Attention bias to threat in infants and parents: child temperament as moderator

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Master Thesis

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Abstract

Little is known regarding the specific mechanisms that underlie the parent-to-child transmission of anxiety. A possible mechanism is the shared attention biases to threat. Also, there is little evidence regarding individual differences, such as negative temperament, in the earliest development of attention bias to threat. Fearful/ negative temperament can act as a risk factor for developing anxiety disorders later in life. This study investigated the relationship between parents' and infants' attention bias, and if negative child temperament strengthened this relationship. Attention bias was measured to fearful faces in infants ($N = 220$) ages 5 to 19 months and parents (N = 229) during an eye-tracking task. Infants' negative temperament was measured with a questionnaire. Results show that infants looked longer towards fearful faces than happy faces. Parents did not pay this attention bias towards fearful faces. We found no relation between parents' attention bias towards fearful faces and infants' attention bias towards fearful faces. We did find an interaction between the attention biases and negative child temperament. In other words, the higher the infants' negative temperament, the stronger the relationship between parents' attention bias towards threatening faces and infants' attention bias towards threatening faces. These findings support the idea that negative temperament is related to attention bias and that it could be a risk factor for future anxiety development.

Keywords: Attention bias, negative temperament, infancy, parents, anxiety

1. Introduction

Anxiety disorders amongst children and adults are one of the most prevalent (19,6%) psychopathologies in the Netherlands (Aktar & Bögels, 2017; Eley, et al., 2015; de Graaf, ten Have & van Dorsselaer, 2010). Anxiety disorders have an early onset in life, with a lifetime prevalence of 30 percent (Eley, et al., 2015) and are associated with a broad range of personal, financial, and social harm (Aktar & Bögels, 2017). Biological factors (genetic and temperamental) and environmental factors (exposure to parents' negative faces and adverse life events), contributes to the development of anxiety disorders (Aktar & Bögels, 2017; Murray, Creswell & Cooper, 2009).

Infants whose parents suffer from anxiety have a genetic vulnerability that predisposes them to anxiety (Murray, et al., 2009). Several studies show the link between anxious parents and children, and state that there is a mechanism through which parental anxiety leads to their child's anxiety (Aktar & Bögels, 2017; Creswell, Cooper, & Murray, 2010). This means that infants of parents with anxiety, not only have a genetic vulnerability, but are also growing up in environments marked by their parents anxious expressions, also known as parent-to-child transmission (Aktar & Bögels, 2017). This parent-to-child transmission of anxiety symptoms can occur when there is repeated exposure to anxious emotions from parents (Aktar & Bögels, 2017; Creswell, et al., 2010). The transmission might happen early in life, such as infancy. From nine months of age, infants become more aware of others and adjust their responses to another persons' emotional response: social referencing (Aktar, Majdandžić, De Vente, & Bögels, 2013; De Rosnay, Cooper, Tsigaras, & Murray, 2006). Social referencing has a stronger relation to anxious emotional states rather than happy emotional states (De Rosnay, et al., 2006). The genetic transmission of anxiety vulnerabilities and the environmental influences, marked by growing up with an anxious parent, both contribute to the overlap between parents' anxiety and infants' anxiety symptoms (Aktar, Van Bockstaele, Pérez-Edgar, Wiers & Bögels, 2018b).

Gaining knowledge of the mechanisms of this transmission is critical for understanding the developmental aspects of anxiety in children and adults. Anxiety is a future-oriented emotion and is characterized with a fast shift in attention to potential risks (Hong, Arshat & Yaacob, 2018). Cognitive theories point out, that a biased attention towards a threat is a central mechanism in the development of anxiety (Aktar, et al., 2018b). According to the literature one of the possible mechanisms that might explain the intergenerational transmission of anxiety is shared attention biases between anxious parents and their children (Aktar & Bögels, 2017; Creswell, et al., 2010). Attention bias is a preferred attention towards particular stimuli over

