Cognitive Therapy and Research (2022) 46:940–955
https://doi.org/10.1007/s10608-022-10304-1

ORIGINAL ARTICLE

The Longitudinal Interplay Between Attention Bias and Interpretation Bias in Social Anxiety in Adolescents

Lisan A. Henricks[1] · Wolf-Gero Lange[1] · Maartje Luijten[1] · Yvonne H. M. van den Berg[1] · Sabine E. M. J. Stoltz[1] · Antonius H. N. Cillessen[1] · Eni S. Becker[1]

Accepted: 5 April 2022 / Published online: 13 May 2022

Abstract

Background Cognitive biases are found to play a role in the onset and maintenance of social anxiety. However, particularly in adolescence, the link between different biases and their role in predicting social anxiety is far from clear. This study therefore investigated the interplay between attention bias and interpretation bias in relation to social anxiety in adolescence across three years.

Methods 816 adolescents in grade 7 to 9 participated at three yearly waves (52.8% boys, $M_{\text{age grade7}} = 12.60$). Social anxiety was measured with a self-report questionnaire. Attention bias was measured with a visual search task with emotional faces. Textual vignettes assessed interpretation bias.

Results Cross-lagged models showed that negative interpretation bias at grade 7 predicted an increase in social anxiety at grade 8. This effect was not found from grade 8 to 9. Attention bias did not predict social anxiety. Attention bias and interpretation bias were not longitudinally related to each other, nor did they interact with each other in predicting social anxiety.

Conclusions Thus, no evidence was found for the Combined Cognitive Bias Hypothesis in social anxiety in adolescents. Instead, our results suggest that interpretation bias rather than attention bias contributes to the increase of social anxiety over time.

Keywords Social anxiety · Attention bias · Interpretation bias · Longitudinal · Adolescence

The Longitudinal Interplay Between Attention Bias and Interpretation Bias in Social Anxiety in Adolescents

Social anxiety involves the fear to be negatively evaluated by others, and is often accompanied by the avoidance of social situations (American Psychiatric Association, 2013). Social anxiety has its onset in childhood (Beesdo et al., 2011), but symptoms increase during adolescence with a prevalence of 5–16% (Mesa et al., 2011). Youth with social anxiety experience severe consequences such as the increased risk of peer victimization (Erath et al., 2007), depression, and substance use (Beesdo et al., 2007). Early detection and treatment are therefore warranted, highlighting the necessity of research on factors contributing to the onset and maintenance of social anxiety.

Many cognitive models assume that biased cognitive processing is such a contributing factor (e.g., Beck et al., 2005; Wong & Rapee, 2016). Specifically, negative attention bias (i.e., the attentional preference for negative stimuli) and negative interpretation bias (i.e., the tendency to negatively interpret ambiguous social situations) increase the risk of experiencing social anxiety symptoms in children and adolescents (Dudeney et al., 2015; Stuijfzand et al., 2018). Most studies in children and adolescents so far have been cross-sectional (e.g., Rozenman et al., 2014; Seefeldt et al., 2014; Vassilopoulos et al., 2009; Waters et al., 2011), making it difficult to draw conclusions about the long-term predictive impact of biases on social anxiety. Exceptions are made for two longitudinal studies. One of these studies showed that adolescents with a negative interpretation style are at higher risk for belonging to a high social anxiety trajectory (Miers et al., 2013). The other study provided evidence that social anxiety was able to predict negative interpretation bias two

✉ Lisan A. Henricks
lisan.henricks@ru.nl

[1] Behavioural Science Institute, Radboud University, PO Box 9104, 6500 HE Nijmegen, The Netherlands

years later. However, interpretation bias could not explain the pathway between shyness and social anxiety over time (Blöte et al., 2019). Longitudinal evidence about the role of attention bias is still lacking. At the same time, most studies in youth investigated the effect of either one of the biases on social anxiety (e.g., Bögels & Zigterman 2000; Miers et al., 2008; Salum et al., 2013), hereby ignoring the fact that biases may be interrelated or interact with each other (Hirsch et al., 2006). To overcome these limitations, the current study focuses on the interplay between attention bias and interpretation bias, and examines the longitudinal predictive ability of cognitive biases on social anxiety across three years in adolescence.

Attention Bias, Interpretation Bias, and Social Anxiety

Both attention and interpretation biases may play a role in the existence and development of social anxiety in adolescence. Following the theory of (Piaget, 1971), adolescence in particular, may be a critical period of time for the development of cognitive biases, as a result of socio-cognitive maturation. Adolescents become able to think and reason in an abstract way, and develop metacognitive beliefs (i.e., the ability to reflect on our own thoughts and behaviours; Weil et al., 2013). This cognitive maturation may result in heightened self-consciousness and concerns about self-presentation, and the development of cognitive biases (Rapee & Spence, 2004; Westenberg et al., 2004).

