J Autism Dev Disord (2016) 46:1142–1151
DOI 10.1007/s10803-015-2624-1

ORIGINAL PAPER

Age-Related Differences in Response to Music-Evoked Emotion Among Children and Adolescents with Autism Spectrum Disorders

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Published online: 31 October 2015

Abstract While research regarding emotion recognition in ASD has focused primarily on social cues, musical stimuli also elicit strong emotional responses. This study extends and expands the few previous studies of response to music in ASD, measuring both psychophysiological and behavioral responses in younger children (ages 8–11) as well as older adolescents (ages 16–18). Compared to controls, the ASD group demonstrated reduced skin conductance response to music-evoked emotion. Younger groups, regardless of diagnosis, showed greater physiological reactivity to scary stimuli than to other emotions. There was a significant interaction of age group and diagnostic group in identifying scary music stimuli, possibly evidencing disrupted developmental trajectories in ASD for integrating physiological and cognitive cues that may underlie symptoms of anxiety.

Keywords Autism spectrum disorder · Music · Anxiety · Emotion · Development · Skin conductance response

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by deficits in reciprocal social communication as well as restricted or repetitive movements and interests (American Psychiatric Association, 2013). In addition to core clinical symptoms of ASD there are a number of associated physical and emotional symptoms, for instance frequent, severe symptoms of anxiety (van Steensel et al. 2011; Vasa et al. 2013). Co-morbid anxiety may lead to substantial functional impairment (Ozsivadjian and Knott 2011; White et al. 2009) including an increase in problematic behaviors (Gotham et al. 2013; Rodgers et al. 2012); more difficulty making decisions (Luke et al. 2012); and higher levels of stress on family systems (Conner et al. 2013).

Research regarding anxiety in general has highlighted overarousal of the amygdala in response to emotional stimuli, in the context of ineffective modulation of amygdala by prefrontal cortex (see Berkowitz et al. 2007; Shin and Liberzon 2009). A seminal review by Pessoa and Adolphs (2010) concludes that amygdala coordinates with pulvinar and cortical networks in the evaluation of emotional significance for visual stimuli. One common paradigm used in this area of research is to evaluate behavioral and physiological responses to emotional faces compared to emotionally-neutral faces (e.g. Easter et al. 2005; Hattingh et al. 2013). Mood and anxiety disorders are associated with impaired recognition of facial emotions, with bias towards the perception of negative affect even in neutral or ambiguous expressions (Demenescu et al. 2010; Lee et al. 2013). One possible explanation for this negative bias is that difficulty discriminating specific emotions leads to a default assumption that all stimuli should be considered threatening, which leads to constant feelings of worry.

Electronic supplementary material The online version of this article (doi:10.1007/s10803-015-2624-1) contains supplementary material, which is available to authorized users.

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Children diagnosed with ASD likewise show impaired emotion matching or labeling tasks for face stimuli (Uljarevic and Hamilton, 2013) and seem to have slightly more difficultly recognizing fear compared to happiness (according to the meta analysis reported by Uljarevic and Hamilton 2013) or mimicking fearful faces (at least for individuals with the highest levels of ASD symptoms; Deschamps et al. 2013). Thus it may be that one mechanism for anxiety in ASD arises from poor discrimination of emotional cues. This notion is complicated, however, by the fact that most studies of emotion recognition in ASD rely exclusively on face processing tasks (e.g. Daly et al. 2012; Kennedy and Adolphs 2012; Song and Hakoda 2012; Tanaka et al. 2012; Wong et al. 2012). There is ample evidence for abnormal face processing in autism independent of emotional content, including theories that link hypo activation of the fusiform face area in ASD to a cascading neural sequence originating with atypical amygdala function (Baron-Cohen et al. 2001; Schultz 2005). Other studies have highlighted the role of the amygdala in anxiety and autism outside of face processing tasks (see Amaral et al. 2008). For example, in a study of adolescents diagnosed with ASD performing a fear conditioning and reversal learning task, South et al. (2012) found impaired recognition or modulation of response to fear versus safety contexts, that may be associated with behavioral rigidity in ASD. It remains an open question whether emotion recognition for non-social and non-face stimuli is impaired in ASD or whether deficits are specific to social situations (Louwerse et al. 2014; Shafritz et al. 2015; South et al. 2008; Williams and Happé 2010; Worsham et al. 2014).

