Diminished Ability to Identify Facial Emotional Expressions in Children with Disorganized

Attachment Representations

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Research Highlights

- This study investigated whether disorganized attachment representations may constitute a psychological mechanism behind deviations in children´s ability to identify facial emotional expressions.

- Disorganized children showed a generally diminished ability to identify facial emotional expressions in a task where facial expressions were blurred to increase performance demands, as emotional expressions are often unclear in real life situations.

- Disorganization of the attachment system may constitute an important psychological mechanism interfering with children's ability to identify facial emotional expressions.

Abstract

The development of children´s ability to identify facial emotional expressions has long been suggested to be experience-dependent, with parental caregiving as an important influencing factor. This study attempts to further this knowledge by examining disorganization of the attachment system as a potential psychological mechanism behind aberrant caregiving experiences and deviations in the ability to identify facial emotional expressions. Typically developing children ($N = 105$, 49.5 % boys) aged 6 - 7 years ($M = 6$ years 8 months, $SD = 1.8$ months) completed an attachment representation task and an emotion identification task, and parents rated children´s negative emotionality. The results showed a generally diminished ability in disorganized children to identify facial emotional expressions, but no response biases. Disorganized attachment was also related to higher levels of negative emotionality, but discrimination of emotional expressions did not moderate or mediate this relation. Our novel findings relate disorganized attachment to deviations in emotion identification, and therefore suggest that disorganization of the attachment system may constitute a psychological mechanism linking aberrant caregiving experiences to deviations in children´s ability to identify facial emotional expressions. Our findings further suggest that deviations in emotion identification in disorganized children, in the absence of maltreatment, may manifest in a generally diminished ability to identify emotional expressions, rather than in specific response biases.

Keywords: disorganized attachment, facial emotional expressions, identification, discrimination, bias.

Facial emotional expressions are a central component of emotional communication and the ability to identify emotional expressions in others is critical for social learning and efficient socio-emotional behavior (Bowlby, 1969; Nelson, 1987; Tomkins, 1995). The ability to identify facial emotional expressions must therefore be robust, as emotional expressions are often unclearly expressed (Moulson et al., 2015; Pollak & Sinha, 2002). Development of facial emotion identification follows a protracted course of gradual refinement throughout childhood and is increasingly shown to be experience-dependent (Gredebäck, Eriksson, Schmitow, Laeng, & Stenberg, 2012; Leppänen & Nelson, 2009; Melinder, Gredebäck, Westerlund, & Nelson, 2010; Moulson, et al., 2015; Pollak, Cicchetti, Hornung, & Reed, 2000; Steele, Steele, & Croft, 2008). Accordingly, it has been shown that identification of facial emotional expressions is not only based on the partial perceptual information from the surface muscles of the face, it is also guided by prior experience with emotional expressions (Pollak, Messner, Kistler, & Cohn, 2009). More research regarding effects of experience is however needed, and there is a need to further our understanding of potential psychological mechanisms behind the relation between variations in experience and individual differences in facial emotion identification (Leppänen & Nelson, 2009; Pollak et al., 2009).

Aberrant Caregiving and Development of Emotion Identification

Caregiver behavior is important for the development of children´s ability to identify facial emotional expressions. Caregivers are responsible for a substantial part of the emotional expressions children are exposed to (Malatesta, 1985). Caregivers also model and mirror emotional expressions (DeOliveira, Neufeld Bailey, Moran, & Pederson, 2004), and provide behavioral responses by which meaning becomes associated with emotional expressions (Pollak & Sinha, 2002). Aberrant caregiving, as in child maltreatment, has proven detrimental to children´s development of facial emotion identification. Abusive caregivers display positive emotional expressions less frequently, negative emotional expressions more frequently and with high intensity, and produce less identifiable emotional expressions (Pollak & Sinha, 2002; Shackman & Pollak, 2014). Maltreated children consistently show deviations in identification of emotional expressions relative to children in typical rearing situations (Schackman & Pollak, 2014). This is particularly true for identification of emotional expressions of suboptimal clarity, which may correspond better to identification of emotional expressions in real life situations where facial expressions are typically unclear (i.e., as in contrast to peak expressions; Moulson et al., 2015; Pollak & Sinha, 2002).

There are at least two general patterns in which deviations in caregiving have been demonstrated to impact the development of children´s ability to identify facial emotional expressions. The first pattern, which may be described as *insufficient exposure* to facial emotional expressions, is manifested in a diminished ability to discriminate emotional expressions, and has been found in children from impoverished but non-abusive contexts. For example, neglected children have been found to show a generally diminished ability to identify emotional expressions (Pollak et al., 2000), and institutionally reared children show a diminished ability to identify happy expressions (Moulson et al., 2015). The second pattern may in contrast be described as *overexposure* to specific facial emotional expressions that have been coupled with negative consequences for the child. This pattern is manifested in an enhanced ability to identify these expressions and/or response biases (i.e., deviations in expectations), and has been demonstrated for angry expressions in physically abused children, whereas the ability to detect other expressions has generally been shown to remain intact (Pollak et al., 2000/2009; Pollak, Klorman, Thatcher, & Cicchetti, 2001; Shackman & Pollak, 2014). The ability to identify facial emotional expressions is therefore likely adapted to the particular expectations and demands of the abusive context, in which some expressions are in need of rapid detection for adaptive responding. This is in line with findings that processing

of faces is modulated by the emotional meaning of faces (Milders, Sahraie, Logan, & Donnellon, 2006; Vuilleumier, 2005).

