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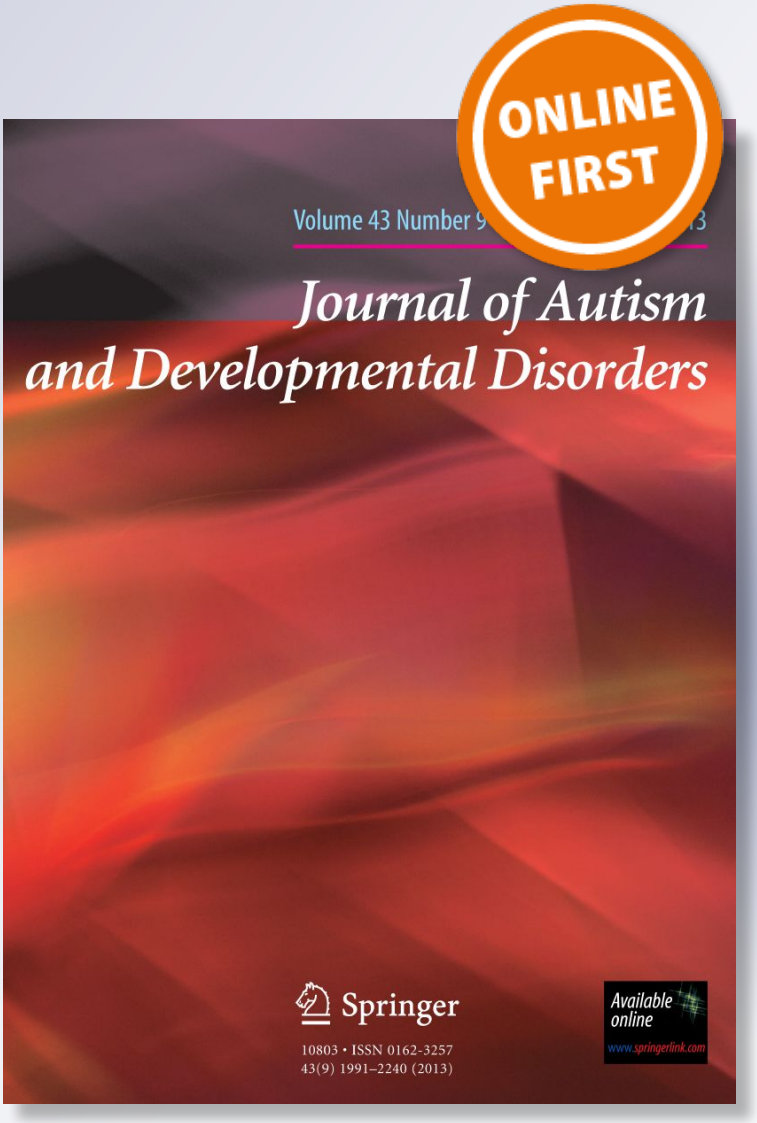

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S.I. : PARENTING CHILDREN WITH ASD

Emotion Coregulation Processes between Mothers and their Children With and Without Autism Spectrum Disorder: Associations with Children's Maladaptive Behaviors

Valentina Valentovich[1] · Wendy A. Goldberg[1] · Dana Rose Garfin[2] · Yuqing Guo[2]

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Abstract
A dyadic microanalysis approach was used to examine emotion coregulation processes in mother–child interactions in relation to children's maladaptive behaviors. Seventy-two mother–child dyads (46 children with Autism Spectrum Disorder (ASD); 26 neurotypical children) were previously videotaped in a semi-structured play procedure at home and mothers reported on children's internalizing and externalizing behaviors. Mother-child interactions were reliably coded in 5-second intervals and analyzed using Space State Grid software. Regression analyses supported moderation, whereby greater dyadic flexibility and more mutual-positive engagements were significantly associated with lower levels of maladaptive outcomes for children with ASD. Results have implications for initiating positive interactions and promoting effective parenting that help improve behavior in young children with ASD.

Keywords Emotion regulation · Problem behaviors · Autism spectrum disorders · Parenting

Introduction

Emotion regulation involves engaging in behaviors and strategies to manage (inhibit, enhance, or maintain) emotional experiences (Calkins and Hill 2007; Thompson 1994). The ability to regulate emotions using effective strategies develops throughout childhood within the context of social interactions. Children and parents engage in a process of emotion coregulation during social exchanges in which parents and children mutually regulate their emotional experiences (Cole et al. 2004; Feldman 2003; Field 1994). Initially, parents play pivotal roles in demonstrating emotion regulation strategies during parent–child interactions (Denham et al. 2011; Kopp 1989). Young children rely on their parents to modify their emotional experiences (e.g., child is physically soothed by being held); as children become older, they increasingly use their own internal regulation strategies (e.g., shifting attention to a different play object when the desired object is not available) (Calkins and Hill 2007; Cicchetti et al. 1991; Kopp 1982, 1989).

Emotion coregulation processes are reciprocal in nature and involve transactions between dyads (Cohn and Tronick 1988; Cole et al. 2004; Field 1994). Parents may engage in various behaviors during interactions to facilitate children's emotion regulation development (e.g., scaffolding, monitoring, responding to child's cues). The engagement states of both parents and children vary in valence; dyads may engage in mutual positive, mutual negative, or mismatched (e.g., child in negative state and mother in positive state) states. The content of emotion coregulation processes differs for children with behavior problems compared to those without such problems. For example, preschool-aged children with conduct problems engaged in more mutual negative (e.g., angry) and mismatched interactions with their mothers relative to children without conduct problems (Cole et al. 2003). Additionally, for preschoolers whose conduct problems improved as they transitioned to school, mother–child interactions were higher in mutual-positive engagement and lower in mutual-negative engagement compared to children who did not improve (Cole et al. 2003), indicating that

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the emotional content of parent–child interactions may be important for managing child conduct problems over time.

Children with Autism Spectrum Disorder (ASD) commonly experience impairments in emotion regulation abilities and social interactions (American Psychiatric Association 2015; Loveland 2005; Mazefsky et al. 2013), which may underlie behavioral problems (Mazefsky and White 2014). Emotion dysregulation, or failure to use efficient emotion regulation strategies, occurs more frequently in individuals with ASD compared to neurotypical (NT) individuals (Samson et al. 2012). Parent reports of emotional experiences indicate that in addition to experiencing more anger and anxiety, children and adolescents with ASD engage in increased maladaptive strategies (e.g., repetitive behaviors) and decreased adaptive emotion regulation strategies (e.g., problem solving) relative to NT children (Samson et al. 2015). Behavioral observations of children with ASD during frustrating tasks also indicate that they use fewer efficient strategies (e.g., distraction) and more maladaptive strategies (e.g., avoidance and venting) compared to NT peers (Jahromi et al. 2012; Konstantareas and Stewart 2006). Of importance, maladaptive strategies tend to be associated with higher levels of internalizing (e.g., anxiety and depression) and externalizing behaviors (e.g., aggression and defiance) for both ASD and NT groups of children (Mazefsky et al. 2014; Rieffe et al. 2011).