Attention bias is a complex phenomenon consisting of multiple components. On the one hand, it is characterized by an enhanced engagement to threat as (socially) fearful individuals are faster to detect negative stimuli in the environment. On the other hand, it encompasses the delayed disengagement from threat, which is described as the difficulty to withdraw one's attention from negative cues (Blicher et al., 2020). Most studies on attention bias in anxious youth focus on one specific attention bias component (e.g., enhanced engagement to threat; Shechner et al., 2013) or use a task which is not able to distinguish between the different attention bias components (e.g., the dot-probe task; Clarke et al., 2013). In this study, we aimed to examine both attention bias components by using a visual search task instead in which participants in different trials either have to detect or ignore a social threat. As such, we could investigate whether attention biases in social anxiety are associated with biases in engagement or disengagement (Donnelly et al., 2010).

Despite the theoretical frameworks and the fact that adult studies continuously found evidence for the role of engagement and disengagement attention biases in social anxiety (Liang et al., 2017), the role of attention bias and its specific components in youth is less clear. A review paper showed that some studies failed to detect a link between attention bias and anxiety in children, including social anxiety (Dudeney et al., 2015; Puliafico & Kendall, 2006), but others showed that socially anxious youth are faster at detecting threatening stimuli such as negative emotional faces (Roy et al., 2008; Schmidtendorf et al., 2018; Seefeldt et al., 2014; Waters et al., 2011). Meta-analyses comparing attention bias in youth and adults are also inconclusive: one found attention bias to be similar across different age groups (Bar-Haim et al., 2007), while another concluded that anxious children show attention bias to a lesser degree than adults (Dudeney et al., 2015). Actually, in line with the idea of socio-cognitive maturation (Piaget, 1971), the association between attention bias and anxiety increased with increasing age in children, with adolescence being a critical period for a possible persisting role of attention bias (Dudeney et al., 2015).

Contrary to attention bias, there is ample evidence for the role of interpretation bias in social anxiety. Recent meta-analyses for adults (Chen et al., 2020), as well as children and adolescents (Stuijfzand et al., 2018), concluded that a negative interpretation bias was related to an increased risk of experiencing anxiety symptoms, including social anxiety. Furthermore, socially anxious children and adolescents were more likely to interpret social situations in a threatening manner than non-anxious individuals (Miers et al., 2008; Rozenman et al., 2014). Similar to the findings of attention bias, and in line with the theory of Piaget (1971), the link between interpretation bias and anxiety also seems to increase in strength from childhood to adolescence (Stuijfzand et al., 2018). This highlights the importance of focusing on cognitive biases during adolescence.

Studies regarding cognitive biases in social anxiety varied on whether the sample was unselected (i.e. a community sample), highly trait anxious, or clinically diagnosed with social anxiety disorder. Different meta-analyses on attention bias and interpretation bias in adults, children, and adolescents found that the variation among effect sizes of different studies were not accounted for by the level of social anxiety symptoms as a sample characteristic (Bar-Haim et al., 2007; Chen et al., 2020; Stuijfzand et al., 2018). In other words, the strength of the link of attention bias and interpretation bias with social anxiety was similar for non-clinically as well as clinically anxious individuals. Cognitive biases were comparable across different types of anxious populations. In our study, we focus specifically on a community sample of adolescents to be able to investigate the relative contribution of attention bias and interpretation bias in the development of social anxiety symptoms.

Combined Cognitive Bias Hypothesis

Attention bias and interpretation bias are often studied as two separate constructs, having their own independent impact on social anxiety. However, the Combined Cognitive Bias Hypothesis (Hirsch et al., 2006) assumes that biases do not operate in isolation. The idea of the CCBH comes from Neisser (1967) who suggested that cognitive processes are cyclical, thus mutually reinforcing each other. Instead of acting alone, attention bias and interpretation bias are expected to be interrelated and influencing each other. Different biases may interact in such a way that the combination of attention bias and interpretation bias is expected to have a greater impact on social anxiety than individual cognitive biases alone.