The distinction of these two patterns is however not entirely clear, as biases towards sad expressions have been reported in neglected children, and a diminished ability to identify sad expressions has been reported in physically abused children (Pollak et al., 2000). More research is therefore needed to clarify how aberrant caregiving is linked to deviations in children´s ability to identify emotional expressions. There is also a need to identify psychological mechanisms behind the relation between aberrant caregiving and individual differences in emotion identification (Leppänen & Nelson, 2009; Pollak et al., 2009).

Disorganized Attachment Representations and Development of Emotion Identification

The attachment system and its corresponding internal working models of self and others (IWM; Bowlby, 1973) may constitute a psychological mechanism that affects the development of identification of facial emotional expressions. The most consistent predictor of individual variations in attachment quality is caregiver sensitivity (DeWolff & van IJzendoorn, 1997), and attachment quality is accordingly considered a proxy for the quality of children´s rearing environment (Bakermans-Kranenburg & van IJzendoorn, 2011). Facial emotional interactions are vital to the development of attachment (Koulomzin et al., 2002), and the IWMs are thought to include templates (or filters) of the attachment figure's face as either punishing or rewarding (Magai, 1999). Attachment quality may therefore be linked to the development of facial emotion identification. Yet, very few studies have investigated identification of facial emotional expressions in relation to attachment quality (Laible & Thompson, 1998; Steele et al., 2008; Steele, Steele, Croft, & Fonagy, 1999). Moreover, no study has investigated attachment quality in relation to identification of emotional expressions in suboptimal conditions that more closely resemble identification of emotional expressions in real life situations, in which facial expressions are often unclear.

The type of insecure attachment referred to as disorganized attachment is of particular interest in relation to deviations in the ability to identify emotional expressions. Disorganized attachment representations often develop as a consequence of aberrant caregiving, including frightening/frightened behaviors and extreme helplessness and withdrawal from the child (Lyons-Ruth, Yellin, Melnick, & Atwood, 2005; Schuengel, Bakermans-Kranenburg, & van IJzendoorn, 1999). Disorganized attachment is highly prevalent among maltreated children (Cyr, Euser, Bakermans-Kranenburg, & van IJzendoorn, 2010), but also develops in the absence of maltreatment (15% in low-risk samples), with higher prevalence when caregivers have psychiatric problems (van IJzendoorn, & Bakermans-Kranenburg, 1996). Disorganized attachment has been related to unresolved trauma in the caregiver, which in turn has been found to impair interactions with the child by causing involuntary frightening/frightened and anomalous behaviors toward the child (Schuengel et al., 1999), and/or profound unresponsiveness (DeOliveira et al., 2004). Mothers of disorganized children find it difficult to identify emotions in their children and to control their own affects and responses to their children´s signals (George & Solomon, 1999; Solomon & George, 1999). Mothers of disorganized children have also been found to show unpredictable and fearful expressions (Main & Hesse, 1990) and to simultaneously give multiple conflicting facial emotional expressions (Liotti, 1999). Taken together, research suggests that disorganized children often are exposed to atypical emotional expressions, suggesting that these children could develop deviations in the ability to identify emotional expressions.

Disorganized attachment representations may furthermore affect the development of emotion identification beyond the aberrant caregiving experiences that led to disorganization of the attachment system. Integral to the workings of IWMs is that they guide attention and behavior in social situations (Johnson, Dweck, Chen, & Stern, 2010), thus possibly affecting children´s subsequent learning opportunities and development. Disorganized infants have for

example been found to lack age-typical biases towards fearful expressions (Peltola, Forssman, Puura, IJzendoorn, & Leppänen, 2015). Disorganization is generally conceptualized as a breakdown in behavior and attention relating to attachment, which is indicative of an inability to stay present and oriented to the immediate environment (Hesse & Main, 2000). It has also been argued that the function of the conflict behaviors characteristic of disorganized attachment may be to avoid close interaction with caregivers perceived as frightening (George and Main, 1979). Disorganized behaviors may therefore be an extreme way of coping that develops when both avoidance and approach are ineffective and result in negative responses from the caregiver (DeOliveira et al., 2004). In sum, disorganized IWMs may constitute a psychological mechanism that impairs these children´s development of the ability to identify emotional expressions beyond the deviations in caregiving that led to disorganization of the attachment system. Given the scarcity of studies examining emotion identification in disorganized children research must, however, first establish whether disorganized children show deviations in the ability to identify emotional expressions.

Disorganized Attachment Representations, Emotion Identification and Emotional Problems

Emotional problems such as negativity and aggression are among the most common problems in maltreated children (Pollak, Cicchetti, & Klorman, 1998). Deviations in processing of emotional expressions have further been found to mediate the relation between experience of maltreatment and emotional negativity (Shackman, & Pollak, 2014; Shackman, Shackman, & Pollak, 2007). Disorganized attachment is also robustly linked to emotional negativity and aggression (Carlson, 1998; Fearon, Bakermans-Kranenburg, van IJzendoorn, Lapsey, & Roisman, 2010; Lyons-Ruth, Alpern, & Repacholi, 1993). Despite a need to examine mechanisms affecting the relation between disorganized attachment and emotional problems (Fearon et al., 2010) no study has investigated deviations in emotion identification as a possible mediator or moderator. Impairments in the ability to identify others' emotional expressions could be part of a negative cycle of miss-attunements in social interactions, negative expectancies of self and others, and increased negative emotionality. Accordingly, disorganized children have been found to react atypically with anger and aggression towards cues of others´ distress (Main & Goldwyn, 1984).