Only a handful of studies has examined how various aspects of emotion coregulation between parents and children with ASD are associated with behavioral outcomes, and whether dyads with children with ASD engage in different patterns of regulation relative to dyads with NT children. Ting and Weiss (2017) examined parent co-regulation, child emotion regulation, and child psychopathology in school-aged children with ASD during discussions of negative past events. Greater parental scaffolding (e.g., sensitive responses to child) and the child's knowledge of appropriate emotion regulation strategies were associated with fewer parent-reported externalizing behaviors. Other work has demonstrated that higher levels of parental emotion coaching behaviors (e.g., intervening in situations that cause emotion) were associated with fewer externalizing behaviors in young and school-aged children with ASD (Wilson et al. 2013).

Prior work suggests that parents of children with ASD engage in a similar range of emotion coregulation behaviors as parents of NT children (Gulsrud et al. 2010; Hirschler-Guttenberg et al. 2015) and are equally as responsive and sensitive to children's cues as parents of NT children (Hirschler-Guttenberg et al. 2015; Siller and Sigman 2002). However, parents of children with ASD vary in the frequency of the specific strategies they employ, which may indicate an awareness of and sensitivity to the child's developmental needs. For example, in one study, mothers of children with ASD used active strategies, such as redirecting, prompting, and providing physical comfort, more frequently relative to mothers of NT children during episodes of distress (Gulsrud et al. 2010). Similarly, Hirschler-Guttenberg and colleagues (2015) found that both mothers and fathers of preschool-aged children with ASD engaged in more direct and physical behaviors, such as physical soothing, verbal comfort, and redirection whereas parents of NT children used more cognitive strategies such as emotional reflection and cognitive reappraisal.

State Space Grid

The State Space Grid (SSG) method offers an approach that allows for moment-to-moment analysis of dyadic behaviors (Lewis et al. 1999) and has been used to analyze the behaviors of mothers and children simultaneously (Hollenstein 2007; Hollenstein and Lewis 2006; Sameroff 2009). Rooted in dynamic systems theory (Ford and Lerner 1992), the SSG provides a graphical representation of the dyadic behaviors in real time against all possible combinations of behaviors (Hollenstein 2007). Using the SSG, parent–child behaviors can be examined on two dimensions, structure (i.e., dyadic flexibility) of interactions and content (i.e., dyadic-affect engagement). Dyadic-affect engagement refers to the mutual positive, mutual negative, or mismatched behaviors of parents and children in real time, and dyadic flexibility refers to the degree of movement across various engagements; greater movement indicates flexibility or emotional variability in dyadic interactions (Hollenstein 2007; Hollenstein et al. 2004; Van der Giessen et al. 2015).

The SSG has recently been used to examine emotion coregulation in mothers and children with ASD (Guo et al. 2017); more commonly, it has been used to examine dyadic emotion processes and maladaptive behaviors in high-risk children and children with behavior problems. For example, Hollenstein and colleagues (2004) observed parents and high-risk kindergarteners during various structured activities and examined the flexibility of interactions. Decreased flexibility of dyadic interactions was associated with higher levels of internalizing and externalizing behaviors. Similarly, aggressive children exhibited fewer externalizing behaviors following a family intervention when parent–child interactions increased in flexibility and mutual positive engagements (Granic et al. 2007).

Past research suggests that the structure as well as the content of parent–child interactions are important aspects of emotion coregulation that are associated with maladaptive behaviors in children. Lunkenheimer and colleagues (2011) examined the interaction between mother- and father-child affect engagement and the flexibility of behaviors in predicting maladaptive behaviors for children at risk for conduct problems. Parent–child interactions were observed when children were 3 years old and teacher-ratings of externalizing

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behaviors were obtained after the transition to kindergarten. The results revealed that greater dyadic positive engagement and flexibility interacted in predicting lower levels of externalizing behaviors. It is presently unknown whether interactions between dyadic-affect engagement and dyadic flexibility are indicative of maladaptive behaviors in children with ASD and it is unknown if similar behavior patterns will emerge for children with ASD and NT children.

The Current Study

Previous research has indicated that emotion coregulation during social interactions between mothers and children is important in children's behavioral functioning; however, there is a paucity of research examining these associations in children with ASD. Moreover, past research has not examined how particular aspects of emotion coregulation interact to predict maladaptive behaviors for children with ASD and whether these interactions vary for dyads with and without a child with ASD. The present study implemented a dynamic systems approach, using the SSG, to analyze moment-to-moment emotion coregulation processes during mother–child dyadic interactions. We examined whether two aspects of the emotion coregulation process, dyadic flexibility and dyadic-affect engagement, significantly interact in indicating maladaptive behaviors in children diagnosed with ASD and NT children.

Hypothesis 1

Given that past research documents differences in psychopathology between NT children and children with ASD (Bauminger et al. 2010; Bölte et al. 1999; Kim et al. 2000), we predicted that children with ASD and NT children would vary on levels of maladaptive behaviors. Specifically, we expected children with ASD would have higher levels of maternal-reported maladaptive (i.e., internalizing and externalizing) behaviors relative to NT children.

Hypothesis 2

Mutual-positive and mutual-negative engagements were expected to moderate the associations between dyadic flexibility and maladaptive behaviors. Based on previous research indicating differences in parent–child interactions between dyads with children with ASD and dyads with NT children (Kasari et al. 1990; Sigman et al. 1986), we hypothesized that the associations would vary for dyads with children with ASD and for dyads with NT children; the direction of the associations was exploratory.

Method

Participants

The participants in the present study were 72 mother–child dyads; 46 children were diagnosed with ASD (34 boys and 12 girls; mean age = 5.27 years, *SD* = 1.42 years) and 26 children were NT (17 boys and 9 girls; mean age = 4.34 years, *SD* = 1.12 years). Forty-four percent ($n = 32$) of the participants were Caucasian, 18% ($n = 13$) were Asian, 18% ($n = 13$) were Hispanic, and 19% ($n = 14$) were of mixed ethnicity. Seventy-one percent ($n = 51$) of mothers obtained at least a four-year college degree and 65% ($n = 44$) of families who provided an annual household income ($n = 68$) reported $75,000/year and above.

