The role of alexithymia in parent-child interaction and in the emotional ability of children with autism spectrum disorder

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Abstract

Children with autism spectrum disorder (ASD) have more emotional difficulties than typically developing (TD) children. Of all the factors that impact children's emotional development, parents, and the way they interact with their children, are of crucial importance. The present study compared the amount of parent-child interactions among 35 dyads of parents and their children with ASD and 41 dyads of parents and their TD children, aged between 3 and 13 years, during a frustration-eliciting situation. We further examined whether children's alexithymia is linked to parent-child interactions and whether parent-child interactions are linked to children's emotional difficulties. We found that parents of children with ASD interacted significantly less with their children than parents of TD children. This reduced interaction was better explained by children's alexithymia than by children's ASD diagnosis. Finally, parent-child interaction mediated the relationship between children's ASD diagnosis and children's emotion regulation ability, as well as some aspects of children's emotional reactivity but only if not accounting for children's alexithymia levels. Our results demonstrate the determinant role children's alexithymia plays on parent-child interactions and on how these interactions are linked to children's difficulties in emotion regulation and emotional reactivity. Results are discussed in light of how parent-child interactions and the emotional ability of children with ASD can be improved by targeting children's alexithymia.

Keywords: Autism spectrum disorder, alexithymia, parent-child interaction, emotional reactivity, emotion regulation

Lay Summary

In the present research, we found that parents of children with autism interact less with their children compared to parents of typically developing children. We also found that this decreased interaction is linked to children's difficulties to recognize, describe, and distinguish emotions, a triad of difficulties known as alexithymia. Furthermore, parents' interaction with their children explains emotional reactivity and emotion regulation problems in children with autism. However, if we take into consideration children's alexithymia, then parents' interaction with their children is not related to their children's emotional difficulties in reactivity and regulation. Therefore, to improve the interaction between parents and their children with autism, and the emotional development of these children, we recommend interventions that teach children with autism how to recognize, describe, and distinguish emotions in themselves and others.

Children with autism spectrum disorder (ASD) have increased emotional difficulties such as intensified emotional reactivity and reduced emotion regulation ability (e.g. Samson et al., 2012). Nevertheless, not all children with ASD have emotional difficulties (Nuske et al., 2013). Factors such as parents' interaction with their children play a decisive role on the ability of children with ASD to regulate their emotions (Hirschler-Guttenberg, Golan, et al., 2015) and on the internalizing and externalizing behaviors of children with ASD (Bauminger et al., 2010). Moreover, children's inability to recognize, describe, and distinguish own emotions as well as emotions in others (Sifneos, 1973; Taylor et al., 1997), i.e. alexithymia, may decrease how much parents interact with their children and subsequently increase children's emotional difficulties.

Understanding these factors is fundamental for prevention and intervention programs aimed at improving developmental outcomes of children with ASD. However, how parents interact with their children with ASD during upsetting situations, which factors influence it, and how this is related to children's emotional ability has so far received little attention.

Emotional Difficulties in Children with ASD

Emotional reactivity and emotion regulation are inter-dependent aspects of emotional functioning essential for children's emotional development (Denham et al., 2003). The emotional difficulties of children with ASD are well reported in the literature and research shows increased negative emotional reactivity and decreased emotion regulation ability in children with ASD compared to typically developing (TD) peers (Mazefsky & White, 2014). These emotional difficulties in ASD can be due to factors common among people with ASD such as sensory hypersensitivity (Black et al., 2017), insistence on sameness (Uljarević et al., 2017), and impaired predictive abilities (Sinha et al., 2014).

How children with ASD express and regulate their emotions significantly affects successful emotional and social development and predict both internalizing (e.g. withdrawal and anxiety) and externalizing (e.g. impulsivity and aggressiveness) problems in ASD (Mazefsky & White, 2014; Mazefsky et al., 2013). Internalizing and externalizing problems are common among people with ASD (Rosen et al., 2018) and even though the prognoses of these problems are largely unknown in ASD (Vaillancourt et al., 2017) in TD children, internalizing and externalizing problems are linked to social competence, peer acceptance, adaptive development, and have repercussions into adolescence and adulthood (Burt et al., 2008).