The Present Study

We suggest that disorganization of the attachment system is a potential psychological mechanism linking aberrant caregiving experiences to deviations in emotion identification. As such, we hypothesized (hypothesis 1) that children with disorganized attachment would demonstrate deviations in emotion identification. We used disorganized attachment as a proxy for aberrant caregiving experiences (e.g., Bakermans-Kranenburg & van IJzendoorn, 2011; Cyr et al., 2010). Following previous research we hypothesized that the alteration of the ability to identify facial emotional expressions in disorganized children may take two forms.

Hypothesis 1.1; deviations in identification of facial emotional expressions may manifest in a diminished ability to identify emotional expressions. This would be consistent with the pattern of insufficient exposure to emotional expressions found in children in impoverished but non-abusive contexts, the impaired ability of mothers of disorganized children to identify and express emotions, and withdrawal from interactions with the child.

Hypothesis 1.2; deviations may manifest in specific enhancements of the ability to identify, or biases towards, angry and/or fearful expressions. This would be consistent with the pattern of overexposure to particular expressions found in children from abusive contexts. Frightening/frightened behaviors are a central predictor of disorganized attachment, and fear and hyper-vigilance are key characteristics of disorganized attachment (Main & Solomon,

1990). Because of a lack of prior research examining emotion identification in children with disorganized attachment, either one or both of these hypotheses may be true.

We also hypothesized that disorganized children would show more negative emotionality (hypothesis 2). This would be consistent with research showing a robust relation between disorganized attachment and emotional as well as behavioral problems (Fearon et al., 2010). Due to a lack of previous research we also asked an exploratory question, namely if deviations in the ability to process emotional expressions would mediate or moderate the presumed relation between disorganized attachment and negative emotionality.

Method

Participants and Procedure

The sample consisted of 105 typically developing children (49.5 % boys) aged 6 - 7 years (M = 6 years 8 months, SD = 1.8 months) that lived in the county of a university town in Sweden. Families were drawn from the local birth register of Uppsala county and were sent a letter inviting them to participate (N = 1062). A total of 156 families (14.7%) responded positively and were subsequently given further information about the study and inclusion criteria. Two inclusion criteria were employed to enable reliable coding of the attachment representation task (below): the children speaking Swedish and not having any known developmental disability, such as autism spectrum disorder. Ninety-three of the children (88.6%) lived with both parents and the remainder primarily with their mothers or alternating between mother and father. All children lived at least part time (50%) with their mothers, and all but two children (98%) were born in Sweden. The educational status of the sample was high, with 85 of the children (81%) having at least one parent with a university degree.

The specific age range (6-7 year olds) was selected for several reasons. First, this age group allows for comparison between our findings and those of previous studies on emotion identification, which often have been based on early school aged children (Moulson et al., 2015; Pollak et al., 2000/2001/2009; Shackman & Pollak, 2014). Second, accurate identification of emotional expressions is becoming more important in this age group as social demands are increasing and children are required to function independently with other children in peer relations and in the school context. Third, the instrument that we used to examine children´s attachment representations was developed for this age group, as children of this age typically have reached the threshold language skills required to complete the attachment interview.

The children took part in a laboratory visit at the department that lasted approximately two hours and included a break. The tasks used in this study were part of a battery of tasks designed to assess various emotional and cognitive components in relation to children´s social functioning. The children were tested individually and performed the tasks in a fixed order with the facial emotion identification task before the attachment representation task. The accompanying parent(s) filled out a questionnaire in an adjacent room. All participants received a toy worth approximately $10 and the parent received a gift voucher worth approximately $12. The study was evaluated to conform to the ethical standards of the Swedish Research Council and as declared in the declaration of Helsinki.

Measures

Identification of facial emotional expressions. The task was constructed for the present study and used 40 frontal view color photographs of Caucasian faces shown neck up with hair against a featureless grey background. The photographs showed happy, angry, fearful, and sad expressions (five photographs per expression type per gender). Photographs were taken from The Karolinska Directed Emotional Faces (KDEF; Lundqvist, Flykt, & Öhman, 1998), which has shown excellent validity in emotional content and test-retest

reliability (Goeleven, De Raedt, Leyman, & Verschuere, 2008). Faces were blurred using Photoshop CS5's Gaussian blur, using three different levels measured in pixel numbers. For each five photographs for a given gender and expression type, three were blurred at level 15, one at level 20, and one at level 25 (see figure 1).

The photographs were blurred to increase performance demands, as previous research indicates that peak expressions may be too easy (e.g., Moulson et al., 2015; Pollak & Sinha, 2002). Indeed, maltreated children have been found to perform on the same level as typically developing children when shown peak expressions, with deviations emerging when performance has been made more demanding (Pollak & Sinha, 2002), using methods similar to the one in the present study (e.g., Moulson et al., 2015; Pollak & Kistler, 2002; Pollak & Sinha, 2002). A second reason for blurring the photographs was that, in real life situations, facial emotional expressions must often be identified based on partial and suboptimal information from the face muscles (e.g., noticing that someone is becoming sad before he/she bursts into tears). Children´s performance for identification of expressions of suboptimal clarity may therefore generalizable better to their ability in real life situations (for similar reasoning see Moulson et al., 2015; Pollak & Sinha, 2002).

