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Emotional Expressivity in Toddlers With Autism Spectrum Disorder

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Abstract

Objective: There is a prevailing notion that children with autism spectrum disorder (ASD) exhibit intense negative and attenuated positive emotions, although the empirical evidence regarding their emotional expressiveness (EE) is limited. Given the importance of emotions in shaping social and cognitive development, we examined intensity and valence of EE and links between EE and autism severity and parent-reported temperament in ASD.

Method: Toddlers (aged 21.2 months) with ASD (n = 43), developmental delay (DD, n = 16), and typical development (TD, n = 40) underwent standardized probes designed to induce anger, joy, and fear. Intensity of EE through facial and vocal channels were coded offline. Autism severity and temperament were quantified using the Autism Diagnostic Observation Schedule–2 (ADOS-2) and Early Childhood Behavior Questionnaire (ECBQ).

Results: The ASD group exhibited less intense fear compared to both the DD and TD groups, more intense anger than DD but not TD, with no differences in joy intensity. All groups showed similar levels of incongruous negative EE. Intensity of fear and anger were not associated with severity of autism symptoms, but lower intensity of joy was related to greater autism severity. Expressed fear and joy were associated with temperament.

Conclusion: The study provides no support for a negative emotionality bias in ASD. Instead, toddlers with ASD display a muted response to threat and an accentuated response to goal blockage, whereas the ability to express positive emotions appears intact. Negative emotionality and social disability dimensions are independent. The study demonstrates the complexity of EE in ASD and motivates investigations into underlying mechanisms as well as its role in shaping complex phenotypes of affected children.

Keywords

autism; emotional expression; temperament; toddlers

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Autism spectrum disorder (ASD) is an early-onset complex neurodevelopmental disorder manifesting in social impairments and a range of rigid and repetitive behaviors.[1] Since autism was first described in 1943, two notions concerning the emotional lives of children affected by the disorder have prevailed: one in which negative emotions dominate,[2] and another in which emotional expressions are muted,[3] particularly positively valenced emotions. Based on clinical observations, Tinbergen and Tinbergen argued that autism "…is characterized by an emotional imbalance, in which fear, anxiety or apprehension dominates and suppresses many forms of social and exploratory behavior.…"[4] Despite the potential long-term impact that either a negative emotionality (NE) bias or an attenuation of positive emotions may have on social, emotional, and cognitive development,[5] research in autism has focused primarily on how children with ASD discriminate and understand emotions of others,[6-8] with relatively few studies focused on the question of how they themselves experience their world emotionally. When doing so, such studies have relied primarily on parental report measures, with few studies directly measuring intensity and valence of emotions in response to standardized response-induction procedures.

Studies using parental report of child temperament support the notion of both an NE bias and a reduced positive emotionality in children with ASD.[9-11] Children with ASD reportedly exhibit higher levels of NE and lower levels of positively valenced emotions than typically developing (TD) children, from early toddler- and preschool-age[9,12-14] to school-age.[11] Studies that use direct measures of emotional valence and intensity in ASD typically evaluate emotional expressions across facial, vocal, or musculoskeletal channels with consideration of duration, peak intensity, or frequency of specific affective expressions. In retrospective home videos, infants later diagnosed with ASD were observed to engage in fewer social smiles than typically developing infants during the first year of life.[15,16] In the context of play-based communication assessments, preschoolers with ASD did not differ in duration of positive and negative facial emotional displays from TD and DD controls.[17] A more fine-grained analysis of these data revealed differences in the contextual modulation of positive affect: preschoolers with ASD spent less time compared to TD and DD controls displaying positive facial expressions toward adults during joint attention acts, but when making requests, they directed similar levels of positive affect.[18] However, in the context of adult—child interactions, young children with ASD have been found to display reduced expression of positive affect compared to controls with idiopathic developmental delays (DD)[19] or with Down syndrome.[20]