Parents' Role in Children's Emotional Difficulties

Emotional reactivity and emotion regulation begin to develop during the first years of life, and many factors have been shown to be important for this process. Without doubt, children's temperament,

neurophysiological, and cognitive factors all play a crucial role in the development of emotional reactivity and emotion regulation ability (Goldsmith & Davidson, 2004). However, parents, and the way they interact with their children, can also have a significant impact (Cole et al., 2004; Grolnick et al., 1996). Parents contribute to shaping children's emotional development by serving as stimulators and arousal regulators that assist children's immature systems to develop regulatory abilities (Field, 1994; Hofer, 1984). Additionally, parent-child co-regulation of emotions provides children with opportunities to model reactions and expression of emotions (Cole et al., 1994) that are also beneficial for children with ASD (Gulsrud et al., 2010). This can influence children's emotional reactivity and emotion regulation: TD children whose parents are responsive and attentive to their needs express more positive emotions (Roque & Veríssimo, 2011) and show better emotion regulation than children whose parents' interaction is constrained or intrusive (Feldman et al., 2011; Kochanska et al., 2008).

In the few studies conducted in ASD, research has shown that mothers' parenting style and parent-child reciprocity predict emotion regulation ability in children with ASD (Hirschler-Guttenberg, Feldman, et al., 2015; Hirschler-Guttenberg, Golan, et al., 2015). However, these studies did not exploit the underlying factors between parent-child interactions and the emotional ability of the children and, compared to TD populations, in ASD, these may involve a more complex interplay of factors (Sivaratnam et al., 2015). Therefore, understanding parents' interaction with their children with ASD is of empirical and clinical relevance (Hirschler-Guttenberg, Golan, et al., 2015).

Parent-Child Interactions in ASD

Interactions between parents and their children with ASD have been assessed in some studies with, nevertheless, inconsistent results. While some studies find differences in responsivity and sensitivity between parents of children with ASD and those of TD children (Hirschler-Guttenberg, Golan, et al., 2015), others do not (Van Ijzendoorn et al., 2007; Oppenheim et al., 2012). Even though there is large evidence indicating that children with ASD can be securely attached to their parents (Dissanayake & Crossley, 1996; Keenan et al., 2016), the overall occurrence of this type of attachment in children with ASD is lower than among children without ASD (for a review, see Rutgers et al., 2004). Additionally, children with ASD, compared to TD children, show more negative and less positive emotions when interacting with their parents (Capps et al., 1993; Pisula, 2008), they show lower sensitivity and less involvement with their parents (Rutgers et al., 2007; Van Ijzendoorn et al., 2007), and they display fewer positive emotions during social interactions in general (Garon et al., 2009).

The fact that children with ASD express more negativity in the presence of their parents, and have difficulties regulating their emotions can influence how parents interact with them. According to the heuristic

model of the socialization of emotion (Eisenberg et al., 1998), parental emotion-related socialization behaviors are not only defined by parents' personality and cultural influences, but also by their children's characteristics. This model emphasizes the fact that emotional socialization is a bidirectional process: children's characteristics, such as reactivity, affect parents' interactions with them; and in turn, how parents react to their children further influences children's experience and expression of emotions (Eisenberg et al., 1998). Research in ASD corroborates this theory. It has been found that mothers of children with ASD adapt their interaction styles differently to their children with and without ASD (Doussard-Roosevelt et al., 2003), which can be explained by a reduced acknowledgment of mothers' attention-regulation bids by children with ASD (Adamson et al., 2001).

Several factors might contribute to parent-child interaction problems in ASD. One possible factor concerns children's alexithymia. Alexithymia, i.e., the inability to recognize, distinguish, and describe emotions in the self and in others (Sifneos, 1973) has been shown to be negatively related to parent-child secure attachment in TD populations (Fasihi et al., 2013). Because alexithymia is highly prevalent among children with ASD (Rieffe et al., 2007) it could explain the compromised emotional exchanges between children with ASD and their parents. Because children with ASD may be less responsive to emotional signals, or communicate emotions inappropriately, parents might feel that their attempts to stimulate or regulate their children's arousal are ineffective and perhaps even counterproductive, and give up on trying interacting with their child during frustrating moments. Applying the heuristic perspective on the socialization of emotion (Eisenberg et al., 1998), children's alexithymia could reduce parents' interactions with their children, which in turn could affect children's emotional ability and strain parent-child interactions.

