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Emotion regulation in autism spectrum disorder: evidence from parent interviews and children's daily diaries

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Background: Although emotion dysregulation is not a defining feature of Autism Spectrum Disorder (ASD), there is a growing consensus that emotional problems play a prominent role in this disorder. **Methods:** The present study examined a wide range of emotion regulation (ER) strategies in 32 individuals with ASD compared to 31 group-matched typically developing (TD) participants in three emotional domains (anger, anxiety, and amusement). Parents of individuals with ASD and TD individuals were interviewed about their child's emotional experience and the use and efficacy of 10 ER strategies. In addition, participants filled out daily diaries on experience and regulation in the same emotional domains. **Results:** Compared to TD individuals, parents reported that individuals with ASD experienced more anger and anxiety and less amusement, made less frequent use of a variety of adaptive ER strategies (e.g. problem solving, cognitive reappraisal), and made more frequent use of maladaptive strategies (e.g. repetitive behavior). Moreover, individuals with ASD were less effective at utilizing adaptive ER strategies. Self-reports showed differences in experience of amusement and in ER strategies for anger and anxiety, but not in experience of anger and anxiety. **Conclusions:** This study provides evidence that individuals with ASD less frequently use adaptive – but more frequently use maladaptive – ER strategies. Implications for ASD treatments that focus on increasing the use of adaptive strategies are discussed. **Keywords:** Autism Spectrum Disorder, core features, emotion regulation, restricted and repetitive behaviors, social/communication deficits.

Introduction

Individuals with Autism Spectrum Disorder (ASD) manifest social and communication deficits as well as restricted and repetitive behaviors (American Psychiatric Association, 2013). Recent advances in the field of affective science show that these individuals also suffer from serious emotional disturbances, and have difficulties regulating their emotions (Laurent & Rubin, 2004; Mazefsky, Borue, Day, & Minshew, 2014; Mazefsky et al., 2013; Samson, Hardan, Podell, Phillips, & Gross, 2015; Samson, Huber, & Gross, 2012; Samson, Phillips, et al., 2014). What is not yet clear, however, is which emotion regulation (ER) strategies are compromised in individuals with ASD.

Emotion experience in autism spectrum disorder

Although emotional disturbance is not a core feature of ASD, there is increasing evidence that individuals with ASD experience more negative and less positive emotion compared to typically developing (TD) controls (e.g. Ben Shalom et al., 2006; CappsCapps, Kasari, Yirmiya, & Sigman, 1993; Kasari & Sigman, 1997; Samson et al., 2012). Greater levels of emotional disturbances (including elevated levels of anxiety and anger such as irritability, meltdowns, tantrums and aggression) are quite common in ASD (Dominick, Ornstein Davis, Lainhart, Tager-Flusberg, & Folstein, 2006; Gotham et al., 2013; Mazefsky et al., 2013; Quek, Sofronoff, Sheffield, White, & Kelly, 2012; Vasa et al., 2013; White, Oswald, Ollendick, & Scahill, 2009) and pose a significant risk factor for the development of mental health problems (Ghaziuddin, 2002). Although research on positive emotions has been relatively sparse, the few studies that have been conducted suggest that individuals with ASD experience less amusement in response to humorous material when compared to TD participants (see Samson, 2013, for a review).

Emotion regulation in autism spectrum disorder

Recent studies on individuals with ASD suggest that an impaired ability to regulate emotions might play a key role in emotional disturbances (Mazefsky et al., 2013; Samson et al., 2012). Individuals with ASD less frequently use adaptive ER strategies (goal-directed behaviors, seeking social support, cognitive reappraisal; Jahromi, Meek, & Ober-Reynolds, 2012; Rieffe et al., 2011; Samson et al., 2012), but more frequently use maladaptive or idiosyncratic strategies (avoidance, venting, expressive suppression; Jahromi et al., 2012; Konstantareas & Stewart, 2006; Samson et al., 2012; Mazefsky et al., 2014). Self-reported difficulties in the use of cognitive reappraisal (which involves reinterpreting the meaning of a stimulus to

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change the trajectory of an emotional response) and increased use of expressive suppression (defined as the conscious goal-directed effort to inhibit ongoing emotion-expressive behavior), are evident even when controlling for emotion experience and alexithymia (Samson et al., 2012). The less frequent use of reappraisal and more frequent use of suppression have recently been replicated in an experimental study with children and adolescents with ASD (Samson, Hardan, et al., 2014).

Although these studies provide initial evidence for emotion dysregulation in individuals with ASD, no study so far has used parent- and self-report simultaneously to broadly examine a wide set of adaptive and maladaptive ER strategies with the goal of better understanding the ER profile of individuals with ASD. Furthermore, no study so far has included regulation of positive emotions, although maintaining, increasing, and at times even decreasing positive emotions is important and associated with adaptive outcomes, particularly in social contexts (e.g. Tugade & Fredrickson, 2007). In addition, no study thus far has examined repetitive behaviors as an attempt to regulate emotions in individuals with ASD. Interestingly, about one quarter of restricted and repetitive behaviors in children with ASD seem to be a response to emotional triggers (Militerni, Bravaccio, Falco, Fico, & Palermo, 2002). Given the potentially soothing function of such behaviors (Hutt & Hutt, 1965; Barber, 2008; see also Leekham, Prior, & Uljarevic, 2011), we suggest that some forms of repetitive behaviors might represent an attempt by individuals with ASD to regulate emotions, which we suggest may be effective in a given situation but maladaptive in the long term.

The current study

The goal of this study was to examine the use and efficacy of a wide range of adaptive and maladaptive ER strategies in individuals with ASD compared to TD participants by combining parent interviews and child daily diaries. ER was examined in three different emotions: anger, anxiety, and amusement. These were selected because they represent both positive and negative emotions and because previous literature has documented pronounced difficulties related to anger and anxiety (Mazefsky et al., 2013; Quek et al., 2012) and humor processing in individuals with ASD (Samson, 2013). While regulating positive emotions may seem less vital than regulating negative emotions, it may be crucial for improving the functioning and well-being of individuals with ASD by enabling them to regulate not only negative but also positive emotions (e.g. expressing positive emotions in socially appropriate ways).