Only a few studies have used real-world probes aimed at eliciting specific emotions by means of standardized induction approaches, and these studies have focused primarily on examining negative emotions. Such studies typically involve probes based on the Laboratory Temperament Assessment Battery (Lab-TAB).[21,22] When preschoolers with ASD were presented with situations designed to elicit anger and frustration (eg, desirable toy placed in a locked box), both their intensity and duration of frustration expressed through facial and bodily channels were comparable to those observed in the TD groups.[23] However, school-aged children with ASD responded to the removal of a desirable toy with increased frequency of negatively valenced facial expressions as well as more neutral and fewer positive expressions.[24] When presented with fear-eliciting probes (stranger approach),

preschoolers with ASD exhibited more intense facial fear compared to TD and Fragile X groups; however, there were no differences in intensity of musculoskeletal fear responses.[25]

Thus, the current literature reveals a rather limited and inconsistent picture of emotion expression (EE) of young children with ASD. The discrepancies between studies are likely driven by a host of methodological differences. Although highly valuable, parental report taps more broadly into emotions, mood, and attitudes across a wide array of situations and is likely to represent facets of the child's temperament filtered through parental personality traits and dynamics of parent—child interactions. Furthermore, traits measured by parent-report scales diverge from the emotional dimensions measured using observational approaches, most notably in the domain of positive emotionality. Although pure positive EE such as smiling and laughter are represented in infant temperament scales, toddler measures capture more complex positive emotions such as eager anticipation of future events.[9,12] The inconsistencies in studies using direct observation methods may stem from differences in induction techniques, intensity and valence of emotional triggers, their type (social/nonsocial), measurement methods, age of the participants, and characteristics of the control groups. The induction probes often involve social stimuli (videos of people or in vivo interaction), and thus it may be difficult to disambiguate the effects of affective impairments from social disability on EE of children with ASD. In addition, there is evidence that children with ASD may not necessarily differ in expressed intensity of emotions; rather, they may display emotions that are incongruent with the valence of real-world events.[17,24,26] Improving our understanding of EE of children with ASD will advance knowledge of their motivational conditions and help clarify links between emotional and social development in autism. This knowledge will advance understanding of the heterogeneity of syndrome expression and of comorbid affective symptoms, and will inform treatment approaches.

The present study aims to address some of the gaps in knowledge of EE of toddlers with ASD. To this end, we examined their emotional responses to real-world scenarios with specific attention to their intensity, valence (joy, anger, fear), and congruence and compared their performance with that of TD and DD controls. To avoid confounding effects of social and affective vulnerabilities on EE in ASD, we strove to limit the social interaction load of the tasks. We operationalize the term "emotion" to signify observed behavioral responses to induction probes emitted through facial and vocal channels.[27] The term "intensity" refers to the peak intensity of emotion expressed through these channels, and thus it reflects salience of the probes as perceived by the child rather than any absolute intensity of the probes.

Although, to date, studies have largely focused on the broader construct of negative emotionality by combining fear, anger, and other responses,[8,10,12] considering that fear is related to withdrawal and anger is related to approach behaviors (eg, hitting, pushing), we considered them separately.[28,29] Fear in young children arises in response to stimuli that convey threat or uncertainty, resulting in self-protection, and elevated fear responses in infancy predict later behavioral inhibition and anxiety.[30] In comparison, anger reflects a child's propensity to express negative emotions in response to restraint or goal blockage and serves the function of reinstating goals.[31,32] Elevated anger in preschool predicts later externalizing behavioral problems.[33] Similar to anger, joy is characterized by approach but

manifests in smiling, laughter, and increased activity and is associated with later expressions of pleasure, sociability, activity level, and impulsivity.[34,35]