To be eligible to participate, children with ASD must have received a clinical diagnosis and further confirmation either through the Autism Diagnostic Observation Schedule-2 assessment (ADOS-2; Lord et al. 2012) or the Social Communication Questionnaire (SCQ; Rutter et al. 2003). Seventeen (37%) of the children with ASD came to the University for the ADOS-2 assessment. The ADOS-2 is a standardized assessment of children's social behaviors and communication. An extensively-trained, certified researcher observed and coded children's behaviors during structured and semi-structured play interactions that constitute the ADOS-2. Standardized cut-off scores were used to determine a classification of Autism, Autism Spectrum, or non-spectrum (Lord et al. 2012).

Children with ASD who were not able to come to the University for the ADOS-2 had their clinical diagnosis confirmed by the SCQ, an assessment of ASD symptom severity in children that has well-established reliability and validity (Rutter et al. 2003). Mothers completed the 40-item questionnaire inquiring about their child's behaviors relating to communication, social functioning, and stereotyped and repetitive behaviors throughout his or her lifetime. A cutoff score of 11 has demonstrated adequate sensitivity for pre-school aged children (Allen et al. 2007). Children in the ASD group met or exceed this score.

Procedure

The study was approved by the University's Institutional Review Board. Families of children with and without ASD were recruited through advertisements distributed at local organizations (e.g., medical offices) and at community events (e.g., Walk Now for Autism Speaks) in a large western state as well as through a database of families who previously expressed interest in participating in research studies. Children with ASD were also recruited through

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an online database of families, the Interactive Autism Network (IAN), and through the IAN Community Research Opportunities Bulletin Board.

Families participated in an in-home study session. Prior to the home visit, mothers received a packet of questionnaires and a written informed consent form in the mail. Mothers engaged in semi-structured play activities with their children during the home visit and completed the questionnaires. The mother–child interactions were videotaped for later coding. The current study is based on micro-coding of the recorded videotapes. Mothers received a $25 gift card and children received a small toy after completing the session.

Measures

Demographic Information

Mothers completed questionnaires that inquired about demographic and background information including their age, education level, ethnicity, income level, and occupation. Mothers also provided information on their children's age, gender, and diagnostic and intervention history.

Broader Autism Phenotype

Mothers completed the Broader Autism Phenotype Questionnaire (BAPQ; Hurley et al. 2007), a 36-question assessment of personality and language characteristics that are similar to symptoms of ASD. Items were rated on a 6-point response scale ranging from 1 (very rarely) to 6 (very often) and covered areas such as social personality, rigid personality, and pragmatic language deficits. Higher scores indicated higher levels of ASD characteristics.

Child Maladaptive Behaviors

The Vineland Adaptive Behavior Scales (VABS-II; Sparrow et al. 2005), a standardized measure of children's adaptive and maladaptive behaviors, was used to assess internalizing and externalizing behaviors. The current study used only the maladaptive scale since the focus is on problem behaviors. Mothers completed the VABS-II parent rating form and rated the frequency with which their children engaged in maladaptive behaviors on a 3-point scale ranging from 0 (never) to 2 (often). Internalizing and externalizing behavior index v-scale scores were obtained from the raw scores on the maladaptive behaviors component. The VABS-II has demonstrated reliability and validity (Sparrow et al. 2005).

Mother–Child Emotion Coregulation

Mothers and children were videotaped during the Three Boxes procedure (Tamis-LeMonda et al. 2004; Vandell 1979), a 10-min semi-structured play activity. Mother–child dyads were presented with three boxes that contained toys (e.g., cash register, money, and food) and mothers were instructed to interact with their children as they normally do at home. This procedure was selected because it captures activities that mothers and children normally engage in and uses a standardized set of toys. It also has a long history of validly and reliably eliciting maternal behaviors (e.g., sensitivity) and child behaviors (e.g., child mood, sustained attention, activity level) and it was a key component of the NICHD early childcare research network toolkit (NICHD Early Child Care Research Network 1997, 1999).

The videotaped interactions were later coded for engagement states of mothers and children as a measure of emotion coregulation based on the combination of mutually exclusive behaviors, body postures, attention, facial expressions, and vocalizations. Mother and child behavior cues were coded in five-second intervals using Mangold International's INTERACT 9.47 (Mangold 2007) software program. Children and mothers were coded separately for positive engagement, negative engagement, and disengagement states; each of the engagement states were coded across three levels: low, medium, and high, as defined by the quality and quantity of behaviors and emotions. The behavioral coding schemes were created using an iterative process by researchers until consensus was reached. Pairs of extensively trained research assistants independently coded the mother and child engagement states; inter-coder reliability for the mother engagement states was 91.76% ($k = 0.81$) and the inter-coder reliability for the child engagement states was 91.07% ($k = 0.82$). Disagreements about codes were resolved through discussion.

Child-positive-engagement states were characterized by child's intermittent or full social interaction with their mother or joyful and affectionate interaction as indicated by hugging or kissing; facing, leaning towards, or close proximity to mother; eye contact with the mother or mutual task; and neutral or positive facial expressions. *Child-negative-engagement states* were characterized by child's active or aggressive protesting of the interaction with mother or frustration as indicated by hitting, kicking, or throwing objects; pushing or rejecting interaction with mother; and whining, fussing, complaining, or crying. *Child-disengagement states* were characterized by child's withdrawal from the interaction as indicated by a slumped posture, turning away, or walking away from the interaction; partial or complete shifts in attention away from the interaction; and flat, fearful, or sad affect. *Child-object engagement* was characterized by child's positive engagement with toys (play objects) as indicated by full attention on toys, self-talk, and no social interaction with mother.

Mother-positive-engagement states were characterized by mother's monitoring, scaffolding, or affectionate social

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interaction with her child as indicated by hugging or kissing child; active imaginative play; facing or leaning toward the child; prompting or guiding child; eye contact with child or mutual task; neutral or exaggerated positive facial expression; and sensitivity to child's cues. *Mother-negative-engagement states* were characterized by mother's frustrated, annoyed, or hostile interactions as indicated by guiding child with abruptness or physical force; intrusive behaviors; and minimal, stern, or angry vocalizations. *Mother-disengagement states* were characterized by mother's brief or full withdrawal from the interaction with child or parallel play with toy without interaction with child as indicated by physically turning away or walking away; ignoring child's request; no attention on interaction or shifts away from interaction; neutral or flat facial expression; and self-talk or talking to sibling or research assistant. Copies of the coding schemes are available from the authors.