Emotion Recognition of Music in ASD

One of the fundamental societal roles of music is to express emotions (Juslin 2001). Recent neuroimaging results have shown common areas of activation for specific emotions such as fear across various emotion modalities including faces, vocalizations, and music (Aubé et al. 2015) including amygdala, auditory cortex, cingulate, thalamus, basal ganglia, as well as white matter connections (see review in Koelsch 2014). Behavioral reports likewise highlight the role of the amygdala in processing sad and scary music. Patient S.M., who has complete bilateral amygdala atrophy without damage to surrounding areas in the temporal lobes, showed impaired ability to recognize sad and scary music while her ability to recognize happy music was intact. She also judged scary music as less intense than controls (Gosselin et al. 2007). Specifically, substructures of the amygdala have been implicated in coding positive or negative reward value of music, autonomic reactions to music, and emotional expression.

Research in emotion and music has also investigated the impact of musical stimuli on a range of psychophysiological measures including heart and pulse rate, biochemical responses, and skin conductance response (SCR) among others. These psychophysiological studies have shown that music is a viable stimulus for eliciting emotional responses in typically developing individuals. Evidence suggests that music causes changes in the autonomic nervous system (ANS) that are thought to be correlated with emotion (Larsen et al. 2008).

These findings have also led researchers to use musical stimuli in the study of emotional recognition in autism. One early study found that children and adolescents with ASD have difficulties judging the expressivity of musical excerpts, rating mechanical excerpts the same as expressive music, while controls rate them as different (Bhatara et al. 2009). A follow up study (Quintin et al. 2011) investigated a simpler task in ASD, similar to the musical paradigm as the one used with Patient S.M. (Gosselin et al. 2007). Quintin et al. first validated musical clips for the same target emotions (happy, sad, scary, and peaceful) as the Gosselin et al. study. All of the clips had good interrater agreement, as reported in Quintin et al. (2011). The music clips ranged in duration from 30 to 50 s and were presented in randomized order for each participant. Participants rated the intended emotion by selecting one of four line drawings of emotional faces (with the name of the emotion written next to the drawing) after each excerpt. They then rated the intensity of each clip using a 32 cm continuous scale ranging from slightly intense (0) to very intense (1). In a sample of 26 children and adolescents (ages 10–19) diagnosed with ASD, Quintin et al. (2011) found that children and adolescents with ASD were not significantly different than age-matched controls at recognizing the four emotions, after controlling for IQ. The ASD group showed similar accuracy as well as intensity ratings compared to controls.

One important question arising from these studies relates to the age of the samples being studied. A seminal study by Schumann et al. (2004) suggested that ASD groups have abnormal age-related growth and connectivity of the amygdala, although there is considerable variability in specific findings across studies (see e.g. Ecker et al. 2012; Greimel et al. 2013). The common element seems to be disrupted connectivity between amygdala and other brain regions, rather than simply changes or differences in amygdala volume (von dem Hagen et al. 2013; Jou et al. 2011). It is possible that the developmental course of emotion recognition in ASD differs from typical trajectories. Thus, the first objective of our study was to expand the Quintin et al. (2011) study by including two separate age groups in order to better understand the impact of age on emotion recognition in ASD, specifically for fearful stimuli associated with amygdala activation (Adolphs et al. 2002).

