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British Journal of Developmental Psychology (2020), 38, 167–185

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Attachment security and attention to facial emotional expressions in preschoolers: An eye-tracking study

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According to attachment theory, internal working models of attachment affect the way in which social and emotional information is processed. The current study examined this theoretical claim by investigating the association between attachment security and attention to facial emotional expressions in 5-year-old children. Attachment security was assessed on a representational level using an Attachment Story Completion Task. Children's attention to facial emotional expressions was measured during an eye-tracking task. Gaze data (fixation duration) were collected during the presentation of pictures displaying five different facial emotional expressions (neutral, angry, fearful, sad, and happy) of unfamiliar persons. Moreover, the Emotionality-Activity-Sociability Temperament Inventory was used to control for children's temperament and was filled out by children's mothers. Regression analyses revealed that attachment security was a significant predictor of children's attention to neutral and sad expressions while controlling for age, gender, and temperament. Moreover, a *t*-test revealed that securely attached children looked longer at the fearful expression than insecurely attached children. These findings provide direct evidence that even on a basic perceptional level attachment security is a predictor of children's emotional information processing.

Statement of contribution

What is already known on this subject?

- Attachment representations substantially affect the way in which emotional information is processed.
- Insecure attachment representations are negatively related to children's attention to emotional stimuli.

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DOI:10.1111/bjdp.12313

What does this study add?
- Eye-tracking technology was used to measure children's visual attention to facial emotional expressions.
- Secure attachment was related to prolonged visual attention to neutral and negative facial emotional expressions.
- Attachment security influences children's emotional information processing even on a basic perceptual level.

Attachment theory proposes that during the first year of life infants' experiences with their primary caregivers are organized in mental representations or 'internal working models' of attachment (Bowlby, 1969/82; Main, Kaplan, & Cassidy, 1985). Moreover, it is suggested that differences in early experiences with the primary caregivers' availability and responsiveness result in the development of different working models, that is, in either secure or insecure working models (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1969/82). As internal working models are proposed to affect cognitive processes such as the direction of attention or organization of memories (Bowlby, 1969/82, Bowlby, 1980; Main *et al.*, 1985), differences in these working models are assumed to lead to differences in information processing (Dykas & Cassidy, 2011; Zimmermann & Iwanski, 2015). According to Bowlby (1973), especially the processing of social information is influenced by attachment working models. More precisely, social information processing is likely biased in ways corresponding to a person's working model, that is, depending on whether this person has a secure or an insecure working model. According to Bowlby's concept of 'defensive exclusion' (Bowlby, 1980, p. 45), individuals with insecure working models will either block further processing of attachment-relevant social information by orienting their attention away from emotionally painful aspects, or they will redirect their attention from the arousing aspects to their own expression of distress. In contrast, individuals with secure working models are expected to process both negative and positive emotional aspects of social information in an open manner because they experienced that their attachment figures have supported them in tolerating and regulating their emotional states effectively (Bowlby, 1980; Dykas & Cassidy, 2011).

An important form of social information is emotional information (Keltner & Haidt, 1999; Van Kleef, 2009). The role of attachment in processing of emotional information becomes evident when attachment is described in terms of emotion regulation (Spangler & Zimmermann, 2014). From this perspective, differences in the attachment working models are interpreted as differences in emotion regulation strategies that influence processing of emotional information (Cassidy, 1994). As attention is an important regulatory processing stage, attachment-related biases are particularly likely in attentional processing of emotional information (Silva, Soares, & Esteves, 2012).

The relation between attachment security and attentional processing of emotional information has mostly been investigated in adults using reaction-time tasks (e.g., Atkinson *et al.*, 2009; Dewitte & De Houwer, 2008; Dewitte, Koster, De Houwer, & Buysse, 2007; Edelstein & Gillath, 2008; Gillath, Giesbrecht, & Shaver, 2009; Zeijlmans van Emmichoven, Van IJzendoorn, De Ruiter, & Brosschot, 2003). These studies have shown that, for instance, adults with dismissing, preoccupied, and unresolved representations as well as adults with higher attachment anxiety and/or avoidance oriented their attention away from threat indicating words (Dewitte *et al.*, 2007; Zeijlmans van Emmichoven *et al.*, 2003) and showed reduced attention for threatening facial expressions (Dewitte & De Houwer, 2008), whereas adults with secure representations did not. In addition,

neurocognitive studies have provided evidence for attachment-related differences in brain activity during perceptual processing of emotional stimuli (Dan & Raz, 2012; Zilber, Goldstein, & Mikulincer, 2007). Hence, findings of adult studies have supported the theoretical idea that differences in attachment representations are associated with differences in attentional and perceptual processing of emotional information.