We focused on children and adolescents because their emotional skills are still developing and malleable, making this age group a particularly important target for interventions to improve emotional functioning (Riediger & Klipker, 2014). For the parent reports, we used an adapted version of a comprehensive and validated interview to understand the typical use and efficacy of different ER strategies (see Werner, Goldin, Ball, Heimberg, & Gross, 2011). Parent reports are important given high levels of alexithymia in this population (Fitzgerald & Bellgrove, 2006). For children's reports, we used daily diaries to examine self-reported experience and ER in the same three emotions and ER strategies over a time period of up to 10 days.

In each of the three emotional domains, we expected individuals with ASD to have a different ER profile compared to TD participants. Specifically, in comparison to controls, we expected individuals with ASD to less frequently use adaptive ER strategies such as problem solving, social support, cognitive reappraisal, cognitive distraction, acceptance, exercise, and relaxation, and to more frequently use maladaptive ER strategies such as avoidance, expressive suppression, and repetitive behaviors. Moreover, we expected individuals with ASD to be less effective in using ER strategies in general, compared to TD participants.

Methods

Participants

Thirty-two individuals with ASD (Three female) and 31 TD individuals (Eight female) between the ages of 8 and 20 years participated in the study (see Table 1). The sample consisted of 62.5% Caucasians, 12.5% Asians, 3.1% Hispanics, 1.6% Afro-Americans, and 20.3% other ethnicities. Participants with ASD were recruited from a clinic specializing in ASD and developmental disabilities as well as from a research registry. TD participants were recruited through flyers advertising an ER study in areas that were comparable to the socioeconomic status of the participants with ASD. Participants were enrolled as part of a larger project. For the present report, parent data were available for 31 individuals with ASD, and 29 TD participants. Diary data were available for 27 individuals with ASD, and 20 TD participants.

The two groups did not differ in age or gender. Individuals with ASD scored significantly lower on Full Scale IQ (FSIQ), showed significantly more restricted and repetitive behaviors (assessed with the RBS-R; Lam & Aman, 2007), social and communication deficits (assessed with the SRS, Constantino & Gruber, 2005; Constantino, Przybeck, Friesen, & Todd, 2000), and externalizing and internalizing behavior (assessed with the CBCL; Achenbach, 1991) compared to TD participants. Individuals with ASD also had more affective problems and anxiety problems, as assessed with the CBCL, suggesting significant emotional difficulties in our ASD group.

Table 1 Sample characteristics

	ASD M (*SD*, range) N or frequency	TD M (*SD*, range) N or frequency	Statistics
N	32	31	
Male/female	29/3	23/8	*ns.*[a]
Age	12.66 (3.32, 8–20)	12.58 (2.86, 8–20)	$t(61) = .10$, *ns.*
FSIQ	104.31 (16.13, 64–129)	113.71 (10.81, 92–133)	$t(61) = -2.71$, $p < .01$
RBS-R	20.03 (14.24, 0–57)	1.60 (2.47, 0–8)	$t(52) = 6.38$, $p < .001$
SRS	94.12 (27.59. 40–149)	20.77 (15.89, 0–59)	$t(48) = 11.63$, $p < .001$
CBCL			
Internalizing behavior	63.81 (8.09, 48–77)	46.04 (10.17, 33–68)	$t(56) = 7.41$, $p < .001$
Externalizing behavior	56.06 (11.96, 33–77)	44.26 (9.16, 33–65)	$t(56) = 4.17$, $p < .001$
Affective problems	66.03 (9.03, 50–82)	52.07 (3.62, 50–63)	$t(56) = 7.51$, $p < .001$
Anxiety problems	64.55 (8.45, 50–79)	51.96 (12.22, 50–73)	$t(56) = 4.61$, $p < .001$

Note: ASD, Autism Spectrum Disorder; TD, Typically Developing participants, FSIQ, Full Scale IQ; RBS-R, Repetitive Behavior Scale-Revised (total score); SRS, Social Responsiveness Scale (total score); CBCL, Child Behavior Checklist.
[a]On the basis of a Fisher's exact test, two-tailed.

Clinical assessment

ASD diagnoses were established through expert clinical evaluation (J.M.P. and A.Y.H.) based on the DSM-IV-TR (American Psychiatric Association, 2000) and confirmed with the Autism Diagnostic Interview-Revised (ADI-R) and Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000; Lord, Rutter, & Le Couteur, 1994). Individuals with secondary autism related to a specific etiology (e.g. tuberous sclerosis, Fragile X) or evidence of genetic, metabolic, or infectious disorders were excluded.

TD participants were screened using face-to-face evaluations (Kiddie-Schedule for Affective Disorders and Schizophrenia for School-Aged Children, Kaufman et al., 1997), telephone interviews, and observation during psychometric tests. Exclusion of TD participants was also performed based on medical and psychiatric history.

Cognitive functioning (FSIQ) was assessed using the Stanford Binet (5th edition, SB5, Roid, 2003). ASD core features were assessed with the Social Responsiveness Scale (SRS, Constantino & Gruber, 2005; Constantino et al., 2000) and the Repetitive Behavior Scale-Revised (RBS-R, Lam & Aman, 2007). Externalizing and internalizing behavior was assessed with the Child Behavior Checklist (Achenbach, 1991). SRS was available for 24 individuals with ASD and 26 TD participants, RBS was available for 29 individuals with ASD and 25 TD participants, CBCL was available for 31 individuals with ASD and 27 TD participants.

This study was approved by the University's Institutional Review Board. Written informed consent was obtained from parents and assent from all participants.