The Present Study

Based on the current state of the literature, the present study aims at investigating three hypotheses. First, that parents of children with ASD interact less with their children than parents of TD children. Second, that children's alexithymia influences parent-child interactions. Third, that, as expected by the heuristic model of the socialization of emotion (Eisenberg et al., 1998), parent-child interactions mediate the emotional difficulties of children with ASD.

Methods

Ethical Considerations

The present study was reviewed and approved by the Ethics Review Panel of the University of Luxembourg. Parents read and signed informed consent for participation and data collection.

Participants

A convenience sample of 35 children previously diagnosed with ASD (4 female) and 41 TD children (9 female) together with one of their parents participated in the study (see Table 1). Children were aged between 3 and 13 years (M_{age} = 8.68; SD_{age} = 2.42); parents were aged between 26 and 53 years (M_{age} = 39.88; SD_{age} = 4.70). Among children diagnosed with ASD, 19 had previously been diagnosed with cognitive impairments and attended special education schools (2 female; M_{age} = 8.84; SD_{age} = 2.83) and 16 did not have cognitive impairments and attended regular schools (2 female; M_{age} = 9.16; SD_{age} = 2.50). Children's diagnoses were carried out with either the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 1999), the Autism Diagnostic Interview-Revised (ADI-R; Lord et al., 1994), or the Childhood Autism Rating Scale (CARS; Schopler et al., 1986) according to criteria provided by the DSM-IV (American Psychiatric Association, 1994) and the DSM-IV-TR (American Psychiatric Association, 2000). Since participants were recruited from governmentally recognized institutions, who apply diagnostic methods that are the basis for obtaining health insurance and defining education type, no confirmatory diagnoses were carried out. Preliminary analyses based on this sample revealed no differences in children's emotional reactivity and emotion regulation or in parent-child interactions among children with ASD with and without cognitive impairments (see supplemental material, Table 1). Therefore, we combined the data from these two groups. Participants in this study were part of a larger study on emotional reactivity and emotion regulation.

[Insert Table 1 here]

Procedure

General procedure. Parents received invitations to participate in the study through health-care institutions for children with ASD and through primary schools. The study consisted of a single visit to the laboratory. During the visit, the researcher asked parents to fill out a demographics' questionnaire and a questionnaire about their children's alexithymia. Questionnaires were completed in French (n = 55), German (n = 16), or English (n = 5), according to parents' language preference. After the questionnaires were completed, a frustration-eliciting situation took place.

Frustration-eliciting situation. A frustration-eliciting situation, adapted from the Laboratory Temperament Assessment Battery (Lab-TAB; Goldsmith & Rothbart, 1999), took place in a laboratory setting. During the situation, the child sat a table and the parent sat at the child's left-hand side. The researcher instructed the parent to act naturally, as in a typical life situation, and invited the child to choose toys to play with from a large array of age-appropriate toys (e.g. spaceship, Lego, sticker books). During the situation, parents were not involved in any other task and they were not informed, prior to the situation, about the procedure and aims of the

situation. Approximately 15 seconds after the child began playing, the researcher removed the toys in an abrupt manner and placed them behind a transparent acrylic barrier for 30 seconds (frustration episode). The child had full view of the toys and the barrier was placed within the child's reach. After the 30-second period had elapsed, the researcher returned the toys to the child and the procedure was repeated two more times. To avoid differences in interactions between the researcher and the child or the parent, the researcher did not say anything when removing the toys and only answered to children and parents' questions after the interaction had finished. Two cameras frontally videotaped the child and the parent during the whole situation. Subsequently, two independent observers coded the three frustration episodes in 10-second intervals resulting in nine coded intervals per child and per parent. Prior to coding, the observers reached 80% inter-rater reliability for two participants.