However, even though attachment theory represents a genuine developmental approach, this theoretical idea has been less researched in developmental populations. To date, only few studies have focused on associations between infants' and children's attachment security and their visual attention to emotional stimuli. In one of the few studies assessing attachment security and processing of emotional information, Main *et al.* (1985) examined whether infant attachment security measured in the Strange Situation Procedure (SSP; Ainsworth, Blehar, Waters, & Wall, 1978) was related to 6-year-old's openness to a family photograph of the child and his/her parents. Insecurely attached children were less open than securely attached children; that is, they actively oriented their attention away from the photograph. In two tasks of their longitudinal study, Kirsh and Cassidy (1997) simultaneously presented drawings of affectively positive, negative, and neutral mother–child interactions to 3.5-year-old children and assessed children's attentional preference (i.e., looking duration). Avoidantly attached children (assessed in the SSP) looked away more from each of the drawings than securely attached children. A second task directly compared children's attentional preference in eight sets of drawings. In each set, a drawing of an affectively positive mother–child interaction and a drawing of a non-interacting, affectively neutral adult pair were presented simultaneously. Again, insecurely attached children looked less at the positive drawings than did securely attached children. More recently, Meinz, Morton, Pederson, and Moran (2017) investigated the longitudinal link between attachment security (SSP with 12 months) and attentional bias in a classical dot-probe task (*cf.* MacLeod, Mathews, & Tata, 1986) in middle childhood. More avoidantly attached children showed higher preferential attention to neutral object stimuli than to emotional infant face stimuli. However, Belsky, Spritz, and Crnic (1996) did not find a longitudinal relation between infants' attachment security and 3.5-year-olds' attention to positive and negative social situations acted out by puppets. A cross-sectional eye-tracking study by Vandevivere, Braet, Bosmans, Mueller, and De Raedt (2014) investigated 8- to 12-year-old's attention to stimuli that contained simultaneously presented facial expressions of their mother and of eight unfamiliar females. Self-report questionnaires were used to measure children's attachment security, attachment avoidance, and attachment anxiety, but no effects on children's attention to the emotional expressions were found. In sum, while the majority of studies discussed here have provided initial evidence for a relation between attachment security and processing of emotional information in children, the findings were equivocal and focused on different aspects of emotion processing.

Our study aimed at filling this research gap by contributing empirical evidence regarding the relation between attachment security and attentional processing of emotional information in children. From a theoretical point, it is important to investigate this relation because attention influences later stages of information processing, such as emotion recognition (Serrano, Owens, & Hallowell, 2018) or memory (Mulligan & Hartman, 1996). However, due to simultaneous presentation of attachment-related/emotional stimuli with non-attachment-related/neutral stimuli (Kirsh & Cassidy, 1997; Vandevivere *et al.*, 2014) or intentional distractions (Belsky *et al.*, 1996), most of the previously discussed studies have assessed attentional measures in the context of other

processes. Moreover, the dot-probe task used by Meinz *et al.* (2017) has been shown to be a rather unreliable measure of attentional biases (Thigpen, Gruss, Garcia, Herring, & Keil, 2018). Although Main *et al.* (1985) measured attention on a more basic level, the measure was solely based on raters' estimations made *post-hoc* from videotapes. In order to provide a more direct and precise measure of children's visual attention, we decided to use eye-tracking technology. In the current study, pictures of unfamiliar faces displaying various emotional expressions (i.e., neutral, angry, fearful, sad, and happy) were presented individually, and children's fixation duration was assessed as a measure of attention. To the best of our knowledge, no study has investigated attachment-related attentional biases to emotional stimuli on such a basic perceptual level in children.

Regarding the assessment of children's attachment security in our study, we decided to use a story stem technique. We did so for two reasons. First, we aimed at assessing children's attachment security on a representational level (i.e., their generalized attachment working models). We were interested to assess children's generalized attachment working models because these generalized models affect children's interactions with other persons in general and are not specific for a particular person (e.g., the mother). The SSP, which was applied in most of the previous studies, was not suitable for this purpose because it allows assessing attachment security only on a behavioural level and towards a particular person in a particular situation. We also decided against the use of the mentioned self-report measure of attachment (in Vandevivere *et al.*, 2014) because the validity of self-reports of attachment has been a subject of debate in the literature (e.g., Jacobvitz, Curran, & Moller, 2002). In contrast, story stem techniques allow assessing children's generalized attachment representations (i.e., working models) with a highly valid and reliable measure (Psouni & Apetroaia, 2014; Psouni, Di Folco, & Zavattini, 2015). In this methodology, children's narratives and enactments in play during the completion of attachment story stems are assumed to reflect their generalized attachment representations. The advantage of this method is that it places little verbal or cognitive demands on children. Thus, story stem tasks can be reliably applied starting from about 4–5 years (Gloger-Tippelt, Gomille, König, & Vetter, 2002). A second reason for using a story stem technique is the possibility to calculate a continuous security measure, which allows considering different degrees of attachment security rather than just attachment subcategories in statistical analyses. Continuous attachment measures, such as the coherence scale of the Adult Attachment Interview (Main, Goldwyn, & Hesse, 2003), have been reliably used in research with adults (e.g., Reese, 2008). Continuous security scores can be calculated also for measures of attachment security in childhood (i.e., story stem tasks) (*cf.* Di Folco, Messina, Zavattini, & Psouni, 2017). In the current study, we assessed the attachment representations of 5-year-old children by means of the German adaption (GEV-B; Gloger-Tippelt & König, 2016) of the Attachment Story Completion Task (ASCT; Bretherton, Ridgeway, & Cassidy, 1990). This story stem task has frequently been employed to assess attachment security in middle childhood (e.g., Gloger-Tippelt & Kappler, 2016; Paulus, Becker, Scheub, & König, 2016) and allows to calculate both a continuous attachment measure and a categorical attachment measure.