The photographs were presented in two semi-randomized sequences, with the same four photographs on the lowest level of blur in the beginning of each sequence. There was no effect of sequence on children´s accuracy scores, $t(103) = .626$, $p = .533$. The photographs (562 x 762 pixels) were shown one at a time on a monitor that measured 33.7 x 27 inch (1280 x 1024 resolution). Participants were seated approximately 60 cm from the monitor (0.022 x 0.023 visual degrees per pixel). Four practice trials with non-blurred faces (one per emotion) were administered before the test trials. The administrator instructed the children to report which of the four emotions was being displayed by each face. There was no time limit for each trial; the test leader manually initiated the next trial after the children responded.
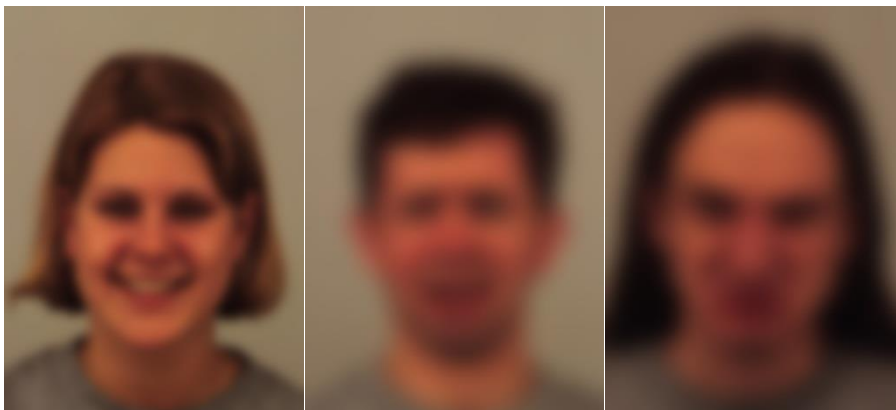

Figure 1. Example stimuli at different blur levels – from left to right, happy female level 15, sad male level 20, angry male level 25. Note three out of five presented pictures were at the lowest blur level.

Seven photographs (2 angry, 2 fearful, 3 sad) had hit-rates below 35%, which given the sample size, would not be considered different from chance responding and were therefore dropped from further analysis. Final analyses are therefore based on data from the remaining 33 photographs. Hit rates (HR) were first calculated for each individual as the percentage of correct responses for each emotional expression type. False alarm rates (FAR) for each individual were calculated for each emotional expression type as the percentage of trials that did not display that emotion for which that emotional expression was incorrectly identified. We next calculated indices for discrimination (D_p) and response-bias (B_p) for each emotion according to recommendations by Snodgrass and Corwin (1988), previously followed by

Pollak and colleagues (Pollak et al., 2000). Discrimination (D_p = HR-FAR per emotion) represents sensitivity to a particular stimulus by taking into account the FAR for that stimulus and is thought of as a bias-free measure of discriminatory ability. Higher scores indicate better discriminatory ability. Bias (B_p = FAR/(1-[HR-FAR]) per emotion) represents response tendencies towards particular stimuli and is thought to primarily influence categorization under uncertainty (See Snodgrass & Corwin, 1988 for a fuller description). We corrected HR of 1 and FAR of 0 with the standard approach to enable calculation of B_p, with a constant of .0001 subtracted from HR of 1 and added to FAR of 0, to affect scores as little as possible. Values of 0.5 for B_r indicates no bias, higher values indicate a liberal criterion, and lower scores indicate a conservative criterion for selecting a particular expression.

        Attachment representations. Child attachment representations were measured with the adapted Separation Anxiety test (SAT; Kaplan, 1987). The administrator presented the children with six black and white drawings, one at a time in a fixed order, that depicted separation situations between a child (presented as same sex as the interviewed child) and his/her parents. The pictures were androgynously drawn with respect to gender of the pictured child and with neutral affective expressions, and taken from the Swedish translation of the interview system (Broberg, Wiberg, & Karlsson, 2000). For each picture the administrator first gave a short vignette (e.g. "in this picture mom and dad are going away for the weekend, and the child is to stay with his/her relatives") and then asked the children (1) how the child in the picture was feeling, (2) why the child was feeling that way, and (3) what the pictured child would do. The administrator used standardized probes (e.g. "take a guess"/ "what do you think") if children did not respond at all or that they didn´t know. As advised by Kaplan (1987), we used 15 standardized follow-up probes (e.g. "is the boy/girl" angry) on four of the pictures. We used a non-obtrusive .mp3 recorder and then transcribed and coded the interviews in accordance with Kaplan´s (1987) coding manual.

        Each transcript was coded categorically for the four attachment categories. Transcripts were coded *"secure-resourceful"* if the participating children described vulnerable feelings for the pictured child and were able to provide active and constructive solutions for how the pictured child would deal with the situations. Transcripts were coded *"insecure/avoidant-inactive"* if the participating children failed to describe constructive solutions for the pictured child (e.g. "I don´t know"/"do nothing"), and *insecure/ambivalent-aggressive* if the participating children described aggressive or passive aggressive behaviors towards the parents of the pictured child and/or contradictory solutions, such as seeking contact with parents in one situation and then being aggressive towards them in others. Transcripts were coded *insecure/disorganized-fearful* if the pictured child was described by the participant as being inexplicably afraid about something and unable to do anything about it, or if the participating children reacted to the interview situation with disorganized out of control behavior (e.g. hurting him-/herself, being mean to the administrator). Indices of fear also include markedly prolonged silences, refusal to say anything or refusal to finish the task, prolonged or marked whispering, and linguistic disorganization (e.g. "yes-no-yes-no-yes-no") or catastrophic fantasies in which the parents or child died or got seriously injured.

        Validity of the SAT, as adapted by Kaplan (1987), has been shown in several samples with concurrent relations to observed reunion behavior in the 6th-year-reunion procedure and in relation to previously observed infant strange situation classification (Main, Kaplan, & Cassidy, 1985; Grossmann et al., 2002). The transcripts were coded by the first author, who was trained by the third author with permission by Dr. Kaplan, and achieved full reliability with the trainer (>80% correct classifications across all four categories and 30 transcripts). In the present study the categorical measure of disorganized attachment was used in comparison to the three organized patterns grouped together (dichotomous variable; D = 1, Non-D = 0). Interrateragreement on classification over 20 cases (with the third author) was

Cohen's kappa $k = .86$ for disorganized/organized. Additionally, interagreement was $k = .74$ for all 4 attachment categories, and $k = .76$ for three-way classification, grouping insecure-avoidant and insecure-ambivalent children together as an organized insecure category.

