Positive outcomes following participation in a music intervention for adolescents and young adults on the autism spectrum

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Abstract

Music interventions are frequently utilized with those with autism spectrum disorders (ASD) and have shown a range of benefits. However, empirical evaluations are lacking and would be a timely step forward in the field. Here we report the findings of our pilot music program for adolescents and young adults with ASD. Evaluation of the program focused on self-esteem, anxiety, and attitudes toward and relationships with peers as these are pervasive challenges for those with ASD. Pre- and post-outcome measures showed a significant increase in self-esteem, reduced self-reported anxiety, and more positive attitudes toward peers. Weekly measures taken pre- and post-each session also showed a significant reduction in self-reported ratings of anxiety. These findings provide some initial empirical support for the efficacy of music participation in treating some of the core challenges seen in ASD.

Keywords

anxiety, autism spectrum, music intervention, peer relationships, self-esteem

Introduction

Individuals with an autism spectrum disorder (ASD), including autism, Asperger's syndrome, and pervasive developmental disorder not otherwise specified, experience challenges in a broad range of areas. High levels of stress and anxiety are common among this population (Goodwin, Groden, Velicer, & Diller, 2007; White, Oswald, Ollendick, & Scahill, 2009), and the negative physical and psychological health effects of stress are well documented in the general population

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(e.g., Cox et al., 1984; Dohrenwend, 2000; Hammen, 2005; Hudd et al., 2000; Gouin, Hantsoo, & Kiecolt-Glaser, 2008). Low self-esteem and depression are often seen among those with ASD (Attwood, 2007; Tantum, 2000). Social challenges are a defining feature of autism spectrum disorders and those with ASD often lack the ability to form age appropriate peer relationships and have limited understanding of social cues (Attwood, 2000), and how to 'read' other people (Baron-Cohen, 1997). This pilot study examines to what extent some of these challenges may be impacted through participation in a music program.

Individuals with autism often show interest in, and a positive response to, listening, playing, and producing music (Kern & Aldridge, 2006; Starr & Zenker, 1998; Wigram & Gold, 2006). Music offers structure and predictability which those with ASD often prefer (Allen, Hill, & Heaton, 2009; Attwood, 2007). Allen and colleagues (2009) found that those with ASD reported benefiting from music in many ways, including helping to change their mood, reducing feelings of depression, having a therapeutic healing effect, and providing feelings of belonging and social connectedness. These responses to music are similar to those reported by typically developing populations, and show that music can greatly impact those with ASD. Their findings also demonstrate that those with ASD have considerable insight into music as well as its effects on them.

Program interventions incorporating music for individuals on the autism spectrum have shown a broad range of benefits including improved play and involvement with peers (Kern & Aldridge, 2006), increased self-esteem (Shore, 2003), enhanced verbal communication (Shore, 2003), increased social involvement and interaction (Wimpory, Chadwick, & Nash, 1995), engagement with others (Toolan & Coleman, 1994), reduced anxiety and stress, improved mood regulation (Trevarthen, 2002), and increased eye contact (Wimpory et al., 1995). Music has also been posited to facilitate multisensory integration, a common challenge seen among those with ASD (Berger, 2002). A meta-analysis of the use of music with individuals with autism showed benefits including increased appropriate social behaviors, increased attention to task, increased vocalizations, gestures and vocabulary comprehension, increased engagement with others, and anxiety reduction (Whipple, 2004).

Boso, Emanuele, Minazzi, Abbamonte, & Politi (2007) investigated the effects of long-term regular music therapy sessions for a group of young adults with autism and found significant improvements in behavioral and psychiatric outcomes. Positive changes have also shown maintenance over time (Wimpory et al., 1995), and generalization of skills to settings outside the music therapy sessions (Kaplan & Steele, 2005). Although there is a considerable amount of support for the use of music activities with those on the autism spectrum, empirical evaluations of such interventions remains lacking (Accordino, Comer, & Heller, 2007; Whipple, 2004). More work is needed to investigate the effects of music therapy over longer time periods, and with larger samples (Gold, Wigram, & Elefant, 2010). Also, few studies have focused on an older adolescent/young adult population, those who are on the high functioning end of the autism spectrum, and less traditional music intervention models.

