range of percussion instruments. Activities in relational music therapy may include singing, improvising, composing, and playing musical games. The Childhood Autism Rating Scale adapted for Brazil (CARS-BR; Pereira et al. 2008) was used for pre-test and post-test assessment of communication.	Results were mixed. There were no significant changes in CARS results from pre-test to post-test for verbal communication, nonverbal communication, or social communication. However, further analysis revealed a statistically significant decrease in CARS scores for participants with autistic disorder in the experimental group (i.e., not participants with PDD-NOS or Asperger's disorder).	The certainty of evidence is conclusive, although the authors suggest that there may have been limitations in outcome measurements by using the CARS to determine changes in communication over a short time frame. CARS was designed as a diagnostic tool, and it may not have been appropriate for this type of assessment. Inter-rater agreement between two raters was established through assessment of seven children with ASD who were not part of the study. Agreement was reported as 91 %. Treatment integrity data were not reported. The authors describe the music therapy process used and note that there was a set of basic procedural guidelines to follow.

Table 1 (continued)

Study	Participants	Dependent variables	Procedures	Results	Certainty of evidence
Number 12: Lim and Draper (2011).	17 boys and 5 girls aged 3 to 5 years, mean age 4:3 (years:months), with diagnoses of ASD.	Increasing verbal production. Verbal production was measured using the Verbal Production Evaluation Scale (VPES; Lim 2010a), which measured semantics, phonology, pragmatics, and prosody.	Used a single-group intervention with three conditions (music training, speech training, and no training) and four verbal operant conditions (mand, tact, echoic, and intraverbal). Participants completed at least six sessions each of music training and speech training. Music Applied Behavior Analysis Verbal Behavior (music ABA VB; Lim 2010b) training consisted of singing verbal instructions. Pictures accompanied target words in tact training. The speech ABA VB involved speaking the verbal instructions. Participant's production of target words was evaluated in a pre- and post-test.	Results were positive as both the music training and speech training had a significant effect on verbal operant production in comparison with the no training control condition. VPES scores for music training were higher than for speech training, but the difference was not significant. Results also showed that performance on target word production relied on echolalia or verbal imitation skills.	The certainty of evidence is preponderant because no data were reported for inter-rater agreement, although the study notes that two speech/language pathologists who were blind to the purpose of the study coded the data. No data for treatment fidelity were reported.

as hand washing, toileting, cleaning up, and performing a morning greeting routine at preschool. One study [Study 7], with 12 participants, focused on developing understanding of four emotions (i.e., happiness, sadness, anger, and fear) by measuring participants' abilities to recognize facial expression in pictures and facially express corresponding emotions themselves. Finally, three studies, including 96 participants, focused on increasing verbal communication [Studies 10, 11, and 12]. Study 11 was the only study that was identified in two categories, namely verbal communication and social interaction/social communication.

Intervention Procedures

Many of the studies implemented music therapy interventions featuring the use of specific songs with lyrics related to target skills [Studies 1, 2, 4, 5, 7, 9, 10, and 12]. Ninety-five of the 147 participants (65 %) received this type of intervention approach. Two studies used pre-composed songs that fit the purposes of the intervention, including a song about cleaning up, and children's songs about emotions [Studies 4 and 7]. Three studies used adapted lyrics set to familiar melodies [Studies 1, 4, and 9], and six studies used originally composed lyrics and music [Studies 2, 4, 5, 7, 10, and 12]. In Study 1, a prescriptive song protocol was used to compose song lyrics based on social stories (Gray and Garand 1993). In Study 10, a video recording of the songs was made, which the participants watched in the intervention.

Several studies focused on music improvisation as the main music therapy approach [Studies 6, 7, 8, and 11]. Fifty-six of the 147 participants (38 %) received this type of intervention. Studies 6 and 8 divided improvised music therapy sessions into two halves. The first half involved following the child's lead in musical play, which was then supported by the therapist. The second half was therapist-directed, that is the therapist introduced modeling and turn-taking activities. In addition to pre-composed songs, Study 7 used recordings of piano improvisations to represent four emotions: happiness, sadness, anger, and fear. The recordings were then played as background music during verbal instruction for each emotion. Study 11 used relational music therapy, which was described as an approach where sessions were mainly client-led and improvised activities were used. Study 3 involved active music therapy sessions including drumming, singing, and piano playing. However, it is unclear whether these were structured or improvisational activities.

Study Designs

Studies were classified as experimental or quasi-experimental. Quasi-experimental designs included A-B designs or a single-group design (Lang et al. 2012; Davis et al. 2013). Ten of the 12 included studies, involving a total of 138 participants, were classified as experimental [Studies 1, 2, 5–12]. Two studies, involving nine participants, were classified as quasi-experimental [Studies 3 and 4].

The experimental studies included the use of several types of single-case experimental designs [Studies 1, 2, 5, and 9]. For example, Studies 1 and 5 used an A-B-A-B design or modified A-B-A-B design, Study 2 used a multiple-baseline design, and Study 9 used an alternating treatments design with baseline and follow-up. The remaining experimental studies were randomized controlled trials, involving 74 participants [Studies 10 and 11], or a repeated-measures design with a control condition and counterbalancing [Studies 6, 7, 8, and 12], involving 54 participants. Study 3 was classified as quasi-experimental because it utilized a pre-post measure without a control group, and Study 4 was classified as quasi-experimental because it seemingly employed an A-B design, although it was unclear whether baseline data were collected.