Ratings of negative emotionality. The children´s accompanying parent(s) completed the short version of the Emotion Questionnaire (Rydell, Berlin, & Bohlin, 2003), with 2 questions per emotion (happiness/exuberance, anger, fearfulness and sadness) that measure the intensity and frequency of the child´s emotional reactivity, respectively. Each question was scored on a scale with a range from 1 (doesn't apply at all) to 5 (applies very well). We used the mean score for negative emotionality (anger, sadness, and fear), with higher values indicative of higher frequency/intensity of emotionality. Cronbach´s alpha was .85 for negative emotional reactivity.

Statistical Analyses

Data was screened for extreme values ($Z > 3.29$, $p < .001$; Field, 2013). Two participants had extreme scores for discrimination of happy expressions. Three participants had extreme bias scores for sad expressions. Participants with extreme scores were excluded from analysis on that particular variable as outliers may have been a result of factors unrelated to the task, such as visual disabilities not yet identified. Analysis of univariate normality showed that all variables were acceptable (Kline, 2011) with skewness ranging from -.1.51 to .236, and kurtosis from .1.65 to .467. Child gender and age were unrelated to all measures.

Analysis of effects of disorganized attachment on discrimination and biases for the four facial emotional expressions were investigated with two 2 (attachment group) x 4 (emotional expression type) mixed ANOVAs. Attachment group (disorganized/organized) was entered as between-group factor in each ANOVA and scores for discrimination and bias (happy, sad, angry, and fearful) was entered as within-group factor in the respective ANOVA. Probability values for repeated measures are reported with Huynh-Feldt corrections and contrasts with Bonferroni corrected probability values.

Relations between disorganized attachment, facial emotion identification, and negative emotionality were first examined with correlations (r). The point-biserial correlation (r_{pb}) was used for correlations with disorganized attachment as this variable was coded as a discrete dichotomy, a common approach in attachment research (e.g., Bohlin, Brocki, Eninger, & Thorell, 2012; Thorell, Rydell, & Bohlin, 2012; Forslund, Brocki, Bohlin, Granqvist, & Eninger, 2016).

Next, facial emotion identification was examined as a potential moderator or mediator of the predicted relation between disorganized attachment and negative emotionality. Analyses were performed using the process tool (version 2.15) developed by Hayes (2012). This tool examines moderation (i.e., interaction between the independent variable and the moderator) and mediation (i.e., indirect effect of the independent variable on the dependent variable through the mediator) using state of the art statistical approaches (Field, 2013). Mediation was examined with both the Sobel test and with bootstrapped confidence intervals (1000 samples), as the present sample size was rather small, which in turn may make the Sobel test too conservative (Field, 2013). Disorganized attachment was entered as the independent variable in each analysis, discrimination of facial emotional expressions as the moderator/mediator, and negative emotionality as the outcome variable.

Results

Descriptive statistics for continuous measures of facial emotion identification (HR) and negative emotionality are presented in Table 1. The hit rates for the four respective emotional expressions correspond well with previous findings, suggesting that happy expressions are easiest to identify followed by angry expressions (Goeleven et al., 2008). Sixteen children (15.2%) were coded as "insecure/disorganized-fearful". Of the 89 organized

children, 55 children (52.4%) were coded as "secure-resourceful", 27 children (25.7%) as "insecure/avoidant-inactive", and 7 children (6.7%) as "insecure/ambivalent-aggressive". The distribution of disorganized attachment corresponds well with meta-analytic data regarding the general prevalence of disorganized attachment in low-risk samples (van IJzendoorn et al., 1999), and with previous research in low-risk samples in Sweden (Forslund et al., 2016).

Table 1

Descriptive Statistics for Disorganized Attachment, Emotion Identification, and Child Emotionality, N=105.

Variables	Minimum	Maximum	M	SD
Disorganized attachment	0	1	.15	.37
Identification of expressions total	.42	.97	.73	.11
Identification of happy expressions	.70	1	.95	.08
Identification of sad expressions	0	1	.50	.24
Identification of angry expressions	.13	1	.83	.21
Identification of fearful expressions	0	1	.56	.29
Negative emotionality	1	4.33	2.31	.82

Emotion Identification Performance and Effects of Emotional Expression Type

The children showed a high ability to discriminate emotional expressions, with discrimination scores (HR - FAR) of .82 for happy, .73 for angry, .45 for fearful, and .35 for sad expressions. There was a main effect of emotional expression type, $F(3, 303) = 86.57$, $n^2 = .46$, $p < .001$. Children were better at discriminating happy expressions than all other expressions (ps < .001 for sad and fearful expressions, $p = .002$ for angry expressions). Additionally, children were better at discriminating angry expressions than sad and fearful expressions (ps < .001). There was no difference between sad and fearful expressions ($p = .151$).

The children were descriptively slightly biased towards suggesting that faces were happy ($B_p = .66$). Children were neutral in choosing angry expressions ($B_p = .44$), and rather conservative in choosing sad ($B_p = .19$) and fearful expressions ($B_p = .26$). There was a main effect of emotional expression type on bias, $F(3, 300) = 25.17$, $n^2 = .20$, $p < .001$, with children more biased towards happy expressions than all other expressions (ps < .001 for sad and fearful expressions, $p = .003$ for angry expressions). Additionally, children were more biased towards selecting angry expressions than sad expressions ($p < .001$) and marginally more biased towards selecting angry than fearful expressions ($p = .08$), but there was no difference between sad and fearful expressions ($p = 1$).