In order to make sure that the association between attachment security and attention duration would not be influenced by intra-individual factors of the child, we assessed children's activity level. Activity can be defined as the amount of energy spent on bodily movements, that is, aspects of restlessness and of a constant urge to move (Buss & Plomin, 1984). Children with a lower activity level might be better able to focus on the story stem

procedure as well as the eye-tracking procedure because they are better in regulating and orienting their attention. It is therefore important to control for this aspect of child temperament in our study.

Based on the above reviewed theoretical considerations (Bowlby, 1980; Dykas & Cassidy, 2011), we made the following predictions:

1. We hypothesized a positive relation between children's attachment security and their attention to negative emotional information. More precisely, we expected that children with insecure attachment representations will look less long at the angry, fearful, and sad faces than children with secure attachment representations. Moreover, we hypothesized that attachment security will be predictive of attention durations to angry, fearful, and sad faces.
2. With respect to children's attention to the neutral face, we did not have a clear hypothesis. Although previous research has shown attachment-related attentional biases for emotionally neutral stimuli (Kirsh & Cassidy, 1997; Meinz *et al.*, 2017), attachment theory does not make a clear prediction. It is possible that attachment does not play a role in processing of neutral social stimuli. At the same time, it is proposed that secure attachment is related to more openness for the exploration of new stimuli (e.g., Green & Campbell, 2000). It is therefore also possible that more securely attached individuals attend more openly (i.e., longer) to neutral faces of unfamiliar persons.
3. There were two possible hypotheses regarding children's attention to the happy face. If an attentional bias exists only for negative emotional information, we expected that attachment security would not be predictive of attention duration to happy faces. In contrast, if an attentional bias exists for emotional information in general, we expected that attachment security would be predictive of attention duration to happy faces. The two hypotheses were derived from previous studies that showed attachment-related biases also for positive emotional information (Kirsh & Cassidy, 1997; Main *et al.*, 1985) as well as from attachment theory, which does not make specific predictions regarding positive emotional information.

Methods

Sample

The present study was part of a larger study that focused on the mother–child relationship during preschool age. Mothers and their children were recruited via public birth records and flyers in local kindergartens. All interested German-speaking mother–child dyads with typically developing children between the age of 5.5 and 6 years were included in the study. A total of 49 5.5-year-old children (M = 69.11 months, SD = 1.40, range = 66.30–71.67 months, 22 females) and their mothers participated in the study. Data of five additionally tested children were excluded due to child's missing willingness to participate (n = 1), procedural errors during the attachment assessment (n = 2), missing eye-tracking data (n = 1), and general health problems (n = 1). All children were white and came predominantly from middle-class families. Of the parents in the final sample, 67.3% of mothers and fathers had a university degree. All children except one were enrolled in a kindergarten. Mothers and their children were informed about the content and procedure of the study, and mothers gave informed written consent. The study was approved by the local ethics committee.

Procedure

Participating children and their mothers were invited into the laboratory for one testing session lasting approximately 90 min. All children were tested individually. The testing session started with the German adaption (Geschichtenergänzungsverfahren, GEV-B; Gloger-Tippelt & König, 2016) of the ASCT (Bretherton *et al.*, 1990). During this task, children were alone in the room with a female experimenter, while mothers were filling out questionnaires on demographic information and child temperament in another test room of the laboratory. Following recommendations of Gloger-Tippelt and König (2016), the GEV-B procedure was always administered first. This was done to convincingly present the GEV-B procedure as a play situation rather than a test situation, so children would be comfortable in playing openly with the experimenter. The GEV-B procedure lasted between 20 and 60 min and was followed by other tasks (e.g., a mother–child play interaction), which are not relevant for the study presented here. Thereafter, an eye-tracking task on children's attention to facial emotional expressions was administered. By administering the eye-tracking task last, we aimed to minimize potential transmission effects of the attachment assessment on the eye-tracking task.

Measures

Attachment security

The German adaption (GEV-B) of the ASCT was used to assess attachment security on a continuous scale. The GEV-B is a semi-projective measure for 5- to 8-year-old children. It consists of several stories that are supposed to activate children's attachment system. Based on how children let the figures in the stories behave, the underlying internal working model of children's attachment representations can be inferred.