However, most studies in youth so far, investigated the effects of different biases separately (Vassilopoulos & Banerjee, 2008; Waters, Mogg, et al., 2008). Even if attention bias and interpretation bias were investigated simultaneously, the interrelation and interplay between biases were often ignored in studies on youth (Klein et al., 2018; Waters, Wharton, et al., 2008). There are two exceptions of studies showing a positive link between attention and interpretation bias in different types of youth anxiety, including social anxiety (Rozenman et al., 2014; Watts & Weems, 2006). In both studies attention bias was assessed using a dot-probe task (either with pictures of emotional faces, Rozenman et al., 2014; or with threatening words and drawings of angry faces, Watts & Weems 2006). In the study of Rozenman et al. (2014), interpretation bias was measured using a word-sentence association paradigm in which threatening/neutral words appeared, with an ambiguous sentence following the word. Adolescents were prompted to indicate whether the word and sentence were related. Watts & Weems (2006) used an ambiguous vignette task to measure interpretation bias. Although results showed a clear relationship between attention and interpretation bias, both of these studies were cross-sectional, hereby overlooking the predictive magnitude of biases on social anxiety, and did not take into account the interaction between different biases, so did not formally test all aspects of the CCBH.

In sum, while it is generally acknowledged that interpretation bias may play an important role in maintaining, if not causing, social fears, the role of attention bias in social anxiety in adolescents is less clear. At the same time, the combined role of attention bias and interpretation bias during adolescence is only scarcely investigated. The current study is set up to overcome this caveat by investigating how attention bias and interpretation bias relate to each other, and whether they individually and/or mutually predict social anxiety over the course of adolescence. Understanding the interplay between biases may also have clinical implications. While Cognitive Bias Modification (CBM) techniques are prevailing as adjunct treatments to classical psychological treatments, modifying only one bias type without addressing other underlying biases may be insufficient. This might be the reason why current CBM techniques do not unequivocally lead to successful reductions of psychological symptoms in youth (Platt et al., 2017).

Evidence regarding the effectiveness of combined CBM, in which both attention bias and interpretation bias were targeted, are mixed. One study showed that the effect of combined CBM on decreasing social anxiety in adolescents 6 months later, was only marginally significant (Sportel et al., 2013). However, there are also studies showing the utility of combined CBM. For instance, adults receiving such a combined CBM reported reduced social anxiety symptoms and this was also shown in a behavioural speech task (Beard et al., 2011). Similarly, there is some preliminary evidence for socially anxious adolescents to show reductions in social anxiety, negative social behaviour, general anxiety, and depression after receiving both an attention and interpretation training (Lisk et al., 2018). However, both of these studies did not include an active control condition (e.g., a single CBM training), limiting the interpretation of the effects. Thus, more evidence for the combined effect of different cognitive biases on social anxiety is needed to guide clinical practice whether targeting multiple biases is necessary for effective treatment.

Current study

The aim of the current study was to investigate how attention biases (both enhanced engagement and delayed disengagement) and interpretation bias predicted social anxiety symptoms during three years in adolescence. Additionally, we tested the Combined Cognitive Bias Hypothesis (Hirsch et al., 2006) by investigating how different biases are related, and whether attention biases and interpretation bias individually predict social anxiety, or whether they interact with each other. Self-esteem and loneliness were included as covariates as they have found to be related to these biases in adults and youth (Lau et al., 2021; Tran et al., 2011), and to social anxiety in youth (Maes et al., 2019; Van Tuijl et al., 2014).

First, we hypothesized that negative attention biases (enhanced engagement and delayed disengagement) and interpretation bias will each independently predict social anxiety one year later. Individuals who are faster to detect negative stimuli (i.e., enhanced engagement), or are slower to withdraw their attention from negative stimuli (i.e., delayed disengagement), or individuals with a higher

negative interpretation bias will experience higher levels of social anxiety at a later time point.

Second, regarding the CCBH, we expected that attention biases (enhanced engagement and delayed disengagement) and interpretation bias will be positively and bidirectionally related to each other. That means that individuals who are faster to detect negative stimuli (i.e., enhanced engagement) or are slower to withdraw their attention from negative stimuli (i.e., delayed disengagement) will show higher negative interpretation bias at a later time point. Vice versa, individuals with higher negative interpretation bias will have higher negative attention biases at a later time point (they experience enhanced engagement to or delayed disengagement from negative stimuli).

Third, we expected attention biases (enhanced engagement and delayed disengagement) and interpretation bias to positively interact with each other when predicting social anxiety over the course of adolescence. Thus, the combined effect of attention biases and interpretation bias on social anxiety is expected to be larger than if biases act alone.

Method

Sample

This study is part of the Kandinsky Longitudinal Study (KLS), an ongoing longitudinal study with yearly assessments in secondary schools in the Netherlands since 2010. The KLS investigates social and emotional functioning of adolescents from grades 7 to grade 10 at a secondary school in the Southeast area of the Netherlands (i.e., first through fourth year of secondary education in the Netherlands). For this study, we use data from the waves in 2017, 2018, and 2019 as these were the waves in which data on the variables of interest were collected.