Effects of Disorganized Attachment on Discrimination of Emotional Expressions and Bias

Scores for discrimination of facial emotional expressions for disorganized and non-disorganized children are presented in Figure 2. There was a main effect of disorganization on discrimination of facial emotional expressions, $F(1, 101) = 5.1$, $n^2 = .05$, $p = .026$, with the disorganized children showing a generally lower ability to discriminate emotional expressions ($D_p = .54$) than organized children ($D_p = .64$). There was no interaction between disorganization and emotional expression type, $F(3, 303) = .74$, $n^2 = .007$, $p = .53$.

To further examine the effect of attachment on discrimination of emotional expressions we performed an exploratory 3 X 4 mixed ANOVA, with insecure-ambivalent and insecure-avoidant children being separated from the organized category and collapsed into a third category constituted by "organized-insecure" children. The results showed a

marginally significant main effect of attachment on discrimination of emotional expressions, $F(2, 100) = 2.62$, $n^2 = .05$, $p = .077$, which likely did not reach conventional criteria for statistical significance due to low power (51%). There was no interaction between attachment group and emotional expression type, $F(6, 300) = .793$, $n^2 = .016$, $p = .56$. Post hoc tests were not examined since the main effect of attachment group was only marginal. However, the performance of secure children ($D_p = .63$) and organized insecure children ($D_p = .65$) were highly similar, and similar to the performance of organized children as a whole ($D_p = .64$), indicating that the effect was likely driven by disorganization ($D_p = .54$).

There was neither a main effect of attachment group on bias scores $F(1, 102) = 1.34$, $n^2 = .01$, $p = .25$ nor an interaction between attachment group and emotional expression type on bias scores, $F(3, 303) = .36$, $n^2 = .004$, $p = .79$.
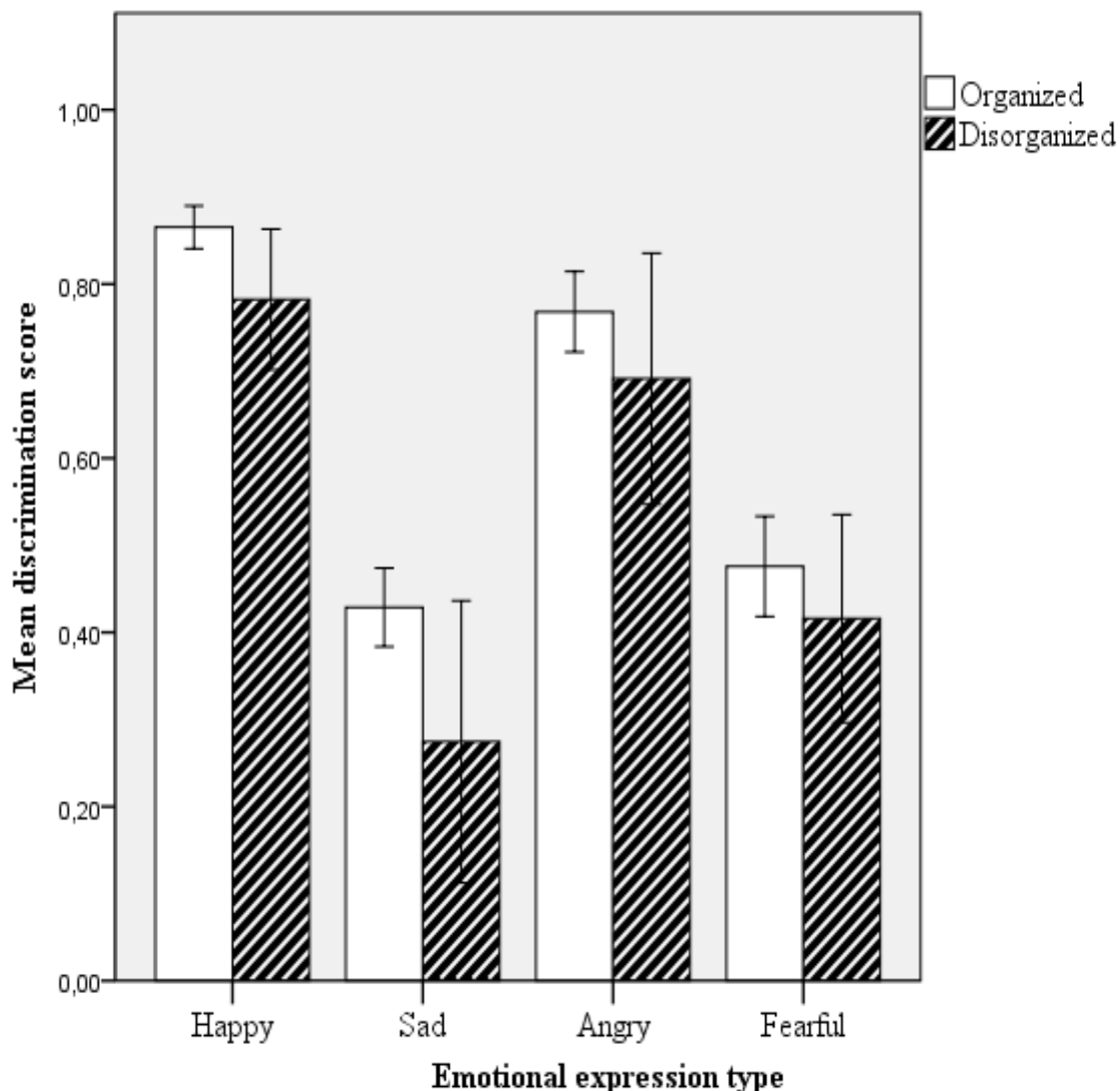

Figure 2. Mean discrimination scores for disorganized and organized children for each type of emotional expression. Error bars represent 95% confidence intervals.