Measures

Measure of children's emotional reactivity. Children's facial expressions during the frustration episodes were coded in terms of the following five emotion categories: sad, angry, afraid, neutral, and happy. Inter-rater reliability between the two coders for 100% of the data yielded a good level of Cohen's Kappa measure of agreement, $\kappa = .76$ (95% CI, .71 to .80), $p < .001$. Emotional expressions were coded using the Emotional Facial Action Coding System (EMFACS) guidelines (Ekman & Friesen, 1978; Friesen & Ekman, 1983) applying a combination of different action units for each emotion (see supplemental material, Table 2). Children's emotional reactivity was analyzed by separately adding the frequency of facial expressions' valences: negative (sad, angry, and afraid), neutral, and positive (happy).

Measure of children's use of adaptive emotion regulation strategies. Children's emotion regulation behaviors during the frustration episodes were coded according to children's common reactions to a mildly frustrating situation (Table 2). These behaviors' categories are based on the work of Grolnick et al. (1996) and adapted by Konstantareas and Stewart (2006). The rating categories are ordered from least to most adaptive and respectively scored from 1 to 12. Two independent observers coded the behaviors in 10-second intervals. The intervals corresponded temporarily to the intervals coded for emotional reactivity. Inter-rater reliability between the two coders for 100% of the data yielded a very good level of Cohen's Kappa measure of agreement, $\kappa = .83$ (95% CI, .80 to .87), $p < .001$. Adaptive emotion regulation was computed by averaging the scores per child.

[Insert Table 2 here]

Measure of parent-child interaction. During the frustration episodes, intervals when parents engaged with their child (e.g. smiling to the child, talking to the child) were coded as interactive; intervals when parents

did not engage with the child (e.g. looking away from the child, looking in the direction of the child with a neutral facial expression) were coded as non-interactive. The intervals corresponded temporarily to the intervals coded for children's emotional reactivity and use of adaptive emotion regulation strategies. Inter-rater reliability between the two coders for 100% of the data yielded a very good level of Cohen's Kappa measure of agreement, $\kappa = .97$ (95% CI, .96 to .99), $p < .001$. To distinguish different patterns of parent-child interactions, parents were categorized into two groups: *Interactive*, representing parents who interacted with their child for most of the intervals (>50% interactive intervals); *Passive*, representing parents who did not interact with their child for most of the intervals (<50% interactive intervals).

Measure of children's alexithymia. The Alexithymia Questionnaire for Children – Parent report (AQC-P) is a 20-item parent-report questionnaire that measures children's alexithymia. The questionnaire is an adaptation of the Alexithymia Questionnaire for Children (Rieffe et al., 2006) in which the items were adjusted to become parent-report (e.g. "My child finds it difficult to say how he/she feels inside"). Parents were asked to rate the degree to which they agreed to statements concerning their child on a 3-point scale ranging from "not true" to "often true" with an additional option for "does not apply". Two independent native speakers translated and back translated the items into French and German. Inconsistencies in translation were discussed and resolved. The 20 items were added to obtain a total alexithymia score. Internal consistencies, computed on the basis of the sample described here, proved satisfactory. Cronbach's alpha was .73 for the French version and .86 for the German version.

Analysis

To compare parent-child interactions (*Interactive*/*Passive*) among parents of children with ASD and parents of TD children, we used a Pearson chi-square test. To examine the role of alexithymia in parent-child interactions we first compared, using an independent samples *t*-test, alexithymia scores between children of *Interactive* and *Passive* parents; then, we used a binary logistic regression analysis to determine the role of alexithymia in parent-child interactions while considering diagnostic group. We entered demographic variables (children's age and gender) in the first step, diagnostic group (TD/ASD) in the second step, and children's alexithymia score in the third step. Preliminary analysis comparing emotional difficulties among groups revealed that children with ASD had significantly more emotional reactivity and emotion regulation difficulties than TD children (see supplemental material, Table 3). Based on these results, we used four 2-path mediation designs to examine whether ASD is linked to children's emotional reactivity and emotion regulation via parent-child

interactions. Given the fact that alexithymia significantly contributed to parent-child interactions, we tested additional 2-path mediation designs with alexithymia included as a covariate.