Another aim of our present study was to utilize psychophysiological measures as another objective test of response to music. Previous studies of atypical amygdala function (Gosselin et al. 2007) and ASD (Bhatara et al. 2009; Quintin et al. 2011) have solely used subjective ratings of perceived intensity and did not incorporate any physiological measure of ANS response. Having both behavioral and physiological measures of intensity will help determine if perception of internal states correlate with physiological response in children and adolescents with ASD. SCR is minimally invasive and easy to administer and has been frequently used as a dependent variable in music emotion studies (Khalfa et al. 2008; Lundqvist et al. 2009; Roy et al. 2009). We therefore utilized SCR in the current experiment to better understand perceived and actual ANS response in ASD compared to controls.

Method

Participants

Approval for this study was obtained through the Brigham Young University Institutional Review Board. Parents provided written consent and participants provided written assent, in line with institutional policy. We tested a group of high-functioning individuals with ASD and a neurotypical control group (CON). All participants in the ASD group had a diagnosis based on DSM-IV-TR criteria and met research criteria for an ASD (scores > 7) according to the Modules 3 or 4 of the Autism Diagnosis Observation Schedule (ADOS; Lord et al. 2000), completed by the third author, a licensed clinical psychologist trained to research reliability on the instrument. Typically developing control participants were recruited by word-of-mouth and flyers placed in the community and their parents reported no history of psychopathology or psychotropic medication use. All participants in the CON group had parent-reported Social Responsiveness Scale scores below the cutoff for concern about autism (raw scores < 75; see Constantino et al. 2003).

The study comprised a total of 91 participants. There were two distinct age groups: a *child* group of (total $n = 50$, ASD $n = 24$) ages 8–11 ($M = 9.89$, $SD = 1.16$); and an *adolescent* group (total $n = 41$, ASD $n = 18$) ages 16–18 ($M = 16.71$, $SD = 1.02$). All participants completed the Wechsler Abbreviated Scales of Intelligence. All IQ index scores were in the average range or above (Full Scale IQ $M = 110.23$, $SD = 11.31$) and there were no statistical differences in IQ scores between ASD and CON groups. As expected, the ASD participants in both age groups had significantly higher levels of autism symptoms as measured by the SRS. The ASD groups also had higher parent-reported anxiety and sensory sensitivity including auditory sensitivity (see Table 1).

Measures

This study was conducted as part of a larger battery of research tasks. All parents completed the SRS as a dimensional measure of autism symptoms; the Spence Children's Anxiety Scale-Parent Version (SCAS-P; Nauta et al. 2004; Spence, 1998) as a measure of trait anxiety; and the Short Sensory Profile (SSP; McIntosh et al. 1999), which provides a measure of sensory sensitivity including auditory sensitivity. Participants received monetary compensation at the conclusion of the full battery.

Task

The music-evoked emotion recognition task was largely based on the design by Quintin et al. (2011). However, we departed from their methodology in several specific ways. We used the identical musical stimuli for the *happy*, *sad*, and *scary* emotions but omitted the *peaceful* selections because of apparent confusion and ambiguity regarding this more complex emotion in the previous Quintin et al. study. Because pilot testing showed that the majority of skin conductance response occurred within the first few seconds of each musical excerpt–with little added information during the rest of the original length–we also reduced the length of each musical excerpt to the first 20 s of each clip in order to target this initial psychophysiological response. Additionally, in the original Quintin et al. study, participants were able to skip the rest of each musical excerpt as soon as they knew which emotion the music was meant to convey. We chose to play each 20 s segment in their entirety in order to have a standard length with which to compare each excerpt. Lastly, we added a modified self-assessment manikin (SAM; see (Bradley and Lang 1994) created for use in this study (see "Supplemental Materials"), in order to minimize the need for verbal ratings of emotion and intensity. The SAM was shown on the computer monitor and the participant responded using mouse clicks.