Materials of the GEV-B were five bendable, wooden toy figures representing a family consisting of mother, father, grandmother, and two siblings (a girl and a boy). Further materials were used to present the context of each story (e.g., chairs, beds, a wooden stick).

During the GEV-B procedure, children's caregivers were not present. The experimenter explained that she will tell the beginning of a story that children could then complete. After a short familiarization with the materials, children were presented with the seven GEV-B stories. In these stories, the child protagonist, who was matched to participants' gender, is confronted with different situations. The first and the last story are neutral stories. The first story presents a birthday party theme and is intended to familiarize the child with the task. The last story depicts the context of a family trip and is intended to provide a positive ending of the GEV-B procedure. The five stories in-between are ordered in a way supposed to represent an increase in attachment-relevant content and therefore an increase in activation of the attachment system (e.g., spilled juice in the first story or reunion with the parents after a separation in the fifth story). In each story, children were asked to continue the story and were then asked two additional questions: 'How does [protagonist's name] feel?' and 'Is [protagonist's name] thinking of something?'

Data were coded only from video recordings by a trained coder who coded two different attachment measures. First, a global attachment security score for each child was calculated that represents the strength of a child's attachment security (i.e., how much the child trusts in the attachment figure's availability and support). This was done by rating each of the five stories based on a coding scheme that includes specific indicators of

secure and insecure attachment representations (Gloger-Tippelt & König, 2016). For instance, in the 'monster' story an elimination of the monster or reassuring behaviour by the parents is an indicator of secure attachment, whereas rejection by or fear of the parents is an indicator of insecure attachment. In addition, there are indicators of insecure attachment that can occur in each of the stories, such as bizarre events or avoidance of attachment-relevant contents. For each story, a score between 0 (=extremely insecure) and 4 (=very secure) was given, and an overall score was computed. Second, a categorical measure of children's attachment representations was created by assessing the global attachment pattern across all five stories. In this coding procedure, elements in each story are identified that indicate qualitative differences in the strategies children apply when dealing with the addressed attachment themes (i.e., pain, fear, separation, reunion) (Gloger-Tippelt & König, 2016). For instance, if the attachment theme is denied or avoided, this is an indication of an insecure-avoidant attachment pattern. If the attachment theme is addressed by the child and there is a solution from competent adults or an active greeting during reunion, a secure attachment pattern can be assumed. If the child is exaggeratedly focusing on the attachment theme and stories are characterized by danger, violence, drama, and incoherence, this indicates an insecure-ambivalent attachment pattern. Moreover, bizarre events, blocking, and/or lack of an identifiable strategy indicate a disorganized attachment status. The assessment of the predominant attachment strategy across all stories resulted in the classic attachment subtypes: secure (n = 18), insecure-avoidant (n = 24), insecure-ambivalent (n = 5), and insecure-disorganized (n = 2). This pattern is similar to the pattern reported by other studies on attachment in middle childhood (Gloger-Tippelt *et al.*, 2002; Gloger-Tippelt & Kappler, 2016). In order to assess reliability, a second trained coder rated 20 of the videos (38%). Inter-rater reliability was excellent: Cohen's kappa = .81 (90% agreement).

Attention to facial expressions

Building on previous studies that assessed visual attention to facial emotional expressions (e.g., Horovitz, Lindenfeld, Melamed, & Shechner, 2018; Peltola, Forssman, Puura, van IJzendoorn, & Leppänen, 2015; Vandevivere *et al.*, 2014), we used eye-tracking technology to collect children's gaze data during presentation of ten facial stimuli displaying five different emotional expressions. The facial stimuli were chosen from the NimStim set of facial expressions (Tottenham *et al.*, 2009) and included pictures of two female models each posing neutral, angry, fearful, sad, and happy expressions (Figure 1a). In order to control for perceptual features of the face stimuli, we decided to use face sets of only one gender. Following previous research (Bayet, Behrendt, Cataldo, Westerlund, & Nelson, 2018; Peltola *et al.*, 2015), we used female faces as stimuli. Eye movements were recorded with a Tobii TX300 eye-tracker (120 Hz sampling rate, Tobii Technology, Stockholm, Sweden). Tobii Studio 3.4.5 software (Tobii Technology) was used to present the stimuli on an integrated 23″ TFT monitor.

Participants sat on a chair at a distance of approximately 60 cm from the screen. Data collection started with a 9-point calibration. In case of missing calibration points, the calibration procedure was repeated until all nine points were calibrated. Before (and if necessary, during) stimulus presentation, children were instructed to move as little as possible and not to talk during the eye-tracking task. After the calibration, the experimenter told children 'I'll show you some pictures now. Just have a look at them' and then started the stimulus presentation.