The present study examines the following predictions: (1) If EE of toddlers with ASD are indeed biased toward negative emotions, we expected that they would display higher intensity of anger and fear and lower intensity of joy in response to real-world induction challenges compared to TD and DD controls.[9] (2) If toddlers with ASD are prone to expressing context-incongruent negative emotions, we expected that they would display higher intensity of fear and anger in response to positively valenced probes. (3) Consistent with our previous study,[9] we hypothesized limited links between intensity of EE and severity of autism symptoms, which would suggest that the two dimensions are independent of one another. (4) Finally, as reported for TD children, we expected weak-to-moderate associations between the intensity of EE and analogous parent-reported temperamental characteristics.[21,36]

METHOD

Participants

Participants included 99 age-matched toddlers, including those with ASD (n = 43), those with DD (n = 16), and typically developing (TD) (n = 40) controls. The children took part in a prospective study of emotion processing development. Toddlers with DD and ASD were referred to a university-based clinic for diagnostic assessment by their parents, health care providers, or educators. TD toddlers were recruited through advertisements. The participants underwent a comprehensive diagnostic characterization examining developmental abilities using the Mullen Scales of Early Learning (MSEL) and severity of autism symptoms using the Autism Diagnostic Observation Schedule–2 (ADOS-2) (Table 1). Diagnostic classification was based on clinical best estimate (CBE) diagnosis by expert clinicians. ASD diagnosis was based on the *DSM-5* criteria.[1] Toddlers in the DD group included those with global or specific (eg, language, communication, motor) delays. Children with history of prematurity or known genetic abnormalities were not included in the study. Research suggests that the diagnosis of ASD is highly stable between 2 and 3 to 4 years, with approximately 10% of children likely to shift from ASD to non-ASD diagnosis in preschool.[37-39] This would translate to up to 4 cases in our sample, which is unlikely to compromise the obtained pattern of results. The toddlers did not differ in age ($p = .204$). The ASD group and DD group were comparable with regard to MSEL Visual Reception, Fine Motor, Receptive and Expressive Language mental ages (all $p > .199$), and their scores were significantly lower than those in the age-matched TD group (all $p < .001$). Social Affect and Restricted Repetitive Behavior Scores on the ADOS-2 were significantly higher in the ASD group than in the DD group ($p < .001$). There were significantly more males in the ASD group (88%) than in the TD (50%) and DD (48%) groups [$\chi^2(2) = 17.42$, $p < .001$] and thus sex was included in the model as a factor.

Procedure

Laboratory Temperament Assessment Battery (Lab-TAB).—To assess the intensity of emotional responses across facial and vocal modalities elicited by positively (joy) and

negatively (anger and fear) valenced, we used a modified set of probes derived from the Laboratory Temperament Assessment Battery—Locomotor Version.[21,22] Each child was administered three emotion-eliciting conditions with three probes per condition: Anger (Car Seat, End of Line, Arm Restraint), Joy (Bubbles, Puppet Show, Penguin Race) and Fear (Spider, Masks, Dinosaur). The induction strategies involved objects (eg, mechanical toys) and activities (bubbles, puppets); none of the strategies involved social interaction or persons displaying emotions (please see Supplement 1, available online, for more detailed descriptions). Each probe consisted of one to three trials, administered in the set order listed above. In the Fear condition, we aimed to induce fear via encounters with novel, potentially threatening, and thereby negatively valenced objects. The Joy and Anger conditions sought to induce emotions from two ends of the positive–negative spectrum. In both conditions, an object or activity with a potentially high reward value either was attained (child had access to a desired activity; Joy condition) or was withdrawn (access was denied; Anger condition). To diminish carry-over effects from one probe to another, standard breaks were instituted between probes, and a new probe began only when the child returned to a neutral, unemotional state. The experiments were videotaped and subsequently coded offline for valence (anger, joy, fear) and peak intensity of emotion, thus capturing the tendency to respond to stimuli using extreme behavioral responses.[40]

