EMOTION DYSREGULATION IN CHILDREN WITH AUTISM: A MULTIMETHOD INVESTIGATION OF THE ROLE OF CHILD AND PARENT FACTORS

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A THESIS SUBMITTED TO
THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF ARTS

GRADUATE PROGRAM IN CLINICAL-DEVELOPMENTAL PSYCHOLOGY
YORK UNIVERSITY
TORONTO, ONTARIO

August 2020

Abstract

Children with autism have been found to experience greater difficulties with emotion regulation than typically developing peers. Characteristics related to autism (i.e., social communication, restricted repetitive behaviours, executive functioning difficulties, differences in physiological arousal) as well as external parent factors (i.e., parent stress, mindful parenting) have been suggested to contribute to the emotion dysregulation (ED) experienced by these youth. This study used a multimethod approach to evaluate associations between child and parent factors, and two indices of child ED (parent report and observational behaviour coding). The sample consisted of 44 children with autism ages 8-13. Correlational analysis revealed that child autism symptomology, executive functioning difficulties, parental stress and mindful parenting were all significantly associated with parent-report of ED, but not with observed ED. Similarly, hierarchical linear regressions revealed that these factors jointly predicted parent report of ED, but not observed ED. Interestingly, restricted interests/repetitive behaviours emerged as a unique positive predictor of parent reported ED, and a negative predictor of observed ED during a lab-based frustration task. Findings highlight the importance of using a multimethod approach and of considering contextual factors when investigating ER in children with autism.

Acknowledgements

I would like to sincerely thank my supervisor, Dr. Jonathan Weiss, for his mentorship, encouragement, and insight that made this project possible. I would also like to thank the members of my thesis committee, Dr. Maggie Toplak, Dr. Yvonne Bohr, and Dr. Rebecca Gunter for their incredibly thoughtful feedback. Thank you to Paula Tablon-Modica for her contributions in developing and implementing the behavioural coding scheme, to Ava Pouyandeh and Mischele Kaplan for their assistance in cleaning the EDA data, and to my lab mates for their continued support and encouragement. A very special thank you to the children and families who participated in this study.

This research was supported by a Joseph Armand Bombardier Canada Graduate Scholarship-Master's from the Social Science and Humanities Research Council, as well as a Lillian Meighen Wright Maternal Child Health Graduate Scholarship.

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Children with autism often experience co-occurring depression, anxiety, or anger as a result of having difficulties with emotion regulation, with the majority of children with autism meeting criteria for at least one co-occurring mental health disorder (Salazar et al., 2015). Emotion regulation (ER) is described as 'the extrinsic and intrinsic processes responsible for monitoring, evaluating, and modifying emotional reactions, especially their intensive and temporal features, to accomplish one's goals' (Thompson, 1994, pp. 27-28). Research suggests that individuals with autism tend to have more difficulties with ER and are less effective at using ER strategies compared to individuals without autism (Bruggink et al., 2016; Samson et al., 2014). Difficulties with ER are particularly salient during frustrating situations, with children with autism tending to display greater dysregulation during frustrating tasks than peers without autism (Jahromi, Meek & Ober-Reynolds, 2012). Considering that emotion dysregulation (ED) and associated mental health difficulties are a consistent concern for children with autism, there is a need to better understand the factors that contribute to ER abilities in this population.

Mazefsky and colleagues (2013) suggest that characteristics of autism, such as difficulty with social communication, cognitive rigidity, and differences in physiological arousal, may underlie the ED experienced by this population. Additionally, parent factors, such as parental stress and mindful parenting have been suggested to play a role in the development of child emotion regulation (Chan & Neece, 2018; Jones et al., 2014). In the literature, child emotion regulation is indexed using many methods, such as parent-report, behavioural observation, self-report, and physiological measures, however most studies of ER in children with autism rely on one of these methods (Weiss, Thomson & Chan, 2014). In addition to considering contributing factors to ED in youth with autism, is important to consider whether different ED measurement

methods display similar patterns of relationships with these factors. The current study investigated how parent and child level factors are associated with parent report of ED and observed behavioural ED in youth with autism. Additionally, I explored potential interactions between child and parent characteristics in explaining ED in this population.

Theoretical Framework

The transactional model (Sameroff, 2009) suggests that child developmental processes are the product of dynamic, bidirectional interactions between children and their social environments. The development of ER skills in children with autism can also be considered within this framework. According to this model, development is a series of transactions between self-regulation and other-regulation over time, during which children progress from relying on others to coregulate their emotions, to being able to self-regulate. Sameroff (2009) suggests that developmental disabilities can place barriers on the range of experiences, or 'transactions,' that children can experience, thus influencing their development. More specifically, the social, behavioural, and sensory challenges that children with autism experience may prevent them from having the same transactions necessary for the development of ER skills as peers without autism. As is suggested in the transactional model, it is important that interventions geared towards improving ER abilities and the mental health of children on the spectrum are flexible and adapt to the ability of the child; thus providing the opportunity for transactions that enable the development of ER skills.

Treating and understanding the ER difficulties experienced by children with autism can be considered from a biopsychosocial perspective. The biopsychosocial model (Engel, 1977), suggests that in order to adequately respond to illness, healthcare professionals must consider biological, psychological, and social dimensions of illness. While this model was originally a

response to the reductionist biomedical model used in psychiatry and medicine at the time, its principles have since been applied broadly to a variety of health and mental health concerns (Borrell-Carrio, Suchman, & Epstein, 2004). Gadow, DeVincent, and Schneider (2008) found that psychiatric symptoms were differentially associated with social and school performance in children with autism, and suggested a need for further research in the area of psychiatric difficulties in children with autism, and their biopsychosocial underpinnings. Addressing the emotional difficulties experienced by children with autism from this perspective involves considering biological factors (i.e., genetics, psychophysiology), social factors (i.e., family environment, friendships, school environment), and psychological factors (i.e., ER, executive functioning difficulties), and the dynamic interplay among these factors.

The "Emotion dysregulation in ASD" model by Mazefsky and colleagues (2013) suggests that autism characteristics (e.g., limited emotional language, lower inhibition, cognitive rigidity, and difficulty reading emotional cues) are likely to be related to the ER difficulties experienced by this population. This model posits that neural mechanisms shared with other psychiatric conditions, in combination with autism behavioural and cognitive characteristics, interact to produce a heterogeneous presentation of ED in this population (Mazefsky et al., 2013). This framework proposes that difficulties with ER may be intrinsic to autism, and impaired ER may provide a more parsimonious explanation for the anger, anxiety and depression that are often seen in this population. The authors suggest that research on ER in autism requires a multimethod approach, preferably combining physiological and behavioural measures, to help inform better mental health treatments for this population.

Autism is a neurodevelopmental disability characterized by deficits in social communication, social interactions, and the presence of restricted, repetitive behaviours

(American Psychiatric Association, 2013). Individuals with autism may also be hypo- or hyperreactive to sensory input, which can impact behaviour and daily functioning (Schaff et al., 2011). An autism diagnosis can be specified as occurring with or without a language impairment, and with or without an intellectual disability (American Psychiatric Association, 2013), thus accounting for the spectrum of symptoms seen in this population. Autism persists across the life course; however, its signs are often noticed in early childhood (Christensen et al., 2016). Throughout development, the social and behavioural challenges that children with autism experience often lead to difficulties making and maintaining friends (Calder, Hill, & Pellicano, 2013), and challenges functioning in school settings (Sinzig et al, 2014). These difficulties are often particularly apparent in middle childhood, when there is an increased emphasis on peer relationships (Steinberg & Morris, 2001), and difficulties in this area can impact children's mental health and quality of life (Whitehouse, Durkin, Jaquet, & Ziatas, 2009).

Children with autism report difficulties with insight into their own emotional functioning and emotional experiences (Losh & Capps, 2006). ER processes help children adapt and modulate the strength of their emotional responses, and impairments in this area are associated with internalizing and externalizing behaviour problems (Eisenberg et al., 2001). Youth with autism use adaptive ER strategies (e.g., problem solving, cognitive reappraisal, and cognitive distraction) less frequently than maladaptive ER strategies (i.e., suppression, avoidance) in comparison to their typically developing peers (Samson et al., 2015).

Difficulties regulating emotions are particularly salient during frustrating situations. Children with autism have been shown to display greater behavioural dysregulation during frustrating tasks than peers without autism (Jahromi, Meek, & Ober-Reynolds, 2012; Samson et al., 2015). More specifically, children with autism have been shown to utilize more venting and avoidance

behaviours in the context of frustration in comparison to typically developing peers, and fewer constructive coping strategies such as social support orienting and support seeking (Jahromi et al., 2012; Samson et al., 2015). More recently, Northrup and colleagues (2020), conducted a study of observed ER in psychiatrically hospitalized youth with autism, ranging the full spectrum of intellectual abilities (mean age 12.76 years-old). They found that during a set of frustrating tasks, younger children displayed greater negative affect, and individuals with lower adaptive functioning and lower verbal ability demonstrated greater emotional reactivity throughout the tasks. These findings suggest that it is important to consider how different autism related characteristics may differentially contribute to ED.