In order to measure a stable initial baseline skin conductance level, participants first completed a short ($\sim$5 min.) task where they were asked to identify pictures of flowers versus other objects from consecutive pairs of pictures on the computer monitor. This task has been used in other studies (Chamberlain et al. 2013; South et al. 2014). After reading instructions for the experimental task on the monitor, participants listened to each musical segment (five for each emotion condition) presented in a randomized order. After each segment the participants were asked "How does this music make you feel?" and

instructed to mark their guess using the SAM on the monitor. S A second 5-point intensity rating SAM (specific to the chosen emotion) followed.

We collected SCR data during the baseline and music tasks using electrodes on the palmar surface of the middle and ring fingers of the left hand, centered around the top joint on each finger which were connected to the Biopac MP150 GSR-100C module (Biopac Systems, Inc., Goleta, California) at 250 Hz. Data acquisition and analysis was done using AcqKnowledge software (Biopac Systems). We accounted for drift in the SCR data by using the Difference mathematical transformation included in the AcqKnowledge software. We analyzed the SCR data from each musical stimulus using the AcqKnowledge "area under the curve" function, and square root transformed the data to normalize the distribution.

Statistical Analysis

For each of the study variables (i.e. SCR, accuracy of emotion identification, and emotion intensity) we ran a 2 (diagnostic group) × 2 (age group) × 3 (emotion condition) repeated measures ANOVA. We then used Tukey's honest significant difference (HSD) post hoc tests to analyze specific differences of significant omnibus effects. Furthermore, in light of the amygdala theory of autism, we also conducted planned comparisons of *scary* trials.

Exclusions

Two of the youngest 8-year-old control participants had outlying low scores on accuracy of their emotion identification. Both of these responded with many false positives by choosing *happy* after *scary* and *sad* trials. Because of this we assumed they either did not understand the task or did not give their full effort. These two participants were excluded from analysis of the behavioral data. One participant with ASD had an outlying high SCR response to *scary* trials and was not included in analysis of the psychophysiological data in order to meet statistical assumptions.

Results

Baseline Physiology

Inspection of the baseline physiological data indicated that skin conductance level (SCL) did not differ between the age-combined ASD and CON groups, $t(86) = .88$, $p = .38$. However, correlation analysis of age and baseline arousal levels demonstrated a significant, negative coefficient $r = -.42$, $p < .001$. We therefore conducted a 2 (age group) × 2 (diagnostic group) ANOVA that indicated a reliable effect for age group, $F(1, 90) = 22.45$, $p < .001$, $\eta^2 = .19$. Follow-up analyses show that the *child* group had significantly higher SCL than the *adolescent* group for both diagnostic categories (ASD $t(37) = 2.35$, $p < .05$; CON $t(47) = .4.43$, $p < .001$ groups). There were no significant differences for diagnostic group, $F(1, 90) = 1.26$, $p = .26$, $\eta^2 = .01$ or a diagnostic group × age group interaction, $F(1, 90) = 0.73$, $p = .40$, $\eta^2 = .00$.

Skin Conductance Response

The 2 × 2 × 3 repeated measures ANOVA for skin conductance response (SCR) to task stimuli revealed significant main effects for diagnosis $F(1, 82) = 6.53$, $p = .01$, $\eta^2 = .05$; age, $F(1, 82) = 14.22$, $p < .001$, $\eta^2 = .11$, and emotion condition $F(2, 164) = 3.45$, $p = .03$, $\eta^2 = .01$. Tukey's HSD post hoc tests revealed that the ASD group showed reduced response compared to the CON group (see Fig. 1). Tukey's HSD also indicated that the *child* groups showed increased SCR compared to the *adolescent* groups (Fig. 2a). A comparison across emotion condition indicated that participants showed increased response to *scary* excerpts compared to *happy*. There were no significant interactions between any of the three factors.

Accuracy of Emotion Identification

A 2 × 2 × 3 analysis of accuracy revealed a main effect for emotion condition $F(2, 170) = 26.47$, $p < .001$, $\eta^2 = .15$. Tukey's HSD revealed significant differences in accuracy across emotion conditions (*happy* > *scary* > *sad*).