Results

Group Differences in Parent-Child Interactions

A Pearson chi-square revealed that there was a significant association between group membership (TD/ASD) and parent-child interaction (*Interactive*/*Passive*) [$\chi^2(1) = 9.20$, $p < .01$]. Based on the odds ratio, the odds of interacting with their child was 4.33 times higher for parents of TD children than for parents of children with ASD. Figure 1 represents parent-child interactions in percentages across groups: the majority of parents of TD children were categorized as *Interactive* (63.4%), while the majority of parents of children with ASD were categorized as *Passive* (71.4%). Since age ranged from 3 to 13 years, we analyzed whether age was related to parent-child interaction. An independent samples *t*-test revealed that children's age did not significantly differ between *Interactive* parents ($M = 8.33$, $SD = 2.58$) and *Passive* parents ($M = 9.00$, $SD = 2.25$); [$t(74) = 1.22$, $p = .23$, $r = .14$].

[Insert Figure 1 here]

Role of Alexithymia in Parent-Child Interactions

An independent samples *t*-test across diagnostic groups revealed that children of *Passive* parents had significantly higher alexithymia levels ($M = 20.03$, $SD = 8.09$) than children of *Interactive* parents ($M = 14.22$, $SD = 6.40$); [$t(74) = 3.44$, $p < .01$, $r = .37$].

We conducted a binary logistic regression analysis to predict parent-child type of interaction (*Passive*/*Interactive*) using children's age and gender (girl/boy) as control variables, and diagnostic group (TD/ASD) and alexithymia's score as predictors (Table 3). Age and gender alone did not contribute to a significant predictive model of parent-child interaction ($R^2 = .04$, $\chi^2(2) = 3.83$, $p = .15$). When diagnostic group was added to the model (Step 2), it was a significant predictor of parent-child interaction ($p < .01$) and this resulted in a significant predictive model ($R^2 = .11$, $\chi^2(3) = 11.85$, $p < .01$): being in the ASD group significantly predicted *Passive* parent-child interactions. When alexithymia was added to the model (Step 3), diagnostic group was no longer a significant predictor of parent-child interaction ($p = .12$) and alexithymia predicted parent-child interaction beyond diagnostic group ($p < .05$). Adding alexithymia to the model resulted in a significant predictive model of parent-child interaction ($R^2 = .15$, $\chi^2(4) = 16.17$, $p < .01$): high alexithymia levels in children significantly predicted *Passive* parent-child interactions.

[Insert Table 3 here]

Role of Parent-Child Interactions on Emotional Difficulties in ASD

Three of the four 2-path indirect effects of diagnostic group on children's emotional difficulties via parent-child interactions were significant (95% CI did not include zero; Figure 2). Parent-child interactions did not have an effect on the relation between children's diagnosis and their expression of negative emotions, ab = -0.01, 95% CI [-0.23, 0.25], $p = .95$ (Figure 2a). However, compared to parents of TD children, parents of children with ASD interacted less with their children, which in turn resulted in children's increased expression of neutral emotions, ab = 0.67, 95% CI [0.17, 1.50], $p < .05$ (Figure 2b) and decreased expression of positive emotions, ab = -0.62, 95% CI [-1.36, -0.19], $p < .05$ (Figure 2c). Similarly, the reduced interaction of parents with their children with ASD resulted in a decreased use of adaptive emotion regulation strategies by children, ab = -0.35, 95% CI [-0.73, -0.11], $p < .05$ (Figure 2d).

Given the 2-path model results and the regression analysis results on the contribution of alexithymia to parent-child interactions, we examined the same four 2-path models with alexithymia included as a covariate. When alexithymia was included, none of the 2-path models' indirect effects was significant: on the expression of negative emotions, ab = 0.04, 95% CI [-0.08, 0.35], $p = .69$; on the expression of neutral emotions, ab = 0.46, 95% CI [-0.07, 1.36], $p = .15$; on the expression of positive emotions, ab = -0.47, 95% CI [-1.33, 0.07], $p = .14$; and on the use of adaptive emotion regulation strategies, ab = -0.25, 95% CI [-0.69, 0.06], $p = .12$ (Figure 2; grey text). This indicates that parent-child interactions have an effect on the emotional difficulties of children with ASD but only if children's alexithymia levels are not taken into account.