Relations between Disorganized Attachment, Discrimination of Emotional Expressions and Negative Emotionality

We first calculated a composite score of discrimination of facial emotional expressions (mean score for discrimination of all expressions), as there was a main effect of disorganization on discrimination of facial emotional expressions but no interaction between

disorganization and emotional expression type. Disorganized attachment and a diminished ability to discriminate facial emotional expressions were both related to higher levels of negative emotionality ($r = .34$, $p < .001$; $r = -.25$, $p = .01$, respectively). Disorganized attachment and discrimination of facial emotional expressions were also related ($r = -.23$, $p = .019$), as reflected in the main effect of disorganized attachment on discrimination of facial emotional expressions.

      Analysis of moderation showed that the model predicting negative emotionality was significant, $F(3,99) = 5.90$, $p = .001$, adjusted $R^2 = .15$, with disorganized attachment contributing significantly to negative emotionality ($b = .63$, 95% CI [.18 – 1.10], $t = 2.77$, $p = .007$), and discrimination of emotional expressions contributing marginally ($b = -.20$, 95% CI [-.42 – .01], $t = -1.85$, $p = .067$). There was no interaction between disorganization and discrimination of emotional expressions ($b = -.15$, 95% CI [-.68 - .39], $t = -.55$, $p = .586$), indicating that discriminative ability did not moderate the relation between disorganization and negative emotionality.

      Analysis of mediation showed that there was no indirect effect of disorganized attachment on negative emotionality through discrimination of emotional expressions, as indicated by the Sobel test ($b = .095$, $z = 1.43$, p $= .153$), as well as the bootstrapped confidence intervals for the indirect effect, $b = .095$, 95% BCa CI [.004, .278], $\kappa^2 = .044$, 95% BCa CI [.055, .131], indicating that discrimination of emotional expressions did not mediate the relation between disorganized attachment and negative emotionality.

Discussion

      The present study investigated whether disorganized attachment is related to deviations in children´s ability to identify facial emotional expressions. We found a generally diminished ability to identify emotional expressions in disorganized children, but no response biases. Disorganized attachment and a poorer ability to discriminate emotional expressions were both related to higher levels of negative emotionality, but discrimination of facial emotional expressions did not moderate or mediate the relation between disorganized attachment and negative emotionality. These findings suggest that disorganized attachment may constitute a psychological mechanism linking aberrant caregiving experiences to deviations in children´s ability to identify facial emotional expressions (Leppänen & Nelson, 2009; Moulson et al., 2015).

Disorganized Attachment and Identification of Facial Emotional Expressions

      The diminished ability to identify emotional expressions in disorganized children is a novel finding. Previous research has shown that disorganized children often are exposed to aberrant caregiving (Cyr et al., 2010); including poor modeling of emotional expressions (Liotti, 1999; Main & Hesse, 1990), underexposure to emotional expressions following caregiver withdrawal and unresponsiveness (DeOliveira et al., 2004; Lyons-Ruth et al., 2005), and/or overexposure to angry and/or fearful expressions due to frightening/frightened behaviors on behalf of the caregiver (Schuengel et al., 1999). The present study used a cross-sectional design, and causal conclusions are therefore not warranted. However, the findings reported above suggest that the diminished ability to identify emotional expressions may be an effect of the aberrant caregiving that disorganized children often experience, and/or disorganization of the attachment system. Secure attachment has also been prospectively linked to a higher ability to identify emotional expressions (Steele et al., 2008).

      Attachment quality does not merely reflect our previous socio-emotional experiences; the IWMs of attachment also affect how we perceive social situations, what we attend to, and how we behave (Johnson et al., 2010). Disorganized children´s inability to stay present and oriented to the immediate environment (Hesse & Main, 2000) may for example limit opportunities for learning about facial emotional expressions. Disorganized children have

indeed been found to avoid close interaction with the caregiver even when he/she is smiling (George & Main, 1979).

The unresolved traumatic experiences in caregivers of many disorganized children have been found to predict trauma-related avoidant and dissociative behaviors in these caregivers (Hesse & van IJzendoorn, 1998; Stovall-McClough & Cloitre, 2006; West, Adam, Spreng, & Rose, 2001). As can be seen in infants' reactions to the still face procedure, severe parental unresponsiveness is very distressing for children (Ekas, Haltigan, & Messinger, 2013; Melinder, Forbes, Tronick, Fikke, & Gredebäck, 2010; Mesman, van IJzendoorn, & Bakermans-Kranenburg, 2009). Children´s reactions to the still-face procedure have also been related to caregiver sensitivity and to attachment quality, with insecurely attached children smiling less to elicit a response from the caregiver and showing a steeper decline in gaze towards the caregiver (Ekas et al., 2014; Mesman et al., 2009). It is possible that painful experiences with a severely unresponsive and/or occasionally frightening caregiver may lead to templates (or filters) of the caregiver´s face as punishing (Magai, 1999). Subsequently, this may result in the infant becoming less attentive to the caregiver´s and others' faces, limiting opportunities to learn about emotional expressions. Disorganized infants have for example been found to lack age-typical biases towards fearful faces (Peltola et al., 2015). Infants whose mothers encourage them to attend to her face have, in contrast, been found to show a higher sensitivity to emotional expressions (Kuchuk, Vibbert, & Bornstein, 1986).