In total, 916 adolescents participated. We selected participants who participated in at least one of the waves. Data from students in Grade 10 were excluded, because this concerns a subsample of students with a higher educational level, limiting the generalizability to a larger sample. There were 23 participants who repeated a grade. For them, we removed data from the duplicate grade onwards. This resulted in removing two participants completely, as they were absent during the non-duplicate years and had no data left for grade 7, 8 or 9.

Our final sample consisted of 816 participants (52.8% boys). In grade 7, participants were between 11.49 and 14.18 years old ($M = 12.60$; $SD = 0.42$). Information on ethnicity was only collected in 2017, so is present for 474 participants (58.1%). The majority was born in the Netherlands (96.4%) or had parents who were born in the Netherlands (88.2–90.9%). Different educational levels were represented in the sample in grade 7: pre-vocational/pre-college (29.2%), pre-college/pre-university (37.5%), and pre-university (33.3%).

Participants in our sample could be divided into four different cohorts, dependent upon which year they entered high school (see Appendix, Table A). The first cohort consisted of adolescents who entered high school in 2017 and were followed across three years (n $\text{cohort}_{2017-2019} = 259$). The second cohort were adolescents who were already in Grade 8 in 2017 and were also assessed when they were in Grade 9 one year later, thus were followed for two years (n $\text{cohort}_{2017-2018} = 242$). The third cohort consisted of adolescents who entered high school in 2018 and were in Grade 8 in 2019, thus were followed for two years (n $\text{cohort}_{2018-2019} = 176$). The fourth cohort consisted of adolescents who entered high school in 2019 and were thus only participating one year (n $\text{cohort}_{2019} = 139$). These cohorts did not

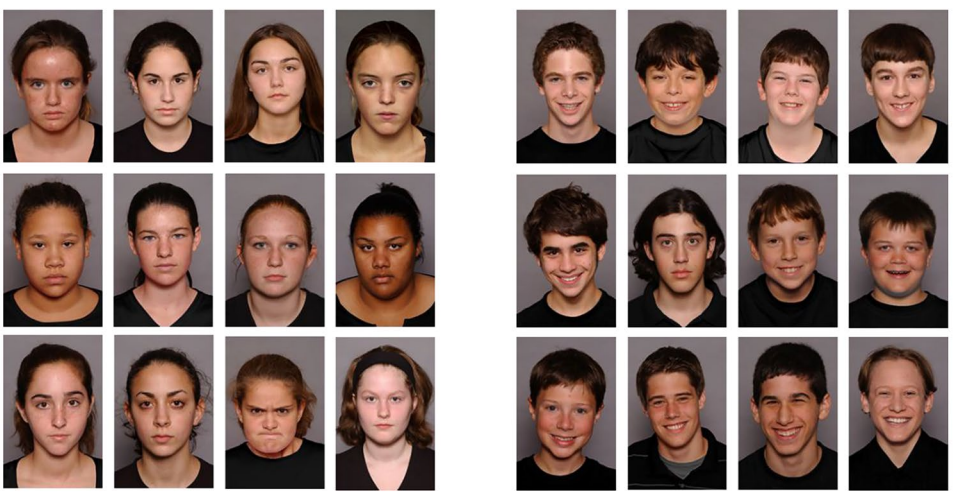

Fig. 1 Example Trials of the Attention Bias Visual Search Task with an Angry in Neutral Female Grid (Left) and a Neutral in Happy Male Grid (Right)

significantly differ from each other in gender, age, educational level, ethnicity, attention biases, self-esteem or loneliness in all grades ($ps > 0.05$). However, there were some mean level differences between cohorts in interpretation bias and social anxiety levels in grade 7, $ps < 0.05$ (but not in grade 8 or 9). Yet more importantly, the associations between variables did not significantly differ between the cohorts (Fisher's r-to-z transformations with $p < .001$ as cut-off due to the many comparisons). Therefore, the four cohorts were treated as one sample of 816 adolescents followed from grade 7 to grade 9 (irrespective of the year in which data were collected)[1].

Measures

Attention biases

We created a visual search task with pictures of emotional adolescent faces, similar to the task of De Voogd et al. (2014). These faces were unfamiliar to the participants, but represented youth of similar age. Both male and female faces were used, but these were shown in separate matrices. A matrix consisted of a 4×3 grid of faces presented on a screen (see Fig. 1). All faces either had a happy, angry or neutral expression, except for one (e.g., one face was looking happy, while the rest showed a neutral expression). This is called the odd-one-out paradigm.