Early Childhood Behavior Questionnaire.—The Early Childhood Behavior Questionnaire (ECBQ)[41] is a validated parent-report measure of temperament for children aged 18 to 36 months. It consists of 18 scales targeting broadly defined Negative Affectivity, Surgency, and Effortful Control domains. Considering their relevance to the aims of the study, here we report on the results of three scales: ECBQ Fear (negative affect related to novelty, anticipated pain, distress, or threat), ECBQ Frustration (negative affect related to interruption of ongoing activity or goal blockage), and ECBQ Positive Anticipation (excitement about the anticipation of pleasurable activities).[42]

Data Reduction

The sessions were videotaped, and the peak intensity of emotional expression for fear, anger, and joy observed in facial and vocal channels was subsequently coded for each trial by coders blinded to the child's diagnostic status. All coders had established reliability with a master coder (intraclass correlation coefficient [ICC] at or above 0.75) before starting to code. Facial expressions were coded based on the AFFEX system,[43] which has been used successfully in studies of the stability of emotional traits[44] and has shown high convergent validity with a microcoding system involving coding in discrete time intervals.[45] Each trial was coded for valence and peak intensity of facial (0–3 scale) and vocal (0–5 scale) expressions (please see Supplement 1, available online, for more details). Parental compliance with task instructions was coded on a scale from 0 to 2 (0 = maintained neutrality with limited interference, 1 = some interference; soothing/eliciting behavior; and 2 = intrusive behavior that deemed the probe ineffective). All trials with a score of 2 were excluded from the analyses (3.75%). Consistent with prior research,[46] intensity of valence-matched facial and vocal expressions were significantly intercorrelated in all groups, with correlations ranging from 0.44 to 0.77 (all $p < .001$). Thus, we computed composite raw scores for overall intensity of fear, anger, and joy responses across the facial and vocal

channels for each trial. Raw peak intensity scores for all trials within each condition were then averaged into a mean intensity score for each emotion. To maintain reliability, 13% of the data files were double coded, with ICCs ranging from 0.72 to 0.91 for the 3 emotion composites.

Statistical Analysis

Within each condition, the hypotheses were tested using group (3) by sex (2) linear mixed models (LMM) analysis comparing the 3 groups on intensity of the emotions within each condition. Planned contrasts compared the ASD group to the DD and TD groups with the significance level for planned comparison set at $\alpha = .05$.[47] Associations between intensity of emotions and severity of social-affective symptoms based on ADOS-2 Social Affect (SA) scores as well as ECBQ Fear, Frustration, and Positive Anticipation scores in the ASD group were tested using Pearson *r* correlation analysis.

RESULTS

Intensity of Congruent Emotions

Three between-group LMM analyses on the intensity of the composite scores of congruent anger, fear, and joy intensity were conducted, with sex as a covariate.

Fear.—Neither an effect of sex ($F_{1,89} = 0.01$, $p = .924$), nor a diagnosis by sex interaction ($F_{2,89} = 2.21$, $p = .116$) was significant (Figure 1). However, there was a significant effect of diagnosis, ($F_{2,89} = 3.77$, $p = .027$). Planned contrasts revealed that toddlers with ASD expressed lower intensity of fear than TD ($p = .009$, $d = -0.74$) and DD ($p = .041$, $d = -0.69$) toddlers.

Anger.—There was a marginal main effect of diagnosis ($F_{2,92} = 2.41$, $p = .095$); planned contrasts revealed that toddlers with ASD expressed higher intensity of anger compared to DD ($p = .032$, $d = 0.91$) but not TD ($p = .137$) groups. A significant effect of sex ($F_{1,192} = 4.62$, $p = .034$) was found, driven by males who expressed higher intensity of anger than females. No diagnosis by sex interaction was found ($F_{2,92} = 1.13$, $p = .327$).

Joy.—There were no significant effects of diagnosis ($F_{2,93} = 0.05$, $p = .951$), sex ($F_{1,93} = 0.03$, $p = .083$), or diagnosis by sex interaction ($F_{2,93} = 1.30$, $p = .278$).