Autism Characteristics Related to Emotion Regulation. As outlined above, the Emotion Dysregulation in ASD model (Mazefsky et al., 2013) suggests that characteristics related to autism (e.g., limited emotional language, lower inhibition, cognitive rigidity, and difficulty reading emotional cues) are likely to be related to the ER difficulties experienced by this population. The challenges with social communication experienced by individuals with autism, such as difficulties taking the perspectives of others (Samson, Huber & Gross, 2012), challenges in describing emotional states (impaired alexithymia; Mazefsky, Kao & Oswold, 2011), and difficulty perceiving others' social and emotional cues have been suggested to interfere with the implementation of adaptive ER strategies (Mazefsky & White, 2014). Additionally, the restricted and repetitive patterns of behaviour experienced by those with autism have been found to be associated with ER, with approximately one quarter of repetitive behaviours reported to be in response to emotional triggers (Militerni, Bravaccio, Falco, Fico, & Palermo, 2002). Additionally, Samson and colleagues (2015) suggest that some forms of repetitive behaviours may represent an attempt to regulate emotions.

Individuals with autism often have difficulties with executive functioning, specifically inhibitory control, flexibility, planning, and attention shifting (Ozonoff & Jensen, 1999; Rinehart, Bradshaw, Moss, Brereton, & Tonge, 2001). Executive functions are defined as a set of cognitive processes that guide thoughts and actions (Miyake & Friedman, 2012). It has been suggested that individuals with autism may have difficulties with emotion regulation, in part, because of difficulties with attention shifting and working memory (Cai et al., 2018). This is supported by the fact that attention shifting and working memory have been related to rumination and cognitive reappraisal (Beckwe et al., 2014; McRae et al.,2012). Two studies have explored associations between aspects of executive functioning and ER (Cibralic et al., 2019). Jahromi and colleagues (2013), found that preschool-aged children with autism whose parents reported greater inhibitory control abilities were better able to regulate their emotions. Additionally, Zantinge et al. (2017) found that preschoolers with autism displayed significantly greater inhibitory control difficulties, and fewer constructive ER strategies compared to typically developing children. To our knowledge, no research to date has explicitly investigated associations between executive function difficulties and ER in school aged children. (Cai et al., 2018).

In addition to autism symptomology and cognitive factors, considering associations between ED and physiological indicators may provide insight into why children with autism tend to experience difficulties regulating during frustrating situations (Zantinge, Rign, Stockmann, & Swaab, 2017). It has been suggested that altered “covert emotional processes” play a role in the manifestation of autism symptoms, and that autism is characterized by altered levels of basal and reactive arousal (White et al., 2014). Physiological regulation is most commonly measured by assessing autonomic nervous system (ANS) activation (Lydon et al., 2016). The ANS is

comprised of the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS) branches. The SNS facilitates attention, fight, and flight, whereas the PNS facilitates restoration and recovery (Lydon et al al., 2016). It is suggested that emotional arousal originates from the ANS (Zantinge et al., 2017). Electrodermal activity (variation in electrical properties of the skin) is one such measure of ANS regulation.

Electrodermal activity (EDA) is a psychophysiological index of sympathetic nervous system arousal, and its non-invasive measurement methods make it a suitable measure of ANS activity for children with autism who may experience sensory challenges. Research in this area has predominantly focused on diagnostic differences in EDA, however, more recent studies have addressed potential associations between EDA (primarily change in skin conductance level in response to specific stimuli) and autism symptoms. In the context of a reward-based task, increased EDA amplitude to unexpected instances of non-reward tended to be associated with poorer parent reported social skills in children with autism (Neuhaus, Bernier, & Beauchaine, 2015). O'Haire, McKenzie, Beck, & Slaughter (2015) found that school-age children with autism displayed greater changes in EDA responses in comparison to typically developing peers when exposed to toy and activity conditions. In contrast, some findings suggest positive associations between heightened EDA response and desirable child outcomes. Stagg and colleagues (2013), for example, found a positive relationship between EDA response to direct eye gaze, and children's receptive vocabulary. While EDA has been investigated in relation to autism symptoms, few studies have examined EDA in children with autism during tasks designed to elicit ER, specifically.

Fenning and colleagues (2017) found that in children ages 4- to 11-years old with autism, greater variability in EDA (as indexed by the standard deviation of EDA responses and non-

specific skin conductance responses) across a variety of tasks (including a frustration task) was associated with higher levels of autism symptoms. More recently, Baker and colleagues (2018) conducted a study on school-age children with autism and found that EDA reactivity moderated the relationship between parental criticism and child externalizing behaviours. That is, criticism was positively associated with externalizing problems under conditions of moderate and high, but not low, child EDA reactivity. Overall, findings in this area appear to suggest associations between heightened EDA reactivity and greater autism symptomology. However, results are inconsistent, and studies have primarily relied on parent report of child behavior, as opposed to observational behaviour measures. Considering associations between child EDA reactivity, parent factors, and ED may allow for a more thorough understanding of the ER difficulties experienced by children with autism.

Parent Factors and Child Emotion Regulation. While many child level factors may impact the ability of children with autism to regulate effectively, parents and caregivers have been suggested to play a crucial role in the development of ER skills. Parent coregulation, which is a parent's use of motivational or emotional scaffolding and strategies to help their children regulate emotions (Gulsrud et al., 2010), may be critical in the development of child ER. Hoffman and colleagues (2006) describe motivational scaffolding as parents' ability to initiate and maintain their child's interest in a task through praise, encouragement, goal restatement, and redirection of the child's attention. Additionally, emotional scaffolding is defined as a parent's ability to make a task a positive experience for their child through sensitivity towards their child's emotions, sharing in their child's positive emotions, and valuing their child's participation (Hoffman et al., 2006). It has been found that parental use of emotional scaffolding, or "emotion coaching" is associated with lower child physiological stress and fewer externalizing

problems in children with and without autism (Hooven et al. 1995; Wilson et al. 2013). While there is a growing body of literature supporting the role of parental coregulation in the development of child ER skills, it is important to understand what factors might contribute to parents' ability to coregulate and support the ER skills of their children with autism.

Parents' wellbeing and parenting style may be related to their ability to emotionally coregulate, and thus impact the development of ER skills in their children. Parents of children with autism report significantly higher levels of stress compared to parents of typically developing children (Baker-Ericzen, Brookman-Frazee, & Stahmer 2005). Notably, maternal stress has been found to be associated with greater ER difficulties in children with autism (Davis & Carter, 2008). There is some evidence to suggest that parents of children with autism who report higher mindfulness traits also report lower stress and mental health problems, and reduced child behaviour problems (Cachia et al., 2016; Connor & White, 2014). Singh and colleagues (2006) found that aggression and maladaptive behaviour in children with autism decreased during and after their parents took part in an intervention targeting parent mindfulness.

Mindfulness can be conceptualized within a parenting context specifically, which has been referred to as "mindful parenting" (Jones et al., 2014). Mindful parenting is conceptualized as the practice of awareness in the moment, and increased attention without judgment and reactivity in a parenting role (Wong et al., 2019). Mindful parenting is posited to improve parent ER, foster parent-child coregulation, and promote improved child ER (Duncan et al., 2009). Zhang and colleagues (2019) found that in typically developing preschoolers, mindful parenting facilitated parent-child attunement, thus contributing to lower emotional lability/negativity (ED) in their children. In children with developmental disabilities (DD), it has been found that mindful parenting mediates the relationship between parental stress and child ER (Chan & Neece, 2018;

Jones et al., 2014). Additionally, in a study involving parents of children with autism specifically, it was found that mindful parenting was related to lower parental stress and lower levels of child behaviour problems, but did not mediate the relationship between parent stress and child behaviour (Beer et al., 2013). These results suggest that there is a need to better understand the role that parental factors such as stress and mindful parenting play in the development of ER in children with autism.

While research in the area is limited, there is some evidence that child level characteristics interact with parent factors in explaining ER ability in children with autism. In a study conducted by Baker and colleagues (2018) involving forty children with autism between the ages of 4 and 11 years, it was found that parental scaffolding moderated the link between sympathetic nervous system under-arousal (indexed using EDA during a regulatory task), and child externalizing problems. That is, under-arousal was associated with externalizing behaviours in the context of low, but not high, levels of parental scaffolding. An additional study conducted by Costa, Steffgen and Vogele (2019) found that parents of children with autism between the ages of 3 and 13 years interacted significantly less with their children than parents of children without autism. Critically, the quantity of observed parent-child interaction mediated the relationship between children's autism diagnosis and children's ER ability when controlling for children's alexithymia levels (Costa et al, 2019). While these findings suggest that parent and child level factors interact in explaining differences in child behaviour problems, no studies to date have investigated how interactions between child autism characteristics and parental stress and mindfulness may be associated with child ED using an observational and parent report measure of child ED.