This pilot study provides an initial empirical evaluation of a music intervention for high functioning adolescents and young adults with ASD. Our evaluation focused on self-esteem, anxiety, and attitudes toward and relationships with peers as these are pervasive challenges for those with ASD. We hypothesized that participants would demonstrate increased self-esteem, reduced self-reported levels of anxiety, and improved attitudes and relationships with peers upon completion of the program compared to the beginning of the program. This study addressed the current demand in the field for increased program accountability. We build on previous work by including established quantitative measures to assess each of these areas, and

by focusing on an older population who are on the high functioning end of the autism spectrum.

In addition, our program moves away from a traditional music therapy model which might typically utilize singing and/or musical instruments as a means to improve verbal and non verbal communication skills (Gold et al., 2010), and instead we focus on the social aspects of group music making and creation which involves the ability to listen to one another and be part of an ensemble. Sturmey (2003) found the use of video technology can lead to positive social and academic outcomes for this population. As with typical teen populations, students with autism are also drawn to technology (Goldsmith & LeBlanc, 2004). In our program, participants work towards a group project where they produce a short movie and soundtrack. Previous work on musical soundtracks has shown that the soundtrack influences the cognitive interpretation of the film and provides additional meaning, emphasis, tension, emotion, etcetera, to the film (e.g., Cohen, 1990, 1993), making this a particularly dynamic and multi-leveled task. Drawing upon the inherent interests adolescents have in music and video, our intervention begins with music from their peer culture (McIntyre, 2007), and incorporates technology, computers, and music production software in the realization of the team based multimedia productions.

Method

Participants

Twenty-two adolescents and young adults on the autism spectrum took part in this study in two separate groups. Participants were aged between 13 and 29 years with an average age of 18. Eighteen participants were male and four were female, which reflects male: female ratio seen in the autism spectrum population. One participant was Asian, and the remaining were Caucasian. All participants were diagnosed with an autism spectrum disorder, either high functioning autism ($n = 2$), pervasive developmental disorder – not otherwise specified (PDD-NOS; $n = 4$), or Asperger's syndrome ($n = 16$). Data was accumulated across two groups of participants from two consecutive implementations of the program in order to yield greater numbers. Both groups experienced the same program curriculum and some overlap in program staff.

To be eligible for the music program participants were required to provide proof of a prior Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV based diagnosis of an autism spectrum disorder (ASD) by an appropriate professional (e.g., pediatrician, psychologist, speech-language pathologist, psychiatrist), aged between 13 and 30 years, and were considered to be 'high-functioning' on the autism spectrum. This was judged using a developmental profile (Hillier, 2007) which was developed by the first author. The developmental profile required parents to assess their child's communication skills, reading and writing ability, social skills, and behavioral profile. The first author reviewed parents' responses to ensure the potential participant would be a good fit for the program. In addition, participants were able to fully participate in the sessions, follow instructions appropriately, and did not exhibit behavioral challenges. It was not necessary for participants to have any prior musical training or experience, and this varied among the participants. However, the majority of participants did not play a musical instrument and had not received any formal music training.

Group members were recruited via brochures describing the program sent to targeted referral sources, such as organizations providing services to those with ASD and their families. Parents/guardians were also asked to complete two evaluation questionnaires before and after the

program. However, not all participants and parents/guardians completed all of the questionnaires depending on their attendance to the pre- and post-program sessions where measures were completed, and/or their choice not to complete a particular questionnaire. Written informed consent was obtained from all participants and parents/guardians. All aspects of the program were performed in accordance with the institutional review board of the University of Massachusetts Lowell, USA.

Program model

The music program called 'SoundScape' was an eight-week program consisting of 90-minute weekly music sessions. Participants were aged between 13 and 29 years but were frequently broken into smaller groups which were designed to have participants of similar ages. As an interdisciplinary program, sessions were run by music education students and students majoring in psychology at our university. Each session was overseen by professors in these departments (AH, AND, GG). Music education students led the sessions with additional support and facilitation provided by the psychology students. Each session was followed by a debriefing meeting between the professors and students. The staff: participant ratio was close to 1:1 (for each group there were nine program staff and around 11 participants).