other stimuli (Creswell, et al., 2010). Attention bias to threat would entail for example, that someone looks longer at a fearful face, instead of a neutral face (Aktar, et al., 2018b). This attention bias maintains and/ or increases anxiety levels and vice versa (Van Bockstaele, et al., 2014). In normal development of infants, this bias emerges between 5 and 11 months of age (Aktar, et al., 2018b; Peltola, Hietanen, Frossman, & Leppänen, 2013). A typically developing infant starts to pay more attention to facial expressions (Aktar, et al., 2018b) and has a relatively longer dwell time to faces compared to other objects (Leppänen, 2011). The biased attention acts like an automatic response that helps evaluate environmental events (Todd, Cunningham, Anderson, & Thompson, 2012). From an evolutionary point of view, detecting threatening stimuli is efficient for survival values (Tipples, Young, Quinlan, Broks & Ellis, 2002). However, according to Aktar and Bögels (2017) there are infants where this attention bias is preserved over time, and they are at risk for later maladaptive developmental pathways. This preserved attention bias might be the result of parents' behaviour. In other words, anxious parents who are more likely to see threats, are more likely to react in an anxious way (Aktar, et al., 2018a). Children might model these anxious ways of information processing (Field & Lester, 2010a). Evidence suggests, that the most important facial input in infants' environment are the faces of the parents (Aktar, et al., 2018a). Variations in parents' negative and anxious emotions might be related to the attention bias of the infants. The attention bias in both, typical and atypical development is the result from genetic factors and environmental factors, which include parental emotions and anxiety (Aktar, et al., 2018a). Taken together, this would entail that the shared attention biases is a possible mechanism that contributes to the development for anxiety disorders later in life (Aktar, et al., 2018a; Field & Lester, 2010b).

One of the genetic factors in infants that contributes to the development of attention biases, is the well-known risk factor: negative temperament. Temperament includes the infants' expressions and regulations of their own emotions and what they perceive in the environment (Aktar, et al., 2018a). Temperament can be defined as a (genetic) response to the environment (Hong, et al., 2018). Previous research indicates that children with high negative temperament, are marked by behavioural inhibition and dysregulated fear (Aktar, et al., 2016), and are causally involved in creating anxiety symptoms (Buss & Kiel, 2013; Field & Lester, 2010b). This can act as an independent risk factor for developing anxiety disorders (Hong, et al., 2018; Rosenbaum, et al., 2000). According to the model of Lonigan and colleagues (2004), negative temperament traits (negative affectivity and behavioural inhibition) are considered crucial for the tendency to pay attention to threatening stimuli. According to Rosenbaum and colleagues (2000) children and infants are more temperamentally fearful if their parents have an anxiety

disorder. Once this sensitivity has developed in the first year of life, children, adolescents and also adults pay more attention to threat-related cues (Shackman, et al., 2016). Adults with this sensitivity can develop an anxiety disorder due to avoidance behaviour and maintain the anxiety symptoms. This avoidance behaviour is marked by expectations of the threat and due to over-predictions trying to escape (Rachman, 2013). This indicates that negative child temperament is involved in the development of the sensitivity and can play a role in developing anxiety later in life.

Several studies investigate the link between attention bias and anxiety symptoms in infants. In a meta-analysis they found an absence of attention bias towards threats in non-anxious adult participants (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzerdoorn, 2007). A possible explanation for this phenomenon according to them is, that non-anxious individuals show an attention bias towards threats, but only with high levels of threat. Whereas anxious individuals show a bias with mild levels of threatening stimuli (Bar-Haim, et al., 2007). A different study investigated the relation between threatening stimuli, and negative affectivity in infants (Nakagawa & Sukigara, 2012). This study concluded that infants with higher negative emotionality looked longer towards fearful facial expressions compared to non-anxious infants. These infants with a strong attention bias might experience the stimuli in a more aversive way, or their negative affectivity might be triggered by the stimuli (Nakagawa & Sukigara, 2012). In contrast, Morales and colleagues (2017) investigated attention bias to threatening stimuli with fearful temperament as one of the predictors, and concluded that there is no relation between infant attention bias (angry vs. neutral faces and angry vs. happy faces) and negative affect, a marker of fearful temperament. Other studies found (Cole, Zapp, Fettig, & Pérez-Edgar, 2016; Pérez-Edgar, et al., 2010) moderation between attention bias, fearful temperament and anxiety. The results of the above mentioned studies are contradictory. Therefore, we wanted to investigate the relationship between the shared attention biases and negative temperament in infants.

Taken together, still little is known regarding the specific mechanisms that underlie the parent-to-child transmission of anxiety. As mentioned, one possible mechanism is the shared attention bias towards threat. Furthermore, individual differences such as fearful/ negative temperament can act as a risk factor for developing anxiety disorders later in life. The findings on the relationship between attention biases, negative temperament, and anxiety symptoms in infants of recent studies contradict each other. Therefore, we wanted to replicate the studies with a different sample pool. In the current study, we investigated the relation between infants' attention bias and parents' attention bias (fearful faces versus happy face). Particularly, the

attention bias towards fearful faces and whether negative child temperament strengthens this relationship. Based on previous literature, we hypothesized that: 1) Infants' attention bias (fearful versus happy faces) is positively related to parents' attention bias, and 2) negative child temperament strengthens the relationship between parents' attention bias (fearful faces versus happy faces) and infants' attention bias.