[Insert Figure 2 here]

Discussion

The first aim of this study was to investigate whether parents of children with ASD differ from parents of TD children in the interaction with their children. The literature in this area is scarce and does not provide a clear picture on parent-child interaction in ASD. In the present study, we found that parents of children with ASD were less likely to interact with their children than parents of TD children. This result contradicts previous studies with younger children in which parents of children with ASD, compared to parents of TD children, were equally responsive and sensitive to their children. In one of these studies (Oppenheim et al., 2012), parents' interaction was observed towards toddlers and preschoolers. In the other study (Van Ijzendoorn et al., 2007), parents' interaction was observed towards toddlers before they had been diagnosed with ASD. Children's developmental stage can be a fundamental factor to understand differences in parent-child interactions in ASD. In the present study, parent-child interaction was not associated with children's age. However, children were

older than 3 years and even though many young children who are later diagnosed with ASD present several symptoms of the disorder, not all symptoms are present before the age of 2 to 3 years (American Psychiatric Association, 2013). It is possible therefore, that parent-child interactions change as the child becomes older, and children's emotional and behavioral problems become more evident.

The second aim of this study concerned the investigation of the role of alexithymia in parent-child interactions among parents of children with ASD and parents of TD children. Not all children with ASD have alexithymia but it has, nevertheless, a high comorbidity in ASD (Rieffe et al., 2006) and has been implicated in the explanation of several emotional disturbances in individuals with ASD beyond the diagnosis (Cook et al., 2013) as well as in parent-child secure attachment in TD populations (Fasihi et al., 2013). For these reasons, and because we found group differences in parent-child interactions, we aimed to examine whether children's alexithymia would be a better predictor of parent-child interaction than ASD diagnosis. We found that, as hypothesized, alexithymia is more important than ASD diagnosis in the explanation of parent-child interactions. Children who have difficulties understanding their emotions are likely to have difficulties communicating inner states to other people, including their parents. This can lead to parents' difficulties understanding when and how to support their child. Furthermore, these children's difficulties understanding other people's emotions will hamper their ability to respond to parents' approaches appropriately. Consequently, the co-regulation of emotions can become debilitated and hinder parent-child interactions.

The last aim of this study was to analyze whether, as expected by the heuristic model of the socialization of emotion (Eisenberg et al., 1998), parent-child interactions contribute to the emotional difficulties of children with ASD. In TD children's literature, it has been reported that parent-child interactions can determine children's emotional reactivity (e.g. Roque & Veríssimo, 2011) and emotion regulation (e.g. Feldman et al., 2011; Kochanska et al., 2008). It has also been found that parenting style predicts the emotional ability of children with ASD (Hirschler-Guttenberg, Feldman, et al., 2015; Hirschler-Guttenberg, Golan, et al., 2015). Because children with ASD have increased emotional difficulties, parents' interaction with their children during frustrating moments can be of paramount relevance: parents can model appropriate responses and influence their children's reactivity. In the present study, we found that the percentage of parent-child interaction had no effect on children's expression of negative emotions. It had, however, an effect on children's expression of positive and neutral emotions as well as on children's use of adaptive emotion regulation strategies — the more parents of children with ASD interacted with their children, the more their children expressed neutral and positive emotions, and used better emotion regulation strategies. However, these indirect effects were only significant

when not accounting for children's alexithymia. When alexithymia was considered, parent-child interaction had no effect on children's emotional reactivity or emotion regulation.

Children who are still learning to regulate their emotions — or who have difficulties regulating their emotions, such as children with ASD — can benefit the most from parents' stimulation and arousal regulation (Field, 1994). However, as we found, children's alexithymia is linked to parent-child interactions: the more parents report their children to have alexithymia, the more unlikely they are to interact with them. Therefore, even though parent-child interaction mediates some emotional difficulties in children with ASD, if we account for children's alexithymia, this mediation disappears. These results are in agreement with the heuristic perspective on the socialization of emotion (Eisenberg et al., 1998): children's alexithymia reduces parent-child interaction, which in turn affects children's emotional ability.