The educational component of this program for our music education and psychology students who facilitate the sessions is an important piece of our program model. Music educators have a long history working with special education students (Darrow, 2007), yet context specific experiences for music teachers in training to work with special needs populations are often non-existent, causing music teachers to feel unprepared to deal with the many behavioral issues that may arise (Colwell & Thompson, 2000; Hammel, 2001). Research suggests music teacher attitudes towards special needs students can negatively or positively impact outcomes for students being mainstreamed into music classes (Colwell & Thompson, 2000; Hammel, 2001; VanWeelden & Whipple, 2007). Classroom field experiences are embedded into many of our university's music methods classes. Though our students get to work with many inclusion classes, the SoundScape program provides additional opportunities for those students wishing to gain experience working with a specific population. In addition this program provides our music education students an additional chance to apply technology in their teaching. As with teachers of any population, technology training as well as experiences applying the training are crucial for the successful integration of technology into the classroom (Hutinger, 1996).

While we do not have music therapy courses on our campus, many of the techniques used in traditional music therapy such as singing, structured and free improvisation, and music listening activities (Gold et al., 2010) are a part of our university's music education curriculum. We concentrate on using improvisatory activities as a non-verbal means of communication for several reasons. It gets the music educator focused on differentiating instruction, as well as directing their own learning towards less 'telling' and more 'doing.'

During the eight sessions participants engaged in a range of hands-on music making activities including: listening to different types of music and considering the various techniques used in musical pieces, playing with and exploring sound with various musical instruments, and composing and improvising music. Given the age of the participants we capitalized on their interest in music and multimedia production. The main project in the curriculum involved participants creating a short film with accompanying music composition (a 'movie soundtrack') which was created using a music looping program 'GarageBand'. Music compositions using GarageBand

were produced in small groups to promote social interactions and opportunities (Goldsmith & LeBlanc, 2004; Sturmey, 2003). Table 1 provides further details on the program curriculum.

The program curriculum required minimal musical ability and aimed to present many opportunities to experience success, acceptance from peers, and accomplishment. We intentionally moved away from a traditional music therapy model which often heavily emphasizes singing and/or musical instruments, and instead incorporated technology, computers, and music production software in an effort to connect the participants' interests in technology with their interests in music (Hutinger, 1996). The software that was utilized does not require a formal knowledge of music and allows for a great deal of student choice based on their personal likes, dislikes and interests (Goldsmith & LeBlanc, 2004; Hutinger, 1996; McIntyre, 2007). The program sought to encourage musical self-expression, and required participants to analyze, problem-solve, create, and reflect on their work. Based on previous work, it was hoped that these features of our program model and engagement with music would result in positive psychological outcomes. Our goal was to evaluate the efficacy of music participation with regards to self-esteem, anxiety, and peer relationships as these are core areas of challenge seen among those with ASD. We hypothesized that these outcomes would be positively impacted following completion of the music program intervention compared to the beginning of the program.

Evaluation

Pre- and post-program measures. Self-report questionnaires were completed before and after the music program by the participants and a parent/guardian. These were completed during a 30 minute session in a quiet room at the university. Responses on these measures were analyzed and compared pre- and post-intervention with non-parametric statistics (Wilcoxon signed ranks test) as a within-groups design. Measures included the Index of Peer Relations (IPR; Hudson, 1982) that questions how the participant views and evaluates those in their peer group, and whether they are accepted and liked by their peer group. Participants' ($n = 16$) rated their peer relations (e.g. 'I get along well with my peers,' 'My peers really seem to respect me,' 'My peers don't seem to even notice me') on a scale of 1 to 7 with 1 representing 'none of the time' and 7 representing 'all of the time.' The IPR has demonstrated excellent reliability and validity (Hudson, Nurius, Daley, & Newsome, 1990), with reliability alpha coefficients of over .90 and support for the construct, discriminant, and factorial validity of the IPR (Klein, Beltran, & Sowers-Hoag, 1990). A version of the IPR was also completed by parents/guardians ($n = 17$) where questions were re-worded from 'I get along well with my peers' to 'S/he gets along well with her/his peers'.

Participants ($n = 18$) also completed a measure of self-esteem, the Rosenberg Self-Esteem Scale (SES; Rosenberg, 1989). Participants responded to 10 statements on a four-point scale from strongly agree to strongly disagree. Examples of items are: 'I have a number of good qualities;' 'Overall I feel that I am a failure;' 'Mostly I am satisfied with who I am.' Reliability on the SES is high with test–retest correlations typically in the range of .82 to .88.