Current Study. There is a need to better understand how child and parent factors are associated with different indices of ED for children with autism. The current study addressed this gap by exploring the following questions and hypotheses:

1. How are child-level characteristics in youth with autism associated with their ability to regulate their emotions?
    a. Hypothesis: children with greater autism symptomology, greater executive function difficulties, and more variable electrodermal activity will have higher parent report of ED.
    b. Hypothesis: children with greater autism symptomology, greater executive function difficulties, and more variable electrodermal activity will display more behavioural ED in the context of a frustration task.
2. How are parent-level factors associated with the ability of youth with autism to emotionally regulate?
    a. Hypothesis: lower levels of mindful parenting and higher levels of parent stress will be associated with higher levels of ED on a parent report measure.
    b. Hypothesis: lower levels of mindful parenting and higher levels of parent stress will be associated with higher levels of observed behavioural ED displayed in the context of a frustration task when a parent is not present.
3. Do parent factors moderate the relationship between child autism characteristics and child emotion dysregulation? This question is exploratory in nature.

Method

This study examined data collected from children with autism between the ages of 8- to 13-years-old and their primary caregivers who participated in a larger randomized trial of cognitive behavioural therapy for emotion regulation in the principal investigator's lab (The Secret Agent Society: Operation Regulation; SAS:OR). This larger trail includes children with different neurodevelopmental disabilities (autism, attention-deficit-hyperactivity disorder, learning disability, fetal alcohol spectrum disorder, and cerebral palsy). However, the current study only included children with an autism diagnosis. Participants were recruited for the SAS:OR trial through various methods, including: a) A pool of research participants who have previously participated in the Principal Investigator's research projects and given their consent to be contacted for relevant research studies; b) An advertisement posted on the Principal Investigator's lab website; c) Advertisements posted on relevant community organization websites (including but not limited to: Centre for Addiction and Mental Health, Surrey Place Centre - Autism Treatment Network, Geneva Centre, Holland Bloorview Kids Rehabilitation Hospital, and the Hospital for Sick Children); and d) word-of-mouth.

Participants

The final sample was 44 children (f = 7; Age: M = 9.70, SD = 1.62; IQ: M = 103.89, SD = 15.85). For children to be included in the larger SAS:OR intervention study, it was required that they demonstrate IQ scores in the average range (a score of at least 79) via the Wechsler Abbreviated Scale of Intelligence-2nd Edition (WASI-II; Wechsler, 2011). Exclusion criteria were the presence of a psychotic disorder or aggressive behaviours that posed a safety threat. Parents provided copies of their children's diagnostic reports to confirm eligibility. Children

must have had least one anxiety, mood, or behavioural disorder, which was verified using the Anxiety Disorders Interview Schedule-Parent Interview (ADIS-P; Silverman & Albano 1996). For the current study, only children with an autism diagnosis were included. Due to missing or corrupted video data, participants were included only if video files were available. Additional demographic information is outlined in Table 1.

Table 1. *Participant Demographics* (*n* = 44)

	M(*SD*) or *N* (%)	Range
Age	9.70(1.62)	8.00 –13.00
Gender		
Female	7(16)	--
IQ		
WASI-II Composite Score	104 (15.85)	79 –147
Child Ethnicity		
White/Caucasian	29(66)	--
Black	2(5)	--
Latin American/Hispanic	2(5)	--
Southeast Asian (Vietnamese, Cambodian, etc.)	1(2)	--
West Asian (Iranian, Afghan etc.)	1(2)	--
Multiethnic	8(18)	--
Prefer not to disclose	1(2)	--
Parent Highest Level of Education		
High school/some college	10(22)	--
Bachelor or Associate's degree	27(61)	--
Master's degree/professional school	7(16)	
Family Income		
< $49,999	5(11.4)	--
$50,000 - $99,999	15(34.1)	--
$100,000 -$200,000	11(25)	--
> $200,000	6 (13.6)	--
Prefer not to disclose	7 (15.9)	--

Measures

Outcome 1: Observed Emotion Dysregulation. Children completed a computerized Mirror Tracing Persistence Task (MTPT; Strong et al., 2013). During this task, children attempted to trace a star with an inverted mouse cursor, and when errors occurred, an irritating

alarm would sound. This task is designed to be difficult and to elicit feelings of frustration. The task consisted of "Easy," "Medium" and "Hard" practice phases. The Easy and Medium phases were 2 minutes in length, and the Hard phases was 1 minute in length. The size of the star decreased across phases, causing the difficulty level to increase in each subsequent phase. Following the completion of the practice phases, children completed the "Test Phase," during which they were provided the opportunity to quit by hitting the spacebar on the computer. This task took between 6 to 13 minutes to complete, depending on how long the child persisted in the Test phase.

Coding. Behavioural emotion dysregulation was measured via standardized observer coding of expressed reactivity and dysphoria using a coding scheme adapted from the Emotion Dysregulation Inventory- Short Form (EDI; Mazefsky et al., 2016), which is a questionnaire measure designed specifically for children with autism. The EDI includes two subscales: *Reactivity* (7 items) and *Dysphoria* (6 items). The EDI is a 5-point Likert scale parent-report measure, with responses ranging from "*Not at all*" to "*Very Severe*."

When adapting the EDI questionnaire measure to a global coding scheme, the wording of some items was adjusted in order to be more applicable to the MTPT (e.g. "Appears uneasy throughout the day" was modified to "Appears uneasy"). The *Reactivity* subscale included 7 items, such as, "Has explosive outbursts." The *Dysphoria* subscale included 5 items such as, "Seems sad or unhappy," (it can be noted that *Dysphoria* items 31 and 43 were combined in this coding scheme due to their similarities). The coding scheme and behavioural coding sheets that I adapted from the EDI questionnaire measure can be found in Appendices A and B. Codes were given for each item on both the *Reactivity* and *Dysphoria* scales, with 0 representing "Not at all"

to 4 representing “Severe.” The Easy, Medium, Hard and phases were coded separately in order evaluate potential differences in observed behaviour across levels of difficulty in the task. Internal consistency was excellent when *Reactivity* and *Dysphoria* items were considered separately between phases, and when all item codes were considered together across phases (α ranging from .94 - .99). Due to very high correlations observed between *Reactivity* and *Dysphoria scores* across phases (r_s ranging from .76 - .96), one “Observed ED” score was computed by finding the mean of *Reactivity* and *Dysphoria* items across practice phases. As such, Observed ED scores had a potential range of 0 to 4, corresponding with the Likert scale (*M* = 1.34, *SD* = .91, Range: 0 – 3.57). While the *Reactivity* and *Dysphoria* subscales are intended to be considered separately in the questionnaire EDI format (Mazefsky et al., 2016), using one observed ED outcome variable for the current study allowed for a more parsimonious exploration of the hypotheses.

Videos of the MTPT task were coded equally between two observers (including myself), and 25% of the videos were coded by both coders for reliability purposes. Interrater reliability statistics for the EDI coding scheme were calculated using intraclass correlation coefficients (ICCs) for approximately 30% of available videos (*n* = 44). Reliability coefficients were based on the two-way random effects ICC (2, 1) model (Koo & Li, 2016). This form of ICC is a reliability estimate of the absolute agreement of each observer’s rating, allowing for the generalization of results to other raters who possess the same characteristics. Interrater reliability was excellent for the *Reactivity* and *Dysphoria* scales (ICC = .91, $p < .001$; ICC = .88, $p < .001$).

Outcome 2: Parent Report of Child Emotion Dysregulation. Parent report of child ED was assessed using the 24-tiem *Emotion Regulation Checklist* (ERC; Shields & Chichetti, 1997).

The ERC measures the frequency of child behaviours on a 4-point scale of (1= 'rarely/never to 4= 'almost always') and consists of two subscales: *Lability/Negativity* and *Emotion Regulation*. The *Lability/Negativity* subscale was used for the current study, as it aligns more closely with the items from the EDI. This scale measures reactivity, mood swings, and negative emotional expression, with high scores indicating high negative affect. The ERC has been used in several studies investigating the ways in which children with autism manage their emotions, as reported by their parents (e.g. Berkovits, Eisenhower, & Blacher, 2017; Weiss et al., 2018). For the current sample, internal consistency for the ERC *Lability/Negativity* scale was good ($\alpha = 0.87$), with scores ranging from 23 to 37 ($M = 37.27$, $SD = 7.19$).