State Space Grid

The mother and child engagement state codes were imported into the State Space Grid GridWare 1.1. (Lamey et al. 2004), a software program that allows for moment-to-moment analysis of dyadic interactions. The nine mother engagement states are located on the *y*-axis and the ten child engagement states are located on the *x*-axis of the grid. A nine-by-ten matrix of 90 cells was created, which represents all possible dyadic engagement states and each cell represents an engagement state. Region-level variables of dyadic-engagement states and grid-level variables of dyadic flexibility were derived from calculations using the Gridware program.

Dyadic-Affect-Engagement State

The content of emotion coregulation was indicated by dyadic-affect-engagement states. Two regions of dyadic-affect-engagement states were created in the SSG: mother–child mutual-positive engagement and mother–child mutual-negative engagement. *Mutual-positive-engagement states* included mother and child positive engagement states across three levels—low, medium and high. *Mutual-negative-engagement states* included mother–child negative engagement and disengagement states across three levels—low, medium and high. A "visit" in the SSG grid refers to a dyad initiating into a particular engagement state and then leaving that state. The frequency of visits reflects the number of times a dyad moves into and out from a dyadic-affect-engagement state. The frequencies of mutual-positive- and mutual-negative-engagement-state visits were examined; visits were divided by the total duration of time spent in the task to account for any variations in the length of the interactions.

Dyadic Flexibility

The structure of emotion coregulation was indicated by dyadic flexibility. Two grid-level variables of flexibility were derived from the SSG: *dispersion* and *average mean duration (AMD)* of engagement states per visit. *Dispersion* refers to the spread of engagement states across all cells or the distribution of dyadic-affect-engagement states. Dispersion is calculated by summing the squared proportional durations across the 90 cells in the grid and is adjusted for the total number of cells producing a value between zero and one. A value of zero signifies that all engagement states are in one cell and a value of one signifies that the engagement states are distributed equally across possible states in the grid. Thus, greater dispersion indicates more flexibility or emotional variability (Hollenstein et al. 2004; Hollenstein and Lewis 2006; Van der Giessen et al. 2015). *AMD* refers to the average amount of time spent in each visit to a engagement state or perseveration in a dyadic-affect-engagement state. Longer time spent in a state indicates less flexibility or emotional variability (Hollenstein et al. 2004). Together, *dispersion* and *AMD* provide the pattern of dyadic engagement across the grid with greater flexibility indicated by more dispersion and shorter AMD.

Plan of Analysis

Major study variables were examined for the presence of outliers. Scores that were three standard deviations above or below the mean were adjusted; two scores were reduced to three standard deviations above the mean. Variables were screened for skewness and kurtosis. To check for possible covariates, independent samples t-tests and Chi square tests between ASD and NT groups were conducted on child's age and gender, and mother's age, level of education, ethnicity, household income, and BAPQ. Next, bivariate correlations between grid- and region-level variables, maladaptive behaviors, and BAPQ were conducted. Group comparisons of mother–child dyads with children with ASD and NT children were also conducted using t-tests to examine differences in study variables of interest including dyadic-engagement states and dyadic flexibility as well as measures of maladaptive behavioral outcomes. For clarity of interpretation, the region-level variables (*mutual-positive-engagement-state* visits and *mutual-negative-engagement-state* visits) were not divided by total duration in the t tests and correlations.

Regression analyses were then conducted separately for ASD and NT samples to examine indicators of two outcomes: internalizing behaviors and externalizing behaviors. Two grid-level measures of flexibility (*dispersion* and

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AMD), two region-level variables of dyadic-affect-engagement-state visits (*mutual-positive-engagement-state* visits and *mutual-negative-engagement-state* visits), and SCQ scores were used as indicator variables. For each dependent variable, the first regression model tested main effects and the second model included the interaction terms for dyadic flexibility and dyadic-affect-engagement-state visits. Three-way interactions were conducted; however, given the small sample size, final analyses were conducted separately for the two groups to conserve power.

Results

ASD-NT Differences

ASD and NT group comparisons on demographic variables indicated that children with ASD were older than NT children [$t(70) = -2.85$, $p < .01$], and mothers of children with ASD had a higher level of education relative to mothers of NT children [$X^2(5) = 12.37$, $p < .05$]. Groups did not differ by child gender, mother ethnicity, family income, or mother BAPQ ($p > 0.05$). Bivariate correlations, separated by group (ASD and NT), among maladaptive behaviors, dyadic flexibility, dyadic-engagement states, BAPQ, and SCQ are shown in Table 1.

Independent samples *t* tests compared children with ASD and NT children on key study variables (e.g., dyadic flexibility, dyadic-affect-engagement-state visits, maladaptive behavior scores) as shown in Table 2. Dyads with children with ASD had significantly higher dispersion (i.e., more flexibility) and lower AMD (i.e., more flexibility) compared to dyads with NT children. Analyses also revealed that dyads with children with ASD had significantly higher frequencies of mutual-negative-engagement-state and mutual-positive-engagement-state visits relative to dyads with NT children. Children with ASD had significantly higher maternal reported levels of internalizing and externalizing behaviors (i.e., maladaptive behaviors) compared to NT children.

Dyadic Flexibility and Mutual-Positive-Engagement-State Visits

Main effects for measures of dyadic flexibility (i.e., dispersion and AMD) and mutual-positive-engagement-state visits in relation to internalizing and externalizing behaviors for children with ASD are displayed in Tables 3 and 4 (see Model 1 for each set of analyses). A higher frequency

Table 1 Correlation matrix of major study variables for ASD (top row; $n = 46$) and NT dyads (bottom row; $n = 26$)

Study variables	1	2	3	4	5	6	7	8
Maladaptive behaviors								
1. Internalizing	–							
2. Externalizing	0.40**	–						
	0.30							
Dyadic flexibility								
3. Dispersion	0.25†	−0.03	–					
	−0.34†	0.12						
4. AMD	−0.12	0.18	−0.79***	–				
	0.25	−0.06	−0.78***					
Dyadic-affect-engagement states								
5. Mutual-positive-engagement visits	0.40**	−0.04	0.62***	−0.63***	–			
	−0.50**	0.01	0.61***	−0.54**				
6. Mutual-negative-engagement visits	0.13	−0.11	0.69***	−0.56***	−0.28†	–		
	0.02	0.19	0.37†	−0.34†	0.16			
Mother characteristic								
7. BAPQ	0.26†	0.13	0.11	−0.08	0.10	0.26†	–	
	0.21	−0.20	−0.24	0.13	−0.25	−0.35†		
Child characteristic								
8. SCQ	0.56***	0.21	0.49***	−0.47**	0.38**	0.34*	0.13	–
	0.08	0.11	−0.03	0.17	−0.24	−0.23	0.22	

ASD autism spectrum disorder, *NT* neurotypical, *AMD* mean duration per visit, *BAPQ* broader autism phenotype questionnaire, *SCQ* social communication questionnaire

†p < .10, *p < .05, **p < .01, ***p < .001

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Table 2 Means, standard deviations, and *t* tests for dyadic-engagement-state visits, dyadic flexibility, and maladaptive behaviors (N = 72)

Study variables	ASD group ($n = 46$)		NT group ($n = 26$)		*t* test
	M	*SD*	*M*	*SD*	
Dyadic-affect-engagement states					
Mutual-positive-engagement visits	14.96	5.07	11.19	5.26	$t(70) = -2.99$**
Mutual-negative-engagement visits	3.35	4.12	1.04	2.60	$t(70) = -2.59$*
Dyadic flexibility					
Dispersion	0.79	0.11	0.68	0.14	$t(70) = -3.41$**
AMD	9.07	2.27	11.49	3.00	$t(70) = 3.86$***
VABS-II behaviors					
Child internalizing behaviors	20.30	2.35	15.92	3.20	$t(70) = -6.66$***
Child externalizing behaviors	18.00	2.94	16.46	3.01	$t(70) = -2.11$*

ASD autism spectrum disorder, *NT* neurotypical, *AMD* mean duration per visit

*p < .05, **p < .01, ***p < .001

of both mutual-positive-engagement-state visits or longer AMD were associated with greater internalizing behaviors for children with ASD (see Table 4).

Analyses revealed several statistically significant interactions. For dyads with children with ASD, the relationship between dispersion and internalizing behaviors was moderated by mutual-positive-engagement-state visits (see Fig. 1). In these dyads with a higher frequency of mutual-positive-engagement-state visits, there was a negative association between dispersion and children's internalizing behaviors.

For dyads with children with ASD, the relationships between AMD and internalizing and externalizing behaviors were moderated by mutual-positive-engagement-state visits (see Fig. 2A and B). In these dyads with a higher frequency of mutual-positive-engagement-state visits, there were positive associations between AMD and children's internalizing and externalizing behaviors. Regression analyses examining the frequency of mutual-positive-engagement-state visits and flexibility (i.e., dispersion and AMD) were not significant for dyads with NT children (ps > 0.05, *ns*).

Dyadic Flexibility and Mutual-Negative-Engagement-State Visits

Main effects for measures of dyadic flexibility (i.e., dispersion and AMD) and mutual-negative-engagement-state visits in relation to internalizing and externalizing behaviors for NT children are displayed in Tables 5 and 6 (see Model 1 for each set of analyses). Analyses revealed several significant interactions. For dyads with NT children, the relationship between dispersion and externalizing behaviors was moderated by mutual-negative-engagement-state visits (see Fig. 3). In these dyads with a higher frequency of mutual-negative-engagement-state visits, there was a negative association between dispersion and children's externalizing behaviors.

For dyads with NT children, the relationship between AMD and externalizing behaviors was moderated by mutual-negative-engagement-state visits (see Fig. 4). In these dyads with a higher frequency of mutual-negative-engagement-state visits, there was a positive association between AMD and children's externalizing behaviors. Regression analyses examining the interactions between flexibility (i.e., dispersion and AMD) and the frequency of mutual-negative-engagement-state visits for children with ASD were not significant (ps > 0.05, *ns*). Because data screening revealed skewness and kurtosis on mutual-negative-engagement states in the NT sample, regression models were rerun using log-transformed variables. The pattern of results was consistent; for ease of interpretation the non-transformed variables are presented in the tables.

Discussion

The present study contributes to our understanding of parenting of children with ASD through its examination of whether the structure and content of emotion coregulation processes in mother–child dyads were associated with child maladaptive behaviors. Specifically, interactions between dyadic flexibility (i.e., dispersion and AMD) and dyadic affect-engagement (mutual-positive and mutual-negative-engagement states) were examined in relation to children's internalizing and externalizing behaviors. For children with ASD, dyadic-positive engagement moderated the relationship between dyadic flexibility and internalizing and externalizing behaviors. For NT children, dyadic-negative engagement moderated the associations between dyadic flexibility and maladaptive behaviors.

Supporting Hypothesis 1, group comparisons revealed that children with ASD and NT children differed significantly on levels of maladaptive behaviors. Children with ASD had higher levels of both internalizing and

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Table 3 Regression analyses of mutual-positive-engagement-state visits and dyadic flexibility (dispersion) for ASD ($n = 46$)

	Model 1				Model 2			
	b(SE)	95% CI	β	p	b(SE)	95% CI	β	p
Internalizing behaviors								
SCQ	0.21 (0.06)	0.10, 0.32	0.55	< 0.001	0.20 (0.05)	0.09, 0.31	0.51	0.001
Mutual-positive-engagement visits	73.17 (42.14)	− 11.87, 158.20	0.26	0.090	645.89 (249.23)	142.57, 1149.21	2.29	0.013
Dispersion	− 3.35 (3.35)	− 10.11, 3.41	− 0.16	0.322	10.82 (6.87)	− 3.06, 24.69	0.52	0.123
Visits × dispersion					− 721.99 (310.09)	− 1348.23, − 95.75	− 2.48	0.025
Constant	17.19 (2.07)	13.01, 21.37		< 0.001	6.59 (4.96)	− 3.42, 16.61		0.191
Model statistics	$F(3, 42) = 7.76$, $p = <.001$, Adjusted $R^2 = 0.31$				$F(4, 41) = 7.79$, $p = <.001$, Adjusted $R^2 = 0.38$			
Externalizing behaviors								
SCQ	0.15 (0.08)	− 0.02, 0.31	0.31	0.079	0.13 (0.08)	− 0.03, 0.29	0.27	0.116
Mutual-positive-engagement visits	− 52.71 (63.12)	− 180.10, 74.68	− 0.15	0.408	681.79 (379.90)	− 85.43, 1449.01	1.93	0.080
Dispersion	− 2.62 (5.02)	− 12.75, 7.50	− 0.10	0.604	15.55 (10.47)	− 5.60, 36.70	0.60	0.145
Visits × dispersion					− 925.93 (472.68)	− 1880.53, 28.66	− 2.54	0.057
Constant	18.46 (3.10)	12.20, 24.72		< 0.001	4.87 (7.56)	− 10.39, 20.14		0.523
Model statistics	$F(3,42) = 1.26$, p = .299, Adjusted $R^2 = 0.02$				$F(4, 41) = 1.97$, p = .117, Adjusted $R^2 = 0.08$			

Mutual-positive-engagement-state visits were divided by the total duration of the interaction

ASD autism spectrum disorder, *SCQ* social communication questionnaire

Dispersion = distribution of emotion states across the grid

Table 4 Regression analyses of mutual-positive-engagement-state visits and dyadic flexibility (AMD) for ASD ($n = 46$)

	Model 1				Model 2			
	b(SE)	95% CI	β	p	b(SE)	95% CI	β	p
Internalizing behaviors								
SCQ	0.24 (0.05)	0.14, 0.34	0.63	< 0.001	0.23 (0.05)	0.13, 0.33	0.60	< 0.001
Mutual-positive-engagement visits	117.35 (41.74)	33.12, 201.58	0.42	0.007	− 161.25 (138.77)	− 441.50, 119.00	− 0.57	0.252
AMD	0.45 (0.16)	0.12, 0.78	0.43	0.009	− 0.17 (0.33)	− 0.84, 0.50	− 0.16	0.619
Visits × AMD					34.21 (16.31)	1.27, 67.14	0.81	0.042
Constant	8.93 (2.59)	3.70, 14.16		0.001	14.37 (3.60)	7.10, 21.63		<0.001
Model statistics	$F(3, 42) = 11.03$, $p < .001$, Adjusted $R^2 = 0.40$				$F(4, 41) = 10.04$, $p < .001$, Adjusted $R^2 = 0.45$			
Externalizing behaviors								
SCQ	0.18 (0.08)	0.02, 0.34	0.38	0.025	0.17 (0.08)	0.01, 0.32	0.34	0.035
Mutual-positive-engagement visits	− 2.59 (64.82)	− 133.41, 128.23	− 0.01	0.968	− 429.83 (215.81)	− 865.68, 6.01	− 1.22	0.053
AMD	0.46 (0.25)	− 0.06, 0.97	0.35	0.079	− 0.48 (0.52)	− 1.53, 0.56	− 0.37	0.355
Visits × AMD					52.46 (25.36)	1.23, 103.68	0.99	0.045
Constant	10.43 (4.03)	2.31, 18.56		0.013	18.78 (5.60)	7.48, 30.07		0.002
Model statistics	$F(3, 42) = 2.33$, $p = .088$, Adjusted $R^2 = 0.08$				$F(4, 41) = 2.96$, $p = .031$, Adjusted $R^2 = 0.15$			

Mutual–positive-engagement-state visits were divided by the total duration of the interaction

ASD autism spectrum disorder, *SCQ* social communication questionnaire, *AMD* mean duration per visit

externalizing behaviors relative to NT children, consistent with previous findings (Bauminger et al. 2010; Kim et al. 2000). Internalizing and externalizing symptomatology likely have bidirectional and reciprocal effects on emotion regulation (Gross and Jazaieri 2014; Werner and Gross 2010). In addition, symptoms of ASD along with symptoms

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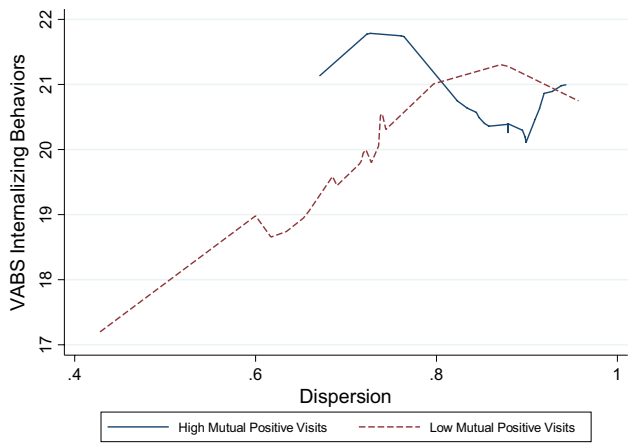

Fig. 1 Interaction between mutual-positive-engagement-state visits and dispersion in predicting internalizing behaviors in children with ASD

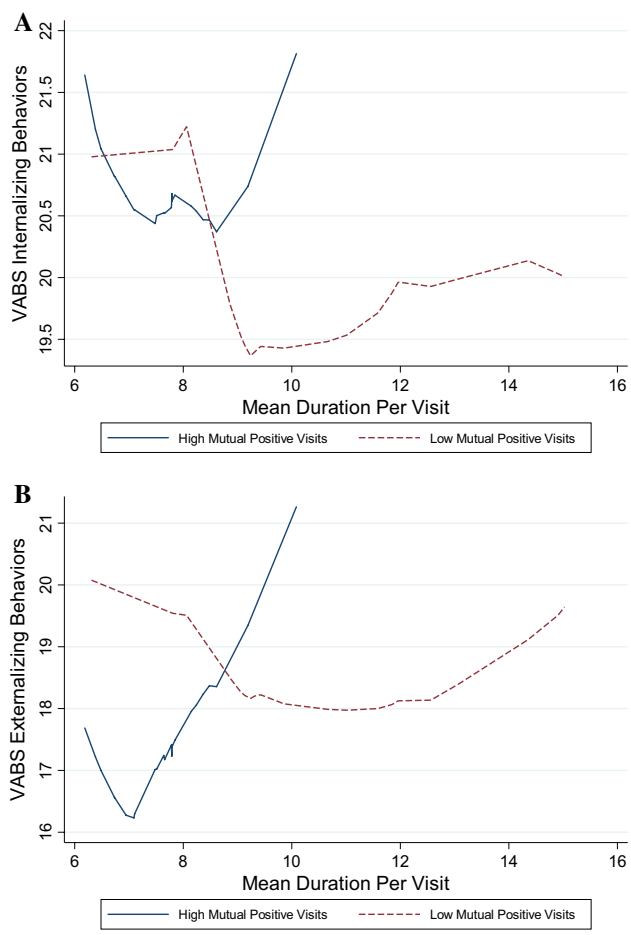

Fig. 2 Interaction between mutual-positive-engagement-state visits and AMD in predicting internalizing (**A**) and externalizing behaviors (**B**) in children with ASD

of depression, anxiety, and behavior problems may have deleterious impacts on children's capacity for effective emotional regulation. It is important for future research to consider these and other comorbid conditions that might affect emotion regulatory processes.

Supporting Hypothesis 2, in dyadic interactions with their mothers, children with ASD who had greater dyadic flexibility (i.e., greater dispersion and shorter AMD) and greater frequency of mutual-positive engagement displayed lower levels of internalizing and externalizing behaviors. Children in NT dyads who engaged in greater dyadic flexibility (i.e., greater dispersion of emotion states and shorter AMD and had higher frequency of mutual-negative engagement during interactions displayed lower levels of externalizing behaviors.

The present study builds on existing literature examining the relationship between emotion coregulation and maladaptive behaviors (Cole et al. 2003; Hollenstein et al. 2004; Ting and Weiss 2017) by suggesting that for children with ASD, the interaction between the structure and content of emotion coregulation may be important in the manifestation of internalizing and externalizing behaviors. Similar to previous research on parents with children at risk for behavioral problems (Lunkenheimer et al. 2011), we found support for dyadic flexibility in conjunction with initiating mutual positive states acting as a protective factor against externalizing behaviors. We extend these findings to mother–child dyads with children with ASD and include internalizing behaviors as well as externalizing outcomes. For children with ASD, the ability of mother–child dyads to initiate mutual positive states while remaining flexible may protect against maladaptive behaviors. These dyads in our study engaged in a wider range of emotional states and for a shorter amount of time than NT dyads. It is likely that when dyads with children with ASD engage in flexible behaviors, they move between positive, negative, and disengagement states. Therefore, if these dyads engage in dyadic flexibility but do not frequently initiate positive states, children with ASD likely do not gain the full benefits of a wide range of emotional interactions. Together, these behavioral patterns indicated that shared dyadic positive engagements in addition to flexible interactions might play a critical role in the psychopathology of children with ASD.

A significant interaction emerged between dyadic flexibility and mutual-negative engagement for NT dyads for maladaptive behaviors. This interaction may be interpreted in the context of adaptive regulation of negative emotions. In other words, this interaction could signify the ability to quickly recover from negative interactions. These results are consistent with prior SSG research demonstrating that improvements in aggressive children's externalizing behaviors were related to increased dyadic flexibility and acquisition of "repair" skills (i.e., ability to move out of negative

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Table 5 Regression analyses of mutual-negative-engagement-state visits and dyadic flexibility (dispersion) for NT dyads ($n = 26$)

	Model 1				Model 2			
	b(SE)	95% CI	β	p	b(SE)	95% CI	β	p
Internalizing behaviors								
SCQ	0.12 (0.23)	−0.35, 0.59	0.11	0.593	0.09 (0.21)	−0.33, 0.52	0.08	0.652
Mutual-negative-engagement visits	138.80 (154.74)	−182.11, 459.71	0.19	0.379	3083.68 (1265.71)	451.49, 5715.86	4.31	0.024
Dispersion	−9.18 (4.75)	−19.02, 0.67	−0.41	0.066	−3.34 (4.99)	−13.73, 7.04	−0.15	0.510
Visits × dispersion					−3544.76 (1514.05)	−6693.39, −396.12	−4.24	0.029
Constant	21.47 (3.31)	14.60, 28.34		< 0.001	17.47 (3.47)	10.26, 24.68		0.001
Model statistics	$F(3, 22) = 1.31$, $p = .295$, Adjusted $R^2 = 0.04$				$F(4, 21) = 2.56$, $p = .069$, Adjusted $R^2 = 0.20$			
Externalizing behaviors								
SCQ	0.16 (0.22)	−0.30, 0.63	0.15	0.473	0.13 (0.18)	−0.25, 0.50	0.12	0.495
Mutual-negative-engagement visits	128.50 (153.44)	−189.70, 446.71	0.19	0.411	4081.08 (1110.41)	1771.86, 6390.31	6.06	0.001
Dispersion	1.18 (4.71)	−8.59,10.94	0.06	0.805	9.01 (4.38)	−0.10, 18.12	0.43	0.052
Visits × dispersion					−4757.73 (1328.28)	−7520.04, −1995.42	−6.05	0.002
Constant	14.78 (3.28)	7.97, 21.59		< 0.001	9.41 (3.04)	3.08, 15.73		0.006
Model statistics	$F(3, 22) = 0.45$, p = .720, Adjusted $R^2 = -0.07$				$F(4, 21) = 3.73$, p = .019, Adjusted $R^2 = 0.30$			

Mutual–negative-engagement-state visits were divided by the total duration of the interaction

Dispersion = distribution of emotion states across the grid

NT neurotypical, *SCQ* social communication questionnaire

Table 6 Regression analyses of mutual-negative-engagement-state visits and dyadic flexibility (AMD) for NT dyads ($n = 26$)

	Model 1				Model 2			
	b(SE)	95% CI	β	p	b(SE)	95% CI	β	p
Internalizing behaviors								
SCQ	0.07 (0.24)	−0.42, 0.56	0.06	0.782	0.05 (0.21)	−0.38, 0.48	0.04	0.817
Mutual-negative-engagement visits	91.68 (158.12)	−236.24, 419.61	0.13	0.568	−1891.73 (738.40)	−3427.31, −356.14	−2.64	0.018
AMD	0.30 (0.23)	−0.19, 0.78	0.28	0.217	0.03 (0.23)	−0.45, 0.50	0.02	0.912
Visits × AMD					230.14 (84.15)	55.15, 405.13	2.74	0.012
Constant	12.09 (2.93)	6.00, 18.17		< 0.001	15.11 (2.80)	9.28, 20.95		< 0.001
Model statistics	$F(3, 22) = 0.60$, $p = .621$, Adjusted $R^2 = -0.05$				$F(4, 21) = 2.45$, $p = .078$, Adjusted $R^2 = 0.19$			
Externalizing behaviors								
SCQ	0.17 (0.22)	−0.30, 0.63	0.16	0.462	0.15 (0.19)	−0.24, 0.54	0.14	0.432
Mutual-negative-engagement visits	138.54 (150.39)	−173.34, 450.43	0.21	0.367	−2030.64 (660.73)	−3404.72, −656.57	−3.02	0.006
AMD	−0.02 (0.22)	−0.48, 0.44	−0.02	0.932	−0.32 (0.20)	−0.74, 0.11	−0.31	0.136
Visits × AMD					251.69 (75.30)	95.11, 408.28	3.18	0.003
Constant	15.76 (2.79)	9.98, 21.55		< 0.001	19.08 (2.51)	13.86, 24.30		< 0.001
Model statistics	$F(3, 22) = 0.43$, $p = .733$, Adjusted $R^2 = -0.07$				$F(4, 21) = 3.27$, $p = .031$, Adjusted $R^2 = 0.27$			

Mutual-negative-engagement-state visits were divided by the total duration of the interaction

NT neurotypical, *SCQ* social communication questionnaire, *AMD* mean duration per visit

states) rather than avoidance of negative states altogether (Granic et al. 2007). Engaging in a range of emotional experiences during dyadic interactions may be adaptive, even if some of those states are negative as long as they do not persist. Conversely, negative dyadic interactions may be detrimental if dyads lack the capacity to quickly recover and move back into a positive state. This may be a component of teaching children positive coping strategies: minor