A measure of anxiety was also completed by the participants ($n = 18$), the State-Trait Anxiety Inventory – trait version (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The STAI includes statements such as 'I feel pleasant,' 'I feel nervous and restless,' 'I feel inadequate' that the participants answer either 'almost never,' 'sometimes,' 'often,' or 'almost always.' The STAI has shown good reliability with test–re-test correlation coefficients ranging from .65 to .86 (Spielberger et al., 1983).

Table 1. Outline of music program curriculum

General activity	Description	Goal(s) of activity
Week 1: Introductions and ice-breaker exercise.	1. Listening activity and discussed what they heard. 2. Created a similar composition, first with body percussion, and then musical instruments (e.g., guitars, keyboards, drums, pitched and non-pitched percussion instruments). 3. Compositions were recorded and played back for reflection.	1. Getting to know each other. 2. Establishing an informal, fun atmosphere for the program. 3. Exposure to different instruments and opportunity to successfully play them. 4. Learning to express oneself through music.
Week 2: Music listening and sharing. Socialization.	1. Participants shared their favorite song with the group and discussed why they liked it. 2. Compared the pieces, what instruments were used and how they were used differently in different pieces, mood created in the music, what made each song unique etc.	1. Getting to know each other. 2. Having opportunity to share and feel accepted. 3. Recognizing different people have different musical tastes. 4. Learning to respect others and feel respected by others. 5. Exposure to a diverse range of music.
Week 3: Sound and motion. Imaginative music making.	1. Group facilitators did short presentation and role play on sound and motion, to set the stage for imaginative music making. 2. Discussion of music's function in film. 3. Participants broke into groups and composed their own mini-story using musical instruments and actions.	1. Building self-confidence. 2. Working in groups and collaborating successfully. 3. Understanding diversity of the purposes and utility of music. 4. Engaging in self-expression through music.
Week 4: Introductory exercise with computers and music production software.	1. Worked in pairs to create a short music composition that evoked motion and imagery using Garageband software. 2. Shared composition with rest of group.	1. Familiarization with the Apple Mac computers and Garageband software. 2. Working successfully with others to complete a short music project. 3. Understanding more about how music can evoke imagery and emotions. 4. Being creative with music, sound effects, and various techniques. 5. Reflecting and analyzing own work through sharing and discussing it with others.
Week 5: Planning and producing movie trailer.	1. Worked in groups to plan the storyline for the movie trailer, write scripts, and decide on scenes. 2. Began filming the movie trailer.	1. Learning to work collaboratively and successfully in groups, while under time pressure. Learning to compromise. 2. Feeling acceptance and recognition from others.

(Continued)

Table 1. (Continued)

General activity	Description	Goal(s) of activity
		3. Having an opportunity to create an original piece of work. 4. Working with video-cameras and learning some basic filming techniques. 5. Building self-confidence.
Week 6: Composing soundtrack to movie trailer.	1. Groups finished filming their movie trailer. Used software to edit movies. 2. Began composing the soundtrack using Garageband software. 3. Keeping track of goals of the music composition, what the group is trying to achieve with their composition.	1. Learning how to use music to help convey the themes, atmosphere, and storyline of the movie trailer. 2. Persuasively communicating ideas to others, accepting and respecting the contributions of others. 3. Role negotiation. 4. Reflecting on progress, direction of music project.
Week 7: Completing music composition project.	1. Groups finished their music compositions using the Garageband software.	1. Working collaboratively with others while under time pressure. 2. Self-expression through music. 3. Recognizing that absolute perfection is unrealistic. 4. Reflecting on and feeling satisfied with one's own contribution to the project.
Week 8: Sharing movie trailers with friends and family.	1. Family members, friends, group members, and program staff came together to view the movie trailers and listen to the accompanying music compositions. 2. Exchanging contact information.	1. Recognizing and celebrating accomplishments made throughout the music program. 2. Experiencing success and feelings of pride. 3. Willingness to share project results with significant others. 4. Identifying potential social connections which could continue outside the program.

Finally, participants completed a questionnaire (SoundScape Questionnaire or SSQ) designed by the authors which provided more general feedback about the music program. Participants responded on a scale from 1–10 on questions assessing whether they had found the program enjoyable, interesting, whether they had benefited socially, and whether they had made any friends in the program (see Appendix 1). Parents completed a similar but re-worded version of the SSQ (e.g., 'How enjoyable do you believe your son/daughter has found the music program?').