Child Factors

Autism Symptomology. The *Social Responsiveness Scale – Second Edition* (SRS-2; Constantino & Grueber, 2012) was used to measure social communication and autistic mannerisms. The SRS-2 is 65-item rating scale measuring deficits in social behaviour associated with autism, as outlined in the *Diagnostic Statistical Manual of Mental Disorder – 4th Edition* (DSM-IV, American Psychiatric Association, 2000). The scale consists of five subscales: Social Awareness, Social Cognition, Social Communication, Social Motivation, and Restricted Interests and Repetitive Behaviour, and a total score. For the purpose of this study, the Social Communication (SRS-SC) and Restricted Interests and Repetitive Behaviour (SRS-RIRB) subscales will be used as indices of child autism symptomology. Higher scores indicate greater social communication difficulties, and more severe restricted interests & repetitive behaviour. The SRS-2 has adequate internal consistency (between .94 and .96) and interrater reliability (.77 for the school-age group). There is also extensive validity data, including predictive validity (sensitivity = .92, and specificity = .92) and mean difference data (Cohen's $d = 2.7$). For the

current sample, internal consistency for the SRS-SC subscale was good (α = 0.81), with scores ranging from 18 to 62 (*M* = 30.43, *SD* = 8.26). Internal consistency for the SRS-RIRB subscale was adequate (α = 0.70), with scores ranging from 9 to 29 (*M* = 18.68, *SD* = 5.00).

Executive Functioning Difficulties. The *Behavior Rating Inventory of Executive Function Parent Form – Second Edition* (BRIEF-2; Gioa, Isquith, Guy & Kenworthy, 2015) is a parent report of children's executive function difficulties. In the current study, the BRIEF Cognitive Regulation Index (BRIEF-CRI) was used to index child executive function difficulties. This index includes 5 subscales: Initiate (ability to begin a task and generate ideas), Working Memory, Plan/Organize, Task-Monitor (ability to assess performance in order to achieve goals), and Organization of Materials. The reliability coefficients for the BRIEF-2 Parent Form are above .90, and it is correlated with other measures of behaviour, including the Cognitive Behaviour Checklist (CBCL; Achenbach & Rescorla, 2001) and the Behaviour Assessment System for Children parent report (BASC; Reynolds & Kamphaus, 2004). The BRIEF-CRI *t*-scores ranged from 45 to 80 (*M* = 67.26, *SD* = 8.28).

Physiological Regulation (EDA Variability). Participants' physiological regulation was assessed via the variability of EDA responses during the emotion eliciting task MTPT task. EDA variability indexes short term fluctuations in the phasic component of EDA (Fenning et al., 2017). Children's EDA responses were collected using a wireless wristband sensor (Q-Sensor, Affectiva Inc., Waltham, MA) specifically designed to support mobile collection. Sensors were placed on the inner side of the child's wrist and secured in place with a wristband, referred to as a "spywatch." Throughout these tasks, EDA was recorded in microsiemens (*us*) at 8 Hz (Picard et al., 2016). These sensors use Ag/AgCl dry disc electrodes and data are collected and stored

within the sensor itself. Data was initially processed using Q Software (Affectiva, 2014). Children were video recorded during the MTPT, and session videos were viewed in order to match time stamps from the Q-sensor files with timing of the MTPT phases. Subsequently, MTPT videos were viewed to identify any significant movements made by children, and motion artifacts were subsequently removed from EDA files. EDA data files were trimmed to align with the 4 phases of the MTPT task (easy, medium, hard & test). Following methods employed by Kleckner et al. (2017), data points were removed if they met any of the following criteria: EDA was out of range (not within 0.05 – 60 *us*); EDA level changed too quickly (faster than +/- 10 *us* per second); temperature was out of range (not within 30 – 40 degrees C); EDA data were surrounding (within 5 seconds) of invalid data portions.

Following data trimming and cleaning, the mean and standard deviation of EDA level (EDA variability) were calculated in excel, and subsequently imported into SPSS. EDA variability was calculated across the practice phases of the MTPT, excluding the test phase. This was due to the fact that the timing of test phases could not be held constant between children. The standard deviation of EDA level has been used in the literature as a measure of EDA variability to index autonomic regulation (Dobrenz et al., 2011; Fenning et al., 2017). A total of 35 participants had usable EDA data. The mean EDA level across phases ranged from .04 *us* to 10.77 *us* (*M* = .1.33, *SD* = 2.3). EDA variability ranged from .0001 *us* to .58 *us* (*M* = .07, *SD* = .12). EDA variability scores were log transformed to account for heavy positive skew (Boucsein, 2012).

Parent Factors

Parental Stress. Parent stress levels were assessed using the *Depression Anxiety Stress Scales-21* (DASS-21; Lovibond & Lovibond, 1995). The DASS-21 is a 21-item measure of depression, anxiety and stress in the past week, with items rated on a scale of 0 ("Did not apply to me at all") to 3 ("Applied to me very much or most of the time"). The measure includes three 7-item scales: *Depression, Anxiety,* and *Stress.* For the current study, only the *Stress* subscale (DASS-Stress) was used (e.g. "I found it hard to wind down," and "I tended to overreact to situations"). The 7 items on the stress scale are summed (possible scores ranging from 0 to 21), with higher scores indicating greater levels of stress. The internal consistency, convergent validity, and divergent validity of the DASS-21 scales are similar across cultural groups (Norton, 2007). The DASS-Stress subscale has demonstrated excellent internal consistency for a typically developing group of adults in the United Kingdom ($\alpha = 0.90$ for stress). In the current sample, internal consistency for the DASS-Stress subscale was good ($\alpha = 0.88$), and scores ranged from 0 to 19 ($M = 7.05$, $SD = 4.12$).

Mindful Parenting. Mindful parenting was assessed using the *Bangor Mindful Parenting Scale* (BMPS; Jones et al., 2014). The BMPS is a 15-item questionnaire measure of mindfulness in the parenting role. The BMPS is comprised of 5 subscales: *Acting with awareness*, *Non-reactivity*, *Non-judgment*, *Observing*, and *Describing.* We did not intend to use the subscale scores, but rather the *Total Score,* which represents the general tendency to be mindful in parenting contexts. This measure has been found to have strong construct validity (Jones et al., 2014). In the current sample, internal consistency for the BMPS was good ($\alpha = 0.85$), with scores ranging from 45 to 80 ($M = 67.26$, $SD = 8.28$).

Control Variables. Two *demographic* variables were considered as potential covariates: child age and child IQ (see Table 1 for details). Gender was not considered as a covariate, given the small number of girls in the current sample (n = 7). Child age was reported by parents in a general demographics form, and child IQ was be measured using the WASI-II, as outlined below.

Procedures

Prior to being randomized for the larger SAS:OR trial, children and their parents came to York for two research assessment sessions. Seeing as children between the ages of 8- and 13-years-old were recruited, we obtained informed consent from caregivers as well as assent from children. Children were informed that all information gathered in the study would be kept confidential, with the exception if there was any indication that the child was being harmed or planned to harm him/herself or others. All participants were assigned a study identification code. All data contained only this Study ID, and no identifying information. All data were kept in a locked metal filing cabinet and on a secure server in the principal investigator's lab space at York University. Only research staff and graduate students had access to this cabinet and server.

Before the research visits, parents completed the SRS-2 and BRIEF-2 online via Qualtrics. During the first session, parents worked with one research assistant to complete the demographics form, in addition to other measures being collected for the trial more broadly. Children worked with another research assistant completing the WASI-II. In the second research visit (which was within one week of the first visit), children completed the video-taped MTPT frustration task. Other measures were collected during this visit, but were not considered for this study. Each of these research assessment sessions took approximately 2 hours.

Data Analysis

Statistical analyses were completed using IBM SPSS Version 26.0 statistical software. Prior to evaluating the main research questions, measures were examined to determine distribution of scores and internal consistency. First, statistical assumptions of normality, linearity, and homoscedasticity were inspected, and each variable was inspected for univariate outliers. Data points were considered outliers and removed if three standard deviations or more from the mean, and if removal improved the distribution upon visual inspection of boxplots (Osborne & Overbay, 2004). Since the behavioural coding items were rated using an ordinal scale and score distributions tended to be skewed, Spearman's rho correlations were calculated to evaluate associations among variables.

Spearman-rho correlations were first calculated to measure bivariate associations between parent & child characteristics (i.e., SRS-CI, SRS-RIRB, BRIEF-CRI , EDA Variability, BMPS, DASS Stress), and observed and parent-reported ED. Multicollinearity of predictor variables was considered by examining correlations among parent and child factors. Two hierarchical regressions were conducted to assess whether the child- and parent-level variables predicted child observed ED and parent-reported ED, respectively (hypotheses 1.a & b, and 2. a & b). In order to control for child age and IQ, these variables were entered in the first step of each regression, followed by the child and parent variables in the second step. To explore the third question, PROCESS macro (Hayes, 2013) was used in SPSS to assess whether parent stress and mindful parenting moderated the relationship between child level factors (those that were significantly associated with ED outcomes), and child observed and parent-report of ED. In these analyses, I used PROCESS Model 1. Due to the limited sample size, 5000 bootstrap samples

were drawn as an estimate of effects, and products were mean centered for moderation analyses. Due to the limited sample size, child age and IQ were not entered as covariates in moderation analyses.