Figure 1. Presented stimuli from the NimStim set of facial expressions (Tottenham et al., 2009) (a) and an example of the AOI 'face' displayed for the fearful emotion (b). [Colour figure can be viewed at wile yonlinelibrary.com]

For each female face, the five facial expression pictures were shown one by one in the same order (due to the correlational approach): neutral, angry, fearful, sad, and happy. To prevent that the novelty of the faces and the displayed emotional information are confounded, the neutral facial expression was always presented first for each face. Each picture was presented for 10 s and followed by 2 s of a black screen to exclude transmission effects from one trial to the next. Before the presentation of the first picture and before the presentation of the second face, a short attention-getter was presented on the centre of the screen. After completion of the task, a short movie was played as a reward.

To identify fixations from the raw data, the Tobii standard fixation filter I-VT with a maximal time between fixations of 75 ms and a maximal angle between fixations of 0.5° was used. The minimal fixation duration was set to 100 ms in order to account for the differentiation between fixation and other eye movements (Manor & Gordon, 2003). We determined two areas of interest (AOI). One rectangle-shaped AOI (AOI 'screen') covered the whole screen and had the same size and same position for all of the pictures. A second

elliptical AOI (AOI 'face') covered the area of the face including the eyes, the nose, and the mouth because these are the most relevant areas in processing of facial emotional expressions (Beaudry, Roy-Charland, Perron, Cormier, & Tapp, 2014; Ekman, 1982). The AOI 'face' had the same size for all the pictures (85,055 pixels) and covered 4.1% of the screen. In order to cover the relevant areas of eyes and mouth, the position of the AOI 'face' was slightly adapted for some pictures. Figure 1b shows an example of the position of the AOI 'face'. We calculated the total fixation duration to both AOIs for each of the pictures. This metric measures the sum of the duration for all fixations within an AOI. In order to define trials with insufficient gaze data, we analysed the total fixation duration to the AOI 'screen' for each picture and excluded all trials with less than 500 ms of gaze data (5.1% of all trials).

In order to test our hypotheses, we analysed the total fixation duration to the AOI 'face' for each of the pictures. For each emotion, we then calculated the mean of these total fixation durations over the two faces. If gaze data were only available for one trial of an emotional expression, the fixation duration of this trial was used for analyses. This was the case for 17 trials. In four additional cases, valid values were missing in both trials. This resulted in slightly different case numbers: neutral face (n = 49), angry face (n = 49), fearful face (n = 48), sad face (n = 48), and happy face (n = 47).

Temperament

The German version of the EAS (Emotionality-Activity-Sociability) Temperament Inventory (Buss & Plomin, 1984; German adaptation by Angleitner, Harrow, Hempel, & Spinath, 1991) was used to assess children's temperament. The EAS Inventory measures children's temperament on four scales, but for the present study only the activity scale was of interest. This scale consists of five items describing behavioural characteristics related to children's physical activity level. Items are, for example, 'Child is very energetic' or 'Child prefers quiet, inactive games to more active ones (reversed item)'. For each item, mothers were asked to indicate on a 5-point scale (from 1 = not characteristic to 5 = very characteristic) how characteristic the behaviour is for their own child. For statistical analyses, we calculated the mean of the activity scale.

Results

Descriptive statistics

The average score of the global attachment security score was M = 2.5 (SD = 0.87, range 1.0–4.0). On average, children looked 5.7 s (SD = 2.0) to the neutral expression, 5.0 s (SD = 2.1) to the angry expression, 4.9 s (SD = 2.3) to the fearful expression, 5.0 s (SD = 2.3) to the sad expression, and 5.1 s (SD = 2.1) to the happy expression. With regard to children's temperament, the mean score of 4.0 (SD = 0.63) indicated a rather high activity level, which is comparable to other studies (Bornstein, Hahn, Putnick, & Pearson, 2019; Rowe & Plomin, 1977; Spinath, 2000).

Inferential statistics

Preliminary analyses

A repeated-measures ANOVA revealed that children's mean attention duration differed significantly between five emotional expressions, $F(4, 184) = 2.84$, $p = .026$. However,

Bonferroni-corrected *post-hoc* tests did not indicate significant differences in attention duration between any of the five emotional expressions (all *p*s = .069–1.000). Table 1 shows the correlations between our main variables (attachment security, attention to facial expressions, and activity level) as well as gender and age.

Continuous attachment measure

Five separate hierarchical linear regression analyses were conducted to predict fixation duration to each of the emotional expressions. We excluded missing data using the listwise option based on recommendations by Field (2018). Due to the wide age range, we included age in days as a control variable. The variables were entered in two steps: In the first model, we entered the three child characteristics gender, age (in days), and activity level as control variables using the enter method. In a second model, children's attachment security score was added using the enter method. Results for the regression analyses are depicted in Table 2. Attention to the neutral expression was predicted by attachment security only. Attention to the angry expression was not predicted by any of the variables in the regression analysis. Attention to the fearful expression was predicted by attachment security only. However, the overall regression model for the fearful expression was not significant. In the regression analysis for the sad expression, activity level as well as attachment security turned out to be significant predictors. Attention to the happy face was predicted by activity level only. However, the overall regression model for the happy expression was not significant.