Intensity of Incongruent Negative Emotions

To evaluate whether toddlers with ASD are prone to expressing negative affect during positively valenced events, we conducted a diagnosis by sex LMM analysis on intensity of fear and anger during the Joy condition (Figure 2). The analyses revealed no effects of diagnosis on intensity of incongruous fear ($F_{2,93} = 0.46$, $p = .636$) or anger ($F_{2,93} = 0.59$, $p = .555$). Neither effect of sex nor sex by diagnosis interaction was significant (p values >. 218).

Intensity of EE and Phenotypic Features

There were no significant associations between the ADOS-2 SA score and intensity of anger [$r(38) = 0.04$, $p = .795$], or fear [$r(36) = 0.01$, $p = .957$] in the ASD group. However, there was a significant negative correlation between intensity of joy and ADOS-2 SA score [$r(39) = -0.365$, $p = .024$]. Intensity of congruent fearful expressions was positively correlated with the parent-reported ECBQ Fear scale score [$r(36) = 0.449$, $p = .007$], and intensity of congruent joyful expressions was associated with the ECBQ Positive Anticipation score [$r(39) = 0.322$, $p = .048$]. Intensity of congruent anger expressions was not associated with the ECBQ Frustration score [$r(38) = 0.141$, $p = .405$].

DISCUSSION

This is the first study to examine intensity and valence of emotional expression (EE) in toddlers with ASD. The results reveal a complex and surprising emotional landscape of very young children with ASD, a landscape that is inconsistent with the negative emotionality bias hypothesis and largely independent of autism symptom severity. The valence and intensity of emotional expression was strongly modulated by the valence of emotional triggers in all toddlers, but the toddlers with ASD diverged from non-ASD controls with respect to negative emotions, expressing less intense fear but greater anger than developmentally matched controls. The capacity for joyful expression appears to be preserved in toddlers with ASD, although the intensity of enjoyment expressed in such contexts was lower for those with higher autism symptom severity. There was no evidence to support increased intensity of incongruous negative emotions in our sample; it is possible that these become apparent later in development as the range and complexity of EE increases. Consistent with studies in non-ASD populations, effects of sex on emotional expression in ASD were rather modest and restricted primarily to greater intensity of anger in boys.[48] In the ASD group, intensity of fear and joy exhibited in the laboratory were related to that exhibited in real life as reported by parents.

In response to fear-eliciting probes, toddlers with ASD showed attenuated intensity of fear compared to the two control groups. This is the first report of its kind, and the underlying mechanisms of attenuated fear response are not clear. One model of emotions posits that emotions arise from an interplay between networks involved in object recognition (sensory and somatosensory cortices), appraisal of the object value (orbitofrontal cortex [OFC], anterior cingulate cortex [ACC]), and regulation of physiological arousal (amygdala complex).[49-52] Although it is plausible that the limited response to threat observed here was driven by impaired object recognition, we would expect a similar effect in other conditions as well, which was not the case. Instead, we hypothesize that the toddlers have a limited capacity to appraise the value of novel and potentially threatening stimuli, and consequently have difficulty differentiating between threatening and nonthreatening stimuli. The hypothesis is consistent with studies of classical fear conditioning in adults with ASD that suggest a limited ability to discriminate between threat and nonthreat cues as indexed by physiological[53] and neuroimaging[54] measures. Specifically, during fear acquisition, individuals with ASD showed attenuated autonomic arousal[53] and decreased activation of the left and right amygdala.[54] Preliminary analyses of the sample considered in the current

study suggest, similarly, attenuated changes in autonomic arousal during the fear-inducing probes (Vernetti *et al.*, unpublished data, August 2018) despite comparable attention to the threat stimuli in toddlers with ASD and the controls (Chawarska *et al.*, unpublished data, August 2018). Clinically, attenuated response to potential threat may increase safety risks for toddlers with ASD. Considering the importance of threat processing to safety and the development of adaptive coping strategies and emotion regulation, more work is needed to decode factors contributing to atypical threat processing in ASD on affective, cognitive, and physiological levels. Given the ubiquity of affective problems in children and adolescents with, ASD[55-57] understanding the possible role of these early unusual responses to threat in the emergence of comorbid conditions constitutes an important new area of inquiry.