Parent interview

The parent interview was adapted from the Emotion Regulation Interview (Werner et al., 2011) which is a theoretically derived structured clinical interview based on Gross's (1998) process model of ER that assesses the use and self-efficacy of five ER strategies in different situations that elicit social anxiety. The parent interview has shown good reliability and convergent validity. We expanded the interview to include more emotional domains and to assess the typical use of a wider range of ER strategies potentially used by children and adolescents with ASD: avoidance, problem solving, seeking social support and sharing emotions, distraction, cognitive reappraisal, acceptance, expressive suppression, exercise, relaxation, and repetitive behaviors such as tapping, hand flapping, body rocking. In case the parent did not know a strategy, further explanations and examples were given (e.g. for repetitive behavior: hand flapping, body rocking, nail biting, etc. with the attempt to regulate emotions).

Emotional experience and the use and efficacy of all ER strategies were examined in three emotions (anger, anxiety, and amusement). For each emotion, parents rated (a) how often on a scale of 1 (never) to 5 (very often) their child used each ER strategy, and (b) how effective on a scale of 1 (completely ineffective) to 5 (completely effective) their child was at using that strategy. If a parent indicated that their child never used a particular regulation strategy, efficacy was not assessed, resulting in smaller sample sizes for efficacy. If parents indicated that they did not know about the use and efficacy of a specific ER strategy, the response was coded as missing data. The parent interview also examined emotional awareness and experience. Parents were presented with a list of emotions and asked to rate each emotion in terms of: (a) whether their child had an awareness of each emotion (yes or no), and (b) how often on a scale of 1 (never) to 5 (very often)[1] their child experienced the emotion.

Daily diaries

Participants received instructions for the daily diaries via email including a web link. They were asked

to fill out the daily diaries in the evening for up to 10 days. The diary asked the degree to which they had experienced anger, anxiety, and amusement during that day, and the degree to which they had used the same ER strategies assessed in the parent interview. Each question was asked on a scale of 1 (not at all) to 5 (very much/strong). The daily diaries were only included in the analysis if they were provided within 20 days. If participants provided multiple entries per day, none of these were included. Individuals with ASD filled out the daily diaries 5.48 times on average (SD = 3.67, ranging from 1 to 12 times), which did not differ from TD participants (M = 5.20, SD = 3.75, ranging from 1 to 12 times).

Statistical analyses

Daily diaries were averaged over all entries per participant for three reasons: (a) to be able to conduct the same analyses for diary and parent ratings, (b) to enhance reliability, and (c) noncompliance to follow the 10-day window resulting in variability in rating intervals which did not allow for conducting multilevel analyses. Because of the broad age range of the participants in the study and the significant group differences in FSIQ, we computed all analyses on emotional experience and the ER strategy use (parent- and self-report) and efficacy (parent report only) with age and FSIQ as covariates.[2] Secondary analyses were conducted to control for emotion experience to assess whether group differences in ER were solely explainable by differences in emotion experience. Therefore, group differences were analyzed using ANCOVAs with age and FSIQ, and, in secondary analyses, with emotion experience as covariates. ER profiles of the use of different ER strategies were examined by repeated measurements two (group) × 10 (strategy) ANCOVAs with age and FSIQ as covariates. Only ANCOVAs instead of profile analyses were computed for ER efficacy due to too few participants who had used all of the ER strategies. Group comparisons for efficacy were computed only for strategies used by at least 10 participants in each group. Therefore, efficacy of exercise, relaxation, and repetitive behavior was not considered in any of the three emotions.

Results

Parent interview

Emotion experience. Controlling for age and FSIQ, individuals with ASD experienced more anger (M = 3.10, SD = 1.32), more anxiety (M = 3.37, SD = 1.22), and less amusement (M = 3.34, SD = 1.16) compared to TD controls (anger: M = 2.36, SD = .81, $F(3,60) = 5.38$, $p < .01$; anxiety: M = 2.36, SD = .99, $F(3,60) = 4.20$, $p < .01$; amusement: M = 4.14, SD = .96, $F(3,59) = 3.50$, $p < .05$).

Emotion regulation frequency. In the domain of anger, the ER profiles of individuals with ASD and TD individuals differed significantly ($F(9, 459) = 6.95$, $p < .001$; Figure 1) as revealed by the interaction of the repeated measurements 2 (group) × 10 (strategy) ANCOVAs with age and FSIQ as covariates. ANCOVAs with age and FSIQ as covariates revealed that individuals with ASD less frequently used problem solving ($F(3, 57) = 2.93$, $p < .05$), reappraisal ($F(3, 56) = 13.27$, $p < .001$), distraction ($F(3, 55) = 5.57$, $p < .01$), and acceptance ($F(3, 57) = 9.31$, $p < .001$), but more frequently used repetitive behaviors $F(3, 56) = 2.87$, $p < .05$) compared to TD participants. When including emotion experience as an additional covariate, the two groups differed significantly on the same ER strategies (problem solving: $F(4, 57) = 3.49$, $p = .01$; reappraisal: $F(4, 56) = 10.45$, $p < .001$; distraction: $F(4, 55) = 4.50$, $p < .01$; acceptance: $F(4, 57) = 9.46$, $p < .001$, and repetitive behaviors: $F(4, 56) = 2.29$, $p = .07$, trending effect).

In the domain of anxiety, the ER profiles of individuals with ASD and TD participants differed significantly ($F(9, 459) = 8.26$, $p < .05$; Figure 1). ANCOVAs with age and FSIQ as covariates revealed that individuals with ASD less frequently used problem solving ($F(3, 56) = 10.07$, $p < .001$), reappraisal ($F(3, 55) = 4.65$, $p < .01$), acceptance ($F(3, 56) = 5.92$, $p < .001$), and suppression ($F(3, 56) = 4.43$, $p < .01$), but more frequently used repetitive behaviors ($F(3, 56) = 4.21$, $p < .01$) compared to controls. When including emotional experience as additional covariate, the two groups differed significantly on the same ER strategies (problem solving: $F(4, 56) = 7.69$, $p < .001$; reappraisal: $F(4, 55) = 3.47$, $p < .05$; acceptance: $F(4, 56) = 4.60$, $p < .01$; suppression: $F(4, 56) = 3.47$, $p = .01$; repetitive behaviors ($F(3, 62) = 5.42$, $p < .01$), and, in addition, social support ($F(4, 56) = 3.12$, $p < .05$).