Categorical attachment measure

While our regression analyses focused on the security score to make use of the continuous nature of the measure, we also explored whether our results are mirrored in analyses focusing on group differences. Due to the small number of participants classified as insecure-ambivalent and insecure-disorganized, we used the secure versus insecure categorization in these analyses. Following our directed hypotheses for negative emotions, the respective analyses were conducted one-tailed. Analyses showed significant differences between the secure and insecure group for attention to the neutral expression, $t(47) = -3.058$, $p < .004$, two-tailed, and for attention to the fearful expression, $t(46) = -1.889$, $p = .032$, one-tailed. There were no differences between

Table 1. Correlations between activity level, attachment security, attention duration, gender, and age

	1	2	3	4	5	6	7	8
1. Attachment security	1							
2. Activity level	−.12	1						
3. Attention duration neutral	.45**	−.18.	1					
4. Attention duration angry	.21	−.20	.67**	1				
5. Attention duration fearful	.31*	−.14.	.68**	.76**	1			
6. Attention duration sad	.24	−.35*	.62**	.83**	.76**	1		
7. Attention duration happy	.24	−.35*	.60**	.79**	.74*	.82**	1	
8. Gender[a]	.17	.11	.08	−.08	−.09	−.15	−.10	1
9. Age in days	−.24	.06	.07	.14	.03	.22	.04	−.21

Notes. [a]Spearman-Rho with dummy coding 0 = male and 1 = female.; **$p < .01$, *$p < .05$, two-tailed.

Table 2. Predictors of attention to the neutral, angry, fearful, sad, and happy facial expression

	Neutral (n = 48)		Angry (n = 48)		Fearful (n = 47)		Sad (n = 47)		Happy (n = 46)	
Variables	β	R^2	β	R^2	β	R^2	β	R^2	β	R^2
Model 1										
Gender	.08		−.02		−.10		−.11		−.13	
Age	.10		.14		−.01		.19		−.00	
Activity level	−.20		−.20		−.13		−.34*		−.34*	
R^2		.04		.06		.03		.18		.14
F		.68		.93		.44		3.12*		2.30†
Model 2										
Gender	.00		−.06		−.16		−.16		−.18	
Age	.19		.19		.05		.24		.04	
Activity level	−.13		−.17		−.11		−.31*		−.32*	
Attachment security	.48*		.25		.35*		.30*		.27†	
R^2		.25		.11		.14		.26		.21
F		3.63*		1.38		1.71		3.77*		2.69*
ΔR^2		.21		.05		.11		.08		.07
F change		11.95*		2.64		5.40*		4.83*		3.44†

Note. **$p < .01$, *$p < .05$, †$p < .10$, two-tailed.

groups regarding children's attention to the angry (p = .196, one-tailed), the sad (p = .097, one-tailed), and the happy expressions (p = .291, two-tailed). Thus, t-test results for the neutral, angry, and happy expressions are in line with results of the regression analyses.

Moreover, from a theoretical point of view there should be a clearer difference between insecure-avoidant and secure attachment strategies than between insecure-ambivalent/disorganized and secure attachment strategies. For this reason, and because there were only few participants classified as insecure-ambivalent (n = 5) or insecure-disorganized (n = 2), we repeated analyses with only the secure and insecure-avoidant subgroups. Analyses showed significant differences between the secure and avoidant groups for attention to the neutral expression, $t(39.23) = -3.436$, $p < .001$, two-tailed, and for attention to the fearful expression, $t(39) = -1.804$, $p = .040$, one-tailed. There were no differences between groups regarding children's attention to the angry (p = .232, one-tailed), the sad (p = .105, one-tailed), and the happy expressions (p = .379, two-tailed). Thus, t-test results for the neutral, angry, and happy expressions are in line with results of the regression analyses.

Discussion

The present study aimed to investigate the relation between children's attachment security and their attention to facial emotional expressions. To this end, we measured 5-year-old children's attachment representations via an ASCT (GEV-B; Gloger-Tippelt & König, 2016). Thereafter, we assessed children's attention duration to neutral, negative, and positive facial expressions in an eye-tracking task. We found that attachment security was associated with children's attention duration to fearful, sad, and neutral facial

expressions. Overall, these results support theoretical proposals that attachment is related to basic attentional processes (Dykas & Cassidy, 2011; Main *et al.*, 1985).