When access to desirable objects or activities was denied in the Anger condition, toddlers with ASD exhibited increased intensity of anger compared to developmentally delayed peers. The probes involved restraint (either in a car seat or by a parent) and, in some cases, removal of a desirable object. Such events are common in early childhood and necessary to ensure safety. Although strong negative emotional responses in such contexts are more the norm than the exception in toddlerhood, these intense negative emotions may challenge the developing emotion regulation system in the early stages of ASD and compound already existing difficulties with communication of emotional states.

The intensity of anger and fear were not associated with severity of autism symptoms, suggesting that the negative emotionality dimensions are independent of the social disability dimension. These findings are incompatible with early accounts suggesting that emotional atypicalities are primary in ASD and contribute to the development of social deficits[4,58,59] or that their emergence is secondary to impairments in, for example, face perception[60] or theory of mind.[61] The results, however, suggest that social and emotional abnormalities represent dissociable areas of vulnerability in ASD, and that their reciprocal influences may shape the development of complex and highly heterogeneous phenotypes in ASD from infancy onward. This view is consistent with recent reports showing a lack of association between negative emotionality traits and severity of autism symptoms in toddlers with ASD[9] and in older children with ASD.[62] The notion is also consistent with neurophysiological studies that suggest that emotional responses to threat and social deficits are not mediated by the same circuitry in the amygdala. Specifically, bilateral amygdala lesions result in reduced response to fear-inducing stimuli, as well as reduced reluctance to engage with a novel animal in adult monkeys[63] and infant primates,[64] but a preserved ability to decode and generate social gestures and initiate and receive affiliative social interactions.[65]

In the present study, the toddlers were passive recipients of joy-inducing activities and did not have to actively seek them. In such a context, toddlers with ASD expressed intensity of joy similar to that of the controls. Yet, clinical experience, parent report, and direct observational studies suggest lower rates of positive affect in real-world contexts.[13,20,66] The discrepancy between results of the present study and observational studies and clinical reports may be related to a dissociation between the “liking” of objects or activities and the ability to pursue them. Specifically, the hedonic (liking) and motivation (wanting) circuitry of the reward system are at least partially distinct[67,68] and can be differentially affected in various disorders,[69] including autism.[70,71] Whereas the hedonic component of the reward

system appears to be spared in ASD, the motivational component appears to be altered.[70-72] This may explain the observation that toddlers with ASD enjoy positively valenced objects and events, as shown in the current study, yet have difficulty pursuing them in the real world. The vast majority of joyful experiences in infancy and toddlerhood are mediated by adults, and access to them depends to a large extent on the child's capacity to communicate his or her preferences and interests. Atypical development of intentional communication skills and social engagement, which are defining to autism and already apparent by the child's first birthday,[73-76] may put infants at risk for encountering fewer adult-mediated, positively valenced experiences, affecting neurodevelopment of reward circuitry in an experience-dependent manner. We hypothesize that although the capacity to feel joy may be intact during the early stages of ASD, the ability to seek out joyful experiences is hampered by poor social-communication skills in ASD, leading to the impression of less overall positive affect. Accordingly, joy was the only expressed emotion that was significantly associated with autism symptom severity in the current study: the greater the severity of social-affective symptoms, the lower the intensity of joyful expression. Notably, positive emotionality represents a largely neglected area of study in autism research. Harnessing the apparently intact capacity for joy in toddlers with ASD for therapeutic purposes will be essential, as activation of positive emotions motivates learning and exploration, the development of social bonds, and fosters activities that counter stress.[77-79].