Our results have implications for the prevention and treatment of emotional difficulties in children with ASD. We support and expand the literature by demonstrating that alexithymia accounts for the influence of parent-child interactions in the emotional difficulties of children with ASD. Additionally, we demonstrate that even though children with ASD could benefit the most from parent-child interactions, their parents interact less with them and this can be due to increased levels of alexithymia in children with ASD. Therefore, interventions and prevention programs aiming at improving emotional ability in children with ASD, as well as improving parent-child interaction, should consider working to reduce children's alexithymia by teaching children to recognize, differentiate, and describe emotions.

Even though our results add to the understanding of emotional difficulties in children with ASD, some limitations need to be addressed. First, we did not assess the quality of parent-child interactions. TD literature demonstrates that the quality of parent-child interactions is relevant for young children (e.g. Feldman et al., 2011). Even though in our study, the amount of parent-child interactions was linked to children's emotional difficulties through alexithymia, the quality of the interactions can possibly play an even greater role. Future studies assessing the effects of parent-child interactions in the emotional ability of children with ASD should also look at the quality and type of interaction that parents provide (e.g. caring and supportive versus intrusive and controlling).

Another limitation concerns the assessment of alexithymia. In the present study, we used a parent-report questionnaire to evaluate children's level of alexithymia. Even though parent-reports of children's emotions are reliable and valid (Capaldi & Rothbart, 1992), it is possible that parents who have difficulties interacting with their children, evaluate their children's emotional difficulties differently. This could have affected our results in a

way that we could not account for. If possible, and while taking children's age and level of development into consideration, children's self-assessment of alexithymia should also be included. Another limitation pertains to the fact that we did not assess parents' alexithymia. Studies have shown that parental alexithymia is linked to parenting style and parental control (Cuzzocrea et al., 2015) and thus it is possible that not only children's alexithymia but also parents' alexithymia could play a role in the parent-child interaction.

Finally, alexithymia and ASD have high co-morbidity and some authors argue that both are the same (Fitzgerald & Bellgrove, 2006). Even though this could be a potential confounding variable, not all children with ASD have alexithymia and vice-versa. Moreover, we found that alexithymia had different effects on the outcome variables, which were statistically distinguishable from ASD's effects.

Conclusions

Children with ASD have several emotional disturbances, including increased reactivity, regulation difficulties, and presence of alexithymia. Parent-child interactions, which benefit TD children, can also help improve emotional ability in children with ASD. However, parent-child interactions in ASD, and the resulting potential benefit in children's emotional ability, can be hampered by children's difficulties such as alexithymia. Research regarding whether parents of children with ASD interact differently with their children has been so far scarce and results inconclusive. Our findings show, however, that parents of children with ASD, compared to parents of TD children, interact less with their children but that this is better explained by children's levels of alexithymia than by the diagnostic status of the child. Finally, we found that parent-child interactions mediate emotional difficulties in children with ASD during a frustration-eliciting situation. However, if we consider children's alexithymia levels, this mediation effect disappears: children's alexithymia affects parent-child interactions, which subsequently affect children's emotional difficulties. We thus recommend that interventions aiming at improving children's emotional ability and parent-child interaction consider and target children's alexithymia.

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Figure Legends

Figure 1 Percentage of Interactive (dark bars) and Passive (light bars) parent-child interactions among parents of children with autism spectrum disorder (ASD) and typically developing (TD) children.

Figure 2 Regression coefficients (ß) from 2-path models depicting the relation between diagnostic group (0 = TD / 1 = ASD) and (a) children's negative reactivity, (b) neutral reactivity, (c)positive reactivity, and (d) use of adaptive emotion regulation strategies via parent-child interactions. Unstandardized estimates are displayed.