Finally, in the domain of amusement, the ER profiles of individuals with ASD and TD individuals differed significantly ($F(9, 441) = 3.95$, $p < .001$). ANCOVAs with age and FSIQ as covariates revealed that participants with ASD less frequently used problem solving ($F(3, 56) = 3.63$, $p < .05$) and acceptance ($F(3, 57) = 4.88$, $p < .01$), but more frequently used repetitive behaviors ($F(3, 56) = 3.38$, $p < .05$) compared to controls. When including emotion experience as additional covariate, the effects were still evident (problem solving: $F(4, 56) = 2.71$, $p < .05$; acceptance: $F(4, 57) = 4.50$, $p < .01$; repetitive behaviors: $F(4, 56) = 2.51$, $p = .05$).

Emotion regulation efficacy. For anger regulation, individuals with ASD were less effective at utilizing the following ER strategies compared to TD participants when controlling for age and FSIQ:

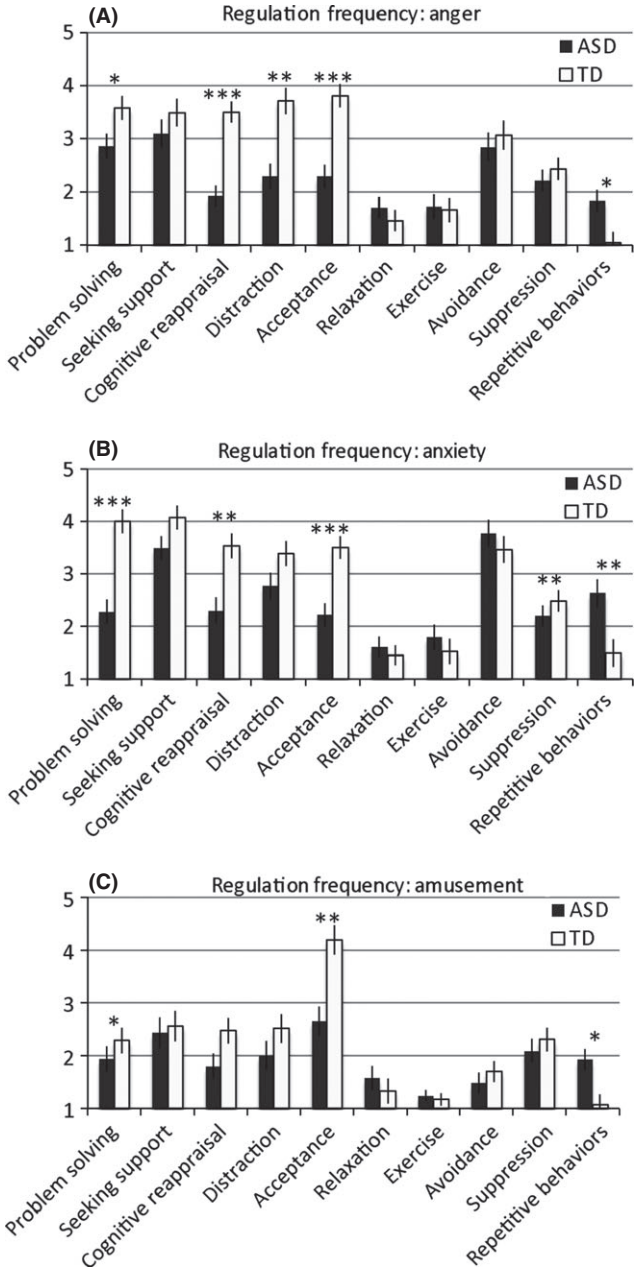

Figure 1 Estimated means for regulation frequency from parent interviews, controlling for age and FSIQ in (A) anger, (B) anxiety, and (C) amusement in individuals with Autism Spectrum Disorder (ASD) and typically developing (TD) participants. Note: *$p < .05$, **$p < .01$, ***$p < .001$