Follow-Up and Generalization

Only one study reported follow-up data after implementation of the intervention [Study 9]. In this study, follow-up took place two weeks after the intervention had ended. Two follow-up sessions, one week apart, were conducted. Additionally, Study 1 stated that the music therapist followed up with the families of each of the participants three weeks after completion of the intervention to obtain verbal reports of occurrences of target behaviors. None of the studies reported measures of generalization; however, the third phase of Study 9 appeared to have included an element of generalization. Specifically, in Phase B, an alternating treatments intervention was introduced, alternating between play sessions with three toys, and musical play sessions with three other toys. In Phase C, the music sessions were continued, as these sessions appeared to be the more effective of the two treatments. At this stage, the toys from the Phase B play session were used in the music sessions to see whether the positive effects observed in the Phase B music sessions would still be evident with the use of the other toys.

Reliability of Data and Treatment Integrity

Most of the studies reported assessing reliability of data collection using inter-observer agreement measures [Studies 1, 2, 4–11]. Of the inter-rater reliability data reported, most were above the generally accepted standard of 80 % agreement. It was unclear whether inter-rater reliability was collected for Study 7, but the authors stated that a researcher and three reliability observers matched photographs to emotions, with a criterion set at .75 for a photograph to be coded as a correct response. Study 11 reported a procedure where inter-rater agreement between two raters was determined by using the study's dependent variables to rate seven children who were

not part of the study. Measures of inter-rater reliability would have been appropriate in the two remaining studies [Studies 3 and 12], but such data do not seem to have been collected.

Treatment integrity data were only reported in one study [Study 2] where teachers and peers were trained by the music therapist to implement a music intervention. The results were varied, but the study reported that most teachers and peers demonstrated a high level of treatment fidelity. Some studies described use of treatment protocols or guidelines [Studies 5, 6, 8, and 11].

Outcomes

Intervention outcomes were classified as positive, negative, or mixed, in accordance with the categories described by Lang et al. (2012). Seven of the studies (58 %), involving 99 of the total 147 participants (67 %), demonstrated positive outcomes [Studies 2, 5, 6, 8–10, 12]. In these studies, significant gains for the treatment condition were found, compared with the control group/condition, or visual analysis of data suggested improvement in all dependent variables for all participants for single-subject research designs. There were mixed results for the remaining five studies [Studies 1, 3, 4, 7, and 11], which involved a total of 48 participants.

Study 1 used an ABAB design. The intervention effects appeared positive from baseline to intervention; however, there was a failure to observe a reversal of trends in the second baseline for two of the three participants. In Study 3, significant improvements in dependent variables were observed for only some of the time periods. Study 4 demonstrated generally positive effects, but the results did not show one condition as consistently more effective than the other in the alternating treatment design. Generally, positive effects were also observed in Study 7; however, the intervention conditions did not show evidence of significantly greater improvement compared with control conditions. A further analysis revealed that once participants' pre-test scores were taken into account, the intervention conditions appeared to be more effective than the control conditions. Similarly, Study 11 did not demonstrate a significant improvement in the experimental group compared with the control group, but a further analysis showed a statistically significant improvement for a subset of the participants. Only participants in the experimental group with diagnoses of autistic disorder (rather than PDD-NOS or Asperger's disorder) showed significant improvement compared with the control group.

Certainty of Evidence

The certainty of evidence was rated as insufficient, preponderant, or conclusive in accordance with Davis et al.'s (2013) definitions. Seven of the studies provided conclusive evidence [Studies 2, 5, 6, 8, 9, 10, and 11]. The majority of these were those that indicated positive outcomes (excluding Study 11). Three studies were rated as providing preponderant evidence [Studies 1, 7, and 12], and two studies were rated as providing insufficient evidence [Studies 3 and 4]. The preponderant ratings were due to the presence of confounding variables and possible carry-over effects [Study 1] and insufficient or absent inter-rater agreement data [Studies 7 and 12]. The two studies with insufficient evidence ratings were classified as such due to reliance on quasi-experimental designs. Study 3 employed a pre-post-test without a control group, while Study 4 employed what appeared to be an A-B design.

Discussion

Twelve studies evaluating the effects of music therapy for individuals with ASD were identified and analyzed in this systematic review. Our analysis of 12 studies indicated that most studies reported positive outcomes, suggesting that music therapy might be a promising intervention for some individuals with ASD and for some specific purposes. However, a number of limitations were revealed in this corpus of studies that warrant discussion.

In terms of scope, there were relatively few studies identified ($n=12$). This review only appraised research since 2004 because Gold et al. (2006) had reviewed the literature prior to 2004. However, Gold et al.'s (2006) review included only group research designs and did not appraise studies using single-case research designs. The most up-to-date research that met inclusion criteria was published in 2011. It is unclear why there are not any more recently published data, although a study protocol for a proposed randomized controlled trial of improvisational music therapy for treatment of ASD was published in 2012 (Geretsegger et al. 2012).