More precisely, in line with hypotheses derived from attachment theory, attachment security was related to children's attention duration to the fearful (*t*-tests) and sad expressions (regression analyses). That is, (more) securely attached children looked longer and (more) insecurely attached children looked shorter to these negative expressions. This is consistent with the theoretical claim that insecurely attached individuals are more likely to use defensive exclusion strategies in processing of negative emotional information than securely attached individuals (Bowlby, 1980; Dykas & Cassidy, 2011). Yet, there was no significant effect for the angry expression even so the direction of the effect was the same as for the fearful and sad expressions. One can speculate that anger is a less painful emotional experience than fear or sadness. Anger is usually rather directed to others and likely expressed by aggressive behaviour, whereas fear and sadness are more directed to oneself and communicate a need for assistance (Van Kleef, De Dreu, & Manstead, 2010). In order to avoid emotional pain, it might therefore be more relevant to regulate oneself in confrontation with fear or sadness than in confrontation with anger. As it has been suggested that attachment styles can be interpreted as patterns of emotion regulation (e.g., Spangler & Zimmermann, 2014), this might explain attachment-related differences in attention to fearful and sad expressions but not to angry expressions.

Moreover, attachment security was related to attention duration to the neutral facial expression. This relates to previous studies that reported links between attachment security and attentional biases to neutral stimuli (Kirsh & Cassidy, 1997; Meinz *et al.*, 2017). This finding can be explained by the proposal that ambiguous stimuli, such as neutral facial expressions, are likely processed corresponding to the underlying attachment working model (Bretherton & Munholland, 1999; Dykas & Cassidy, 2011). That is, insecurely attached individuals are more likely to process even neutral social information with a negative bias, and, conversely, more securely attached children are more open in processing of social information (Dykas & Cassidy, 2011; Zimmermann & Iwanski, 2015). It is important to note that in our study the neutral stimulus was always the first presented. Therefore, a transmission effect from negative facial expressions is unlikely. Moreover, the neutral facial expression was always the first encounter with each of the unfamiliar faces. As securely attached individuals are more open to explore new stimuli (Green & Campbell, 2000), the relation of attachment security and attention might be due to the novelty of the face rather than to the neutrality of the expression. More research is needed to investigate this issue.

Regarding the happy expression, we stated two contrasting hypotheses. We expected that attachment security will not be predictive of attention duration to happy faces if an attentional bias exists only for negative emotional information. In contrast, we expected that attachment security will be predictive of attention duration to happy faces if an attentional bias exists for emotional information in general. Our findings showed that there was no relation between attachment security and attention duration to the happy expression. This contradicts the second hypothesis regarding the happy face, namely, that an attentional bias exists for emotional information in general. This finding is in line with attachment theory, which refers to biases in processing of potentially painful social information but not of positive emotional information (Bowlby, 1980; Dykas & Cassidy, 2011). Our findings extend previous research with adults, where differences in attachment security were not related to differences in processing of positive information (Dewitte *et al.*, 2007; Zeijlmans van Emmichoven *et al.*, 2003).

In general, our findings are an in line with the theoretical view that insecure attachment is associated with defensive exclusion of potentially painful social information (Bowlby, 1980; Dykas & Cassidy, 2011). From a theoretical perspective, our results do not support an effect of attachment security on attentional processing of facial emotional expressions in general but rather suggest a specific effect for negative and neutral facial expressions. This can be explained by the fact that different facial emotional expressions convey different information about a person's internal state and his/her orientation towards the other. Negative expressions like fearful or sad faces indicate that the other person is currently more concentrated on his/her own need for help (Van Kleef *et al.*, 2010). This makes it less likely that the person is available for the child. This is in line with studies on maternal depression, which suggest that depressed mothers are emotionally less available and less sensitive to their children than non-depressed mothers (Bernard, Nissim, Vaccaro, Harris, & Lindhiem, 2018; Trapolini, Ungerer, & McMahon, 2008). Neutral facial expressions are more ambiguous and might therefore be misinterpreted by insecure children as more negative than they really are (Cassidy, Kirsh, Scolton, & Parke, 1996; Raikes & Thompson, 2008). In addition, neutral facial expressions might be interpreted as indifference or disinterest and might therefore be perceived as potentially hurtful by insecure children. Consequently, the proposed exclusion effect in attention is likely relevant in confrontation with negative and neutral faces. Because positive facial expressions usually signal an benevolent orientation towards the relationship and a willingness to provide support (Van Kleef *et al.*, 2010), avoidance of such information is less likely for insecure children.

It is noteworthy that attachment security was a predictor of attention duration to the sad and neutral facial expressions even so we included children's activity level as a control measure. This excludes the possibility that insecurely attached children are just more physically active and therefore attended shorter to the emotional expressions. In addition, even though activity level was associated with children's attention duration to the sad facial expression, attachment security was a significant predictor as well. This shows the high predictive value of attachment security in attentional processing of emotional stimuli.