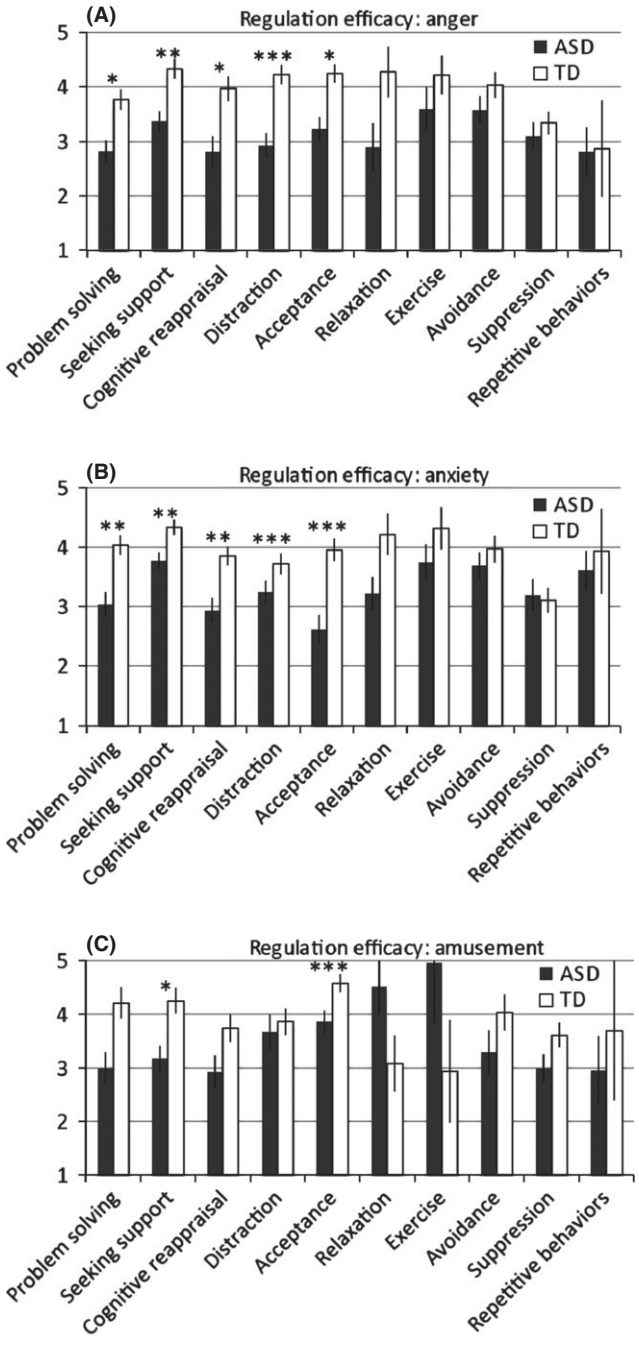

Figure 2 Estimated means for regulation efficacy from parent interviews, controlling for age and FSIQ in (A) anger, (B) anxiety, and (C) amusement in individuals with Autism Spectrum Disorder (ASD, N ranging from 4 to 25) and typically developing (TD, N ranging from 2 to 29) participants. Note: *$p < .05$, **$p < .01$, ***$p < .001$. No statistical analyses were performed for relaxation, exercise and repetitive behaviors due to the low Ns for these cells

problem solving ($F(3, 51) = 3.98$, $p < .05$), social support ($F(3, 50) = 4.49$, $p < .01$), reappraisal ($F(3, 43) = 3.37$, $p < .05$), distraction ($F(3, 44) = 6.36$, $p < .001$), and acceptance ($F(3, 44) = 4.57$, $p < .01$, see Figure 2). When including emotion experience as an additional covariate, group differences were still evident: problem solving ($F(4, 51) = 2.99$, $p < .05$), social support ($F(4, 50) = 3.33$, $p < .05$), reappraisal ($F(4, 43) = 3.12$, $p < .05$), distraction ($F(4, 44) = 4.65$, $p < .01$), and acceptance ($F(4, 44) = 3.55$, $p = .01$).

For anxiety regulation, individuals with ASD were less effective at utilizing the following ER strategies compared to TD participants when controlling for age and FSIQ: problem solving ($F(3, 46) = 5.17$, $p < .01$), social support ($F(3, 51) = 5.72$, $p < .01$), reappraisal ($F(3, 42) = 5.38$, $p < .01$), distraction ($F(3, 49) = 8.74$, $p < .001$), and acceptance ($F(3, 45) = 7.08$, $p < .001$). Also when including emotion experience as an additional covariate, the findings remained consistent (problem solving: $F(4, 46) = 4.14$, $p < .01$; social support: $F(4,$

51) = 4.23, $p < .01$; reappraisal: $F(4, 42) = 3.96$, $p < .01$; distraction: $F(4, 49) = 6.77$, $p < .001$; and acceptance: $F(4, 45) = 5.49$, $p < .001$).

Finally, individuals with ASD were less effective at regulating amusement using problem solving ($F(3, 34) = 2.87$, $p = .06$, trending effect), social support ($F(3, 34) = 4.16$, $p < .05$), and acceptance ($F(3, 43) = 6.48$, $p < .001$) when controlling for age and FSIQ. When including emotion experience as additional covariate, the findings remained consistent, although the significance of problem solving dropped (problem solving: $F(4, 34) = 2.34$, $p = .08$; social support: $F(4, 34) = 3.89$, $p = .01$; acceptance: $F(4, 43) = 5.85$, $p < .001$).

Children daily diaries

Emotion experience. Controlling for age and FSIQ, individuals with ASD reported similar levels of anger ($M = 2.02$, $SD = 1.04$) and anxiety ($M = 2.09$, $SD = 1.01$), but less amusement ($M = 2.77$, $SD = 1.02$) compared to controls (anger: $M = 2.30$, $SD = .94$, $F(3,46) = .32$, *ns.*; anxiety: $M = 2.32$, $SD = .80$, $F(3,46) = 2.54$, *ns.*; amusement: $M = 3.54$, $SD = .75$, $F(3,46) = 2.80$, $p = .05$).

Emotion regulation frequency. In the domain of anger, the ER profiles of individuals with ASD and TD individuals differed significantly when controlling for age and FSIQ ($F(9, 387) = 2.49$, $p < .01$, Figure 3). ANCOVAs with age and FSIQ as covariates revealed that individuals with ASD less frequently used problem solving ($F(3, 46) = 3.13$, $p < .05$), reappraisal ($F(3, 46) = 3.33$, $p < .05$), distraction ($F(3, 46) = 3.25$, $p < .05$), acceptance ($F(3, 46) = 5.64$, $p < .01$), relaxation ($F(3, 46) = 2.89$, $p < .05$), and avoidance ($F(3, 46) = 5.03$, $p < .01$) compared to controls. When including emotion experience as an additional covariate, the groups differed significantly on the same ER strategies (problem solving: $F(4, 46) = 3.67$, $p = .01$; reappraisal: $F(4, 46) = 2.98$, $p < .05$; distraction: $F(4, 46) = 2.93$, $p < .05$; acceptance $F(4, 46) = 5.00$, $p < .01$; and relaxation $F(4, 46) = 2.53$, $p = .06$, trending effect; avoidance: $F(4, 46) = 4.40$, $p < .01$). In addition, individuals with ASD less frequently used social support ($F(4, 46) = 2.58$, $p = .05$), suppression ($F(4, 46) = 2.48$, $p = .06$, trending effect), but more frequently used repetitive behaviors ($F(4, 46) = 3.69$, $p < .05$).

