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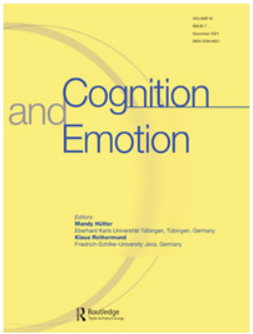

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BRIEF ARTICLE

The relation between early behavioural inhibition and later social anxiety, independent of attentional biases to threat

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ABSTRACT

Early behavioural inhibition, a temperamental characteristic defined by fearful, overly-sensitive, avoidant, or withdrawn reactions to the unknown, is a predictor of later social anxiety. However, not all behaviourally inhibited children develop anxiety problems, and attentional bias to threat has been proposed to moderate the relation between behavioural inhibition and anxiety. The current study aimed to further specify the relation between early behavioural inhibition and later social anxiety by testing this potentially moderating role of childhood attentional bias to threat. Behavioural inhibition was assessed during toddlerhood (age 2.5 years) using laboratory observations of children's behaviours in response to unknown objects and situations. When children were 7.5 years old, attentional bias was measured in 86 children (46 girls) using both a visual probe task and a visual search task with angry and happy faces. Child social anxiety was measured using questionnaires completed by the child and both parents, and clinical interviews conducted with both parents. Our results showed that while early behavioural inhibition was related to later social anxiety, there was no evidence for a moderation of this relation by attentional bias, suggesting that the relation between early fearful temperament and later social anxiety holds across children, independent of their attentional biases.

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Temperament; behavioural inhibition; social anxiety; attentional bias

Behavioural inhibition is a temperament trait reflecting children's initial fearful, overly-sensitive, avoidant, or withdrawn reactions to unknown or unfamiliar people or situations (Fox et al., 2005). Behavioural inhibition in infancy and early childhood is predictive of the development of later psychopathology, in particular anxiety problems. In a meta-analysis, Clauss and Blackford (2012) found that 43% of behaviourally inhibited children developed social anxiety disorder during their later childhood or adolescence, relative to only 12% of non-inhibited children. Although these numbers indicate that a substantial number of behaviourally inhibited children are at risk for developing social anxiety, they also show that not all behaviourally inhibited children will do so. Consequently, researchers have focused on identifying potential moderators of this relation, trying to further specify the nature of the relation between behavioural inhibition and social anxiety.

One such potential moderator that has received considerable attention is attentional bias to threat, that is, the preferential allocation of attention to threatening over non-threatening stimuli. Earlier evidence has revealed a direct link between attentional

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bias and anxiety: Relative to non-anxious people, anxious people are typically faster to respond to stimuli appearing in the vicinity of threatening stimuli and are slower to respond to stimuli appearing in the vicinity of positive or neutral stimuli (Bar-Haim et al., 2007). Attentional bias has been found in both anxious adults and anxious children (Bar-Haim et al., 2007), and is considered an important factor in the development or maintenance of anxiety (for a review, see Van Bockstaele et al., 2014).

Pérez-Edgar et al. (2010) were the first to address the potential moderating role of attentional bias to threat in the relation between early behavioural inhibition and later social anxiety. In a sample of adolescents, they assessed levels of social withdrawal as a proxy for social anxiety, and measured attentional bias using the visual probe task. In this task, pictures of an angry and a neutral face were presented simultaneously at two different locations on a computer screen. After 500 ms, the faces were replaced by a target stimulus appearing at one of the two previously cued locations. Attentional bias to threat is evidenced by faster reaction times (RTs) to targets appearing at the location of the angry face compared to targets appearing at the location of the neutral face. Pérez-Edgar et al. (2010) found that attentional bias to threat significantly moderated the relation between early behavioural inhibition, measured at different ages (14 months, 24 months, 4 years, and 7 years) during the adolescents' childhoods and using both mother-reports and lab observations, and later social withdrawal: There was a significant positive correlation between childhood behavioural inhibition and social withdrawal during adolescence only for those adolescents with a large attentional bias to threat.

The moderating role of attentional bias to threat in the relation between early behavioural inhibition and later social anxiety was also addressed in two other studies. Pérez-Edgar et al. (2011) measured social withdrawal and attentional bias, using a similar visual probe task, in 5-year-old children. In line with the findings of Pérez-Edgar et al. (2010), the association between behavioural inhibition in toddlerhood (measured at ages 24 and 36 months) and social withdrawal at age 5 was stronger for children who displayed an attentional bias to threat than for children who showed no such bias, while the relation was not significant in children who showed avoidance of threat. Addressing the same question when the children of the Pérez-Edgar et al. (2011) study were 7 years old, White et al. (2017) found that behavioural inhibition in toddlerhood was related to anxiety at age 7 in those children who, at age 7, showed either a bias towards threat or no bias. This relation was not significant in children showing attentional avoidance of threat. Taken together, these findings show relatively consistently that attentional bias to threat moderates the relation between early behavioural inhibition and later social anxiety, such that the relation is stronger in children with a bias towards the threat.

Although studies on the moderating role of attentional bias in the relation between early fearful temperament and later social anxiety have yielded relatively consistent findings, these studies have exclusively relied on the visual probe task to measure attentional bias. However, this task has been widely criticised because of its poor psychometric properties. Several studies have shown that the attentional bias scores derived from visual probe tasks have very low internal consistency (Schmukle, 2005; Van Bockstaele et al., 2020), making these scores problematic in studies addressing individual differences. To more convincingly demonstrate the moderating role of attentional bias, including more reliable measures of attentional bias is crucial.

In the present study, we set out to replicate and extend earlier findings, testing whether childhood attentional bias to threat moderates the relation between toddlerhood behavioural inhibition and childhood social anxiety. Behavioural inhibition was measured at the age of 2.5 years using laboratory observations. We measured attentional bias to threat at 7.5 years, using both a visual probe task and a visual search task. In the visual probe task, children responded to the location of a target stimulus that appeared on the location of either a happy or an angry face. The visual search task involved finding an angry face in a crowd of happy faces and finding a happy face in a crowd of angry faces. Recent studies have demonstrated that such a relevant feature visual search task yields more reliable estimates of attentional bias than the visual probe task (Aktar et al., 2019; Van Bockstaele et al., 2020). Child social anxiety was also measured at the age of 7.5 years, using not only primary caregivers' reports (White et al., 2017) but also child self-reports. We expected that children with higher levels of behavioural inhibition in toddlerhood would show higher levels of social anxiety at 7.5 years. In addition, based on the proposed moderating role of attentional

bias (Pérez-Edgar et al., 2010, 2011; White et al., 2017) we expected the relation between early behavioural inhibition and later social anxiety to be especially pronounced for children displaying a larger attentional bias to threat.

Method

Participants

The initial sample consisted of 89 children (47 girls, $M_{age} = 7.52$ years, SD = 0.08) who participated in a larger longitudinal study on social development (for more elaborate descriptions of the sample, see Aktar et al., 2019). For the analyses, we retained the data of 86 children who successfully completed (1) at least one of the attentional bias measures (see below; one child was excluded because they made too many errors on both tasks), (2) at least three of the five indices of social anxiety (see below; one child was excluded because they completed only two social anxiety indices), and (3) at least four of the eight behavioural inhibition tasks (see below; one child was excluded because they only completed three behavioural inhibition tasks). Therefore, the final sample consisted of 86 children (46 girls). Children who completed the attention tasks did not differ from non-completers on age, gender distribution, or behavioural inhibition, all *p*s > .50. Using G*Power (Faul et al., 2007), a post-hoc sensitivity analysis with a conventional power of .80 showed that the sample size was large enough to detect significant medium-sized effects (for R^2 significantly deviating from zero in a model with three predictors, our minimum $f^2 = 0.13$; for a single significant regression coefficient, our minimum $f^2 = 0.09$; conventional interpretations for f^2 are 0.02, 0.15, and 0.35 for small, medium, and large effects, respectively; see Cohen, 1992).

Behavioural inhibition

Behavioural inhibition was assessed when children were 2.5 years old, in eight observational tasks from the Laboratory Temperament Assessment Battery (Goldsmith et al., 1995): Unpredictable Mechanical Toy, Stranger Approach, Clown, Unknown Mechanical Toys (a dinosaur robot, a beetle robot, and a large parrot), and two versions of a Risk Room (with a set of new and ambiguous toys, such as a tunnel, a small staircase, and a scary mask; see Hayden et al., 2005). A variety of fear-relevant behaviours (e.g. facial, bodily, and verbal expressions of fear, latency to touch the stimulus) were coded in time intervals of about 30 seconds, depending on the course of the task. For each of the eight tasks, these behaviours were averaged across time intervals, standardised, and averaged to obtain child task scores, which were then averaged across tasks to create a behavioural inhibition score (for more elaborate descriptions of the tasks, see Aktar et al., 2018).