$^{**}p < .01$, $^{***}p < .001$

† Regression coefficients with alexithymia as a covariate

Table Legends

Table 1 Sample characteristics for ASD group and TD group: Means (M), standard deviations (SD), ranges, sample size, 2-tailed Fisher's exact test, t-values, Pearson's chi square values, and significance levels (p) for age and gender differences between children with ASD and TD children and their parents

Table 2 Sequence of emotion regulation strategies used by children during a mildly frustrating situation (from least adaptive to most adaptive). Adapted from Grolnick et al. (1996) and Konstantareas and Stewart (2006)

Table 3 Three-step binary logistic regression analysis for variables predicting parent-child interactions (Passive/Interactive). Control variables: children's age and gender. Predictors: Group (TD/ASD) and Alexithymia (AQC-P)

Table 1 Sample characteristics for ASD group and TD group: Means (M), standard deviations (SD), ranges, sample size, 2-tailed Fisher's exact test, t-values, Pearson's chi square values, and significance levels (p) for age and gender differences between children with ASD and TD children and their parents

	ASD *M* (*SD*, range) *n* = 35	TD *M* (*SD*, range) *n* = 41	Statistics (ASD/TD)
Children			
Male / Female	31 / 4	32 / 9	$p = .36$, 2-tailed Fisher's exact test
Age	8.99 (2.65, 3–13)	8.42 (2.20, 4–13)	$t(74) = 1.03$, $p = .31$
Parents			
Mother / Father	29 / 6	36 / 5	$\chi^2(1) = 0.37$, $p = .75$
Age	40.82 (4.25, 33–53)	39.12 (4.77, 26–49)	$t(72) = 1.56$, $p = .12$

ASD autism spectrum disorder; *TD* typically developing

Table 2 Sequence of emotion regulation strategies used by children during a mildly frustrating situation (from least adaptive to most adaptive). Adapted from Grolnick et al. (1996) and Konstantareas and Stewart (2006)

Score	Emotion regulation strategy	Description of typical behavior employed
1	Physical objection	Hitting (hands, feet, head)
2	Crying or venting	Crying, whimper, stomping feet, little cries, stimming
3	Defending	Hiding the toy or trying to hold the toy back
4	Infraction	Retrieving or trying to retrieve the toy from behind barrier
5	Verbal objection	Saying "No" or complaining
6	Staring	Staring at the toy behind the barrier
7	Doing nothing	Staring into space
8	Self-distraction	Playing with clothing or fingers
9	Parent or researcher	Talking or making sounds (for non-verbal children) towards the parent or researcher (not oriented at the toy)
10	Directing situation	Asking for playing longer, to have the toy, or pointing at the toy (for non-verbal children)
11	Engaging in alternative activity	Leaving to play with other toys or engaging in imaginary play
12	Complying	Returning the toy immediately or helping return the toy

Table 3 Three-step binary logistic regression analysis for variables predicting parent-child interactions (Passive/Interactive). Control variables: children's age and gender. Predictors: Group (TD/ASD) and Alexithymia (AQC-P)

Variables			95% CI for Odds Ratio		
	β	SE	Lower	Odds Ratio	Upper
Step 1					
Constant	0.71 [-0.39, 2.46]	0.61			
Age	-0.21 [-0.81, 0.23]	0.24	0.50	0.81	1.30
Gender	-0.99 [-2.76, 0.25]	0.67	0.10	0.37	1.38
Step 2					
Constant	1.22 [-0.00, 3.31]	0.68			
Age	-0.17 [-0.83, 0.37]	0.26	0.51	0.85	1.40
Gender	-0.86 [-2.96, 0.53]	0.70	0.11	0.42	1.68
Group	-1.39 [-2.82, -0.42]**	0.50	0.09	0.25	0.67
Step 3					
Constant	0.99 [-0.41, 3.14]	0.69			
Age	-0.11 [-0.82, 0.48]	0.27	0.53	0.90	1.51
Gender	-0.89 [-3.01, 0.63]	0.71	0.10	0.41	1.66
Group	-0.89 [-2.41, 0.28]	0.56	0.14	0.41	1.24
Alexithymia (AQC-P)	-0.62 [-1.36, -0.08]*	0.31	0.29	0.54	0.99

AQC-P Alexithymia Questionnaire for Children – Parent version (total score)

Note. Standardized coefficients are shown. In Step 1, $R^2 = .04$, $\chi^2(2) = 3.83$, $p = .15$; in Step 2, $R^2 = .11$, $\chi^2(3) = 11.85$, $p < .01$; in Step 3 $R^2 = .15$, $\chi^2(4) = 16.17$, $p < .01$.

*$p < .05$, **$p < .01$; R^2: Hosmer & Lemeshow goodness-of-fit statistic