In the domain of anxiety, the ER profiles of individuals with ASD and TD individuals differed significantly ($F(9, 387) = 3.48$, $p < .001$) when controlling for age and FSIQ. ANCOVAs with age and FSIQ as covariates revealed that participants with ASD less frequently used problem solving ($F(3, 46) = 5.47$, $p < .01$), reappraisal ($F(3, 46) = 5.35$, $p < .01$), distraction ($F(3, 46) = 7.79$, $p < .001$), acceptance ($F(3, 46) = 6.89$, $p < .001$), relaxation ($F(3, 46) = 2.82$, $p = .05$), and avoidance ($F(3, 46) = 2.87$, $p < .05$) compared to controls. When including emotion experience as an additional covariate, the two groups differed significantly on the same ER strategies (problem solving: $F(4, 46) = 4.01$, $p < .01$, distraction: $F(4, 46) = 6.29$, $p < .001$, reappraisal: $F(4, 46) = 3.93$, $p < .01$, acceptance: $F(4, 46) = 5.15$, $p < .01$, relaxation: $F(4, 46) = 5.15$, $p < .01$, and avoidance: $F(4, 46) = 6.64$, $p < .001$).

Finally, in the domain of amusement, the ER profiles of individuals with ASD and controls did not differ significantly, as revealed by the interaction

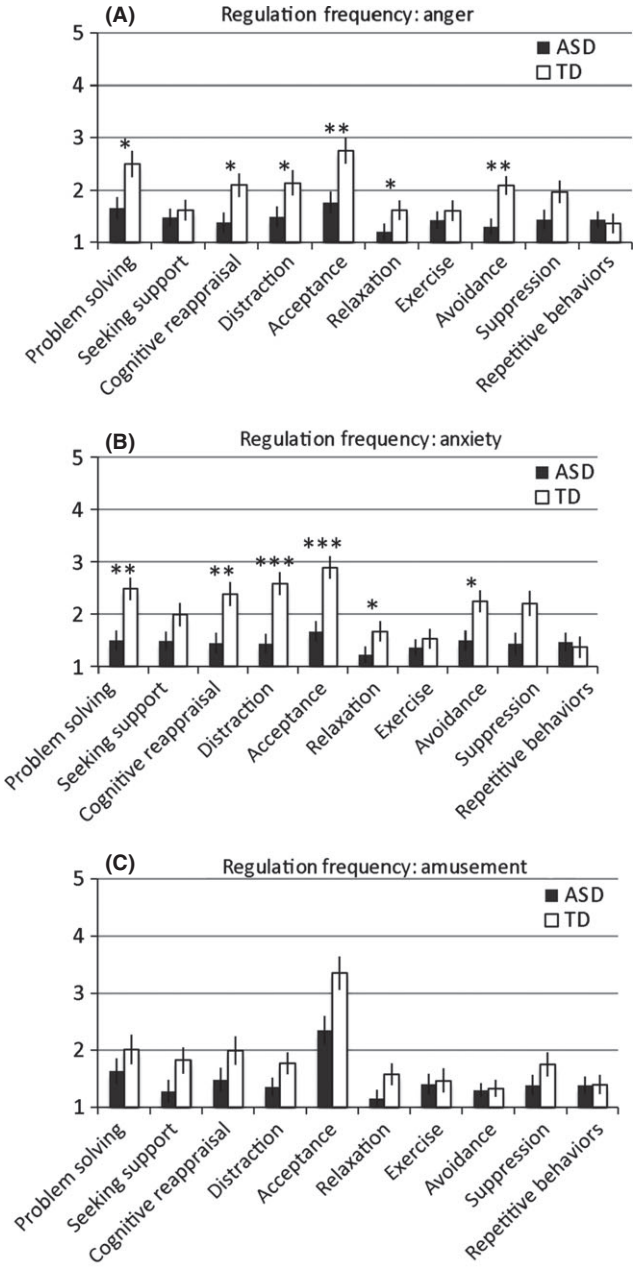

Figure 3 Estimated means for regulation frequency from daily diaries, controlling for age and FSIQ in (A) anger, (B) anxiety, and (C) amusement in individuals with Autism Spectrum Disorder (ASD) and typically developing (TD) participants. Note: *$p < .05$, **$p < .01$, ***$p < .001$

effect ($F(9, 432) = 1.73$, *ns.*). Consequently, no ANCOVAs were computed.

Discussion

Parent interviews and child daily diaries revealed pronounced differences between individuals with ASD and controls in emotion experience and in the use and efficacy of a wide range of ER strategies. Children and adolescents with ASD had significantly different ER profiles compared to TD participants in all three emotional domains, characterized by less frequent use of adaptive and more frequent use of maladaptive ER strategies. Moreover, individuals with ASD were less effective at implementing ER strategies. Our study contributes to prior literature by demonstrating differences between individuals with ASD compared to TD participants in a variety of ER strategies in three different emotions.

Emotion experience in autism spectrum disorder

Consistent with previous literature, parents reported that individuals with ASD experienced more negative emotions compared to controls (e.g. Ben Shalom et al., 2006; Capps et al., 1993; Samson et al., 2012). Interestingly, however, there were no group differences in self-reported negative emotions, in contrast to previous literature suggesting high agreement between child and parent-reported anxiety symptoms (Ozsivadjian, Hibberd, & Hollocks, 2014). Given the previous findings, it is possible that individuals with ASD were not able to complete daily dairies on days they had experienced strong negative emotions. However, further research should be done in this area as the present findings could also be the result of a lack of awareness of elevated levels of negative emotions in individuals with ASD (compared to others) or difficulties comparing themselves to other children due to deficits in social cognition. Both parents and participants reported less amusement in individuals with ASD consistent with previous studies showing that individuals with ASD have difficulties processing various types of humor, which may lead to less amusement overall (see Samson, 2013; for a review). In general, the expression of anger (e.g. tantrums or meltdowns) and anxiety combined with lower levels of positive emotions can impede daily functioning and well-being of individuals with ASD (e.g. Mazefsky et al., 2013).