Since fear and hyper vigilance are characteristics of disorganized attachment, atypical expectancies in the form of response biases towards angry and/or fearful faces might have been expected, but we did not find this in the current study. Biased expectancies have however generally been found in abusive contexts, in which rapid detection of particular expressions that signal threat is important (Shackman & Pollak, 2014). We investigated children in a low risk sample where prevalence of physical abuse is low. Corporal punishment is also illegal in Sweden and the prevalence of physical child abuse relatively low (Annerbäck, Sahlqvist, Svedin, & Gustafsson, 2012). In a presumably non-abusive context, with no adaptive need to rapidly detect cues of threat, a diminished ability to identify facial emotional expressions may be the likeliest outcome of deviating emotional interactions with caregivers. Previous research reporting deviations in children´s ability to identify facial emotional expressions have mainly been based on children subjected to maltreatment. Our finding of a generally diminished ability to identify emotional expressions in disorganized children from a low-risk context therefore adds to previous research, as it suggests that aberrant caregiving may have negative effects on facial emotion identification presumably in the absence of maltreatment.

Disorganized Attachment, Discrimination of Emotional Expressions, and Negative Emotionality

As hypothesized, disorganized attachment was related to higher levels of negative emotionality. This result is consistent with previous research that has demonstrated a robust concurrent and prospective relation between disorganized attachment and emotional problems (Carlson, 1998; Fearon et al., 2010; Groh et al., 2014; Lyons-Ruth & Block, 1996). The relation between deviations in the ability to identify emotional expressions and negative emotionality is also consistent with previous research reporting similar results in maltreated children (e.g., Shackman & Pollak, 2014). Disorganized attachment and negative emotionality was, however, neither moderated nor mediated by facial emotion identification. The higher levels of negative emotionality in disorganized children may therefore depend on other factors not examined herein. Mediating factors between deviations in processing of facial emotional expressions and negative emotionality, such as a lack of attentional control, have however been found primarily in homogeneous samples of physically abused children showing specific biases towards angry expressions (Shackman & Pollak, 2014). Again, the present sample was

from a low-risk context, in which the prevalence of physical abuse can be presumed to be low, and accordingly the disorganized children did not show response biases. Moreover, disorganized attachment is heterogeneously expressed by school age in different maladaptive patterns of controlling strategies that have different emotional concomitants (Moss, Cyr, & Dubois-Comtois, 2004). Future research should therefore try to separate different subtypes of disorganized children.

Limitations

Some limitations of the current study present opportunities for future research. Most importantly, we did not obtain information regarding caregiver behaviors. Although aberrant caregiving experiences is a strong predictor of disorganization (Cyr et al., 2010; Schuengel et al., 1999) not all disorganized children experience aberrant caregiving (Granqvist et al., 2016). Future research examining disorganization and emotion identification should therefore simultaneously examine caregiver behaviors, to establish that the effect has a relational basis and is not due to children´s neurological dispositions (Padrón, Carlson, & Sroufe, 2014). Research simultaneously examining caregiving behaviors would also further our understanding of whether disorganized IWMs cause impairments in emotion identification over and beyond exposure to aberrant caregiving, which in and of itself is related to development of deviations in emotion identification (DeOliveira et al., 2004).

Additionally, we investigated facial emotion identification in disorganized children in a low-risk context. Future research should therefore investigate emotion identification in disorganized children with experience of abuse, since a history of abuse has been related to response biases, to shed further light on whether disorganization is specifically linked to a diminished ability to identify emotional expressions.

Negative emotionality was rated by the children´s caregivers, and it is possible that caregivers of disorganized children may be less reliable than caregivers of organized children. However, a recent meta-analysis found that disorganized attachment was associated with externalizing behavior problems (and aggression) as rated by both mothers and teachers (Fearon et al., 2010). More importantly, the association was not significantly moderated by mother vs teacher ratings. Interestingly, caregivers of disorganized children have been found to under-report child negative emotionality in comparison to trained observers and teachers, whereas caregivers of secure children have been found to over-report child negative emotionality (Lyons-Ruth, Easterbrooks, & Cibelli, 1997; Stevenson-Hinde & Shouldice, 1990). Together, these findings suggest that the effect size in the present study could be conservative. Future research should, however, preferably examine child negative emotionality using ratings by trained observers, which have been found to be more strongly associated with child disorganization than ratings by mothers or teachers (Fearon et al., 2010).

Lastly, this study was cross-sectional, and future studies should investigate the relation between disorganized attachment and the ability to identify facial emotional expressions longitudinally, so that the question of process direction can be clarified. Future research on attachment and emotion identification should preferably be longitudinal and follow children from infancy, as the development of these processes begins very early in life. Methods such as eye-tracking can for example be used to examine emotion identification in pre-verbal infants (e.g., Gredebäck et al., 2012; Peltola et al., 2015; Johnson et al., 2010), and could furthermore be used to study the ability to identify facial emotional expressions in more complex scenes, to further examine the generalizability of findings to real life situations.

Conclusions

This is to our knowledge the first study that demonstrates deviations in identification of emotional expressions in children with disorganized attachment, suggesting that disorganized attachment may constitute a psychological mechanism contributing to the

development of deviations in identification of facial emotional expressions. Our findings further indicate that deviations in emotion identification in disorganized children may manifest in a generally diminished ability to identify emotional expressions rather than in response biases, at least in children from low-risk contexts. Given the critical importance of emotion identification for social behavior and learning, and the need to examine psychological mechanisms contributing to the development of facial emotion identification, the diminished ability of disorganized children to identify emotional expressions clearly warrants further research.

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