Social anxiety measures

To obtain a composite score of child social anxiety, we averaged the standardised scores across three measures of social anxiety.

Picture anxiety test (PAT)

All 86 children completed the PAT (Dubi & Schneider, 2009), consisting of 21 items, each scored on a 4-point scale, using coloured illustrations representing anxiety in a variety of situations (e.g. going to school, meeting peers). For the current study, we used the scores from the social anxiety subscale (3 items, Cronbach's alpha = .67).

Screen for child anxiety related emotional disorders-71 (SCARED)

Fathers' and mothers' ratings of child social anxiety were assessed with the SCARED (Bodden et al., 2009). We used the social anxiety subscale, consisting of nine items, with each item scored on a 3-point scale. Cronbach's alphas of maternal ($N = 84$) and paternal ($N = 72$) reports were .86 and .81, respectively. The correlation between mother and father reports was .57 ($p < .001$). Mothers' and fathers' reports were averaged to obtain a single parent score.

Structured clinical interview for DSM-5-junior (SCID-junior)

Both parents completed the SCID-Junior (Braet et al., 2015), a clinical interview about the child, conducted by one of four trained interviewers. To assess the inter-observer reliability, an independent observer coded the interview recordings for 22 cases (from 11 mothers and 11 fathers). The inter-observer reliability per symptom ranged from 81 to 100% for mothers, and from 91 to 100% for fathers. The correlations between mother-(N = 83) and father-reported (N = 82) social anxiety symptom count was .62 ($p < .001$).

A child social anxiety symptom score was obtained by averaging mothers' and fathers' symptom counts.

Attentional bias measures

Details of the attentional bias tasks, including schematic figures, outlier analyses, and scoring procedures, are provided in the online supplement.

Visual probe task

Children completed a visual probe task in which they responded as fast as possible to the location of a target that was presented at one of two previously cued locations. The cues were pictures of an angry and a happy adult face and were presented for 500 ms. On threat-congruent trials, the target was presented at the angry face location, while on threat-incongruent trials, the target appeared at the happy face location. The task consisted of 24 congruent and 24 incongruent trials. We calculated attentional bias scores by subtracting mean RTs on threat-congruent trials from mean RTs on threat-incongruent trials. Positive scores reflect an attentional bias to angry over happy faces, while negative scores reflect an attentional bias to happy over angry faces.

Visual search task

In the visual search task, eight faces were presented in a 3×3 grid with the middle position empty. In a "find angry" block, consisting of 24 trials, children clicked as fast as possible on an angry target face amidst seven happy faces, while in a "find happy" block, also consisting of 24 trials, children clicked as fast as possible on a happy target face amidst seven angry faces. Attentional bias scores were calculated by subtracting the mean RT of the find angry block from the mean RT of the find happy block. As in the visual probe task, positive scores reflect an attentional bias to angry over happy faces, while negative scores reflect an attentional bias to happy over angry faces.

Procedure

At 2.5 years, children completed the observational behavioural inhibition tasks in lab visits with their mother and father. The visual probe task and the visual search task were completed in this fixed order as part of a 7.5 years measurement in a quiet room at families' homes. Children completed the PAT during the same home visit. Parents completed the SCARED while children were doing the attention tasks, and completed the SCID in a telephone interview. The entire procedure was approved by the ethical committee of the University of Amsterdam.

Statistical analyses

The composite social anxiety score was used as the outcome variable in hierarchical linear regression models testing whether attentional bias to threat moderates the relation between early behavioural inhibition and later social anxiety. First, a model including behavioural inhibition and attentional bias as predictors was tested, followed by a second model including behavioural inhibition, attentional bias, and the interaction between behavioural inhibition and attentional bias. Separate regression analyses were conducted for attentional bias measured using the visual probe task and using the visual search task. All variables were standardised prior to the analyses. Because some participants did not complete all measures (see Table 1), initial sample sizes differed between regressions.

Because regression models are particularly prone to outliers, we identified possible outlying or influential cases following the best-practice recommendations of Aguinis et al. (2013) in a preliminary analysis including all participants. We flagged potential model fit outliers (i.e. cases disproportionally affecting the overall model fit, operationalised as cases with either leverage, Mahalanobis distance, or studentised deleted residuals exceeding design-specific cut-offs) as well as potential prediction outliers (i.e. cases disproportionally affecting one or more regression coefficients, operationalised as cases with Cook's distance, standardised differences in fit, or standardised differences in beta exceeding design-specific cut-offs). We then tested each regression model again after removing these outliers. In line with the best-practice recommendations of Aguinis et al., in the tables and results section below, we present the models after removing potential outliers, and we specify explicitly whether and how these results diverged from the models including all cases.

Results

Descriptive statistics and correlations

Descriptive statistics and non-parametric correlations between the variables of interest are presented in Table 1. As expected, there were consistent positive

Table 1. Descriptive statistics and correlations between variables of interest.

	N	Mean	SD	2.	3.	4.	5.	6.	7.
1. PAT	86	0.77	0.67	.30**	.25*	.76**	.28**	.11	−.26*
2. SCARED	86	1.41	0.35		.54**	.79**	.15	−.01	.00
3. SCID	84	0.66	1.85			.60**	.07	.14	−.12
4. Aggregated social anxiety score	86	0.00	0.76				.33**	.07	−.10
5. Behavioural inhibition	86	0.01	0.39					.22*	.01
6. AB visual probe task	83	−4.40	42.86						.03
7. AB visual search task	80	667.85	748.10						

Notes: * $p < .05$, ** $p < .01$ (two-tailed). PAT, picture anxiety test; SCARED, screen for child anxiety related emotional disorder; SCID, structured clinical interview for DSM; AB, attentional bias. Scores on the PAT and SCARED represent average social anxiety item scores, and scores on the SCID reflect the social anxiety symptom count averaged across parents. The aggregated social anxiety score is the average of the standardised PAT, SCARED, and SCID scores. The behavioural inhibition score represents the mean of standardised indices of behavioural inhibition across the eight observational tasks. The attentional bias measurements are expressed in milliseconds. Correlations are expressed as Spearman's ρ coefficients.

correlations between the indices of social anxiety. In line with the idea that early behavioural inhibition is related to later social anxiety, there was a positive correlation between behavioural inhibition at age 2.5 and the aggregated social anxiety score at age 7.5 (Figure 1), though correlations with individual indices of social anxiety were weaker and inconsistent. Attentional bias in neither the visual probe task nor the visual search task was consistently related to indices of social anxiety. As also reported in Aktar et al. (2019), Spearman-Brown corrected split-half reliability indices based on odd versus even trials showed that the attentional bias score in the visual probe task had poor reliability ($r = .06$), while the attentional bias score in the visual search task was more reliable ($r = .56$).[1]

Moderation of the relation between early behavioural inhibition and later social anxiety

Visual probe task

After removing 13 potential outliers (resulting $N = 70$), both the main effects model and the interaction model failed to reach significance, $F(2, 69) = 2.67$, $p = .076$, $R^2 = .074$, and $F(3, 66) = 2.42$, $p = .074$, $R^2 = .099$ respectively, and the inclusion of the interaction did not significantly improve the model fit (for details see Table S1 of the online supplement). In line with our correlational findings, behavioural inhibition was the only predictor reaching significance in the main effects model ($p = .024$), but behavioural inhibition no longer significantly predicted anxiety in the interaction model ($p = .077$). The analysis including all participants ($N = 83$) yielded overall

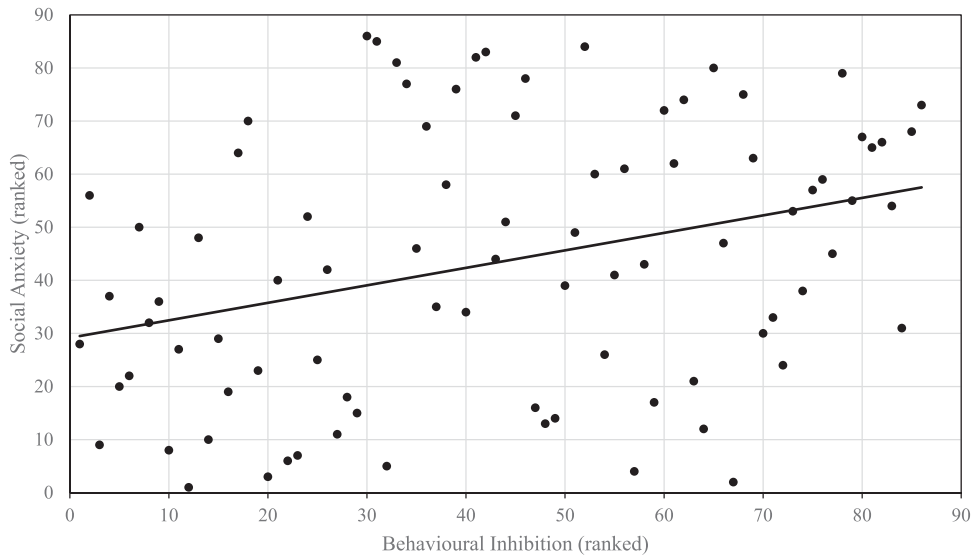

Figure 1. Scatter plot of the relation between behavioural inhibition at age 2.5 and aggregated social anxiety at age 7.5.

Table 2. Hierarchical regression model with 2.5-year behavioural inhibition and 7.5-year visual search task attentional bias predicting 7.5-year social anxiety.

	R^2	F	p	ΔR^2	ΔF	Δp	B	SE B	β	t	p
Model 1	.082	2.963	.059								
Constant							−0.185	0.078		2.381	.020
Behavioural Inhibition							0.185	0.092	0.240	2.007	.049
AB Visual Search Task							−0.090	0.086	−0.124	1.042	.301
Model 2	.095	2.283	.087	.013	0.928	.339					
Constant							−0.169	0.080		2.122	.038
Behavioural Inhibition							0.203	0.094	0.264	2.160	.034
AB Visual Probe Task							−0.052	0.095	−0.072	0.547	.586
Behavioural Inhibition X AB Visual Search Task							0.111	0.115	0.126	0.964	.339

Notes: The results in this table are based on the analyses after exclusion of potential outliers. AB, attentional bias.

non-significant results: Both the main effects model and the interaction model failed to reach significance (both Fs < 1.78, both ps > .17, both R^2 < .05), and none of the predictors were significant (all ts < 1.62, all ps > .11). We thus found some support for the hypothesis that early behavioural inhibition predicts later social anxiety, but we found no evidence for the moderation of this relation by attentional bias towards threat in the visual probe task.

Visual search task

After removing 11 cases as potential outliers (resulting in $N = 69$), both the main effects model and the interaction model failed to reach significance, and the inclusion of the interaction did not improve the fit (Table 2). Again, behavioural inhibition was the only significant predictor of social anxiety. The analysis including all participants ($N = 80$) again produced non-significant results, with both models failing to reach significance (both Fs < 2.10, both ps > .13, both R^2 < .07), and none of the predictors were significant (all ts < 1.69, all ps > .09). We thus found some evidence for the relation between early behavioural inhibition and later social anxiety, but despite using a more reliable measure of attentional bias, we did not find the expected moderation of the relation between behavioural inhibition and anxiety by an attentional bias towards threat in the visual search task.

Discussion

We investigated the longitudinal relation between toddlerhood behavioural inhibition and childhood social anxiety and tested the potentially moderating role of childhood attentional bias to threat in this relation. Overall, our findings supported the direct relation between behavioural inhibition and social anxiety (Clauss & Blackford, 2012), though the significance of this relation depended on the in/exclusion of potential multivariate outliers in the regression models, as well as on the measures of social anxiety in the correlational findings. Contrary to our hypothesis, we found no evidence for the idea that 7.5-year attentional bias towards threat moderates the relation between 2.5-year behavioural inhibition and 7.5-year social anxiety, irrespective of whether attentional bias was measured using a visual probe task or a visual search task.

Our correlational findings are broadly in line with evidence showing a direct association between early behavioural inhibition and later social anxiety, although this relation was not always statistically significant in the regressions. While Muris et al. (2011) found very large correlations of around .70 between early behavioural inhibition and later social anxiety, the correlation in our current sample was only medium-sized. However, Muris et al. did not use an observational index of behavioural inhibition. Both their behavioural inhibition and their social anxiety measures were based on parent reports, which may have inflated the size of their correlations due to common-method variance. Correlations between observational indices of early behavioural inhibition and later social anxiety are typically more modest, with previous studies reporting correlations between .15 and .25 (Pérez-Edgar et al., 2011; White et al., 2017; White, McDermott, Degnan, Henderson, & Fox, 2011). Our results are in line with those more modest correlations.

We found no support for a moderating role of childhood attentional bias in the relation between toddlerhood behavioural inhibition and childhood social anxiety. While going against evidence from previous studies (Pérez-Edgar et al., 2010, 2011; White et al., 2017), the absence of moderation is in line with findings from a recent study by Dodd et al. (2020). They investigated child attentional biases at 3–4 years using an eye-tracking task with angry,

happy, and neutral faces, along with behavioural inhibition. Parents reported child trait anxiety and child state anxiety at the start of schooling as a naturally occurring stressor. In parallel with our findings, Dodd et al. reported prospective associations between behavioural inhibition and *trait* anxiety, but no significant main effect of or moderation by attentional biases. Interestingly, they did find a significant moderation by attentional bias for angry faces in the relation between behavioural inhibition and children's *state* anxiety. Thus, while our current findings challenge the idea that attentional bias consistently moderates the relation between behavioural inhibition and trait anxiety, it is possible that this moderation holds for measures of state anxiety.

In the absence of evidence for moderation, our study suggests that the relation between early behavioural inhibition and later social anxiety holds across children, irrespective of their attentional biases. Past studies have advocated for the use of attentional bias modification procedures in behaviourally inhibited children (for a review, see Van Bockstaele et al., 2014), building on their finding that enhanced attentional bias towards threat increases the probability that behaviourally inhibited children develop social anxiety. Although evidence for the effectiveness of attentional bias modification training as a means to reduce anxiety is mixed (Cristea et al., 2015; Van Bockstaele et al., 2014), these procedures aim to reduce attentional bias and have thus been argued to reduce the likelihood of behaviourally inhibited children developing social anxiety. Our current findings are not in line with this perspective: As attentional bias to threat did not moderate the relation between behavioural inhibition and later social anxiety, training temperamentally at-risk toddlers to attend less to threat would not necessarily reduce the likelihood of these toddlers becoming socially anxious children. Recent models of the development of anxiety propose more complex interactive pathways, in which the relations between fearful temperament, attentional biases, and anxiety are further influenced by inhibitory and attentional control (Liu & Bell, 2020). Future studies could consider these interactive effects of inhibitory and attentional control, attentional bias, and fearful temperament in the development of anxiety.

Our study has a number of limitations. First, because social anxiety and attentional biases were concurrently measured, the study does not allow for inferences on the developmental trajectories or moderators of this association. Second, two of the three measures used for the child social anxiety composite score were based on parent-reports. Although questionnaires reliably assess these dimensions of child behaviour and affect, parents' perceptions of their child's anxiety may be biased by their own anxiety (Najman et al., 2000). Third, reaction time tasks are prone to measurement errors stemming from the variable motor functioning in children (Brown et al., 2014). Our study did not take these individual differences in motor functioning into account, which may partially explain the relatively low reliabilities of our attentional bias scores. Fourth, while our sample was large enough to detect medium-sized effects, it was too small to also detect smaller effects. Finally, we operationalised attentional bias as the difference between attention for angry and happy faces, while earlier studies (Pérez-Edgar et al., 2010, 2011; White et al., 2017) have looked at differences between angry and neutral faces. Because both angry and happy faces are emotional, attentional bias in our study must have been driven by the angry versus happy nature of the emotion rather than by a potential difference between generally emotional and neutral faces. However, in absence of neutral faces, our procedure does not mirror earlier studies, thus complicating the comparison of our findings with those from past studies. Notwithstanding these limitations, our study shows that while there may be a direct relation between toddlerhood behavioural inhibition and social anxiety in later childhood, attentional bias towards threat does not necessarily moderate this relation.

Note

1. The reliability indices reported here differ slightly from the ones previously reported in Aktar et al. (2019) because (1) we report Spearman-Brown corrected values here and (2) our current sample included slightly fewer children.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Availability of data and material

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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