Emotion regulation in autism spectrum disorder

The current study revealed remarkable group differences in parent- and self-reported use and efficacy of several adaptive ER strategies, such as problem solving, cognitive reappraisal, and acceptance. The finding that individuals with ASD less frequently utilize adaptive strategies to regulate negative emotions is consistent with a number of earlier studies (Jahromi et al., 2012; Rieffe et al., 2011; Samson et al., 2012), but is at odds with a recent study that only found an increased use of maladaptive, but not a decreased use of adaptive strategies (Mazefsky et al., 2014). Importantly, in the present study, group differences in the use and efficacy of a wide range of ER strategies generally cannot be explained by differences in emotion experience, which provides evidence that individuals with ASD do indeed have deficits in ER and do not merely have stronger negative and weaker positive emotions.

Interestingly, individuals with ASD less frequently used expressive suppression to regulate anger (self-report, only when controlling for emotional experience) and anxiety (parent report). This contradicts previous findings that adults with ASD reported more frequent use of suppression (Samson et al., 2012), and that children and adolescents with ASD more frequently used suppression in an experimental ER task (Samson, Hardan, et al., 2014) compared to TD controls. Parents may have particular difficulties identifying expressive suppression in their children and distinguishing it from a lack of emotion. It may also be situation-dependent whether individuals with ASD employ suppression. Further research that disentangles blunted affect from goal-directed effort to inhibit emotional behavior is needed to better understand expressive suppression in ASD.

Consistent with our hypothesis, parents reported more frequent use of repetitive behaviors to regulate all three emotions. Individuals with ASD also self-reported more repetitive behaviors to deal with anger (when controlling for emotional experience). While the presence of repetitive behaviors in ASD is not surprising, it is novel that these behaviors may be used as an attempt to regulate emotions. Additional analyses showed that the increased use of repetitive behaviors as ER strategy cannot be explained by repetitive behaviors in general.[3] Repetitive behaviors might be one way to gain control over an environment that otherwise seems confusing, and might therefore be a pathway for individuals with ASD to deal with overwhelming emotions. This observation contrasts with prevailing beliefs that repetitive behaviors only reflect immature or inappropriate responses that interfere with social interactions (see Evans, Lewis, & Iobst, 2004). Repetitive behaviors may be beneficial for individuals who have difficulties with implementing adaptive ER strategies to cope with unwanted emotions, especially if the repetitive behavior is not harmful to an individual or to others (see Roberts, O'Connor, & Bélanger, 2013). However, further studies need to address the role of repetitive behaviors as ER strategy in different contexts to test their efficacy to regulate emotions in individuals with ASD.

Interestingly, the differences in ER profiles shown by the ER interview may be specific to ASD, as a previous study using this measure in social anxious individuals found greater use of avoidance and expressive suppression, as well as lower self-efficacy in implementing reappraisal and suppression. However, we used an adapted form of the interview which may limit comparability between the studies (e.g. adults vs. children and adolescents, Werner et al., 2011).

Despite high correspondence between parent- and self-report, a few strategies showed group differences in self-report but not parent report, such as avoidance and relaxation in the domains of anger and anxiety, and distraction in anxiety. In addition, group differences in regulating amusement emerged in the parent report only. Such differences might also be related to the parent-reported typical use of ER strategies in contrast to rather state like reports as assessed in the daily diaries which may be more prone to impacts from situational characteristics affecting agreement between multiple informants (Kanne, Abbacchi, & Constantino, 2009). Interestingly, positive emotions were less frequently regulated than negative emotions. Regulating negative emotions is probably not only more challenging but also more adaptive and important for emotional well-being.

Limitations and future directions

Using a novel combination of parent interviews and child daily diaries, our findings shed new light on emotion experience and regulation in children and adolescents with ASD. However, it is also important to mention several limitations of the present study.

First, we focused on a relatively small number of high-functioning individuals with ASD. Future research needs to replicate the current findings in larger samples that include lower functioning individuals. Such studies will permit a better understanding of the ER profiles of individuals across the full ASD range. This would also make it possible to examine the impact of cognitive functioning on ER profiles.

Second, although averaging the daily diary reports allowed for comparison between parent- and self-reported ER profiles, it may have led to differences in reliability for participants with only one entry. Future studies should examine daily diaries by both parents and children with multilevel analyses to better understand temporal trajectories of emotions in ASD and to possibly resolve discrepancies between parent and child reports. Not only the child's ability to report about their own emotion, but also the parent's ability to report about their children's emotion is likely to affect both, parent interview and daily diaries. Future studies that include more objective measures are required to be able to generalize these findings.

Third, while this study provided evidence for emotion dysregulation in ASD, it is based on observational findings only. Given our cross-sectional design, it is not possible to distinguish between experience that resulted from successful ER or whether unregulated emotions were reported. Experimental studies in which emotions are induced and then regulated would enable a better understanding of the associations between experience and regulation.

Concluding comment

The current study revealed crucial group differences in the use of adaptive and maladaptive ER strategies and offers insight that may improve individualized interventions that promote ER strategies accessible to an individual with ASD. The current findings may point to promising avenues of treatment, especially for lower functioning individuals with ASD who have difficulties implementing more cognitively challenging ER strategies. Although engaging in cognitive strategies such as reappraisal might be more optimal, if lower functioning individuals are unable to learn these strategies, repetitive behaviors might be beneficial, particularly if flexibly employed. Possible longer term costs associated with excessive reliance on repetitive behaviors (such as withdrawal from social interaction) need to be carefully considered. Future studies are required to better understand whether individuals with ASD might benefit from both more and less cognitively challenging ER strategies (cognitive reappraisal vs. relaxation, for example) and to better understand the malleability of the ER profile (e.g. whether increased use of more adaptive ER strategies would lead to a decreased use of maladaptive strategies).