There was a significant age × diagnosis × emotion condition interaction, $F(2, 170) = 5.28$, $p = .006$, $\eta^2 = .03$. In order to better understand this effect, we conducted post hoc comparisons by analyzing the age groups separately using 2 (diagnostic group) × 3 (emotion condition) repeated measures ANOVAs. Neither age group showed a main effect for diagnosis.

There was significant interaction of emotion condition × diagnosis within the *child* group $F(2, 92) = 4.48$, $p = .01$, $\eta^2 = .05$ driven by a between-groups difference specifically to *scary* stimuli, which was identified in the ASD group more accurately than *sad* music while the opposite pattern was observed for the CON group (see Fig. 3a). For the *adolescent* group, the overall interaction for all emotion conditions was not significant $F(2, 78) = 1.41$, $p = .25$, $\eta^2 = .02$; however visual inspection of the analysis plots showed that groups again differed specifically for *scary* stimuli but in the opposite direction: the CON group identified *scary* stimuli significantly more accurately than *sad* stimuli while the ASD group was (non-significantly) more accurate for *sad* than *scary* (see Fig. 3b).

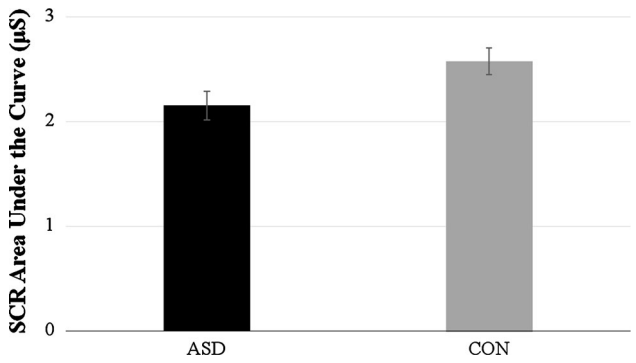

Fig. 1 Skin conductance response averaged across emotion conditions and age group for both ASD and controls. *Error bars* represent ± one standard error of the mean