2. Method

2.1 Participants

The research contained a cross-sectional design. The participants were not assigned to different conditions, and during the study the participants were tested once. The research sample consisted of 251 families (infants with their primary caregivers) out of a non-clinical group. The infants were between 5 and 19 months old and were added in three different age groups (5-7 months, 11-13 months, 17-19 months). Parents were included in the study if they have an infant which fit into one of the three categories of age. Both parents had to be fluent in English or in Dutch. The participants were recruited via invitation letters sent by the municipality of Amsterdam. The participants were randomly assigned to the sample. The project was approved by the Ethics Committee Psychology of Amsterdam University. Prior to the participation, the parents provided written informed consent.

2.2 Materials

This study was a part of a larger study and therefore, the materials were limited to the used ones for the specific analyses for this study. See Table 1 in the appendix for the complete list of materials that were used in the larger study.

2.2.1 Infant temperament

The infants' temperament was measured via the Infant Behaviour Questionnaire Revised (IBQ-R; Rothbart, 1981). Each parent (mother and father) filled in the questionnaire that was designed to measure temperament in infants in the age range of 3 to 12 months. They rated the frequency of daily behaviours using a 7-point scale with a range from 1 (never) to 7 (always). The subscales from the questionnaire used in this study are Sadness, Distress to Limitations, and Fear (Gartstein & Rothbart, 2003; van Schagen Johnson, et al., 2016). The three subscales are combined to create a new subscale: negative affectivity (negative child temperament). The parents needed to rate the frequency of temperament-related behaviour that they observed over

the past week. The reliability (all 14 subscales ranging from 0.70 to 0.90) and validity (0.77 to 0.87) of the questionnaire were both acceptable (Parade & Leerkes, 2008; Rothbart & Gartstein, 2003). To obtain the final score of infants' temperament the average score of mother's and father's ratings on the three subscales were used as a continuous variable (Bosquet Enlow, White, Hails, Cabrera & Wright, 2016).

2.2.2 Attention bias

Measurements of infants' and parents' attention bias were conducted and recorded during lab visits. The attention bias was measured via eye-trackers, by assessing infants' and parents' dwell times in milliseconds. The area of interest (AOI) is the whole face of the dynamic photos. The faces used in the experiment were collected from the NimStim database (Tottenham, et al., 2009). Based on previous studies, which used face pairs consisted of a happy face paired with a neutral face, an angry face paired with a neutral face, or two neutral faces (Cole, et al., 2016; Pérez-Edgar, et al., 2010), in this study different face pairs (fearful vs. happy) were used. All previous research used neutral faces as a reference. However, findings suggest that neutral faces might be interpreted as ambiguous and can be seen as a negative emotion (Lee, Kang, Park, Kim & An, 2008). Also, a happy face is more dynamic than neutral and therefore, happy faces were used as a reference to the fearful faces. To obtain a final score of the eye-tracking data, the total dwell time in milliseconds was used as a continuous scale for the analyses. The attention bias scores were calculated by subtracting participants' total dwell-times in milliseconds for fearful faces from the total dwell-times in milliseconds for happy faces (Telzera, et al., 2008; Montirosso, Cozzi, Putnam, Garstein & Borgatti, 2010).

2.3 Procedure

Each parent filled in the online questionnaires before they visited the lab with their infant(s). At the lab visit, the infant was placed in a car seat about 60cm away from the computer screen. The parent (only one of the parents visit the lab) was sitting on the right side of the infant. First, the eye-tracker (Tobii T120) is calibrated. The trials included dynamic videos of two male and two female faces (happy vs. fearful). Each trial started with 500ms attention-getter stimuli followed by 1000ms of blank screen. This was followed by 1500ms presentation of blurred face and ends with dynamic stimuli. The blocks included a neutral expression followed by four emotional stimuli (random). The entire experiment consisted of 40 trials. The eye-tracker measured the fixations (dwell times) in milliseconds towards threatening stimuli compared to non-threatening stimuli (relative looking-time).