Supporting information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Examples of emotion dysregulation.

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Key points

- A wide range of emotion regulation (ER) strategies were examined in children and adolescents with ASD and were compared to typically developing (TD) participants in three emotional domains (anger, anxiety, and amusement).
- Parent interviews and child daily diaries were used to examine emotional experience and the use and efficacy of 10 ER strategies.
- Children and adolescents with ASD had significantly different ER profiles compared to TD participants in all three emotional domains, characterized by less frequent use of adaptive (problem solving, cognitive reappraisal) and more frequent use of maladaptive ER strategies (repetitive behaviors).
- This study provides evidence that individuals with ASD have maladaptive ER profiles. Implications for ASD treatments that focus on increasing the use of adaptive strategies are discussed.

Notes

1. For awareness and experience, parents were also asked to report on several other emotions. However, as the ER part of the interview only assessed amusement, anger, and anxiety, we also focus on experience of these emotions in the current paper. As all children understood what it meant to feel amusement, anger, and anxiety, awareness was not considered further. In addition, parents were asked to describe, in an open-ended format, any ER difficulties of their child (for examples see appendix S1 available online).
2. Effects of age and FSIQ as covariates were tested for the parent interview and children's daily diaries. Several age effects are suggesting a developmental component in self-reported ER. As all correlations were positive, it seems the use (and efficacy) of ER strategies increased with age. Cognitive functioning did not seem to play an important role in the present study. **Parent Interview**. *Emotion Experience:* Significant effects of age as a covariate were found on anger ($F(1, 59) = 7.46$, $p < .01$), and increased age was associated with less anger ($r = -.38$, $p < .01$). *Emotion Regulation Frequency:* Age affected the ER profiles in the domain of anxiety ($F(9, 459) = 8.26$, $p < .001$). Age affected the use of suppression ($F(1, 56) = 11.50$, $p < .001$), and increased age was associated with more suppression ($r = .41$, $p < .001$). Age also affected problem solving in amusement ($F(1, 56) = 7.19$, $p < .05$), and increased age was associated with more problem solving ($r = .33$, $p < .01$). *Emotion Regulation Efficacy:* Age had an effect on suppression in anger ($F(1, 43) = 5.01$, $p < .05$). A positive correlation suggested higher efficacy of using suppression with increased age ($r = .34$, $p < .05$). Age affected distraction ($F(1, 49) = 15.66$, $p < .001$) and suppression ($F(1, 39) = 5.98$, $p < .05$) in anxiety. Positive correlations suggested higher efficacy of using distraction ($r = .47$, $p < .001$) and suppression ($r = .39$, $p < .05$) with increased age. FSIQ also affected distraction in anxiety ($F(1, 49) = 4.35$, $p < .05$) and acceptance in amusement ($F(1, 43) = 5.22$, $p < .05$). Positive correlations suggested higher efficacy for distraction ($r = .28$, $p < .05$) and acceptance ($r = .46$, $p < .01$) with increased FSIQ. **Children Daily Diaries**. *Emotion Experience:* FSIQ as a covariate affected anxiety ($F(1, 46) = 5.93$, $p < .05$) and higher FSIQ was associated with less anxiety ($r = -.28$, $p = .06$). *Emotion Regulation Frequency:* Age affected the ER profiles in anger ($F(9, 387) = 3.36$, $p < .001$). Age had an effect on avoidance ($F(1, 46) = 4.12$, $p < .05$; $r = .30$, $p < .05$), distraction ($F(1, 46) = 5.09$, $p < .05$; $r = .33$, $p < .05$), reappraisal ($F(1, 46) = 3.45$, $p < .05$; $r = .30$, $p < .05$), acceptance ($F(1, 46) = 7.64$, $p < .01$; $r = .37$, $p < .01$), and relaxation ($F(1, 46) = 5.35$, $p < .05$; $r = .34$, $p < .05$). Also in anxiety, age affected problem solving ($F(1, 46) = 4.76$, $p < .05$; $r = .29$, $p < .05$), distraction ($F(1, 46) = 8.02$, $p < .01$; $r = .37$, $p < .01$), reappraisal ($F(1, 46) = 5.01$, $p < .05$; $r = .30$, $p < .05$), acceptance ($F(1, 46) = 4.43$, $p < .05$; $r = .29$, $p < .05$), and relaxation ($F(1, 46) = 5.24$, $p < .05$; $r = .33$, $p < .05$). In amusement, age affected the ER profiles ($F(9, 387) = 2.02$, $p < .05$), reappraisal ($F(1, 46) = 3.84$, $p = .06$; $r = .29$, $p = .05$), and suppression ($F(1, 46) = 8.04$, $p < .01$; $r = .40$, $p < .01$). The self-reported use of ER strategies increased with increasing age.
3. To better understand repetitive behaviors as an ER strategy, we conducted secondary analyses in which we included RBS (total score) as a covariate. Group differences in repetitive behaviors to regulate emotions were still evident, even when controlling for RBS (for anger: $F(2, 47) = 9.17$, $p < .001$, for anxiety: $F(2, 47) = 4.87$, $p < .05$, and for amusement: $F(2, 47) = 3.66$, $p < .05$). In addition, RBS was positively associated with the use of repetitive behavior as an ER strategy in parent-reported anger ($r = .54$, $p < .001$) and anxiety ($r = .35$, $p < .05$) and child-reported anger ($r = .37$, $p < .05$), anxiety ($r = .43$,

$p < .01$), and amusement ($r = .36$, $p < .05$) indicating that more frequent repetitive behaviors are associated with the increased use of repetitive behaviors as an ER strategy.

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