The faces were adapted from the National Institute of Mental Health Child Emotional Faces Picture Set (NIMH-ChEFS; Egger et al., 2011). All pictures were resized so the matrix fit on the screen. The colour of the outfits of the actors was made black in Adobe Photoshop, to ensure that each picture had similar colour features. Two sets of pictures were selected: one for the practice trials and one for the actual task. Both sets consisted of pictures of 12 male and 12 female actors. For each actor we had a picture of a happy, angry, and neutral facial expression. All faces were randomly selected and positioned in the grid for each trial.

There were eight different types of trials, in which one matrix of faces was shown: happy in neutral, neutral in happy, angry in neutral, and neutral in angry, all separately for male and female faces. Each type of trial occurred six times, resulting in a total of 48 trials. These 48 trials were divided into two consecutive blocks (24 trials per block), with each trial type occurring three times per block. Participants started with eight practice trials, one for each trial type. During the practice trials, feedback was provided if the response was incorrect and the same trial was then repeated. Correct responses were thus required before participants could continue. After the practice trials, the actual trials started. Participants had to detect the emotional face in a neutral grid or the neutral face in an emotional grid as fast as possible, by clicking on the face which had a different expression than the others. The matrix was presented until the participant responded, followed by a new trial. Per trial we measured whether the trial was correct (i.e., the participant clicked on the face which was the odd-one-out) and the latency in milliseconds that it took to click on the face.

We cleaned the reaction time data in a similar way as De Voogd et al. (2014). First, we filtered out all incorrect trials (4.27% of the trials in grade 7, 4.65% in grade 8, and 1.99% in grade 9). Second, we removed all reaction time data of participants who had more than 20% of the trials incorrect (3.68% of the participants in grade 7, 5.15% in grade 8, and 1.72% in grade 9). Third, we removed all fast outlier data: correct trials with a reaction time lower than 200 milliseconds (0.01% of the trials in grade 7, 0.01% in grade 8, 0.01% in grade 9). Finally, we removed slow outliers, which are correct trials with a latency of two standard deviations or higher than the mean latency of correct trials for their grade (7.97% of the trials in grade 7, 8.68% in grade 8, 5.54% in grade 9).

After cleaning the data, we computed the mean latency of the happy-in-neutral trials, the angry-in-neutral trials, the neutral-in-happy trials, and the neutral-in-angry trials, separately for the two consecutive blocks and for the trials with female versus male faces. Pearson correlations between the different blocks ranged across grades between $r = .40$-0.54. The correlations between male and female trials ranged between $r = 0.44$-0.66 across grades. We combined the scores for both blocks[2] and for the male/female trials[3].

This resulted in four different mean latency scores: one for the happy-in-neutral trials, one for the angry-in-neutral trials, one for the neutral-in-happy trials, and one for the neutral-in-angry trials. A difference score of the mean latency of the angry-in-neutral trials minus the happy-in-neutral trials was used as an indication of attention bias engagement. Delayed disengagement from threat was computed as the difference score of the mean latency of the neutral-in-happy trials minus the neutral-in-angry trials. We standardized both difference scores. Higher positive scores

[1] Differently than stated in the pre-registration, we did not explore whether the longitudinal model differently applied to the four cohorts, because we found no cohort differences in the associations between variables.

[2] Exploratory analyses using Wald tests with $p < .001$ showed that our models similarly apply if only trials from the first or second block were taken into account.

[3] We explored whether the models similarly applied if only male or female trials were included using Wald tests with $p < .001$ while controlling for participants' own gender. Results were comparable, but there was one difference. Attention bias engagement in grade 7 predicted attention bias engagement in grade 8 more strongly for the female trials than the male trials. This difference was both present for boys and girls.

on these indices represent higher positive biases, higher negative scores higher negative biases, and scores around zero indicate that an adolescent has no attention engagement or disengagement preference.

Interpretation bias

Seven textual vignettes describing social ambiguous scenarios were used to asses interpretation bias. Each scenario was accompanied by a positive, negative, and neutral interpretation of the scenario. Adolescents rated for each interpretation type how likely they found this interpretation matching the scenario on a 6-point Likert-scale (1 = *'absolutely not'* to 6 = *'absolutely'*). An example is: *'Two classmates talking to each other are looking at you. Why are they looking at you?'* with the following interpretations: *'They tell something nice about me'* (positive), *'They are gossiping about me'* (negative), and *'They happen to be looking in my direction'* (neutral). Three vignettes were adopted from the Adolescents Interpretation and Belief Questionnaire (Miers et al., 2008), one is from the Interpretation and Judgmental Questionnaire (IJQ; Voncken et al., 2003), one is from an interpretation bias task developed by Mobach et al. (2019), and the remaining two vignettes were developed by the authors of the present study. Previous studies consistently detected interpretation bias in individuals with social fears using such verbal vignette tasks (Stuijfzand et al., 2018), providing evidence for its adequate psychometric properties. By only including vignettes describing socially ambiguous scenarios, the task was ecologically valid for socially anxious adolescents.