2.4 Statistical analyses

IBM SPSS Statistics 24 was used to investigate the data. A significance level of 0.05 was used for testing all the hypotheses. The assumptions for regression and the distributions of residuals were checked for normality, homoscedasticity and linearity. Afterwards, the data was checked for outliers. The scores were transformed to *z*-scores, and scores with |3| standard deviations away from the mean were considered as outliers. Based on previous studies, we decided to remove outliers larger than three standard deviations away from the mean (Markant, Oakes & Amso, 2016) from the sample.

First, preliminary analyses were executed to check for correlations between the variables. The correlations between the subscales (combined negative affectivity scale) of the IBQ-R were calculated. Also the Cronbach's alpha was calculated for this particular sample. Thereafter, the difference in dwell-times towards fearful and happy faces (eye tracking data) were analysed with a paired sample *t*-test for both parents and infants.

A statistical linear regression test was used to investigate the relation between parents' attention bias (independent) and infants' attention bias (dependent). If the parents' attention bias (to fearful faces) score had a significant correlation to the infants' attention bias (to fearful faces) score, the null hypothesis would be rejected. The null hypothesis means that there is no relation between parents' attention bias and infants' attention bias. If there was a relation, the alternative hypothesis would be supported. This means that the attention bias of the parents predicts the attention bias of the infants towards threatening faces.

To investigate whether negative child temperament influences the relationship between parents' attention bias (fearful faces versus happy faces) and infants' attention bias, a moderation analysis was applied. The moderation analysis was performed in SPSS PROCESS. The combined negative affectivity score functioned as a moderator in the analysis. The moderation analysis revealed to what extent the relationship between parents' attention bias (X) and infants' attention bias (Y) can change at different values of negative affectivity score (M). This study investigated if the moderator can strengthen (positive direction) the relationship between X and Y. This means the higher the infants score on the negative affectivity scale (3 subscales), the stronger the relationship between parents' attention bias towards threatening faces, and infants' attention bias towards threatening faces. The null hypotheses would be rejected when we found a significant interaction-effect between the variables. The null hypothesis means that a higher infants score on the negative affectivity factor does not moderate the relationship between parent attention bias and infant attention bias towards threatening faces. If the results demonstrated an effect, the alternative hypothesis would be supported.

3. Results

3.1 Preliminary analyses

The research started with a sample that consisted of 251 families (infants with their primary caregivers). The final sample consisted of 220 infants (108 boys and 112 girls) with 229 primary caregivers (155 mothers and 74 fathers). A total of 14 families were tested, but removed from the analysis due to infant fussiness, equipment failure and tracking problems. An additional 17 infants and eight parents were removed from the analysis due to missing data and drop-out. Only parents who completed both the questionnaire, and the eye tracking task were included in the sample of this study. The demographic characteristics of the sample are shown in table 1 for the infants and table 2 for the parents.

The assumptions for regression were checked. All the distributions were found to be satisfactory, except for the normality of parents' attention bias. The variable parents' attention bias was not normally distributed (D (229) = 0.076, p = 0.003). According to the *Central Limit Theorem* (Kwak, & Kim, 2017) the assumption of normality was not violated. The analysis was robust against violation due to the big sample size.

Table 1

Sample characteristics Infants

	Infants	*M* (*SD*)
Gender		
Boys	108	
Girls	112	
Age % (*N*)		
6 months old (range 5.00 – 7.50)	33.19% (73)	6.08 (0.52)
12 months old (range 10.70 – 12.90)	35.45% (78)	12.08 (0.60)
18 months old (range 16.50 – 19.00)	31.36% (69)	17.88 (0.64)
Infant negative child temperament *M* (*SD*)	2.76 (0.621)	

Note. *M* = mean, *SD* = standard deviation

Infant temperament was assessed with an 7-point scale (1 = never, 7 = always)

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Table 2

Sample characteristics parents

	Mothers	Fathers
Age *M* (*SD*)	34.29 (4.106)	35.55 (4.853)
Educational level % (*N*)		
Primary school / primary education	0	2.7% (*N*=2)
Lower vocational education (LBO)	1.3% (*N*=2)	1.4% (*N*=1)
Secondary general secondary education (MAVO)	1.9% (*N*=3)	0
Higher general secondary education (HAVO)	1.3% (*N*=2)	5.4% (*N*=4)
Preparatory science education (VWO)	8.4% (*N*=13)	2.7% (*N*=2)
Secondary vocational education (MBO)	23.2% (*N*=36)	4.1% (*N*=3)
Higher professional education (HBO)	63.2% (*N*=98)	20.3% (*N*=15)
Scientific education (University)	0.6% (*N*=1)	48.6% (*N*=36)
Others	0	1.4% (*N*=1)
Professional level % (*N*)		
Never worked	0	0
Predominantly manual labor without vocational training	0.6% (*N*=1)	1.4% (*N*=1)
Predominantly manual labor requiring vocational training	1.3% (*N*=2)	1.4% (*N*=1)
Predominantly principal work requiring vocational training	2.6% (*N*=4)	2.7% (*N*=2)
Predominantly main work at LBO or MBO level and not managerial	4.5% (*N*=7)	1.4% (*N*=1)
Independent entrepreneur with a maximum of 4 employees	11 % (*N*=17)	12.2% (*N*=9)
Independent entrepreneur with more than 4 employees	2.6% (*N*=4)	4.1% (*N*=3)
Salaried at LBO or MBO level and managerial	3.9% (*N*=6)	1.4% (*N*=1)
Salaried at HBO level and not managerial	25.2% (*N*=39)	21.6% (*N*=16)
Salaried at HBO level and managerial	9.0% (*N*=14)	6.8% (*N*=5)
Salaried employment requiring scientific training	39.4% (*N*=61)	33.8% (*N*=25)
Monthly income % (*N*)		
<500 euro	7.7% (*N*=12)	2.7% (*N*=2)
500 – 1000 euro	9 % (*N*=14)	4.1% (*N*=3)
1000 – 2000 euro	17.4 % (*N*=27)	6.8% (*N*=5)
2000 – 3000 euro	23.2 % (*N*=36)	20.3% (*N*=15)
3000 – 4000 euro	20 % (*N*=31)	18.9% (*N*=14)
4000 – 5000 euro	7.1 % (*N*=11)	14.9% (*N*=11)
>5000 euro	7.1 % (*N*=11)	14.9% (*N*=11)
I don't know	0.6% (*N*=1)	0
I don't want to say	7.7% (*N*=12)	4.1% (*N*=3)
Current working status % (*N*)		
HK	9.7% (*N*=15)	1.4% (*N*=1)
PT	58.7% (*N*=91)	29.7% (*N*=122)
FT	18.7% (*N*=29)	47.3% (*N*=135)

Note. *M* = mean, *SD* = standard deviation, HK = Housekeeper, PT = Part-time, FT = Full-time, N = number of participants

3.2 Outliers

Outliers were calculated by transforming the scores in to standardized *z*-scores. Scores with |3| standard deviations away from the mean were considered as outliers. The analysis shows outliers on the attention bias variable in parents and infants. To investigate the reason of the outliers, the *z*-score was compared with the number of trials they completed. There was one outlier (infant) with a *z*-score of -3.145, that completed only 12 trials. Two parents ($z = 3.409$

and $z = 3.738$) were outliers on the attention bias variable. Both completed in order 37 and 40 trials. In total one infant (attention bias) and two parents (attention bias) were removed from the sample for the main analyses as outliers (>3 SD) (Markant, et al., 2016).

3.3 Child temperament

The three subscales of the combined negative affectivity scale had a relatively strong correlation (ranging from 0.33 to 0.57), and are shown in table 3. There appears to be a relatively strong positive correlation ($r = .378$, $p < .001$; $N = 213$) between the subscales 'Fear' and 'Distress to Limitations'. Also, there appears to be a relatively strong positive correlation ($r = .329$, $p < .001$; $N = 213$) between the subscales 'Fear' and 'Sadness'. Finally, there appears to be a relatively strong positive correlation ($r = .567$, $p < .001$; $N = 216$) between the subscales 'Sadness' and 'Distress to Limitations'. Therefore, the scale negative affectivity was constructed. The reliability of the negative affectivity scale in the current sample, based on 46 items, was good ($\alpha = 0.84$). On average the infants had a score of 2.76 on the Negative Child Temperament scale of the IBQ-R.

Table 3

Pearson Correlations of the subscales

	Distress to Limitations	Fear	Sadness
Distress to Limitations	1	.378[**]	.567[**]
Fear	.378[**]	1	.329[**]
Sadness	.567[**]	.329[**]	1

Note. ** Correlation is significant at the 0.01 level (2-tailed).

3.4 Attention bias

Although 220 infants provided data for the analyses, not all infants completed all the trials. In the study of Amso and colleagues (2014), they found invalid results for participants who completed less than 30% of the trials. Therefore, we decided to remove participants who completed 30% or less (≤ 12 trials) from the research sample. This led to one exclusion (0.45% compared to non-exclusions). On average, infants provided data of approximately 34 trials ($M = 34.341$, $SD = 6.746$). The average completed trials for the parents is 38 trials ($M = 38.767$, $SD = 3.629$). The bias score is created by separately (infants and parents) subtracting participants' total dwell-times towards fearful faces from total dwell-times towards happy faces. To check whether there is an attention bias in the parent and infant sample, a paired sample *t*-test is executed. On average infants had more attention for fearful faces ($M = 3273.24$, $SD = $

1102.48) than happy faces ($M = 3149.67$, $SD = 1124.34$). This difference is significant; t (410) = 3.067, $p = 0.002$. This implies that infants have an attention bias towards fearful faces. Also, on average the parents paid more attention towards fearful ($M = 4272.82$, $SD = 998.75$) faces than happy faces ($M = 4234.91$, $SD = 1012.03$), but this difference is insignificant. This implies that parents do not have an attention bias towards fearful faces.

3.5 Main analyses

A simple linear regression was used to predict infants' attention bias from parents' attention bias. The analysis showed no relation between parents' attention bias and infants' attention bias, F (1, 196) = 0.016, $p = 0.91$, $R^2 = 0.000$. This meant that parents' attention bias towards fearful faces was not related to infants' attention bias towards fearful faces.

A moderation analysis was applied to predict the moderating effect of negative child temperament on the relationship between infants' attention bias and parents' attention bias. The explained variance of the model was not significant ($R^2 = 0.023$, F (3, 181) = 1.412, $p = 0.24$). Negative child temperament was not a significant predictor in the model ($B_1 = -17.17$, $t = -0.18$, $p = 0.86$). Parents' attention bias was also not a significant predictor of infants' attention bias ($B_2 = -1.40$, $t = -1.88$, $p = 0.06$). The interaction between parents' attention bias and negative child temperament was significant on infants' attention bias ($B_3 = 0.516$, $t = 2.01$, $p = 0.0462$). This was a positive moderation, meaning that negative child temperament strengthened the relationship between parents' attention bias and infants' attention bias. This implied, the higher the score on negative child temperament, the stronger the relationship between parents' attention bias and infants' attention bias. The results of both analyses are shown in table 4.

Table 4.

Regression and moderation model

Model	B	SD	t	p	
1					R^2
(Constant)	147.946	274.67	2.148	0.033	0.00
Parent Attention Bias	-0.17	0.152	-0.115	0.91	
2					R^2
(Constant)	147.946	274.67	0.5908	0.59	0.02
Parent Attention Bias	-1.40	0.7435	0.0613	0.06	
Negative Child Temperament	-17.17	96.32	0.8587	0.86	
Parent AB * Negative Child Temperament	0.5162	0.2571	2.0072	0.0087	

Note. Dependent Variable: Infant attention bias
Model 1: Regression model coefficients
Model 2: Moderation model coefficients

4. Discussion

The primary goal of this study was to examine the relation between attention biases and individual differences, as potential risk factors for the development of anxiety disorders later in life. The study was aimed to investigate one possible mechanism that underlie the parent-to-child transmission of anxiety (Aktar & Bögels, 2017; Creswell, et al., 2010). One possible mechanism mentioned before is the shared attention biases (Aktar & Bögels, 2017; Creswell, et al., 2010) towards threat between parents and infants. These shared attention biases are a result from genetic and environmental factors (Aktar, et al., 2018b). One of these genetic factors (negative temperament) was investigated in this study to increase our understanding of risk factors for developing anxiety disorders later in life. The study investigated whether 1) infants' attention bias (fearful versus happy faces) is positively related to parents' attention bias, and 2) negative child temperament strengthens the relationship of parents' attention bias (fearful faces versus happy faces) and infants' attentional bias. At first, the study investigated if the findings from previous studies could be replicated that infants and parents have an attention bias towards fearful faces.

The results show that infants pay significantly more attention towards fearful faces. This is a similar finding compared to the study of Peltola and colleagues (2013), who also found an attention bias towards fearful expressions in young infants (fearful vs. happy, and fearful vs. neutral). The results suggest that an attention bias to fearful faces is emerging during early development. This means that infants' attention might be captured by physical characteristics of fearful facial expressions (Leppänen, et al., 2018; Nakagawa & Sukigara, 2012), such as wide-open eyes, and can help the infant to evaluate environmental events (Todd, et al., 2012).