Results

Bivariate Correlations Among Variables

Spearman's rho correlations were conducted to investigate the relationships among all predictor variables and observed & parent report of ED. Notably, observed ED (EDI), and parent report of ED (ERC-LN), were not significantly associated with each other, $r_s(44) = .13$, $p = .40$. As shown in Table 2, observed ED (EDI) had no significant associations with any of the predictor variables. Parent report of ED (ERC-LN) was significantly associated with child social communication difficulties (SRS-SC; $r_s(44) = .43$, $p = .001$, child restricted interests and repetitive behaviours (SRS-RIRB), $r_s(44) = .68$, $p < .001$, child executive function difficulties (BRIEF-CRI), $r_s(43) = .33$, $p = .03$, parent stress (DASS-Stress) $r_s(44) = .30$, $p = .05$, and mindful parenting (BMPS), $r_s(44) = -.31$, $p = .04$).

Additionally, some of the predictor variables were significantly related to each other. There was a strong correlation between child social communication difficulties (SRS-SC), and restricted and repetitive behaviour (SRS-RIRB), $r_s(44) = .63$, $p < .001$. There were also moderate associations between parent report of executive function difficulties and parent report of child autism symptoms, with $r_s(43) = .33$, $p = .03$ for the SRS-SC subscale, and $r_s(43) = .44$, $p = .003$ for the SRS-RIRB subscale. Additionally, there was a moderate negative correlation between parent report of social communication difficulties and mindful parenting, $r_s(44) = -.31$,

p = .04. Finally, parent report of their own stress was negatively associated with mindful parenting, r_s (44) = -.56, p < .001.

Table 2
Correlations Among Predictor and Dependent Variable

	Predictor Variables							Dependent Variables	
	2 (n = 44)	3 (n = 44)	4 (n= 44)	5 (n = 43)	6 (n = 35)	7 (n = 44)	8 (n = 44)	EDI (n = 44)	ERC-LN (n = 44)
1.Age	-.13	.16	.08	.03	-.31	-.03	.131	- .14	-.02
2. IQ		-.25	-.16	-.24	.09	.21	-.43**	.18	.16
3. SRS-SC			.63**	.33*	-.14	.14	-.31*	.03	.43**
4. SRS-RIRB				.44**	-.14	.26	.26	-.14	.68**
5. BRIEF-CRI						-.004	.14	.02	.33*
6. EDA Variability						-.07	.21	.20	-.01
7. DASS Stress							-.56**	.08	.30*
8. BMPS								-.22	-.31*

Note. EDI = Observed emotion dysregulation coded using the Emotion Dysregulation Inventory; ERC-LN = Emotion Regulation Checklist – Lability/Negativity subscale; SRS-SC = Social Responsiveness Scale – Social Communication Subscale; SRS-RIRB = Social Responsiveness Scale – Restricted Interests and Repetitive Behavior Subscale; BRIEF-CRI = Behavior Rating Inventory of Executive Function Parent Form – 2nd Edition – Cognitive Regulation Index; EDA Variability = standard deviation of electrodermal activity; DASS = Depression Anxiety Stress Scales-21; BMPS = Bangor Mindful Parenting Scale.
** p < .01, * p < .05

Hierarchical Regression

Hierarchical linear regressions were conducted to determine whether child factors (autism symptomology, executive function difficulties, & EDA variability) and parent factors (parental stress and mindful parenting) predicted observed and parent reported of ED, as shown in Table 3.

Parent Report of ED (ERC-LN). Controlling for age and IQ, the overall model significantly predicted parent report of ED, $F(8, 26) = 4.65$, $p = .001$, accounting for 46% of overall variance. At the same time, only child *Restricted Interests & Repetitive Behaviours* (SRS-RIRB) emerged as a unique predictor, $p = .01$, $sr^2 = .11$.

Observed ED (EDI). Controlling for age and IQ, the overall model did not significantly predict observed ED, $F(8, 26) = 1.77$, $p = .13$, accounting for 15% of the overall variance. *Restricted Interests & Repetitive Behaviours* (SRS-RIRB) emerged as a unique predictor, $p = .03$, $sr^2 = .13$, and *Mindful Parenting* (BMPS) had marginal significance, $p = .05$, $sr^2 = .11$.

Table 3

Hierarchical Linear Regressions Predicting Observed Parent Report of ED by Child and Parent Factors (n = 35)

Predictor	Unstandardized coefficient		Standardized coefficient	*p*	*F*	Adjusted R^2
	B	*SE*	β			
ERC (Parent Report ED)	-	-	-	**.001**	4.65	.46
Constant	- .61	1.28	-	.64		
Age	0.01	0.04	.02	.90		
IQ	0.01	0.01	.35	**.04**		
SRS-SC	0.01	0.01	.19	.27		
SRS-RRBI	0.05	0.02	.48	**.01**		
BRIEF-CRI	0.01	0.01	.13	.42		
EDA Variability	0.04	0.09	.07	.51		
DASS Stress	.12	0.12	.16	.31		
BMPS	0.01	0.02	.07	.73		
EDI (*Observed ED*)	-	-	-	.13	1.77	.15
Constant	3.14	2.83	-	.28		
Age	- 0.02	0.09	- .04	.82		
IQ	- 0.002	0.01	.05	.83		
SRS-SC	0.03	0.02	.32	.15		
SRS-RIRB	- 0.09	0.04	- .51	**.03**		
BRIEF-CRI	0.02	0.02	.21	.29		
EDA Variability	0.25	0.19	.23	.21		
DASS Stress	- 0.24	0.26	- .18	.37		
BMPS	- 0.05	0.03	- .51	**.05**		

Note. SRS-SC = Social Responsiveness Scale – Social Communication Subscale; SRS-RIRB = Social Responsiveness Scale – Restricted Interests and Repetitive Behavior Subscale; BRIEF-CRI = Behavior Rating Inventory of Executive Function Parent Form – 2nd Edition – Cognitive Regulation Index; EDA Variability = standard deviation of electrodermal activity; DASS = Depression Anxiety Stress Scales-21; BMPS = Bangor Mindful Parenting Scale.

Moderation Analysis

In order to explore Question 3, simple moderation analyses (Hayes Process model 1) were conducted to assess whether parental stress and mindful parenting moderated the association between each significantly correlated child factor (social communication difficulties, restricted interests and repetitive behaviour, and executive functioning difficulties) and parent report of ED (ERC-LN). Due to the non-significant associations between predictors and observed ED (see Table 2), the following moderation analyses focused on predictors of parent report of ED only.

Parental Stress

As seen in Table 4, each of the three full models were significant. Social communication (SRS-SC) and restricted interests and repetitive behaviours (SRS-RIRB) each emerged as significant unique predictors in their respective models. Child executive function difficulties (BRIEF-CRI) did not emerge as a unique predictor. Parental stress (DASS-Stress) emerged as a unique predictor in this model when controlling for child executive function difficulties, but not in the other two models. The interaction terms for parental stress and each of the child factors were not significant, indicating that there were no moderation effects.

Table 4

Parental Stress as a Moderator of Child Factors & Parent Report of ED

Variable	*B*	*SE*	*p*	*F*	R^2
Predictor: SRS-SC (*n* = 44)	-	-	**.005**	4.94	.27
Constant	2.50	.07	< .001		
SRS-SC	.03	.01	**.008**		
DASS Stress	.17	.11	.14		
SRS-SC x DASS Stress	-.01	.01	.50		
Predictor: SRS-RIRB (*n* = 44)	-	-	**< .001**	11.63	.46
Constant	2.49	.06	**< .001**		
SRS-RIRB	.06	.01	**< .001**		
DASS Stress	.15	.09	.11		
SRS-RIRB x DASS Stress	-.004	.02	.78		
Predictor: BRIEF-CRI (*n* = 43)	-	-	**.03**	3.26	.20
Constant	2.47	.07	< .001		
BRIEF-CRI	.02	.01	.08		
DASS Stress	.24	.11	**.03**		
BRIEF-CRI x DASS Stress	.0004	.01	.98		

Note. SRS-SC = Social Responsiveness Scale – Social Communication Subscale; SRS-RIRB = Social Responsiveness Scale – Restricted Interests and Repetitive Behavior Subscale; BRIEF-CRI = Behavior Rating Inventory of Executive Function Parent Form – 2nd Edition – Cognitive Regulation Index; DASS = Depression Anxiety Stress Scales-21.