A total of 147 individuals were represented in the identified studies. However, age range of participants was limited; eight of the studies included participants in the 3 to 5-year age range, while only one study focused on intervention for adults with ASD. This may be due, in part, to an emphasis on early intervention; however, more research on the effects of music therapy for older children, adolescents, and adults with ASD is needed. Another limitation is related to methodological quality. There is still a need for more rigorous, high-quality experimental research. The majority of studies failed to report treatment integrity data or include measures of generalization or maintenance.

Despite these methodological limitations, over half of the studies were of a sufficiently high standard to provide conclusive evidence. Positive outcomes were reported for 58 % of studies, while the remaining studies reported mixed outcomes. There were no studies reporting negative outcomes. Generally, positive outcomes were reported from studies that

were mostly rated as capable of providing conclusive evidence, whereas studies reporting mixed outcomes generally had more procedural limitations.

Seven of the 12 studies focused on social interaction/social communication as the main intervention target [Studies 2, 6, 8, 9, 10, 11, and 12]. Other studies indirectly aimed to increase these behaviors; Studies 1 and 3 sought to decrease undesirable behaviors, thus promoting appropriate social interaction as alternative behavior. This supports the findings of Kaplan and Steele (2005) whose review of clinicians' music therapy goals for individuals with ASD revealed that they were most likely to focus on improving communication and language, and promote behavioral and social skills.

As a considerable proportion of music therapy interventions for this population focused on increasing verbal and social communication, it would seem important to determine ASD severity, and indicate accompanying language impairments. A few studies reported on the severity of the symptoms of ASD [Studies 2, 5, 9, and 10], while two studies also specified whether participants were diagnosed with autistic disorder, PDD-NOS, or Asperger's disorder [Studies 1 and 11]. With the release of *The Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM–5*; American Psychiatric Association 2013), the former diagnoses of autistic disorder, PDD-NOS, Asperger's disorder, and childhood disintegrative disorder have been collapsed into the single ASD category. Therefore, it may be particularly important to specify the severity of ASD. By doing so, further understanding may be gained about the impact of music therapy interventions for individuals with differing severity of ASD and language impairment.

The studies in this literature review primarily employed one of two music therapy approaches. These were the use of specific songs with lyrics related to target skills and the use of clinical improvisation. An analysis of intervention approach and study outcome revealed that both approaches were fairly equally spread across studies with positive results and studies with mixed results, suggesting that both approaches may be equally effective. However, there appears to be a paucity of research on other music therapy approaches that might be used with ASD populations, such as the use of structured musical activities, or songwriting and composition (see Wheeler et al. 2005). Future studies could investigate the effectiveness of these different approaches for individuals with ASD in different age ranges and with differing severity of ASD and language impairment.

At present, the results of this review point to an emerging evidence base on the effects of music therapy for individuals with ASD. Within this evidence base, there is sufficient conclusive evidence reporting positive outcomes to classify music therapy as a promising intervention for individuals with ASD. Positive outcomes have mainly been reported with respect to the frequency of verbal communication and social interaction. Because of its promise, additional research aimed at comparing music therapy to other forms of therapies for increasing communication and social skills would seem warranted. Studies evaluating the components responsible for, and the mechanism underlying, the promising effects of music therapy would also seem warranted.

Appendix

Excluded Studies [and reason for exclusion]

Gadberry, A. L. (2012). Client communicative acts and therapist prompts with and without aided augmentative and alternative communication systems. *Music Therapy Perspectives*, *30*, 151–157. [Not focused on determining the effect of music therapy intervention compared with control].

Hillier, A., Greher, G., Poto, N., & Dougherty, M. (2011). Positive outcomes following participation in a music intervention for adolescents and young adults on the autism spectrum. *Psychology of Music*, *40*, 201–215. doi:10.1177/0305735610386837 [Not classified as a music therapy intervention].

Kalas, A. (2012). Joint attention responses of children with autism spectrum disorder to simple versus complex music. *Journal of Music Therapy*, *49*, 430–452. [Not focused on determining the effect of music therapy intervention compared with control].

Kern, P. (2004). Using a music therapy collaborative consultative approach for the inclusion of young children with autism in a childcare program. (Doctoral thesis, University of Witten-Herdecke, Witten, Germany). Retrieved from http://www.wfmt.info/Musictherapyworld/modules/archive/dissertations/pdfs/Diss_2004_Petra_Kern.pdf [Duplication of Studies 2, 4, and 5].

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Sandiford, G. A., Mainess, K. J., & Daher, N. S. (2013). A pilot study on the efficacy of melodic based communication therapy for eliciting speech in nonverbal children with autism. *Journal of Autism and Developmental Disorders*, *43*, 1298–1307. doi:10.1007/s10803-012-1672-z [Not classified as a music therapy intervention].

Stephens, C. E. (2008). Spontaneous imitation by children with autism during a repetitive musical play routine. *Autism*,

12, 645–671. doi:10.1177/1362361308097117 [Not classified as a music therapy intervention].

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