Parents on the other hand did not have an attention bias towards fearful faces. This is in line with the meta-analysis of Bar-Heim and colleagues (2007), who found an absence of attention bias towards threats in non-anxious participants. In the current study, we used the DASS (Depression, Anxiety, Stress Scale) for measuring anxiety symptoms in parents. The cut-off score for the subscale 'Anxiety' is seven (Lovibond & Lovibond, 1995). This means that participants who scored lower or equal to seven on that particular subscale, belong to the normal/ non-anxious group (Lovibond & Lovibond, 1995). The current sample consisted mostly out of non-anxious parents (average anxiety symptom score is 1.31) rather than anxious parents. This means, according to Bar-Heim and colleagues (2007), that higher levels of threat-related stimuli are needed for an attention bias to occur in non-anxious participants. This finding is contradictory with the results of Leppänen and Nelson (2008), who did find a preferential

attention towards fearful faces in adults. They measured the attention presented simultaneously with neutral or happy facial expressions as a reference. They note that attention bias to fearful stimuli in adults is similar to infants attention bias to fear, suggesting that there is a similar underlying mechanism (Leppänen & Nelson, 2008). A possible explanation for the contradictory findings, could be that under mild threat conditions, non-anxious adults show avoidance of the threat-related expressions and shift their attention away from the threat (Bar-Heim, et al., 2017).

Contrary to previous evidence indicating a relationship between parents' attention bias and infants' attention bias (Creswell, et al., 2010); Peltola, et al., 2013), parents' attention bias to threat was not related to infants' attention bias to threat in this study. These results are in line with Aktar and colleagues (2018b), who also did not find a direct link between attention biases in infants and parents. They point out that from a developmental perspective, attention biases were only observed in infants and children, and that this phenomenon is in line with the idea that attention biases to threat-related stimuli might fade away across time during normal development (Aktar, et al., 2018a). According to the literature, shared attention biases could explain the intergenerational transmission of anxiety (Creswell, et al., 2010). The absence of the direct relationship between parents' attention bias and infants' attention bias reveals that parents' attention bias alone is unlikely to contribute to the development of attention biases in their infants. Other aspects, such as parenting behaviour and environmental exposure to parental anxiety (Aktar & Bögels, 2017), might influence the infants' attention bias more directly.

In line with the idea that parents' attention bias alone is unlikely to contribute to the development of attention biases in their infants (Aktar & Bögels, 2017), the results revealed that highly negative temperament was linked to a stronger relationship between parents' attention bias and infants' attention bias. This confirms the cognitive model of Lonigan and colleagues (2004), saying that negative temperament traits are considered crucial for the tendency to pay attention to threatening stimuli. These results are similar to the studies of Cole and colleagues (2016) and Pérez-Edgar and colleagues (2010), who found moderation between attention bias, fearful temperament and anxiety. They revealed that infants with higher negative temperament looked longer towards fearful facial expressions compared to infants with low negative temperament. A possible explanation could be, that infants with an attention bias to threat might experience the stimuli in a more aversive way, or their negative affectivity might be triggered by the stimuli (Nakagawa & Sukigara, 2012). This would entail that fearful/ negative temperament influences attention bias, which might lead to greater risk for developing anxiety symptoms. However, the current findings contradict with the study of Morales and

colleagues (2017). Although they found an increased attention bias in infants to threatening faces, they did not find a relation between infants' attention bias and negative affect (marker of fearful temperament). We found an attention bias to fearful faces in infants, and a relation between the shared attention biases and negative temperament. Whereas they used angry and fearful facial expressions as threat-related stimuli, we only used fearful facial expressions as threat-related stimuli. Also, they used neutral faces as a reference, whereas we used happy faces as a reference. A possible explanation for the contradictory findings, could be that they used neutral faces as a reference, and it may be interpreted as ambiguous which can be seen as a negative emotion (Lee, et al., 2008). Given the survival value of the negativity bias in infancy, one would expect this effect to be particularly noticeable with negative emotions compared to positive emotions (Aktar, et al., 2016).