Mindful Parenting

As seen in Table 5, each of the full models were significant. Social communication (SRS-SC), restricted interests and repetitive behaviours (SRS-RIRB), and child executive function difficulties emerged as significant unique predictors. Mindful parenting (BMPS) did not emerge as a unique predictor when controlling for social communication and restricted interests and

repetitive behaviours, though it did when controlling for child executive function difficulties. Again, interaction terms for mindful parenting and each of the child factors were not significant.

Table 5

Mindful Parenting as a Moderator of Child Factors & Parent Report of ED

Variable	*B*	*SE*	*p*	*F*	R^2
Predictor: SRS-SC (n = 44)	-	-	**.004**	5.32	.29
Constant	2.47	.07	< .001		
SRS-SC	.02	.01	**.006**		
BMPS Total Score	-.014	.01	.19		
SRS-SC x BMPS	-.001	.001	.38		
Predictor: SRS-RIRB (n = 44)	-	-	**< .001**	11.5	.46
Constant	2.49	.06	**< .001**		
SRS-RIRB	.06	.01	**< .001**		
BMPS Total Score	-.014	.01	.13		
SRS-RIRB x BMPS	.004	.002	.85		
Predictor: BRIEF-CRI (n = 43)	-	-	**.02**	3.94	.23
Constant	2.47	.07	**< .001**		
BRIEF-CRI	.02	.01	.06		
BMPS	-. 03	.01	**< .001**		
BRIEF-CRI x BMPS	.0001	.001	.93		

Note. SRS-SC = Social Responsiveness Scale – Social Communication Subscale; SRS-RIRB = Social Responsiveness Scale – Restricted Interests and Repetitive Behavior Subscale; BRIEF-CRI = Behavior Rating Inventory of Executive Function Parent Form – 2nd Edition – Cognitive Regulation Index; BMPS = Bangor Mindful Parenting Scale.

Discussion

Previous studies on emotion regulation in children with autism have largely relied on assessing ED using one method of measurement (Weiss et al., 2014). It has been suggested that using a combination of method types (i.e. observational-methods, informant-report,

physiological methods) is most conducive to elucidating the multidimensional nature of ER (Adrian et al., 2011). The Emotion Dysregulation in ASD model suggests characteristics related to autism, such as poor social communication, executive functioning difficulties, and differences in physiological arousal may underlie the ED experienced by this group (Mazefsky et al., 2013). Additionally, it has been suggested that parent factors, such as parental stress and mindful parenting, may contribute to parents' capacity to aid in their child's ER development (Chan & Neece, 2018; Jones et al., 2014). The current study examined the role of child autism related characteristics (autism symptomology, executive functioning difficulties, and physiological regulation) and parent factors (parental stress, mindful parenting) in observed and parent reported child ED. Additionally, we explored the possibility of interactions between parent and child factors in their association with child ER abilities. To our knowledge, this is the first study to explore associations among child autism factors, parent factors and child ER using multiple methods.

Behavioural Observation & Parent Report

True to the notion that multiple methods of measuring ED may reflect different constructs, the current study found that parent report of child ED (emotional lability & negativity) and behavioral observation of ED during a frustrating task were only weakly associated with each other, and not at the level of statistical significance. Additionally, these two ED variables displayed different patterns of relationships with child and parent factors. This suggests that the lab-based frustration task used in the current study may not be reflective of the daily situations that elicit ED observed by parents. Specifically, the frustration task took place in a lab environment in the presence of one research assistant, which might have elicited a different

ED response in children than would be seen regularly by parents. This weak association highlights the importance of considering how different tasks may elicit different patterns of ED in children with autism, and of considering differences in ED between a controlled lab environment and day-to-day life. Using a multimethod approach allowed us to evaluate how ED in different contexts can be differentially associated with child and parent factors.

Parent Report of Emotion Dysregulation

While restricted and repetitive behaviour was the only unique predictor of parent report of ED in the hierarchical regression analysis, the overall model accounted for a significant portion of variance (46%), suggesting the combined importance of child autism characteristics, and parent stress and mindfulness in explaining parent report of ED. This aligns with the Emotion Dysregulation in ASD model (Mazefsky et al., 2013), which suggests that many characteristics of children with autism underlie the ED experienced in this population. This finding also suggests that it is important to consider factors external to the child, such as factors that may impact parent-child co-regulation, when attempting to better understand ED in youth with autism.

Child factors. As expected, autism symptomology (greater social communication difficulties and more restricted interests/repetitive behaviours), and executive function difficulties were positively associated with parent report of child ED. Restricted interests and repetitive behaviours displayed a strong association, and social communication and executive function difficulties displayed moderate associations. Interestingly, restricted interests and repetitive behaviours emerged as the only unique predictor of parent reported ED in the hierarchical regression model, when other child and parent factors were held constant. This

finding closely aligns with that of Samson and colleagues (2014), who similarly found that while all core aspects of autism symptomology (social communication deficits, restricted and repetitive behaviours, and sensory challenges) were moderately associated with parent report of ED, restricted and repetitive behaviours emerged as the only unique predictor when other factors were considered. One potential explanation for this finding is that dysregulation may trigger compensatory control mechanisms in children with autism, which are expressed as restricted interests, inflexibility to change, and repetitive motor mannerisms (Oschner & Gross, 2008; Samson et al., 2015). Alternatively, it has been suggested that perseveration (a repetitive behaviour) may lead to the development and maintenance of ED (Mazefsky et al., 2012). Additional research using multiple indices of rigidity and ED (i.e., parent report, self-report, behavioural observational) will be needed to examine the specificity of the relationship between these constructs in children with autism. Additionally, longitudinal studies evaluating the impact of ER-focused interventions on child rigidity and ED will help elucidate whether rigidity is an underlying contributing factor to ED in this population, or rather a compensatory response to the ED children with autism are experiencing.

There is also research that explains why ED is associated with social communication difficulties in children with autism. Social communication involves the ability to take others' perspectives both cognitively and affectively (also referred to as theory of mind), and it has been suggested that deficits in theory of mind may lead to difficulty implementing emotion regulation strategies, such as cognitive reframing (Samson et al., 2012). Social communication deficits also involve difficulties perceiving the social and emotional cues of others, which have been suggested to interfere with the appropriate timing and implementation of ER strategies (Mazesfky & White, 2014). Additionally, the difficulty distinguishing and describing emotions

(alexithymia) often found in children with autism has been suggested to play a role in the social communication difficulties experienced by this group (Mazefsky, Kao & Oswold, 2011), and alexithymia has been proposed to make the use of effortful ER strategies more difficult (Barrett et al., 2001; Mazefsky et al., 2011). It is notable that social communication and restricted interests and repetitive behaviours were strongly correlated in the current study, suggesting that shared variance might have prevented social communication from emerging as stronger predictor variable in the regression model.

Research examining associations between executive function difficulties and ED in children with autism is minimal, however there is some evidence that supports the moderate association found between these two constructs. In the current study, executive function difficulties were indexed using the BRIEF-CRI, which assesses parents' perception of their children's challenges with initiation, working memory, planning, task-monitoring, and organization of materials. One review of the literature concluded that individuals with autism experience difficulties attention-shift and working memory (O'Hearn et al., 2008), and it is been suggest that these difficulties with attention-shifting and working memory may contribute to the frustration and ED experienced by those with autism (Cai et al., 2018). It is notable that in the current study, executive function difficulties were moderately associated with restricted interests and repetitive behaviours, suggesting that some aspects of executive function difficulties (e.g., difficulty shifting attention and beginning new tasks) may overlap with these kinds of behaviours, and thus share variance in explaining differences in ED in children with autism. Additionally, it has been found that aspects of ER and executive function during lab-based tasks are supported by overlapping brain regions (Logue & Gould, 2014), and that these regions show atypical patterns of activity in those with autism across a range of executive function tasks

(Minshew & Keller, 2010). It is notable that these brain-based studies used performance-based measures of executive function, whereas the current study used informant report. These different measures appear to capture different levels of cognition, with performance-based tasks measuring efficiency of cognitive abilities, and informant report assessing success in pursuit of a goal (Toplak, West & Stanovich, 2013). It is thus important that both task-based and informant report measures of executive function be used to tease apart the underlying cognitive mechanisms contributing to ED in children with autism.

Parent factors. As expected, parents who reported higher levels of stress also reported higher levels of ED in their children. Additionally, those who indicated higher levels of mindful parenting reported lower levels of ED. These two parent factors were also negatively associated with one another in the current study. Maternal stress has been associated with child ER difficulties in children with autism (Davis & Carter, 2008), and mindful parenting was related to lower parental stress and lower externalizing symptoms in children with autism (Beer et al., 2013). Our findings also align with the literature demonstrating that mindfulness interventions for parents of children with autism lead to reduced parental stress, and reduced aggression and maladaptive behavior in their children with autism (Singh et al. 2006). At the same time, it is difficult to determine directionality between parent stress and mindful parenting, as well as the direction between these two parent factors and child ED. While the use of mindful parenting strategies, such as awareness in the moment and attention without judgment, may reduce parent stress, it is also likely that parents with lower levels of stress are better able to use these mindful parenting techniques. Keeping in mind the dynamic interplay between child and parent behaviour outlined in the transactional model (Sameroff, 2009), child ED may also heighten parent stress and thus reduce their capacity to parent mindfully. Given that parental stress,

mindful parenting, and child ED were all parent-report measures, it may also be that parents' stress levels and mindful traits impact the ways in which they view their child's behaviours.