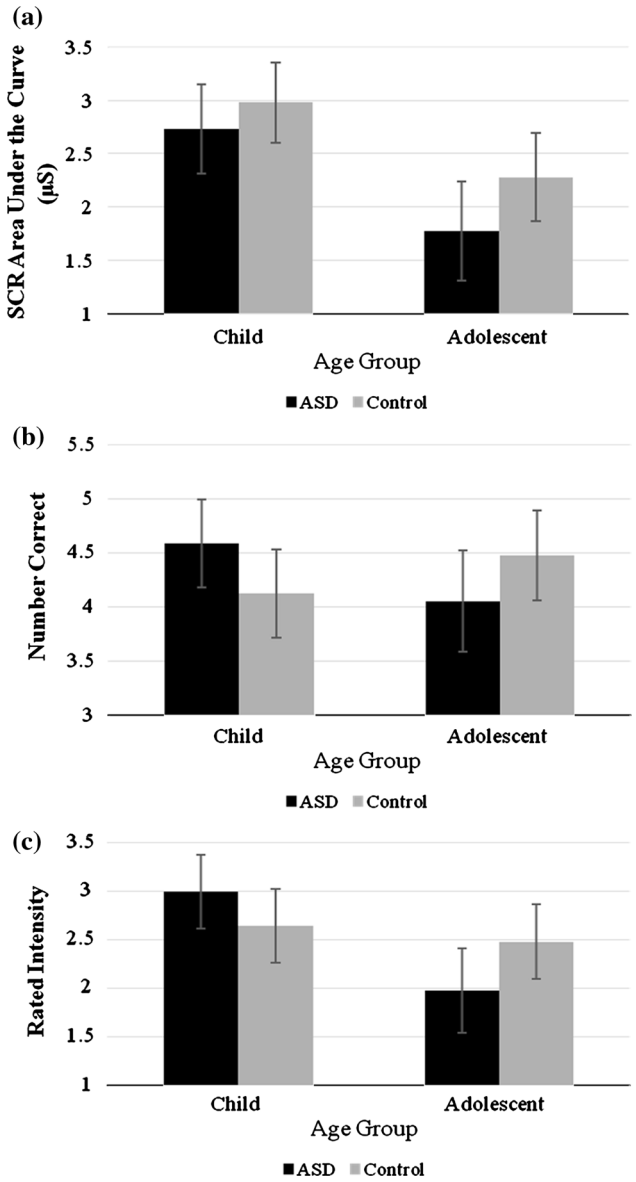

Fig. 2 ANOVA analyses for *scary* music across age group for **a** mean SCR, **b** mean identification accuracy, and **c** mean intensity rating. *Error bars* represent ± one standard error of the mean

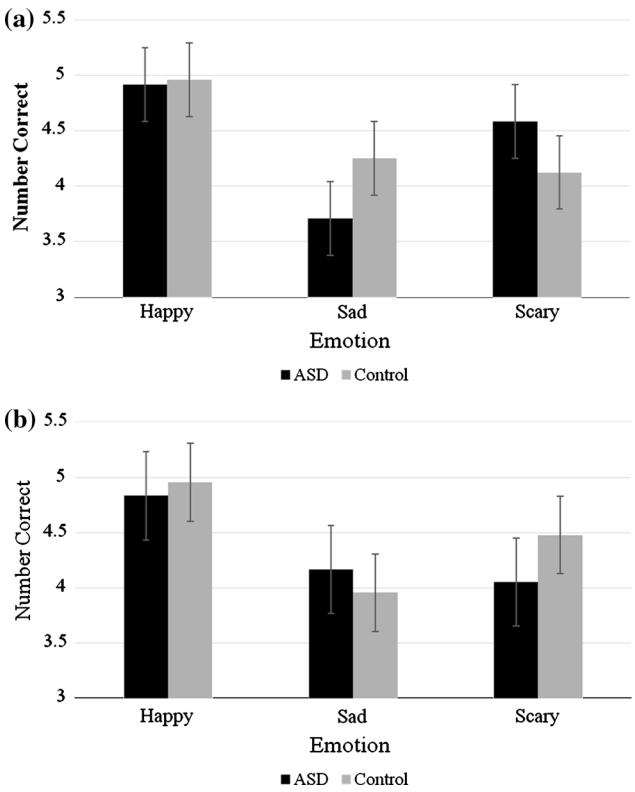

Fig. 3 Accuracy of music-evoked emotion recognition for the **a** child group and **b** adolescent group. *Error bars* represent ± one standard error of the mean

To better understand the age-related differences in ASD compared with typically developing controls and following our planned comparison to test the amygdala theory of autism, we conducted a 2 (diagnostic group) × 2 (age group) ANOVA for the *scary* music response. The significant interaction effect is depicted in Fig. 2b, $F(1,85) = 4.25$, $p = .04$, $\eta^2 = .048$. For the participants with ASD, the *child* group recognized *scary* music more accurately than the *adolescent* group while the opposite pattern was observed for the CON participants, i.e. the *adolescent* group recognized *scary* music more accurately than the *child* group.

Emotion Intensity

Following the pattern of the accuracy results, emotion intensity results indicated a main effect for emotion condition, $F(2, 169) = 29.38$, $p < .001$, $\eta^2 = .10$. Interestingly, using the SAM rating scale, both ASD and CON groups described the *sad* music stimuli as significantly more intense than either *happy* or *scary* items. In the case of emotion intensity, the age × diagnosis × emotion condition interaction was only marginally significant, $F(2, 169) = 2.41$, $p = .09$, $\eta^2 = .01$. However, we again

looked specifically at the *scary* stimuli and found the same pattern of result, namely a significant age × diagnosis interaction, $F(1, 85) = 4.59$, $p = .04$, $\eta^2 = .05$. Again, this was driven by the participants with ASD, i.e. the *child* ASD group rated *scary* music as more intense than the ASD *adolescent* group (Fig. 2c).

Discussion

This study has two main findings: (1) overall, our ASD samples demonstrated reduced skin conductance response to music-evoked emotions; and (2) behavioral responses to *scary* music showed a pattern of change across the younger children as well as older adolescents with ASD that were opposite to the change seen in controls. Young children with ASD tended to be *more* accurate than their older ASD peers in identifying the *scary* music whereas the young children in the CON group tended to be *less* accurate at identifying the *scary* music than their older peers. Our findings extend those of Quintin et al. (2011) by showing age-related effects for recognition, intensity rating, and physiological response to *scary* music. This effect was most prominent with *scary* music for participants with ASD; the younger group had increased response and subjective intensity rating with an associated increased accuracy compared to the adolescent group.

In non-autism samples, increased anxiety is most often associated with increased autonomic response (Lang et al. 1998; Shin and Liberzon 2009). In our older adolescent ASD group, however, physiological response appeared to be decreased despite elevated self- and parent-reports of anxiety symptoms. On the whole it appears that the relationship between physiological response and behavioral manifestations of anxiety is less straightforward in ASD and may depend much more than usual on context, such as degree of uncertainty (Chamberlain et al. 2013), available social cues (Riby et al. 2014), or the specific physiological measure (Kushki et al. 2013).

Face processing research has shown decreased accuracy for emotion recognition in ASD. We wondered whether emotion recognition for non-face stimuli, e.g. music stimuli, would likewise be impaired. Because findings differed across the two age groups, we frame the rest of our discussion in terms of possible age-related mechanisms. In typical development there are age-related increases in the integration of physiological and cognitive emotional cues in association with increased white matter connectivity (see Monk et al. 2009). In this study baseline skin conductance arousal was significantly higher for children compared with adolescents, indicating that reliance on physiological cues for emotion recognition in music potentially decreases with age. In our ASD group, however, the subjective intensity ratings and accuracy ratings of *scary* music and accuracy rating are also decreased in the older age group. These behavioral measures suggest that adolescents with ASD are not able to compensate as well as their typically developing peers without the physiological cues; it may be that awareness and sensitivity to physiological responsiveness decrease as individuals with ASD develop.

Schumann et al. (2004) suggested that hyperactivity in amygdala and related structures during early development may lead to decreased function later in life. The increased accuracy for identifying *scary* music stimuli in our younger ASD group may reflect a general bias towards threat interpretation in childhood associated with amygdala overgrowth. However, a later plateau in the development of the amygdala and associated connections may leave some individuals with ASD with reduced emotion capacity in adolescence (White et al. 2014).

There are a number of limitations to this study. Although our sample sizes are larger than many previous studies, they are still modest and larger samples are needed to establish the reliability of our procedure especially for the age-related differences. While we explicitly chose a younger and an older group to exclude the midpoint of the Schumann et al. (2004) findings on amygdala development, inclusion of a continuous age span would allow for a smoother examination of age and emotion response. Prospective longitudinal research would help to clarify age-related changes in emotion recognition in ASD. Our SAM rating system was made specifically for this study. Our intent was to use a nonverbal rating of emotion and intensity. However, by doing so we may have introduced another confound since past studies have shown abnormal face processing in ASD (Ewing et al. 2013; Greimel et al. 2014; Nickl-Jockschat et al. 2014). We only recruited high-functioning individuals with ASD. Because of the broad range of symptoms and severity in ASD, we are not able to extend our finding across all individuals along the autism spectrum. Functional imaging studies may help us better understand the potential underlying neural correlates of emotion processing of music. Based on our observations of decreased physiological response during music listening, future studies could investigate potential psychophysiological differences of active (i.e. participants are asked to identify target emotions) versus passive (i.e. participants listen to music without any direction) music listening. Future studies may also investigate auditory sensitivity as a possible causal factor leading to the group differences and interactions observed in our study.