A question that arises from these findings, is why infants with negative temperament have a more similar attention bias to their parents compared to infants with less negative temperament. In the absence of previous evidence on the direct link of the shared attention biases and negative temperament, we can only speculate about the causes. As mentioned before, temperament is a response to the environment, including parents' emotional expressions (Hong, et al., 2018). Infants' negative emotionality refers to negative moods and negative reactions, such as anger and fearfulness (Paulussen-Hoogeboom, Stams, Hermanss, & Peetsma, 2007). Typically developing infants start to pay more attention to facial expressions (Aktar, et al., 2018b; Kochanska, Friesenborg, Lange, & Martel, 2004). Temperamentally fearful infants are, according to Aktar and Bögels (2017), more sensitive to the effects of exposure to parents' negative emotions. However, still little is known regarding how infants' fearfulness may have an impact on the relationship with their parents. Possibly, parenting plays a role, because several studies found an association between temperament and parenting, with the idea that negative emotionality in infants is a characteristic of negative temperament that makes infants hard to parent (Grusec & Hastings, 2007; Paulussen-Hoogeboom, et al., 2007). Fearful infants pose more challenges and may elicit less responsive parenting (Kochanska, et al., 2004). Others suggest that fearful infants may receive more protective parenting (Kiff, Lengua, & Zalewski, 2011). The challenges that fearful infants pose, might have a negative effect on their parents' state of mind (Gulley, Oppenheimer, & Hankin, 2014). Research has shown that increased negative feelings, increase the attention bias towards threats (Aktar & Bögels, 2017). Also, Gulley and collagenous (2014) suggest that parental affect influences information processing biases to threat in infants, and that parents' negative interpretations were associated with infants' negative interpretations. This implies that infants might model their parents behaviour,

such as pay more attention to fearful stimuli (Field & Lester, 2010a). Therefore, Gulley and collagenous (2014) argue, that parenting might be related to attention biases to threat. In short, fearful infants are more sensitive to parents' negative emotions, and negative temperament might influence the parent-child relationship, which can influence parenting behaviour. Taken together, all these aspects can contribute to the result that infants with negative temperament have a more similar attention bias to their parents.

This study has a number of notable strengths. First, to our knowledge this is the first study that directly links parents' attention bias to infants' attention bias in the same eye-tracking task. Second, due to a large sample a greater power is achieved. Third, we used dynamic facial expressions, whereas other studies mainly use static facial expressions. Evidence reveals a greater influence on infants' emotion processing (Grossmann, 2010) when using dynamic facial expressions. Finally, the current study included fathers into the sample, whereas most studies only investigated mothers. This benefits the generalizability and gives more insight in infants' socio-emotional development (Aktar, et al., 2016).

However the findings in this study should be considered in light of some limitations. First, infants' negative temperament was assessed via a questionnaire rather than observations. Although the questionnaire was suitable to assess traits for research purposes, parents' perception of infants' temperament might be biased due to their own state of mind at that time. Future research could add observational data (measures that do not rely on parents reports) to improve the validity and reliability of the temperament measurements. Second, the study had a cross-sectional design, and is therefore not able to assess causal relations of the developmental risk factors for anxiety and attention bias towards threat. In the future, longitudinal research is recommended to accomplish a better understanding of attention biases, negative temperament and its consequences over time. Third, this study utilized fearful faces as the threat stimuli, whereas some studies used a combination of angry faces and fearful faces. Evidence reveals that during the development of information-processing in infants, exposure to parents' facial expressions are crucial (Burkhouse, Siegle, & Gibb, 2014). It might be useful in future research, to use angry and fearful emotions together to increase the generalizability to the different emotions. Finally, the families were relatively highly educated, and had a higher socio-economic background compared to the general population. This limits the generalizability of the results to the general population. Also, fathers were underrepresented in the sample. The measured attention bias of the parents is probably more due to the bias of the mothers. This might also have an impact on the generalizability. In future research more fathers and a more heterogeneous socio-economic background is recommended to benefit the generalizability of

the results.

Despite these limitations, the current study found evidence for significant associations between infants' negative temperament and the relation between parents' and infants' attention bias towards fearful facial expressions. The current findings support the growing literature suggesting that attention bias to threat develops in early infanthood. We also found support for the idea that negative temperament is related to attention bias, which would be a risk factor for future anxiety development. In short, the current study extended the literature by examining the relation between attention bias and potential risk factors of future anxiety, namely negative temperament.

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Appendix

Table 1

Complete list of materials

Questionnaires	Construct
Socio-demographic information	Age, gender, nationality, educational level, profession level monthly income, hours of work per week, working status, duration relationship and civil state.
DASS	Depression, Anxiety and Stress
IBQ	Infant temperament
PANAS	Positive and Negative Affect
ASQ	Ages and Stages, developmental progress in infants and children
IRI	Interpersonal reactivity, individual differences in empathy

Eye tracking	Measurement
Fixation (dwell times in milliseconds)	The visual gaze on a single location, measuring attention bias/ selective attention
Pupil dilation	Pupil size and degree of change, measuring arousal

Note. Materials used in current study are extensive described in the method section.