Observed Emotion Dysregulation

Child factors. Contrary to expectations, observed ED during a frustrating lab-based task was not significantly correlated with autism symptomology, executive function difficulties, or EDA variability. This pattern differs greatly from that seen for parent report of ED. This lack of association between child autism characteristics and behavioural ED in a lab setting emphasizes the importance of using a multimethod approach when exploring associations between child characteristics and ED in children with autism.

Interestingly, when all other variables were held constant in the regression, those who had higher levels of restricted interests and repetitive behaviours displayed less ED during the frustration task. This is the opposite pattern to what was seen for parent report of ED, where higher levels of restricted interests and repetitive behaviours were associated with greater ED. The lab task is a structured, rule-based task; it may be that children with greater rigidity responded more positively to the structured nature of this task than children who display less rigidity. It may also be that children with higher rigidity display more ED in response to daily changes in routine, and less ED during structured tasks. Notably, the frustration task is also a computer-based task. It has been observed that video games can be an absorbent interest for some children with autism, as it has been found that children with autism tend to spend twice the amount of time play video games than do children without autism (Mazurek & Engelhart, 2013). It may be that children with higher levels of restricted interests and repetitive behaviour in our sample have had more exposure to similar frustration eliciting video games than those with fewer restricted interests, and were thus were not as easily frustrated.

Parent factors. While parental stress was correlated with parent report of ED, it was not associated with observed ED during a frustrating task. Interestingly, while mindful parenting was not significantly correlated with observed ED, it emerged as marginally significant negative predictor when all other variables were held constant in the regression analysis. That is, children whose parents reported lower levels of mindful parenting displayed higher levels of ED during the frustration task. This aligns with findings in the literature suggesting that improvement in mindful parenting is related to reduction in child externalizing behaviour (Singh et al., 2006). This is effect is small however, and further research is required to evaluate potential associations between mindful parenting and behavioural ED when a parent is not present. Seeing as though parents were not present during the MTPT task, it may be that the bidirectional effect between parent stress and child ED noted above is not reflected in this specific context.

Electrodermal Variability and Emotion Dysregulation

There was no significant association found between EDA variability during the frustration task, and parent report or observed ED. In fact, there were no significant associations between EDA variability and any of the child or parent factors. This may be due to the small sample size, as typically only moderate associations are found between EDA measures and child characteristics (Baker et al., 2018; Fenning et al., 2017). Additionally, it may be that EDA variability (the standard deviation of EDA level) is not the best choice of measurement to index autonomic nervous system regulation, and that other measures that are used in the EDA literature (such as nonspecific skin conductance responses or specific skin conductance responses) may be better indicators of physiological regulation. While others have found an association between greater EDA variability during emotion eliciting tasks and child autism symptom severity (Fenning et al. 2017), as well as associations between lower EDA mean level and child

externalizing problems in children with autism (Baker et al., 2018), there are no studies to our knowledge that have investigated associations between EDA variability and child ED, specifically.

Studies exploring EDA in children with autism have used various EDA measurements to index physiological arousal, demonstrating inconsistent results. Several studies have failed to find associations between EDA measures (both EDA mean level and specific skin conductance responses) and core symptoms of autism (Louwerse et al., 2013; McCormick et al., 2014). One multi-measure study found that the amplitude of EDA responses was related to parent report of child social skills and problem behaviour in children with autism, but that nonspecific skin conductance responses were not associated with either of these factors (Neuhaus et al., 2015). Inconsistent EDA responses have also been reported in response to social stimuli, with children with autism being found to display heightened responses (Joseph et al., 2008; Kylliainen et al., 2012), and blunted responses (Hubert et al., 2009; Riby et al., 2012), compared to children without autism, as well as no significant differences between the groups (Louwerse at al., 2013). The mixed EDA findings in the literature suggest that future studies should utilize multiple measures of EDA, and that replication of previous findings is required in order to better understand potential differences in physiological regulation for this population.

Limitations & Future Directions

In light of these results, a number of limitations should be considered. Firstly, generalizability of these results may be limited due to the fact that the sample consisted entirely of parents who were seeking treatment for their child's emotion regulation challenges. As such, parents in this group may exhibit different levels of stress or mindful parenting than parents who are not seeking treatment. Additionally, all children had an IQ of at least 79, and the presence of

at least one mood, anxiety, or behavioural disorder. It is thus unclear whether the current findings might differ for children with autism with lower levels of intellectual functioning, or those without clinical levels of mental health challenges. Regression analyses would have had increased power with a larger sample size, leading to the possibility of Type II error in the current study. The sample size for the hierarchical regressions was particularly low (N =35), due to the fact that only 35 out of the 44 participants had usable EDA data. EDA data was lost as a result of data collection issues (e.g. sensor malfunction, poor connection on wrist, child sensitivity to the watch, and corrupted files).

There are other important considerations with regard to the EDA data in this study. Skin temperature and motor movement have been highlighted as possible moderators of EDA response in recommendations of best practice (Boucsein, 2012). Due to our small sample size, we chose to not to include these two variables in our analyses. However, we inspected both temperature and movement qualitatively, as outlined in the Methods section. Additionally, there are a number of other EDA measurement methods, in addition to EDA variability, that are suggested to index physiological regulation (i.e. nonspecific skin conductance responses, skin conductance level; Boucsein, 2012). While this study would have benefited from investigating different EDA measurements, due to the small sample size and time constraints, we chose to only examine the standard deviation of EDA level (EDA variability).

Conclusion

There is a critical need to better understand emotion regulation difficulties experienced by children with autism, considering the implications that ED has for mental health and wellness. The different patterns of association found between observed and parent report of ED in the current study highlight the importance of employing a multimethod approach when exploring

factors that contribute to child ER. While associations were found between parent report of ED and child and parent factors, these same patterns were not found for observed ED during a frustrating lab task, suggesting that the factors contributing to ED for children with autism may vary across contexts. The exploration of EDA as an index of physiological regulation ultimately led to more questions than answers, highlighting the need for greater methodological control and strict replication of previous EDA studies involving children with autism. Our findings suggest that autism symptomology, parental stress, and mindful parenting are important factors to consider when exploring ER.

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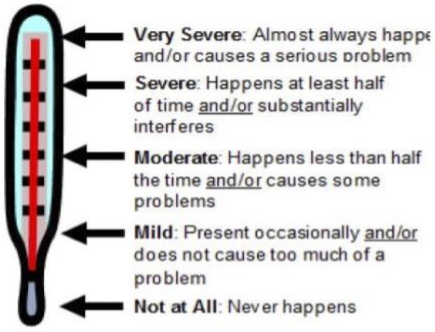
Appendix A: Behavioural Coding Scheme for Frustration Task

EDI Behaviour Coding Guide



(Mazefsky et al., 2016)

Notes for Coding:

- Keep in mind the **severity**, **frequency**, and the extent to which the behaviour **interferes** with completing the task.
    - However, a behaviour need not interfere with the task in order for it to be considered severe. For example, a child may have a "Very Severe" outburst (angry, loud etc.) and continue to work on the task.

How much of a problem was this during this phase of the Mirror Tracing Task?

REACTIVITY

Items	Coding Explanation
3. Has explosive outbursts	**Not at all:** No explosive outbursts occur. **Mild:** Mild exclamations of frustration or behaviours demonstrating frustration in response to task. Does not cause too much of a problem. **Moderate:** Moderate exclamations of frustration in response to task. Child may stop momentarily and then return to completing task. **Severe:** Emotionally valenced response to task (angry and/or sad). Volume of child's voice may increase. This response may substantially interfere with working on the task. **Very Severe:** Very emotionally valenced response to the task (angry and/or sad). Volume of child's voice increases. Child may bang the table, throw hands up in the air, or stand up. This outburst may cause a serious problem in completing the task.
4. Cries or appears angry throughout the activity.	**Not at all:** Does not appear angry or distressed. **Mild:** Mild expression(s) of frustration/distress but this does not cause too much of a problem. **Moderate:** Child appears frustrated/distressed. This may cause some problems with completing the task. **Severe:** Child is angry/distressed for a prolonged period. This may substantially interfere with completing the task. **Very Severe:** Child is very angry/distressed for a prolonged period. This may cause a serious problem in completing the task.