Weekly measures. During weeks 2–7 participants completed the State-Trait Anxiety Inventory – state version (STAI, Spielberger et al., 1983) at the beginning and end of each session. The state version of the STAI examines transitory changes in feelings of tension and apprehension, and heightened autonomic nervous system activity. Therefore, state anxiety may fluctuate over time and can vary in intensity (Spielberger et al., 1983). In contrast, the trait version (used in the pre- and post-program intervention analyses) is thought to measure relatively stable

Table 2. Results on the pre- and post-program intervention measures

Measure	N	Mean pre score (± SD)	Mean post score (± SD)	Z	P
Index of Peer Relations (participant version)	16	96.4 (13.3)	126.27 (26.1)	2.41	0.016
Index of Peer Relations (parent version)	17	87.88 (23.4)	95.82 (21.9)	1.97	0.049
Rosenberg Self-Esteem Scale	18	28.36 (5.9)	30.22 (5.1)	2.42	0.015
State-Trait Anxiety Inventory	18	46.83 (11.1)	40.78 (11.2)	2.92	0.004

Note: Not all participants and parents/guardians completed all the measures depending on their choice and their attendance to the pre- and post-evaluation sessions.

individual differences in anxiety proneness. Statements in the state version include 'I feel strained,' 'I feel satisfied,' 'I am jittery.'

Results

Pre- and post-program measures

Responses on the Rosenberg Self-Esteem Scale (SES; Rosenberg, 1989), the Index of Peer Relations (parent and participant version) (IPR; Hudson, 1982), and the State-Trait Anxiety Inventory – trait version (STAI; Spielberger et al., 1983) were compared pre- and post-program intervention in a within-groups design. Data from both groups of the music program were combined. Data were analyzed non-parametrically due to the type of data and small participant numbers (Wilcoxon signed ranks test), and hypotheses were two-tailed. Responses on all three measures showed positive improvements following participation in the music program compared to responses given at the beginning of the program. Self-esteem scores were significantly higher following program participation, attitudes toward peers were significantly more positive on both the parent and participant version, and trait anxiety was rated as significantly lower. These findings are summarized in Table 2. We also examined whether responses on the Index of Peer Relations were correlated between the participants and the parents. This was not significant for the pre-measures ($r = .381$; $p = .199$; $n = 13$) or post-measures ($r = .156$; $p = .612$; $n = 13$) indicating that parents and participants were not in strong agreement regarding the participants' peer relationships. Although both participants and parents rated peer relationships significantly more positively at the end of the program, parents gave substantially lower ratings of the participants' peer relationships compared to the participants themselves.

On the SoundScape Questionnaire (designed by the authors) the participants ($n = 22$) rated the program as 7.9 out of 10 for how enjoyable they found the program, 7.8 out of 10 for how interesting they found the program, and 7 out of 10 for how much they felt they had benefited from the program socially. Twenty out of 22 participants said they had made friends in the program. Sixteen out of 18 parents who completed this measure said they benefited from the opportunity to interact with other parents. These positive responses were reflected in the attendance to the program, which was excellent.

Weekly measures

Data from the weekly STAI-state version were combined across weeks 2–7. Self-report ratings of anxiety were significantly lower at the end of the music sessions compared to ratings given at the beginning of the sessions ($n = 125$; Wilcoxon: $Z = 5.077$; $p = 0.001$).

Discussion

This pilot study provides an initial empirical evaluation of the efficacy of music participation in treating some of the core challenges seen among those on the autism spectrum. Findings from our music intervention show that engaging with music can positively impact a range of psychological outcomes for those with ASD. Following completion of the music program participants showed significantly higher self-esteem, significantly lower self-reported anxiety, and significantly improved attitudes toward peers as measured by a questionnaire completed by participants themselves and also a questionnaire completed by their parents/guardians. These findings were supported by a weekly measure of anxiety collected pre- and post-program of six sessions (STAI; state version; Spielberger et al., 1983). Ratings for how enjoyable and interesting participants found the program, and how much they benefited socially, were high.

These findings contribute to the current literature by including established quantitative measures to assess each of the core areas, by focusing on an older population who are on the high functioning end of the autism spectrum, and by moving away from a traditional music therapy model and instead incorporating technology and music production software. From an applied perspective, this work also addresses the current gap in service provision for this population (particularly adolescents and young adults), which is becoming a serious concern with dramatically rising numbers of individuals being diagnosed with ASD (Waterhouse, 2008). There is also greater demand in the field for improved program evaluations and accountability.

Many components of the music program seemed effective in yielding our positive outcomes. It is therefore difficult to tease apart the extent to which engaging with music alone contributed to the benefits observed in our program. Many other factors may have led to the improvements reported on the questionnaires such as simply being in a group of other young adults with ASD, or receiving high levels of positive reinforcement from the program staff. In a similar vein, whether improvements are due to music alone or music as a soundtrack to a short film is also impossible to decipher. Overall, engaging with music in a variety of different ways, including playing with instruments, composing music using software, working on a soundtrack associated with a film, etcetera, seems to be beneficial for this population.

In addition, simply listening to music can reduce anxiety (e.g., Khalfa, Dalla, Roy, Peretz, & Lupien, 2003; Miluk-Kolasa, Obminski, Stupnicki, & Golec, 1994). A number of studies have shown reduced levels of cortisol, a stress hormone, through the use of music (Khalfa et al., 2003; Lindblad, Hogmark, & Theorell, 2007; McKinney, Antoni, Kuma, Tims, & McCabe, 1997; Nilsson, Unosson, & Rawal, 2005; Suda, Morimoto, Obata, Koizumi, & Maki, 2008; Uedo et al., 2004). The use of computers seemed to be an additional factor that was a very effective medium for this population. The music production software was structured and predictable, making the experience more controllable and less overwhelming, an important component for those with ASD. Within the structured framework, the flexible and creative nature of the music composition exercises completed in our program may have improved tolerance for change and the unexpected among the participants. This in turn may have reduced symptoms of anxiety as reflected in our self-report measures.

Also, the program sessions themselves provided structure and predictability which may have also led to reduced symptoms of anxiety among the participants. At the beginning of each session participants were informed of the activities for that session and what would happen when. The sessions were well organized, took place on the same day and time each week, utilized the same rooms, and included the same participants and program staff each week. This structure and predictability are important components for developing a successful intervention with this population.

While several of the initial exercises were individual projects, the final 'movie soundtrack' project was designed as a group project. Working with others did prove challenging for some of the participants, as would be expected given the deficits in social skills seen among those with ASD (Attwood, 2000; Baron-Cohen, 1997). However, ultimately all were able to benefit from these interactions and reported significantly improved attitudes toward peers at the end of the program. The necessity of compromise inherent in the music composition exercises gave participants the opportunity to gain from the insights and work of others. These situations, which are probably rare for many young adults with ASD, may have facilitated more positive attitudes toward their peers. Anecdotally, a number of the participants met up with each other outside of the program sessions and continued to do so after the program ended. Also, all participants utilized the program's social networking website and communicated with each other online between sessions.

Adolescents and young adults with ASD often suffer from low self-esteem and depressive symptomatology (Attwood, 2007; Tantum, 2000). Our music intervention resulted in significantly higher levels of self-esteem reported by participants, an outcome which could have important positive implications for other areas of functioning. In considering this outcome, certain features of the program may have particular utility for increasing self-confidence and self-esteem. Participants worked on activities for which there was no right or wrong procedure so failure was impossible (see Table 1). In addition, the group projects were so diverse that making comparisons was very difficult. By the end of the intervention participants had an experience of working successfully with others. They were able to learn and demonstrate new skills and accomplishments which, at the beginning of the intervention, they may not have thought possible, particularly for those without formal musical training.