The inter-item reliability was acceptable (Field, 2009), with Cronbach's $\alpha = 0.66$-0.71 for positive interpretations across grades, and $\alpha = 0.72$ for negative interpretations in all grades. To get an indication of interpretation bias, we calculated a difference score between the total score of the positive minus the total score of the negative interpretations. Next, we standardized this difference score. A positive score on this index represents a higher positive bias, a negative score a higher negative bias, and a difference score of around zero indicates that an adolescent has no preference for a certain interpretation type. The neutral interpretations were not used for this calculation as they merely functioned as filler items to ensure that participants were not forced into a higher positive or negative interpretation bias.

Social anxiety

The Dutch version of the Social Anxiety Scale for Adolescents (SAS-A; La Greca & Lopez 1998) was used to assess adolescents' social anxiety levels. This questionnaire consists of 18 items. Participants indicated for each item how much it describes themselves via a 5-point scale ranging from 1 = *'never'* to 5 = *'always'*. An example item is *'I worry about what others think of me'*. In our study, inter-item reliability of this questionnaire was good (Field, 2009), with Cronbach's $\alpha = 0.91$-0.92 across grades. We calculated a total score by summing all items and subsequently standardized this score. A higher score indicates higher levels of social anxiety.

Self-esteem

The Rosenberg Self-Esteem Scale (RSES; Rosenberg 1965) assessed self-esteem (included as a covariate in the analyses). This scale consists of 10 items which had to be answered on a 4-point scale ranging from 1 = *'strongly disagree'* to 4 = *'strongly agree'*. An example item is *'In general, I am satisfied with myself'*. We reverse coded half of the items before calculating a total score by summing all items. Next, we standardized this total score, with higher score indicating higher levels of self-esteem. In our study, inter-item reliability of this questionnaire was good (Field, 2009), with Cronbach's $\alpha = 0.83$-0.89 across grades.

Loneliness

The subscale peer-related loneliness of the Loneliness and Aloneness Scale for Children and Adolescents (LACA; Maes et al., 2015) was used to measure loneliness (included as a covariate in the analyses). This subscale contains 12 items which had to be answered on a 4-point scale ranging from 1 = *'never'* to 4 = *'often'*. An example item is: *'I find that I have fewer friends than others'*. We computed a total score by summing all items and subsequently standardizing the score. A higher score indicates higher levels of loneliness. In our study inter-item reliability was good (Field, 2009), with Cronbach's $\alpha = 0.88$-0.89 across grades.

Procedure

The research questions, hypotheses, and analytic strategy of this study are pre-registered (see: https://osf.io/xq25b/). Each year, the school director requested the research and claimed responsibility for the parental consent procedure. In 2017 and 2018 passive parental consent was obtained by the school. In 2019 the consent procedure changed and parents gave active consent. Adolescent gave assent to the study at the start of the assessment each year. Both procedures have been approved by the Institutional Review Board of the Faculty of Social Sciences of Radboud University (approval code for 2018 and earlier waves: ECG2012-2505-038; approval code for 2019 and later waves: ECSW-2018-086).

Data collection took place at school, within a 45 to 60-minute classroom session. Adolescents completed different self-report questionnaires, peer-nomination items (not relevant for the current study), the interpretation bias vignettes, and the attention bias paradigm on individual computers. At least two researchers were present during the assessment in the classroom. Prior to assessment, one researcher explained the goal and set-up of the study. Participants were explained that the data would be processed anonymously and handled confidentially. Adolescents were asked to keep their answers to themselves and to be truthful in answering all questions.

During the data collection, adolescents sat at a private desk with partitioning screens. They were not allowed to talk to each other during the assessment, but could ask questions to the researchers. They could stop at any given moment. Each year, all participants received a small present and several tablets were raffled.

Missing Data

In total, 38.7% of the data was missing. This incomplete data were due to three different types of missing data in our sample. First, there were person-level missings, participants who are missing for an entire grade. This was because they did not enter high school in 2017 and thus had not data available at all grades (i.e., three of the four cohorts consisted of those participants, $n = 557$), shifted to another school ($n = 54$), were ill at the day of the assessment ($n = 81$), did not receive consent or give assent in a certain grade ($n = 138$), or their data for a grade were removed by us because they duplicated a grade ($n = 21$). Second, there were construct-level missing data, meaning that there is no data for an entire construct at a wave. Participants were present, but did not complete the measures within the one-hour classroom session ($n = 83$), or, with regards to attention bias, because they had more than 20% incorrect trials and their data were removed from further analyses ($n = 86$). Third, and finally, there were item-level missings with some items of a variable being completed, but others not. Item-level missing was only present for attention bias data and occurred by us removing data of the incorrect trials and outliers. In total 11.04% of the attention bias values were missing.

Attrition analyses using Bonferroni corrections showed that participants with or without missing data did not significantly differ from each other in gender, age, educational level, ethnicity, attention biases, interpretation bias, social anxiety, self-esteem or loneliness in all grades ($ps > 0.05$). Little's MCAR test showed that the normed χ^2 ratio was 1.35 and thus seen as acceptable (i.e. < 3; Ulman, 2013). The different missing types were handled according to the guidelines of Newman (2014). For item-level missing, we used the available items to compute a mean score for this construct. For construct-level and person-level missing, we automatically replaced the missing data with the full information maximum likelihood (FIML) estimator in Mplus, version 8.6.

Results[4]

Preliminary analyses

Descriptive statistics of attention biases (enhanced engagement and delayed disengagement), interpretation bias, social anxiety, self-esteem, and loneliness in grade 7, 8, and 9 are shown in Table 1[5]. The mean social anxiety level in the sample was relatively low, with only 10.8–14.7% of individuals across grades experiencing clinical levels of social

Table 1 Means and Standard Deviations of Attention bias, Interpretation Bias, Social Anxiety, Self-Esteem, and Loneliness per Grade

	Grade 7			Grade 8			Grade 9		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
AB engagement	519	938.26	1119.31	568	847.18	1181.68	355	875.99	975.75
AB disengagement	519	-1286.61	1257.70	568	-1233.52	1191.47	355	-1182.29	1029.15
Interpretation bias	552	5.49	9.07	611	5.41	9.21	368	5.25	8.65
Social anxiety	552	35.23	10.79	610	35.21	11.06	368	36.57	10.94
Self-esteem	552	32.09	4.58	610	32.16	4.96	368	31.95	5.16
Loneliness	551	16.66	5.17	610	16.49	5.28	368	16.65	5.11

Note. AB = attention bias; Sample size differs per variable and per grade due to missing data.

[4] All analyses described in the results section included the difference score of interpretation bias (the total score of the positive minus the total score of the negative interpretations). We also re-ran all analyses with the raw negative interpretations scores instead. These results were almost similar as the analyses with the interpretation difference scores (with the exception of negative interpretations in grade 7 being no longer a significant predictor of social anxiety in grade 8). The findings of these exploratory analyses can be found in table C, part D, and figure E of the appendix

[5] Table B in the Appendix also presents the descriptive statistics of the raw positive, negative and neutral interpretation scores.

anxiety (scores of 50 or higher as described by La Greca & Lopez 1998)[6]. On average, adolescents had the tendency to engage faster to positive than to negative stimuli (represented by the positive mean scores in all grades), but experienced difficulty disengaging from threat (represented by the negative mean scores in all grades). Moreover, as seen by the positive mean scores for interpretation bias, adolescents were in general more likely to interpret social situations in a positive manner. However, the relatively high standard deviations indicated that individual differences in attention biases and interpretation bias were large.

Pearson's correlation analyses between all variables at all three grades were conducted to see how the variables related to each other over the course of adolescence (see Table 2). Attention bias engagement levels only correlated weakly between grade 7 and 9, but were not linked at the other grades. A weak correlation was found between attention bias disengagement in grade 7 and 8; and in grade 8 and 9, but levels in grade 7 and 9 did not correlate significantly. Interpretation bias, social anxiety, self-esteem, and loneliness were moderately to highly stable across grades.

The different attention bias components correlated negatively but weakly with each other within and across all grades, with the exception for the link between engagement at grade 7 and disengagement at grade 9 for which the correlation was positive. Different than expected, in general, higher enhanced engagement to threat was thus related to less difficulty with disengaging from threat. Attention bias engagement and disengagement were not related to interpretation bias, social anxiety, self-esteem or loneliness within or across any of the grades with two exceptions: (1) more difficulty with disengaging from threat in grade 8 was related to a higher positive interpretation bias in grade 9; and (2) a higher positive interpretation bias in grade 7 was related to more difficulty with disengaging from threat in grade 9. These directions were different than what was expected, but both of these correlations were weak.

Social anxiety, interpretation bias, self-esteem, and loneliness significantly correlated within and across waves with each other, but the strengths of the correlations varied from weak to strong. Higher levels of social anxiety were related to higher negative interpretation bias and loneliness, and to lower self-esteem. Higher negative interpretation bias was linked to higher loneliness and lower self-esteem. Finally, higher loneliness related to lower self-esteem.