Our findings are theoretically relevant because attention is a process that operates at early stages of information processing, which in turn influences the following processes, such as recognition of emotions (Serrano *et al.*, 2018) or memory processes (Mulligan, 1998; Mulligan & Hartman, 1996). If already attention duration to emotional expressions is influenced by attachment security, then it is likely that the shorter or longer perceptual processing of the emotional information influences further processing, especially in emotionally negative situations. This claim can be supported by studies that show that insecure children are less accurate in recognizing and understanding emotions of others (Laible & Thompson, 1998; Steele, Steele, Croft, & Fonagy, 2001). Research in the area of emotion regulation also shows that, compared to insecurely attached children, securely attached children report more cognitive engagement strategies when explicitly asked (Colle & Del Giudice, 2011) and more often use cognitive and social support strategies themselves (Cooke, Kochendorfer, Stuart-Parrigon, Koehn, & Kerns, 2018). Our study adds to this research by focusing on a basic level of emotion regulation, namely attentional regulation strategies. Therefore, our findings are also informing theoretical considerations regarding the relation of attachment and different aspects of children's emotion regulation. It might be interesting for future research to assess different aspects of children's emotion regulation (i.e., attentional/behavioural strategies as well as explicit knowledge) together in one study.

The current study also adds to the field by measuring children's attention on a basic perceptual level. By applying eye-tracking technology, we were able to precisely assess fixation duration to the facial expressions. This means, we directly assessed visual attention instead of inferring attentional processes from indirect measures, such as the dot-probe task (Meinz *et al.*, 2017). Moreover, previous studies mostly measured attention during simultaneous presentation of emotional and neutral stimuli (Kirsh & Cassidy, 1997; Meinz *et al.*, 2017). In contrast, in the current study we presented each facial stimulus individually and thereby ensured that children's attention to the displayed emotion was not confounded with other processes. Thus, the current study extends previous work by focusing more directly on visual attention to facial emotional expressions.

One could speculate that the findings of our study have implications for clinical practice. If attachment security influences the processing of emotional information not just in interactions with attachment figures but also in other social interactions, this is relevant for children's later emotion regulation and social functioning outside the attachment relationship. It is likely that positive effects of attachment interventions that focus on improving parental attachment-relevant behaviours, such as sensitivity, can be further enhanced through greater understanding of attachment-related differences in social information processing.

Even though our study contributes empirical evidence to fill an important research gap, there are some limitations that should be addressed in future research. First, although our sample size was similar to those in previous studies, a larger sample size might have helped to reveal also smaller effects, for example, for the angry or happy facial expressions. Future studies should therefore assess attachment security and attentional processing in larger samples. This would also make it possible to include further predictor variables. For instance, parental sensitivity has been shown to be a crucial factor in the development of a secure attachment style (Grossmann, Grossmann, Spangler, Suess, & Unzner, 1985; Lucassen *et al.*, 2011) and to be related to children's emotion regulation (Frick *et al.*, 2018). Therefore, sensitivity might be predictive of children's attentional processing of emotional stimuli as well. Another variable of interest is children's verbal ability. While some studies suggest that this factor is related to attachment security assessed in story stem tasks (*cf.* Stievenart, Roskam, Meunier, & van de Moortele, 2011; Veríssimo *et al.*, 2017), other research does not support an effect of verbal abilities on attachment security (Veríssimo, Santos, Fernandes, Shin, & Vaughn, 2014). It might therefore be interesting to consider this factor in future research. Furthermore, although our categorical analyses based on the secure and insecure (-avoidant) subgroups largely supported our main analyses, a larger sample would allow investigating differences between all four attachment patterns. Second, although the present study provides empirical evidence for a relation between attachment security and attentional processing of emotional information, the cross-sectional and correlational design precludes causal claims. As we noted before, it is possible that parental sensitivity plays a role for the association between attachment security and children's attention to emotional facial expressions. Future research should therefore focus on effects of such potential mediating or interacting variables. A third limitation refers to the limited cultural generalizability of our study, as the sample included only German children. Research has suggested that the activation of the attachment system depends not only on individual factors but also on cultural context (see Mesman, van IJzendoorn, & Sagi-Schwartz, 2016 for a review). Thus, it is important for future studies to consider possible cultural differences when investigating the relation between attachment security and emotion processing. In

addition to the future research directions derived from the discussed limitations, we suggest that future studies could also assess how accurate children are in identifying the emotional expressions and if this is related to their visual attention duration. Moreover, it might be interesting whether and how findings may change, when videos rather than motionless pictures of emotional expressions are used as stimuli.

Taken together, our study examined whether preschool children's attachment security is related to their attentional processing of emotional facial expressions. We provide first empirical evidence that attachment security influences attentional processes to negative and neutral emotional information on basic perceptual level.

Acknowledgements

For support with data acquisition and data coding, we are grateful to Lisa Ackermann, Theresa Schmid, and Annemarie Scheub. Moreover, we thank all parents and children who made this research possible.

Conflicts of interest

All authors declare no conflict of interest.

Data availability statement

Research data are not shared.

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Received 28 May 2019; revised version received 5 November 2019'