EDI Behaviour Coding Guide

19. Has extreme or intense emotional reactions *Keep in mind that these can be positive or negative emotional reactions	**Not at all:** No emotional reactions. **Mild:** Mild emotional reaction(s). Child may say they are feeling distressed/frustrated, but this may not have been apparent otherwise. This does not cause much of a problem completing the task. **Moderate:** Child has emotional reaction(s) to the task, but these reactions are not extreme. This may cause some problems completing the task. **Severe:** Intense/extreme emotional reaction(s) to the task. This may cause a substantial interference in completing the task. **Very Severe:** Very intense/extreme emotional reaction(s) to the task. This may cause a serious problem completing the activity.
21. Hard to calm him/her down when mad or upset *It is hard for the RA to calm the child down	**Not at all:** The child is not mad or upset, or calms down immediately when the RA comforts/encourages him/her. **Mild:** It takes a moment for the child to calm down in response to RA, but this does not cause too much of a problem. **Moderate:** It is somewhat difficult for the RA to calm the child down. It may take a few attempts of encouragement or suggestions form the RA before the child calms. This may cause some problems competing the task. **Severe:** It is very difficult to calm the child down. The child only calms down after the RA makes many attempts to calm the child. This may substantially interfere with completing the task. **Very Severe:** Child does not calm down in response to RA when mad or upset. Child's reactions may escalate following the RA attempting to calm the child down.
34. Emotions go from 0 to 100 instantly *Note that these can be positive or negative emotions	**Not at all:** Emotions do not change. **Mild:** Mild changes in emotions, but this does not cause too much of a problem. **Moderate:** Quick changes in emotions, however these changes are moderate (not extreme). These changes may cause some problems completing the task. **Severe:** Very quick and palpable changes in emotions. These changes may substantially interfere with the task. **Very Severe:** Very quick and extreme changes in emotions. These changes may cause serious problems in completing the task.
36. Has trouble calming him/herself down	**Not at all:** Child does not require calming down, or calms down without any difficulties. **Mild:** It takes a moment for the child to calm him/herself down, but this does not cause too much of a problem. **Moderate:** t is somewhat difficult for the child calm him/herself down. This may cause some problems competing the task. **Severe:** It is very difficult for the child to calm him/herself down.

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	This may substantially interfere with completing the task. **Very Severe:** Child cannot seem to calm him/herself down. Child's reactions may escalate throughout this phase rather than calm, and this may cause serious problems completing the task.
46. Reactions are usually more severe than the situation calls for *Keep in mind that this task is meant to be difficult/frustrating. If the child says, "This is hard" or "That sound is annoying," pay attention to how they are saying these statements. If they say these types of statements as a matter of fact, this is not more severe than the situation calls for. If they say statements like this with a loud/angry or sad tone, this is more severe. *Some children may be more sensitive to the sound in the task than others. For coding purposes, we cannot interpret how different children experience this sound differently.	**Not at all:** Reactions are not more severe than the situation calls for. **Mild:** Reactions may be slightly more severe than the situation calls for and/ or do not cause too much of a problem in completing the task. **Moderate:** Reactions are more severe than the situation calls for, but not extremely so. These reactions may cause some problems completing the task. **Severe:** Reactions are much more severe than the situation calls for. These reactions may cause substantial problems completing the task. **Very Severe:** Reactions are extreme and much more severe than the situation calls for. These reactions may cause serious problems completing the task (ie. Child is very angry or distressed to the point of refusing to do the task.)

DYSPHORIA

Items	Coding Explanation
31/43. Does not seem to enjoy any aspects of the activity/Very few aspects of the activity make him/her happy. *What the child says and how they say it may not match. For example, the child may say, "This hard," but say this while smiling. Keep in mind both the content of speech and how it was said when assessing enjoyment of the activity. *Child may show enjoyment and dislike towards the activity during one phase. However, the focus of this item is enjoyment of the activity. If child shows any enjoyment related to the task, must score a "Not at all" or "Mild."	**Not at all:** Child enjoys parts of the activity. Smiles/is happy in response to achieving something in the task. **Mild:** Child appears neutral towards the activity or shows mild enjoyment in response to parts of the task. **Moderate:** Child does not seem to enjoy any aspects of the task and may indicate disliking the activity. This may cause some problems competing the task. **Severe:** Child does not enjoy any aspects of the activity and demonstrates that he/she actively dislikes the activity. This may substantially interfere with completing the activity. **Very Severe:** Child does not enjoy any aspects of the activity and demonstrates an intensely dislikes the activity. This may cause serious problems in completing the activity.
51. Refuses to do the activity	**Not at all:** Child works persistently on the activity. **Mild:** Child may indicate not wanting to complete the activity or disliking it. "Why do we have to do this?" But this does not cause too much of a problem completing the task. i.e. May only stop task for a second or two. **Moderate:** Child indicates wanting to stop the task. This may cause some problems in completing the task, but child does return to working on task.

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	Severe: Child refuses to do the task for a large portion of the phase. This substantially interferes with completing the task. **Very Severe:** Child is persistent in their refusal to do the task and this causes serious problems completing the task. For example, the child may stop the task early.
57. Not responsive to praise or good things happening in the task	**Not at all:** Child responds positively to doing well on the task or praise from the RA. **Mild:** Child only sometimes responds to praise or good things happening in the task, but this does not cause too much of a problem. **Moderate:** Child does not respond to praise or good things happening in the task. This may cause some problems in completing the task. **Severe:** Child does not respond to praise or good things happening in the task, and this may happen persistently throughout the task. This may cause substantial problems in completing the task. **Very Severe:** Child does not respond to praise or good things happening in the task. Child may respond negatively to encouragement/praise from RA. This may occur for the majority of the task and/or cause serious problems in completing the task.
63. Seems sad or unhappy	**Not at all:** Child appears happy/neutrally valenced. **Mild:** Child appears neutral valenced, and/or mildly distressed at points. This does not cause too much of a problem completing the task. **Moderate:** Child appears sad/distressed at points, and this may cause some problems completing the task. **Severe:** Child appears sad and unhappy. Child may seem sad/unhappy for a substantial portion of the phase and/or this may cause substantial problems completing the task. **Very Severe:** Child appears very sad/unhappy/distressed. This may occur for the majority of the task and/or may cause serious problem completing the task.
64. Appears uneasy	**Not at all:** Child does not appear uneasy during the activity. Appears content and/or focused. **Mild:** Child may appear slightly uneasy at points, but this does not cause too much of problem completing the task. **Moderate:** Child is uneasy (dislikes noise or finds the task difficult. This may cause some problems completing the task. **Severe:** Child is uneasy (distressed, really dislikes sound). This may occur for a large portion of the phase and/or may substantially interfere with completing the task.

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	Very Severe: Child is very uneasy (finds the task very distressing). This may occur for almost the entirety of the phase and/or may cause serious problems completing the task.

Coding based on:

- The Emotion Dysregulation Inventory – Progress Monitory Version (Mazefsky et al., 2016).
    - This is a caregiver-report questionnaire used to measure emotion dysregulation in children with autism across a range of functioning
- We have adapted items 4, 31, 43, 51, and 64 so that they are more applicable to the frustration task.
- We combined items 31/43 for coding purposes, as these items address the same thing within the task.

Original Codes:
*The codes that have been altered are in bold.

Reactivity:

3. Has explosive outbursts
4. Cries or stays angry for more than 5 minutes.
19. Has extreme or intense emotional reactions.
21. Hard to calm him/her down when mad or upset.
34. Emotions go from 0 to 100 instantly.
36. Has trouble calming him/herself down.
46. Reactions are usually more severe than the situation calls for.

Dysphoria:

31./43. Does not seem to enjoy anything/Very little makes him/her happy.
51. Refuses to leave the house or go to school or activities unless forced.
57. Not responsive to praise or good things happening.
63. Seems sad or unhappy.
64. Appears uneasy through the day.

Appendix B: Behavioral Coding Form for Frustration Task

Emotion Dysregulation Inventory Behavioural Coding

Coder: _____ Date: _____ SAS-OR: _____ Test Phase: ____

Phase Start: (Video)_____ (Clock) _____ Phase End: (Video)_____ (Clock) _____

Reactivity

Items	Not at all	Mild	Moderate	Severe	Very Severe	Notes
3. Has explosive outbursts						
4. Cries or appears angry						
19. Has extreme or intense emotional reactions						
21. Hard to calm him/her down when mad or upset						
34. Emotions go from 0 to 100 instantly						
36. Has trouble calming him/herself down						
46. Reactions are more severe than the situation calls for						

Dysphoria

Items	Not at all	Mild	Moderate	Severe	Very Severe	Notes
31./43. Does not seem to enjoy any aspects of the activity/ Very few aspects of the activity make him/her happy						
51. Refuses to do the activity.						
57. Not responsive to praise or good things happening in the task						
63. Seems sad or unhappy						
64. Appears uneasy						

General Notes: