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ORIGINAL PAPER

Emotional Responsivity in Children with Autism, Children with Other Developmental Disabilities, and Children with Typical Development

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Abstract Twenty six children with autism, 24 children with developmental disabilities, and 15 typically developing children participated in tasks in which an adult displayed emotions. Child focus of attention, change in facial tone (i.e., hedonic tone), and latency to changes in tone were measured and summary scores of emotional contagion were created. Group differences existed in the ratio of episodes that resulted in emotional contagion. Correlations existed between measures of emotional contagion, measures of joint attention, and indices of severity of autism. Children with autism demonstrated muted changes in affect, but these responses occurred much less frequently than in comparison groups. The findings suggest directions for early identification and early treatment of autism.

Keywords Young children with autism · Developmental disabilities · Empathy · Emotional responsiveness

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Introduction

Emde (1983) described early emotional exchanges between infants and caregivers as "the language of infancy." Stern (1985) has drawn on a number of different streams of empirical work to demonstrate the importance of affect sharing and affect coordination between caregivers and infants in the earliest stages of development. These authors emphasized the importance of exchanges of affective information with social partners early in life and indicate that the affective exchanges that occur early in development lay the foundation for more complex types of communication. Children with autism have a number of documented deficits in the area of social emotional relatedness and, therefore, may not have the same opportunities as other children to develop a strong foundation in social exchanges of affect that lay the foundation for later communication and social interaction.

The importance of the social exchange of affect is not limited to early social exchanges and is frequently discussed as emotional contagion. Descriptions of emotional contagion have emphasized the idea that exact matches in discrete affect are not necessary in order for emotional contagion to be experienced; rather it is the coordination of the expressions of the individuals involved in an exchange in terms of the valence (e.g., positive or negative emotional expression) and timing of changes in their expressions (Hatfield, Cacioppo, & Rapson, 1994). The concept of emotional contagion is built on a process of relatively automatic imitation of other people's movements, gestures, and expressions of affect and, therefore, has considerable relevance to affective exchanges and deficits associated with autism. Imitation, especially this kind of automatic mirroring of a social partner's affective behavior, is considerably impaired in autism (Hobson & Lee, 1999; see also Rogers, 1999; Williams, Whiten, & Singh, 2004, for recent reviews). The current study is focused on children's tendency to attend to the affective display of others, reflect affect that is similar in tone, and coordinate the timing of their display with others in an interaction.

Findings from numerous studies indicate that children with autism have difficulties related to affective exchanges throughout childhood. Individuals with autism exhibit less attention to negative emotional displays of others (Bacon, Fein, Morris, Waterhouse, & Allen, 1998; Charman et al., 1997; Corona, Dissanayake, Arbelle, Wellington, & Sigman, 1998; Sigman, Kasari, Kwon, & Yirmiya, 1992), demonstrate less positive affect in combination with attention to social partner (Dawson, Hill, Spencer, Galpert, & Watson, 1990; Snow, Hertzig, & Shapiro, 1987), more negative affect in social interactions (Yirmiya, Kasari, Sigman, & Mundy, 1989), and exhibit limited affect expression in social interactions (Joseph & Tager-Flusberg, 1997) when compared with matched controls. These studies indicate that social emotional relatedness is limited in both the degree of sharing of affect and in the frequency of sharing of affect in children with autism. The questions that remain are related to the details of social emotional exchanges such as the synchrony and matching of affect or emotional responsivity in both positive and negative exchanges of emotion.

The current study is designed to provide more detail about the deficit in emotional responsivity. Specifically, do children with autism have less frequent displays than children with other developmental disabilities or children with typical development? Is the impairment in emotional responsiveness related to a mutedness of emotional responses similar to what has been documented in other groups of children with developmental delays, or is it unique to autism? Is emotional responsivity related to other early social and communicative behaviors thought to play crucial roles in the development of autism such as imitation and joint attention?

Method

Participants

Participants were 65 young children: 26 with Autistic Disorder, 24 with other developmental delays and 15 with typically development who were participants in a larger longitudinal study of the development of the autism phenotype. The participants were recruited through the only two major medical facilities that specialized in early diagnosis of developmental problems in a large western city. All children were mobile and had no significant motor or sensory impairments.

Children with Autism

This group consisted of 26 children (20 boys, 6 girls) (see Table 1 for descriptive information). Upon enrollment in the study, children were free from identified medical conditions. All had previously received clinical diagnoses of autism before entering the study and study clinicians confirmed their diagnoses via four criteria: (1) the Diagnostic and Statistical Manual—Fourth Edition (DSM-IV) (APA, 1994); (2) Autism Diagnostic Interview (ADI-R) (Lord, Rutter, & Le Couteur, 1994); (3) the Autism Diagnostic Observation Schedule (ADOS) (Lord, Rutter, & DiLavore, 1997) and (4) an expert clinician's judgment of diagnosis considering all relevant data. Twenty three children in this group met all four criteria. Three children did not meet autism criteria on the ADI-R due to too few endorsements in the repetitive activities and interests domain. However, due to their young age, and the evidence that symptoms in this domain are not as frequent for children under three (Lord, 1995; Stone et al., 1999), these children were included in the study. They clearly met ADI-R criteria on the social and communication sections and exceeded the autism cutoff on the ADOS. Any bias created by including them would be a conservative bias.

Children with Other Developmental Delays

This group consisted of 24 children (13 boys, 11 girls) with previous diagnoses of global developmental delay (see Table 1 for descriptive information). Nine of these children had Down syndrome, 12 had idiopathic developmental delays, and 3 had other documented genetic abnormalities (1 on chromosome 15, 1 on chromosome 18, and 1 on chromosome 22). None of these children had documentation of seizure disorders. Eighteen of the children in this group did not meet threshold for autism on any of the 4 criteria; 1 child met the threshold for autism and 4 met criteria for Pervasive Developmental Disorder, Not Otherwise Specified (PDD.NOS) on the ADOS but not on any of the other 3 criteria; 1 child met the threshold for autism on the ADI but not on any of the other 3 criteria. All of the children who met one of the criteria for

Table 1 Comparison of diagnostic groups on demographic and developmental variables

Variable	Children with autism		Children with developmental delays		Typically developing children		F (df) and P
	M Range (low, high)	SD	M Range (low, high)	SD	M Range (low, high)	SD	
Chronological age (months)	34 (26, 41)	4.0	33 (24, 45)	6.8	17 (12, 23)	3.7	F (2, 63) = 60.0, P < 0.01
Overall mental age[a] (months)	19 (11, 28)	4.7	22 (14, 32)	5.6	20 (14–28)	4.6	F (2, 61) = 1.2, P = 0.31
Adaptive composite (SS)	60 (51, 80)	7.3	66 (49, 86)	69.4	104 (87, 133)	14.7	F (2, 60) = 89.0, P < 0.01
Nonverbal mental age[a] (months)	23 (13, 34)	4.8	23 (16, 35)	5.8	20 (16, 27)	3.6	F (2, 61) = 1.9, P = 0.16
Verbal mental age[a] (months)	15 (5, 27)	56.2	22 (11, 30)	5.8	21 (12, 31)	6.4	F (2, 61) = 5.7, P < 0.01
Socio-economic status	48 (22, 66)	11.9	55 (40, 66)	9.0	54 (22, 66)	14.4	F (2, 47) = 1.6, P = 0.20

[a] The Mullen Scales of Early Learning (MSEL) (Mullen, 1989) was used to estimate overall mental age, nonverbal mental age, and verbal mental age

autism had a mental age of less than 18 months which Lord, Risi, DiLavore, and Rutter (1999) identified as a risk factor for false positives on the ADOS. Two clinicians independently reviewed diagnostic decisions in-depth and determined that developmental delay and not autism was the appropriate diagnosis.

Typically Developing Children

This group consisted of 15 children (7 boys, 8 girls) with typical development (see Table 1 for descriptive information). None of these children were considered to have any health problems or developmental problems in the past or present and all were functioning within one and a half standard deviations of their age norms on developmental testing.

Participants were fairly representative of the ethnic and racial composition of the large western city from which they came (i.e., 85% White, 9% bi-racial, 2% Asian, and 3% Hispanic). The three groups did not differ significantly from each other on mental age, socio-economic status, or ethnicity. By design, the typical group was significantly younger than the two clinical groups, who did not differ from each other on chronological age. The groups with autism had a greater proportion of males than the other two groups, as reflects the nature of the disorder. See Table 1 for demographic information about the groups.

In an effort to balance the number of experimental presses participants in each group experienced, groups contain different numbers of participants. There are two reasons for the differences in experiences of the groups. First, the laboratory tasks were being refined early in the study and 8 of the children with autism, 2 of the children with other developmental disabilities, and 1 of the children with typical development did not experience the surprise boxes episodes. Second, children were required to attend to the experimenter while affect was displayed and some of the children did not attend to the experimenter during the displays of emotion.

Measures

ADI-R (Lord et al., 1994)

The ADI-R is a structured, standardized parent interview developed to assess the presence and severity of symptoms of autism in early childhood across all three main symptom areas involved in autism: social relatedness, communication, and repetitive, restrictive behaviors. Trained raters administered the ADI-R to parents of all subjects in the study. Raters were reliable at the diagnostic and severity levels of agreement, checked on 20% of the participants.

ADOS (Lord et al., 1997)

The ADOS is a semi-structured standardized assessment administered directly to children for the purposes of assessing for symptoms of autism. In the present study, all subjects received Module 1, for preverbal children or those just beginning to speak. Raters were reliable at the diagnostic and severity levels of agreement checked for 20% of participants. Trained raters administered the ADOS to all subjects in the study.

Mullen Scales of Early Learning (MSEL) (Mullen, 1989)

The MSEL is a standardized developmental test for children ages 3–60 months. The MSEL allows for separate standard verbal and nonverbal summary scores to be constructed. It was standardized on a nationally representative sample.

The Vineland Adaptive Behavior Scales, Interview Edition (Sparrow, Balla, & Cicchetti, 1984)

The Vineland is norm referenced and standardized on a representative national sample including both typical samples and those with developmental delays.

Measure of Joint Attention: Revised Early Social and Communication Scales (ESCS, Seibert, Hogan, & Mundy, 1982; Mundy, Hogan, & Doehring, 1996)

These procedures involved a 20-min semi-structured, toy-based interaction designed to elicit nonverbal communicative behaviors involving joint attention, requesting, and turn-taking. Inter-rater reliability was established at 85% and maintained throughout the project by having two raters code 30% of all tapes.

Measures of Emotional Responsivity

During the course of three laboratory visits children participated in three tasks that contained six stimuli designed to elicit emotional responses from children. Two of the stimulus tasks involved both positively and negatively valenced expressions of emotion by the experimenter and one involved only negatively valenced expressions of emotion. The episodes took place in the context of three tasks: (1) Surprise Boxes, (2) Yummy Yucky (Repacholi & Gopnik, 1997) and (3) Experimenter Distress (Sigman et al., 1992; Zahn-Waxler & Radke-Yarrow, 1990).

Tasks were administered in a manner similar to procedures described by Repacholi and Gopnik (1997) and Sigman et al. (1992) in that children were seated across a small table from an experimenter with their parents sitting close by. In each press, the experimenter gained the child's focus of attention before beginning the display of affect and started the display while the child was in a neutral affective state. The experimenter used nonword verbalizations and appropriate facial and postural expressions to exhibit a strong emotional display. During the six displays that were presented to each participant, the presenter displayed four discrete affects: joy, fear, pain, and disgust, all embedded in naturalistic events.

Experimenters' Displays of Affect

Experimenters displayed the affect for approximately 10 s; however, there were differences in the displays experienced by groups ($F(2, 64) = 7.10$, $P < .01$) such that typically developing children experienced slightly longer displays ($\bar{X} = 12.3$, SD = 4.1 s), than did children with autism ($\bar{X} = 8.9$, SD = 2.5 s) or children with other developmental delays ($\bar{X} = 10.2$, SD = 2.1 s) whom did not differ from one another. It is believed that this difference in affective displays does not effect the results of the study since the latency to emotional responsivity [$\bar{X} = 2.8$ s, SD = 1.7 s range (.4–8.3 s)] did not differ for the three groups and the latency to emotional responsivity was well within the time frame of the experimenters' affective displays for all groups. Independent observers who were blind to the experimental condition coded approximately 10% of the episodes and indicated that experimenters displayed the intended discrete emotion 95% of the time and did so with at least a moderate level of intensity (rated on a three point scale of—low, moderate, and high intensity).

Within each task that had both positively and negatively valenced episodes, the two episodes were counterbalanced within diagnostic groups so that the number of children in each group who experienced a positively valenced episode first is equal to the number of children who experienced a negatively valenced episode first.

Surprise Boxes contained both a positively and negatively valenced episode. In this task, the experimenter opened a small gift box, the contents of which (a toy) were hidden from the child's view, and, while looking inside the box, vocalized either "oohhh" or "aahhh" while displaying obvious facial expressions of either joy or fear.

Yummy-Yucky (Repacholi & Gopnik, 1997) also contained both a positively and negatively valenced episode. This task was administered with two differences from Repacholi and Gopnik (1997) in that the experimenter first asked the child's parent to choose two snack foods from an array of choices for which the child had equal liking, whereas, Repacholi and Gopnik (1997) used one food that was thought to be universally disliked by children (broccoli). This change was made because we were concerned that the children with autism would not attend to a food that they found distasteful. Children were given an opportunity to eat both choices and once the child had lost interest in the snack, the experimenter took the two bowls of food from the child and tasted one of the foods, expressing disgust, and then tasted the other food, expressing delight. Both positively and negatively valenced episodes were presented in succession to each child in a counterbalanced fashion and the second episode was administered after approximately 10 s of displaying the affect related to the first food choice.

Experimenter Distress (Sigman et al., 1992; Zahn-Waxler & Radke-Yarrow, 1990) consisted of two episodes which were presented on separate laboratory visits. The knee-bang episode occurred when the experimenter got up out of her seat, bumped her knee on the edge of the table, and sat back down in her chair rubbing her knee and expressing pain. After a 10 s display of pain, the experimenter pointed to her knee and assured the child that her knee was not hurting her anymore by saying ''It's okay now.'' The thumb-bang episode occurred when the experimenter took a turn playing with a xylophone and banged her thumb with the mallet, immediately rubbing her thumb and expressing pain. Again, following a 10 s display of emotion, the experimenter showed the child her thumb and assured the child that ''It's okay now.''

Procedure

Parents were present during all of the experimental tasks. The children came to the lab for 1.5 h appointments for these measures and others not being reported here.

Coding Procedures and Specific Observations

Coding procedures first described by Yirmiya et al. (1989) provided the basis for the coding procedure described here. We were interested in children's focus of attention, their emotional response, and the latency to their emotional response to experimenters' emotional displays. Rather than coding for exact matches in discrete affect between participants and experimenters, the episodes were coded for coordination of the valence and intensity of hedonic tone of the affective expression (i.e., positive, neutral, negative) between the experimenter and the child. Attention to the adult and latency to a child's change in affect were also recorded. The children's focus of attention, facial tone, and behavior were coded continuously from 1 s before the experimenter's display of affect through the end of the experimenter's display of affect.

The child's behavior and facial tone were coded frame-by-frame (30 frames per second). Behaviors and/latencies were recorded for change in focus of eye gaze (e.g., Did the child look at the experimenter following the emotional display?) and change in hedonic tone (e.g., Is there a change in tension in specific areas of the face and if so what is the valence of the resulting emotional expression?). The hedonic tone change score rated the most intense display of hedonic tone that followed the adult display. It was rated in both positive and negative directions, on 4 point scales, in which neutral was coded 0, mild ± 1, moderate ± 2, and intense ± 3. Positive and negative affect changes were coded on opposite ends of the scale and behavioral anchors were provided at each point of intensity.

Creating Summary Variables

Three summary variables were created based on the coding of attention, behavior, and facial expression change at a frame-by-frame level of analysis. Only episodes in which the child focused their attention on the experimenter were coded for emotional responsivity. Emotional Responsivity (ER) was coded as present or not present based on whether or not the child changed his or her hedonic tone following the experimenter's display and whether or not that change was in the direction of the adult's display. Hedonic tone change score captured the degree of change in the child's emotional tone from the child's display at the beginning of the experimenter's display of affect to the child's most intense hedonic display. The hedonic change variable contained both the degree of change in tone and the direction of the change and potentially ranged from extremely negative emotional display to extremely positive emotional displays. Latency to ER was calculated in hundredths of seconds by subtracting the real time of the experimenter's onset of emotion from the time at which the child exhibited a change in hedonic tone.

Five coders attained reliability on behavioral codes and latency (measured to within .5 s) at above 80% over at least 20 episodes prior to coding any episodes for the study. Inter-rater reliability for specific codes was assessed by calculating kappa statistic for variables of interest. Ten percent of the episodes were randomly selected and recoded by a second observer. Coders attained 85% agreement across categories and kappa coefficients were as follows: 1.0 for child focus of attention, .59 for change in hedonic tone, and .40 for emotional responsivity. Agreement on time variables was measured by .5-s intervals, so that latencies to emotional responsivity were considered in agreement if ratings were within .5 s of each other. This level of agreement was obtained for 75% of the latency measurements

Overall Summary Scores

Summary scores were calculated for each child based on the episodes in which they attended to the experimenter during the display of affect. The summary scores combined their responses to the six stimuli for emotional responsivity and included: (1) an overall ER score, which was the proportion of stimulus tasks that resulted in ER; (2) an overall hedonic tone change score which was the mean degree of change in hedonic tone that the participant exhibited when the participant displayed emotional responsivity; (3) An overall latency to ER score which was the average latency to ER that the child demonstrated over the presses to which they were exposed.

Results

Group Comparisons

A group (i.e., children with autism, children with other developmental disabilities, and children with typical development) by episode (i.e., positively and negatively valenced episodes of the yummy yucky task, the surprise boxes task, and the two experimenter injury episodes) analysis of variance (ANOVA) is presented first. The group by episode ANOVA yielded significant differences between groups on one of the six episodes (see Fig. 1) [F (2, 55) = 6.96, $P < .01$]. Post Hoc analyses revealed that the children with autism reacted to fewer of the experimenter distress episodes in which the experimenter banged her thumb than did children with other developmental disabilities (mean difference = .34, $P < .05$) or children with typical development (mean difference = .56, $P < .01$). While 19 children with autism attended to the episode in which the experimenter banged her thumb, only 2 responded with emotional responsivity. Analyses of latency to contagion and change in hedonic tone indicate that the groups did not differ significantly on latency or change in tone on any of the episodes with the exception of the episode in which the experimenter banged her thumb and since there were only two children with autism who responded to this episode, group differences are not reported here.

These analyses were followed by analyses in which data was pooled across examples of similarly valenced emotional responsivity (i.e., positively valenced episodes and negatively valenced episodes). The choice to pool data was made because there were some children who did not have data on emotional responsivity for all six of the episodes. There are two reasons for children having incomplete data on all six episodes of the tasks. First, the laboratory tasks were being refined early in the study and eight of the children with autism, two of the children with other developmental disabilities, and one of the children with typical development did not experience the surprise boxes episodes. Second, children were required to attend to the experimenter while affect was displayed and some of the children did not attend to the experimenter during the displays of emotion. As a result of these two problems, it was determined that a more accurate representation of emotional responsivity would be presented if data were pooled across positively valenced episodes and negatively valenced episodes of emotional responsivity.

As mentioned previously, diagnostic groups differed significantly on measures of verbal mental age. While communication limitations are a central feature of

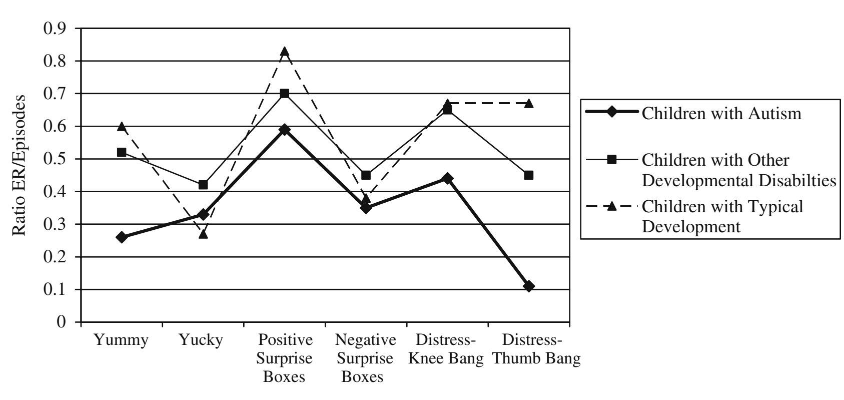

Fig. 1 Ratio of ER/episodes by experimental episode and diagnostic group

autism, assessing diagnostic group differences while controlling for verbal mental age has been suggested as a method for assuring that diagnostic group differences are not fully accounted for by differences in verbal abilities (Charman, 2004). Therefore, the analyses presented here all covarying verbal mental age.

Repeated measures analyses of covariance (ANCOVA) were completed to examine (1) between group differences on the three dependent variables of interest (i.e., proportion of stimuli that resulted in ER, latency to ER, and hedonic tone change), (2) within subject differences in responses to stimuli of different valences (i.e., positively versus negatively valenced episodes), and (3) interactions between diagnostic group and episode valence. Results of these analyses are presented below.

Proportion of Episodes that Resulted in Emotional Responsivity

Between-subjects analyses revealed significant group differences in the proportion of tasks that resulted in ER [F (2, 52) = 4.63, P = .01]. Post hoc analyses of means using a Bonferroni correction for multiple comparisons revealed that the proportion of episodes that resulted in ER was significantly smaller for children with autism than the children with typical development (mean difference = .24, P < .05) and approached significance for children with other developmental disabilities (mean difference = .19, P = .06). Typically developing children and children with other developmental disabilities did not differ significantly from each other. Analyses of within-subjects differences did not reveal significant differences in the proportion of episodes that resulted in emotional responsivity for positive compared to negative valenced episodes nor were there significant group by valence interactions.

The mean and 95% confidence interval for the proportion of episodes resulting in emotional responsivity were calculated without covarying VMA and are as follows: (1) children with autism ($\bar{X}$ = .32, 95% CI: .22–.41), (2) children with other developmental disabilities ($\bar{X}$ = .52, 95% CI: .42–.62), and 3) children with typical development ($\bar{X}$ = .58, 95% CI: .45–.71) (see Fig. 2).

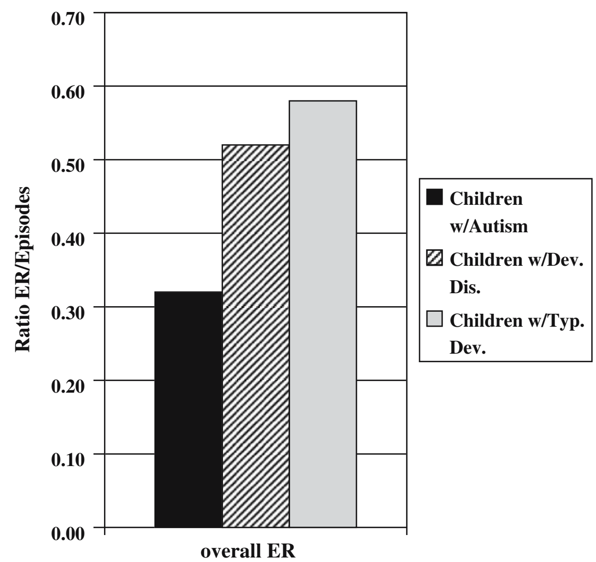

Fig. 2 Overall ratio of ER/episode by diagnostic group

Latency to Emotional Responsivity

Group comparisons of latency to ER did not reveal significant group differences (Table 2). Within-subject analyses of latency to ER for positively valenced versus negatively valenced episodes did reveal significantly differences [Wilk's Lambda, F (1, 29) = 4.34, P < .05] with children taking longer to react to positively valenced episodes ($\bar{X}$ = 3.10 s, SD = 2.2 s) than negatively valenced episodes ($\bar{X}$ = 2.85 s, SD = 2.5 s). No significant group by valence interactions were revealed.

Hedonic Tone Change

Group comparisons and within subject analyses of hedonic tone change are based only on data from episodes in which children expressed emotional responsivity. Group comparisons and within subject analyses did not reveal significant differences in hedonic tone change when verbal mental age was covaried. Group by valence interactions were not significant.

Relations among Primary Variables of Interest

Correlations between measures of emotional contagion and joint attention, and symptom severity on the ADOS and ADI were calculated for the group of children with autism and for the entire sample without covarying verbal mental age. Results of these analyses are presented in Table 3. Within the group of children with autism these analyses revealed marginally significant relations between measures of ER and a measure of initiating joint attention and severity of social–communicative impairments in dyadic and triadic responses as measured by the ADOS social–communication scores. When data from the entire sample is examined, significant relations are apparent between

Table 2 Responses to experimenter's expressions of emotion by diagnostic group and valence of emotional display covarying verbal mental age

	Children with autism						Children with developmental delays						Typically developing children						Main effect (covarying VMA)	
	Positive emotion displays			Negative emotion displays			Positive emotion displays			Negative emotion displays			Positive emotion displays			Negative emotion displays			Diagnostic Group	Stimuli Valence
	M	SD	*n*	*M*	SD	*n*	*M*	SD	*n*	*M*	SD	*n*	*M*	SD	*n*	*M*	SD	*n*	*F*	*F*
Proportion of ER	.38	.4	20	.33	.3	20	.60	.4	21	.525	.3	21	.70	.4	15	.52	.4	15	4.63**	n.s.
Latency to ER (s)	4.1	1.3	7	4.2	3.0	7	3.0	2.7	16	2.7	2.8	16	2.6	1.8	10	2.1	.6	10	n.s.	4.34*

* $P < .05$, ** $P = .01$

the same measures of emotional responsivity and a measure of joint attention and severity of autism symptoms.

Logistic Regression

Finally, logistic regression analysis was used to examine the usefulness of measures of emotional response in predicting diagnostic status (i.e., autism versus no autism) in the entire sample. A model with two variables: (1) proportion of episodes that resulted in ER and (2) degree of hedonic tone change—significantly improved correct classification over base rate predictions (X^2 (2) = 15.29, $P < .001$). Specifically, this model improved correct classification from a base rate of 60% to a correct classification of 69% with a specificity of 82% and a sensitivity of 50%. This analysis was compared to a logistic regression using two variables measuring proportions of responses and initiations of joint attention from the ESCS. The joint attention model also improved prediction over base rates (X^2 (2) = 13.87, $P < .01$) correctly classifying 79% of the children with a specificity of 80% and a sensitivity of 77%. A final regression analysis included joint attention variables at block one and ER variables at block two. The addition of ER variables at block two added significantly to the overall model (X^2 (4) = 24.77, $P < .001$, block 2 X^2 (2) = 10.90, $p < .01$) and improved correct classification to 81% with a specificity of 83% and a sensitivity of 77%. Thus, while the ER variable significantly improved classification of children by diagnosis, the joint attention variable was more powerful in classifying children. Combining ER with joint attention added significantly to the model, but the amount of improvement was small.

Discussion

In the current study we combined existing methods in order to provide specific detail about children's emotional responsivity in controlled experimental tasks. We have provided presses for both positive and negative emotional responsivity and have measured the degree of change in hedonic tone and latency to emotional responsivity in a detailed manner. We carefully examined child attention, and analyzed only those episodes in which children looked directly at the adult during the emotional display. While children with autism as a group looked less frequently at these displays, we only eliminated a few of the 350 episodes due to lack of attention to the experimenter.

Table 3 Correlations between measures of emotional responsivity and developmental variables for the children with autism and the entire sample without covarying verbal mental age

		Initiates joint attention (ESCS) *r* *N*	Soc/com severity on ADOS *r* *N*	Severity of autism (ADI-R) *r* *N*
Children with autism	Frequency of ER	.38*	–.27	–.20
		23	23	24
	Tone change	.58***	–.46**	–.15
		23	23	24
Entire sample	Frequency of ER	.36**	–.43***	–.47***
		54	48	60
	Tone change	.33**	–.27*	–.31**
		54	48	60

* $P < .10$, ** significant at $P < 0.05$, *** significant at $P < .01$

The current findings demonstrate that the children with autism responded to the emotional presses with emotional contagion approximately half as often as the other two groups. Specifically, children with autism responded with emotional contagion to approximately a third of the presses, significantly less than the other two groups, who responded with contagion to approximately half of the presses. Thus, we replicated earlier findings of reduced frequency of emotional responsiveness in young children with autism compared to typical and clinical control groups (Corona et al., 1998; Sigman et al., 1992). However, in the present study, only stimulus episodes in which the child attended to the experimenter were included, so a lack of attention in the children with autism can not explain these group differences in emotional responsivity.

An alternative explanation for group differences in emotional responsivity might be related to the longer processing time noted previously for children with autism (Dawson et al., 2004). It is possible that the experimenters did not provide a long enough display for children with autism to process and react to the affect. However, this explanation is unlikely given that the mean latency to emotional responsivity in the group with autism was approximately 4 s and the experimenter displays of affect for the group with autism was approximately 9 s.

There was also a strong relation between emotional contagion and the current social–communicative symptoms associated with autism in the total group. While this might be simply reflecting the fact that the children with autism were the ones with the deficit in emotional contagion, the relation appears to exist even within the autism group, in which correlations of both frequency and intensity of contagion with ADOS social–communicative symptom severity shows a trend towards significance, and it also appears in both the DD and the typical groups, with intensity of contagion related to ADI social communicative scores. If this finding holds up through replications, it may support the idea that a defining feature in autism—the impairment in interpersonal relatedness—has at its core the lack of this expected, automatic, basic emotional responsivity.

Given the powerful effect that children's emotional displays have on parents and the importance of coherence of emotional displays and exchanges on social relationships (Keltner & Kring, 1998), we assume that the reduced frequency and intensity of the emotional displays of the children with autism changes the interpersonal milieu over time. Loveland (2001) has reminded us of the importance of an ecological perspective in understanding the impact of a deficit in emotional responsivity for children with autism. Specifically, the emotional stimuli used in the current study were intense and sustained for approximately 10 s. It is notable that even using this exaggerated press for emotional responsivity there were limited responses from the children with autism. If adults do not perceive children's responses and thus do not receive this emotional feedback from the children, adults may direct emotional displays with children with autism less frequently over time. Indeed, Dawson and colleagues (Dawson et al., 1990) found that while children with autism were less likely to respond in kind to their mothers' smiles, the mothers of children with autism directed fewer social smiles at their children with autism. The cycle of limited affective exchanges between children with autism and others may lead to even fewer opportunities for children with autism to learn about social–emotional communication. This may be one of the steps in a developmental cascade that results in the pervasive social–emotional deficits present in older children with autism. A broader range of ages would have provided additional information for a developmental psychopathology perspective on emotional responsivity. In fact, the data presented here are part of a longitudinal study; therefore, we will soon have data on emotional responsivity from a second time point approximately 2 years later than the information presented here.

Interventions can be informed by the current research in that we have demonstrated that children with autism exhibit emotional responsivity but do so at a level that is much more infrequent than there peers. Only a few treatment models for young children with autism specifically include affective exchanges as an elemental part of the early treatment of autism (see the Denver Model; Rogers, Hall, Osaki, Reaven, & Herbison, 2001; Greenspan & Weider, 1998;RDI relationship development intervention, Gutstein & Sheely, 2002). It will be important to determine whether direct attention to these kinds of emotional exchanges result in more normalized emotional responsivity in children with autism, and whether a change in emotional responsivity results in collateral effects. In addition, the results of logistic regression analyses indicate that a combination of deficits in emotional responsivity and joint attention skills were most predictive of diagnostic status. This finding suggests that interventions should focus both on the early social emotional relatedness and early communication skills.

In summary, we found impairment in emotional responsivity in these very young children with autism. This was not due to lack of attention to the adult face, since children were focusing on the experimenter in all of the episodes used in the current study. Individual differences in emotional responsivity were most strongly related to variability on core aspects of social relatedness and joint attention, and not to other characteristics like IQ, language ability, or imitation skill. The lack of relation with IQ, the specificity of and severity of the impairment in the children with autism, and the developmental precedence of emotional responsivity in comparison to joint attention in normal development, all lead to the conclusion that this deficit in emotional contagion may be an important early impairment in autism. Impairments in dyadic processes like social orienting (Dawson & Lewy, 1989), emotional responsivity, and imitation—rather than triadic process like joint attention—may be the prime or first impairments leading to the altered developmental trajectory seen in autism. Symptoms that occur later in typical development such as joint attention perhaps reflect the presence of an independent additional primary impairment, or perhaps result from the altered developmental trajectory already in place. We are not arguing for one primary deficit in autism, but we are arguing that a core social impairment in autism involves dyadic exchange.

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