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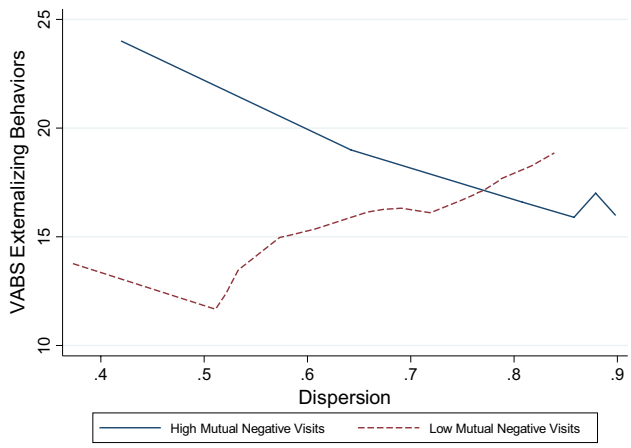

Fig. 3 Interaction between mutual-negative-engagement-state visits and dispersion on externalizing behaviors in NT children

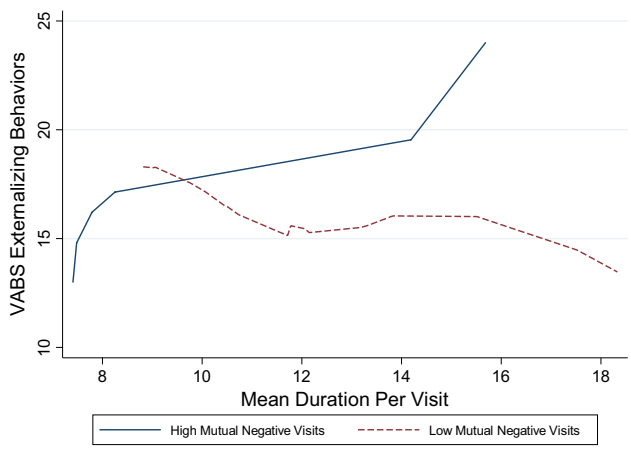

Fig. 4 Interaction between mutual-negative-engagement-state visits and AMD on externalizing behaviors in NT children

disturbances in dyadic interactions need not evolve into sustained negatively. Indeed, effective coping strategies involve the ability to regulate inherent negative emotions that arise in interpersonal interactions (Aldao et al. 2010; Southam-Gerow and Kendall 2002; Zeman et al. 2002).

The other part of Hypothesis 2, which stated that the structure and content of dyadic interactions would be differentially associated with behavioral outcomes in children with ASD and NT children, also was supported. Dyadic flexibility and the frequency of mutual-positive engagement were significantly associated with maladaptive outcomes for children with ASD, whereas dyadic flexibility and the frequency of mutual-negative engagement were significantly associated with maladaptive outcomes for NT children. We did not find that mutual-negative engagement moderated the association between flexibility and maladaptive behaviors for children with ASD, nor did we find that mutual-positive engagement moderated relations between flexibility and maladaptive behaviors for NT children. Our results are in line with past research documenting diagnostic group differences in emotion regulation behaviors for children with ASD and NT children (Jahromi et al. 2012; Samson et al. 2015) and differences in parent–child affective engagement states in children with and without behavioral problems (Dumas et al. 2001). The findings build on past research by highlighting the different manner in which dyadic flexibility interacts with emotion states in predicting internalizing and externalizing behaviors for children with ASD and NT children.

The present research has clinical implications for family-systems-based interventions for children with ASD (Sivberg 2002). In particular, interventions that focus on helping parents assist their children in engaging in positive dyadic interactions may improve children's behavior. The effective use of emotion coregulation strategies in the comparatively low stress environment of the home may help the child modulate displays of maladaptive behaviors. A variety of techniques could plausibly be used to improve initiation of positive interactions in dyads with children with ASD. Mindfulness-based interventions (Cachia et al. 2016), relational savoring interventions (Burkhart et al. 2015), and mentalization-based interventions (Slade 2005) may help promote positive dyadic engagement, improve parental perception of dyadic interactions, and increase parental sensitivity.

Limitations and Future Directions

One limitation in the present study is that the mother–child behaviors were observed during a low-stress play task. In everyday life, families encounter both low- and high-stress situations and the emotional demands of situations vary considerably. For example, it is likely that children and parents experienced more positive emotions in the present low-stress context than in a high-stress context, such as a frustrating event, which could modify the patterns of emotion coregulation behaviors (Stansbury and Sigman 2000). Additional research should determine whether similar pattern of interactions between dyadic-affect-engagement states and dyadic flexibility remain when parent–child behaviors are observed in other contexts such as during high-stress tasks or emotion eliciting events.

Another limitation of the study is the relatively small sample size. Future research should be conducted to replicate these findings in a larger sample of children, which would allow for statistical testing of three-way interactions. A larger sample size would also allow for additional covariates (maternal education and child age) to be included in the regression analyses to replicate and strengthen our findings. Future studies might include measures of children's cognitive abilities in addition to behavioral outcomes and a

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fuller complement of parental mental health measures (e.g., depressive symptoms).

All children with ASD in the present study had a parent-reported, physician-diagnosis of ASD, which was confirmed by either the ADOS-2 or SCQ scores; however, ideally, all children would have received an ADOS-2 assessment. Finally, the analyses examine how aspects of parent–child interactions may contribute to maladaptive behaviors in children in a cross-sectional design; however, we cannot draw causal inferences. It is likely that parent–child interactions and children's behaviors have reciprocal influences and children's maladaptive behaviors contribute to the emotion coregulation processes (Collins et al. 2000; Kiff et al. 2011). Future work utilizing a longitudinal study design may help elucidate these complex relationships. For greater insight into parent-child coregulation processes, future research also might be directed toward examining whether the child or parent takes the initiative in changing dyadic-affect states.

Conclusion

In conclusion, the observed relations between the content and structure of dyadic interactions in association with maladaptive behaviors provide support that emotion regulation in the context of parent–child relationships are important factors in the expression of child psychopathology. The present study extends previous work on emotion coregulation to include the interaction between the structure and content of parent–child interactions and to examine these relations in dyads of children with ASD and dyads of NT children. Our study is one of the few to use dyadic moment-to-moment microanalysis of emotion coregulation in these dyads. Results demonstrate the unique manner in which emotion coregulation processes relate to maladaptive behaviors for children. When dyads frequently initiate mutually positive interactions, high dyadic flexibility is related to fewer maladaptive behaviors for children with ASD. For NT children, high dyadic flexibility involving mutually negative interactions is related to fewer maladaptive behaviors. Importantly, the results indicate unique implications for children with ASD. Dyadic flexibility combined with the initiation of mutual-positive interactions would be particularly beneficial for the behavior of children with ASD.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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