This study reports on emotional expressions at the earliest stages when ASD can be reliably diagnosed, leaving unanswered the question of when emotional abnormalities begin to manifest and what role they play in shaping the emerging phenotypes of children with ASD. Best-suited for addressing these questions are prospective studies of infants at risk for ASD. The probes presented in the current study were intentionally stripped of social content to limit the impact of social disability on emotional expression. Future research would benefit from direct examination of EE in response to social versus nonsocial challenges. There is also a need for better measurement of emotional expressions and vocalizations in real-world environments; however, the technology to support this type of research in young and atypically developing children is still under development. Because of the young age of the participants, the study relied primarily on behavioral displays of intensity and valence of emotions, which may not give full access to the internal experiences of our participants. Nonetheless, we report on emotional expressions before "display rules"[80] come into effect, whereby children learn to voluntarily inhibit, produce, or alter their natural emotional expressions. Future studies will benefit from supplementing behavioral measures with measures of attention and physiological arousal.

In conclusion, we found no evidence for a negative emotionality bias, blunted positive affect, or incongruous negative emotional expressions in toddlers with ASD. Consistent with work in non-ASD populations,[40] our results suggest that the broad dimension of proneness to distress (eg, "negative affectivity") is less useful in capturing emotional phenotypes of toddlers with ASD compared with more fine-grained focal dimensions of fearfulness and anger-proneness.[81] The discovery that toddlers with ASD exhibited a muted response to novel, intrusive stimuli is important, as it suggests atypical appraisal of threatening elements in the environment and provides motivation for examining its underlying cognitive, physiological, and neurodevelopmental mechanisms. The findings also provide motivation

for an investigation into development of positive emotionality in ASD and its links with core social-communicative impairments in ASD. In particular, there is a pressing need to improve our understanding of the discrepancy between the capacity to experience and pursue activities that elicit joy and to use this information in the service of intervention. Moreover, the notion that young children with ASD characteristically present either with muted affect or with affect marked by a high degree of negativity may lead to lowering the detection rate among children who appear more affectively engaged, especially around activities that aim to elicit positive emotions. Our work on emotional expression adds a much-needed facet to our knowledge of emotion processing in young children with ASD, and may be consequential for identifying precursors to later comorbid affective problems so common in children and adolescents with ASD.[82]

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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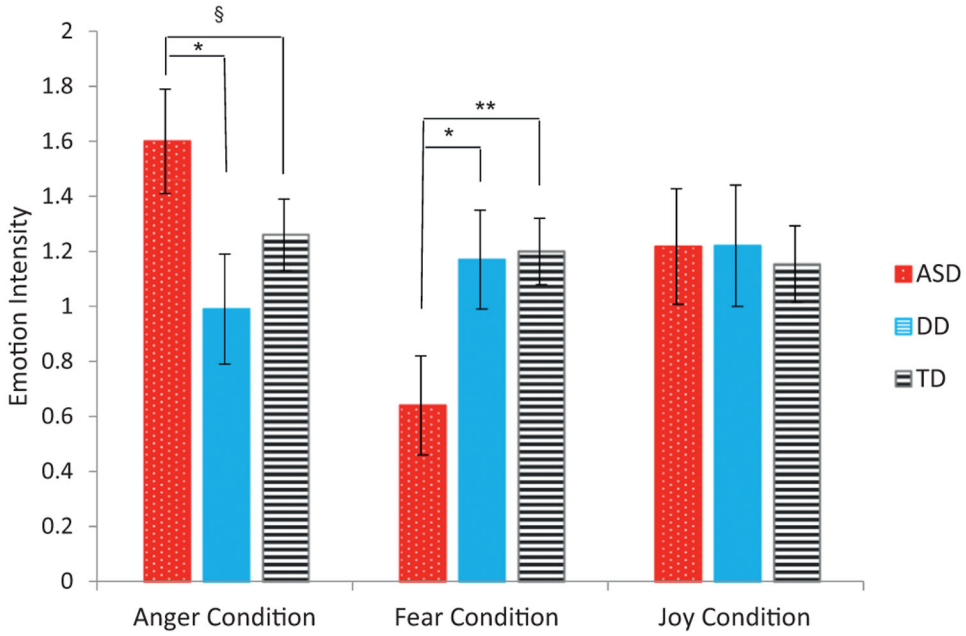

FIGURE 1. Peak Intensity (Marginal Means ± 1 SE) of Condition-Congruent Angry, Fearful, and Joyful Emotions During Anger, Fear, and Joy Conditions in Autism Spectrum Disorder (ASD), Developmental Delay (DD), and Typical Development (TD) Groups

Note: *p < *.05*, **p < *.01*, § = *.137. Please note color figures are available online*.