Conclusion

Understanding the mechanisms that underlie significant symptoms of anxiety and other emotion regulation difficulties in ASD may lead to improved understanding of the neurobiology of autism and to improved specificity of interventions. However, findings regarding the relationship of cognition, physiology, and behavior continue to be mixed. White et al. (2014) note the importance of various kinds of context, reviewing a number of studies that show increases or decreases in psychophysiological response depending on the situation and/or the measurement method. The present study shows that age is an important context to consider when trying to elucidate the balance of physiological response and cognitive awareness of emotional cues in ASD. Music can be an effective non-social emotional stimulus and future studies of emotion in autism may benefit from manipulations involving musical cues.

Acknowledgments We thank our study participants and their families for their willingness to participate in this research. Special thanks to Porter Charles for design of the self-assessment manikins. This research was supported by a College of Family, Home and Social Sciences Research Award from Brigham Young University.

Author Contributions KGS conceived of the study, participated in the design and coordination (including data acquisition), performed the statistical analyses, and drafted the manuscript. EMQ helped with study conception and design, data interpretation, and drafting of manuscript. MS also helped with study conception and design, data interpretation, and drafting of manuscript.

Appendix

See Table 1.

Table 1 Participant characteristics

Measure	M		SD		Range		*t*
	ASD	CON	ASD	CON	ASD	CON	
Child group (ASD n = 24; CON n = 26)							
Age (years)	10.03	9.76	1.22	1.11	8–12	8–11	0.83
FSIQ	110.5	111.85	12.58	11.50	94–136	86–132	0.39
VIQ	104.68	108.73	12.68	13.16	81–133	85–133	1.08
PIQ	114	112.88	15.02	12.06	93–143	89–135	0.29
SRS total	112.38	26.25	20.91	14.22	80–145	4–50	16.69***
ADOS total	13.12	–	4.39	–	7–21	–	–
SCAS-P total	30.20	13.80	18.21	11.30	2–76	2–37	3.42***
SCAS-C total	27.95	29.12	12.85	14.19	0–52	10–68	0.28
IUS-P	39	23.65	9.87	10.13	19–58	12–45	4.79***
SSP-A	22.25	11.26	3.39	4.10	16–29	6–22	7.95***
Adolescent group (ASD n = 18; CON n = 23)							
Age (years)	16.58	16.81	0.91	1.10	15–18	14–18	0.72
FSIQ	108.12	109.68	12.22	9.36	85–124	92–124	0.45
VIQ	108.28	110.09	13.71	10.12	86–126	93–126	0.48
PIQ	107.06	107.14	11.22	10.31	88–120	86–125	0.02
SRS total	102.18	24.37	21.42	16.97	68–136	2–68	12.15***
ADOS total	13.17	–	4.22	–	7–20	–	–
SCAS-P total	22.40	10.38	12.14	8.79	3–45	3–39	3.17**
SCAS-C total	23.29	19.50	8.16	8.07	2–36	6–40	1.42
IUS-P	37.36	22.18	10.50	7.91	19–56	12–40	4.59***
SSP-A	98.70	12.73	29.87	7.70	65–159	6–29	2.75**

ASD Autism Spectrum Disorder, *CON* typical control. IQ from the Wechsler Abbreviated Scales of Intelligence (*FSIQ* Full Scale IQ, *VIQ* Verbal IQ, *PIQ* Performance IQ). *SRS* Social Responsiveness Scale. *ADOS* Autism Diagnostic Observation Schedule (Module 3 or 4), *SCAS* Spence Children's Anxiety Scales (*P* Parent report, *C* Child report), *IUS* Intolerance of Uncertainty Scale (*P* Parent report, *C* Child report), *SSP* Short Sensory Profile (*A* Auditory)

** $p < .01$, *** $p < .001$

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