Our findings rely on self-report measures which produce limitations in all research studies. However, such measures could be of greater concern regarding individuals with ASD who may have difficulty recognizing their feelings, such as feelings of self-esteem, anxiety and attitudes towards their peers. For example, Berthoz and Hill's (2005) work on alexithymia found that those with ASD were able to reliably reflect and report on their own emotions using self-report measures, but showed greater difficulties in identifying, verbalizing and analyzing their emotions. These emotion insight difficulties are an important concern when using self-report measures with those with ASD. Requesting parents to complete alternative versions of two of our evaluation tools (the Index of Peer Relations and the SoundScape Questionnaire) helped to partially overcome this issue, and this was helpful as there was not a significant correlation between participants' and parents' responses on the Index of Peer Relations. Although both participants and parents rated peer relationships significantly more positively at the end of the program, parents gave lower ratings of the participants' peer relationships. Future work should utilize a broader range of tools, such as observations inside and outside of the music sessions, and/or questionnaires completed by teachers and other professionals. This would also be useful in assessing whether improvements in self-esteem, anxiety and attitude towards peers have generalized over time and to other settings. In addition, a language assessment, such as the Peabody picture vocabulary test (Dunn & Dunn, 2007), would be helpful as this may have impacted how participants responded to the questionnaires. Future studies could also collect IQ scores and account for that in responding to the questionnaires. Measuring stress and anxiety could be accomplished using biomarkers such as monitoring levels of the stress hormone cortisol and examining heart rate variability.

Overall, the experience of working successfully with others, utilizing technology, and producing a unique piece of work all combined to result in the significant positive changes we report in our data. Previous programs demonstrating success have typically followed a more

traditional music therapy model utilizing singing and/or musical instruments. Our findings show that, for today's student music production software programs, technology and computers may produce comparable beneficial outcomes. Future work should focus on continuing to improve our understanding of the efficacy of music participation for those with ASD using empirical methods including random assignment to a control group for comparative purposes, utilizing a broader range of evaluation tools, and investigating the long-term maintenance of positive outcomes.

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Biographies

Ashleigh Hillier, Ph.D., is an Assistant Professor of Psychology at the University of Massachusetts Lowell where she teaches undergraduate and graduate classes in Disability and Community Service. Her main research interests include evaluating interventions for young adults on the autism spectrum, and she runs a number of programs for this population at UMass Lowell. She is also interested in neuropsychology and psychophysiology, with a focus on understanding and processing affective material among those on the autism spectrum.

Gena R. Greher, Ed.D., is Associate Professor/Coordinator of Music Education at the University of Massachusetts Lowell. She teaches undergraduate and graduate level music education classes. Her research interests focus on creativity and listening skill development in children and examining the influence of integrating multimedia technology in urban music classrooms, as well as in the music teacher education curriculum through School-University partnerships. Recent projects include: a music technology mentor/partnership with K-8 and High School students; Soundscapes, a technology infused music intervention program for teenagers with autism spectrum disorders; Performamatics, an NSF CPATH grant linking computer science to the arts.

Nataliya Poto, MA, is a recent graduate of the University of Massachusetts Lowell, where she completed her Masters degree in Community Social Psychology and worked as a research/teaching assistant. Her work involved facilitating and evaluating programs for young adults on the autism spectrum. Currently, she is program manager for "LifeMAP", a coaching program for adults with Asperger's Syndrome and related conditions run by the Asperger's Association of New England.

Margaret Dougherty graduated from the University of Massachusetts at Lowell with her Masters degree in Music Education in 2009. She was an undergraduate assistant for one year and the

music education graduate research assistant for the SoundScape project for the last two years. Her areas of interest include instrumental music and music technology. Margaret thoroughly enjoys assisting her students develop and cultivate their unique musical voices. She is currently teaching elementary general music in Lowell, and she is also an assistant rowing coach in Boston.

Appendix 1. Music program – participant post-intervention questionnaire

Participant number: Group: Date:

We use your responses on this questionnaire to help us evaluate the impact the music program has had on you. It is important to answer the questions as accurately as possible.

1. How enjoyable have you found the music program?
   1   2   3   4   5   6   7   8   9   10
   not at all enjoyable   very enjoyable
2. How interesting have you found the music program?
   1   2   3   4   5   6   7   8   9   10
   not at all interesting   very interesting
3. How much do you believe you have benefited SOCIALLY from the music program?
   1   2   3   4   5   6   7   8   9   10
   no benefit   great benefit
4. Have you made any friends in the music program?
   Yes   No

   Please describe:
   _____
   _____
   _____

5. Have you noticed any other changes in yourself (e.g., change in attitude, mood, stress etc.) which you could attribute to the music program?
   Yes   No

   Please describe:
   _____
   _____
   _____

6. What do you think you have learned through participating in the music program?

   Please describe:
   _____
   _____
   _____
   _____
   _____

7. How could we improve the music program?

   _____
   _____
   _____
   _____

8. Additional comments:

   _____
   _____
   _____
   _____