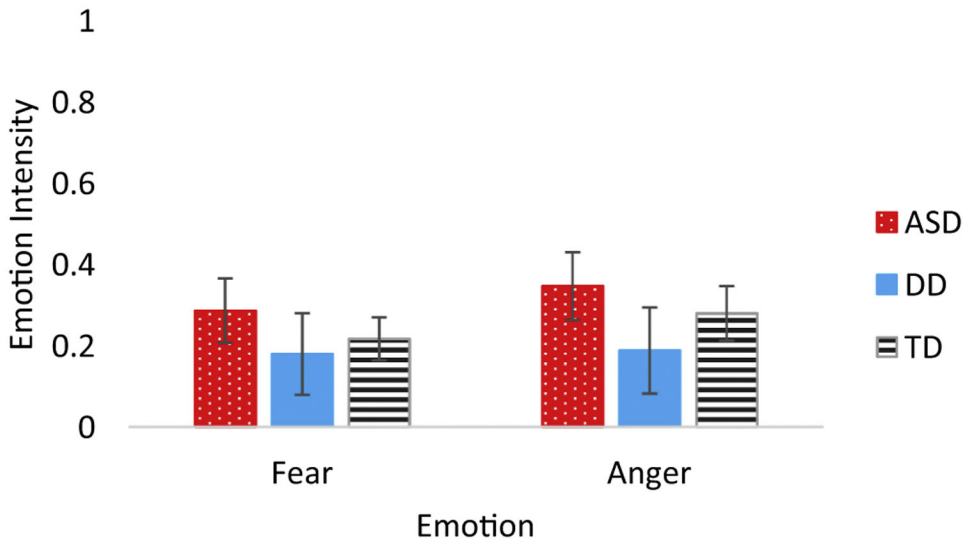

FIGURE 2. Peak Intensity (Marginal Means (± 1 SE) of Incongruent Fearful and Angry Emotions During the Joy Condition in Autism Spectrum Disorder (ASD), Developmental Delay (DD), and Typical Development (TD) Groups

Note: Please note color figures are available online.

TABLE 1

Characteristics of Study Sample

Characteristic	ASD	DD	TD	Contrast
N	43	16	40	
% Male	88	48	50	ASD>DD=TD
Age, mo	21.9 (3.0)	20.3 (3.6)	20.8 (3.9)	ASD=DD=TD
MSEL Visual Reception AE, mo	17.7 (4.9)	19.6 (5.9)	23.2 (5.5)	ASD = DD<TD
MSEL Fine Motor AE, mo	18.3 (3.5)	19.3 (3.6)	22.1(3.5)	ASD = DD<TD
MSEL Receptive Language AE, mo	11.8 (7.8)	15.3 (7.8)	23.6 (5.9)	ASD = DD<TD
MSEL Expressive Language AE, mo	11.3 (6.2)	11.7 (4.6)	21.9 (6.2)	ASD = DD<TD
ADOS-2 SA	13.8 (4.6)	7.0 (3.0)	—	ASD>DD
ADOS-2 RRB	4.2 (1.8)	1.2 (0.9)	—	ASD>DD

Note: Each cell displays mean (SD). ADOS = Autism Diagnostic Observation Schedule; AE = age equivalent; ASD = Autism Spectrum Disorder; DD = developmental delay; MSEL = Mullen Scales of Early Learning; RRB = restricted repetitive behavior; SA = social affect; TD = typical development.

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