	Grade 7						Grade 8						Grade 9					
	1.	2.	3.	4.	5.	6.	1.	2.	3.	4.	5.	6.	1.	2.	3.	4.	5.	6.
Grade 7																		
1. AB eng.	--	-.23*	.00	-.06	.02	-.07	.05	-.12*	-.00	.02	.07	.05	.20*	.20*	-.00	-.06	.03	-.02
2. AB diseng.		--	-.08	-.01	-.08	.01	-.20*	.14*	-.00	-.04	-.04	.02	-.20*	.11	.02	.15	.02	.16
3. Int. bias			--	-.45*	.44*	-.41*	-.01	-.03	.60*	-.35*	.27*	-.24*	-.03	-.17*	.63*	-.28*	.21*	-.22*
4. Social anx.				--	-.54*	.73*	-.04	.03	-.38*	.65*	-.40*	.54*	-.09	.10	-.39*	.48*	-.31*	.37*
5. Self-esteem					--	-.51*	.02	-.05	.37*	-.53*	.66*	-.44*	-.04	-.15	.33*	-.37*	.55*	-.30*
6. Loneliness						--	-.07	.03	-.35*	.51*	-.35*	.63*	.03	.12	-.32*	.42*	-.30*	.43*
Grade 8																		
1. AB eng.							--	-.23*	.01	-.02	.06	-.00	.11	-.11*	.06	-.04	.04	.00
2. AB diseng.								--	-.05	.02	-.02	.03	-.15*	.24*	-.13*	.07	-.04	.05
3. Int. bias									--	-.48*	.41*	-.41*	.02	-.03	.63*	-.41*	.33*	-.27*
4. Social anx.										--	-.56*	.69*	-.03	-.00	-.44*	.69*	-.45*	.45*
5. Self-esteem											--	-.49*	.02	.04	.38*	-.48*	.70*	-.35*
6. Loneliness												--	-.05	.02	-.36*	.60*	-.41*	.59*
Grade 9																		
1. AB eng.													--	-.20*	.05	-.01	-.02	-.03
2. AB diseng.														--	-.06	-.04	-.07	-.10
3. Int. bias															--	-.50*	.45*	-.40*
4. Social anx.																--	-.57*	.71*
5. Self-esteem																	--	-.46*
6. Loneliness																		--

Note. AB eng. = attention bias engagement; AB diseng. = attention bias disengagement; Int. bias = interpretation bias; Social anx. = social anxiety.
Sample size differs per correlation due to missing data.
* Significant correlation, $p < .05$.
$r = .10$ was considered as a weak, $r = .30$ as a moderate, and $r = .50$ as a strong effect (Cohen, 1988).

Table 2 Pearson's Correlations Between Attention Bias, Interpretation Bias, Social Anxiety, Self-Esteem, and Loneliness for Grade 7, Grade 8, Grade 9 (white), and Across Waves (grey) including Autocorrelations (black)

[6] When using a cut-off of 44 or higher as described by Olivares et al. (2002) 20.1–25.8% of individuals across grades experienced clinical levels of social anxiety.

Main Longitudinal Analyses

Model construction

There were no major violations of the assumptions for linear regression analyses (see pre-registration for more information). We computed cross-lagged panel models in Mplus version 8.6 (Muthén & Muthén, n.d.). Three models were tested to investigate the direct effects of attention biases (enhanced engagement and delayed disengagement), and interpretation bias on social anxiety (Model 1), the link between attention biases and interpretation bias over time (Model 2), and the interaction effect of attention biases and interpretation bias on social anxiety (Model 3). In all models, autoregressive paths of attention biases, interpretation bias, and social anxiety from grade 7 to 8, and from grade 8 to 9 were modelled to control for stability of the variables. Within-grade correlations between all variables in each grade were modelled. In all models, self-esteem and loneliness were added as covariates (i.e., autoregressive paths of the covariates and within-grade correlations between the covariates and all other variables in all grades were modelled). Model 1 included the direct effects from attention biases (enhanced engagement and delayed disengagement) and interpretation bias in grade 7 to social anxiety in grade 8, and from biases in grade 8 to social anxiety in grade 9. Model 2 included in addition the cross-lagged paths between attention biases and interpretation bias. Model 3 included the same paths as Model 2, but also included the interaction terms between attention biases and interpretation bias to social anxiety. We computed interaction terms of the standardized bias difference scores of attention bias and interpretation bias by multiplying them with each other. We did this separately for attention bias enhanced engagement and delayed disengagement.

Good model fit was concluded if the chi-square test was non-significant, $p > .05$, CFI > 0.95, RMSEA < 0.06, and SRMR < 0.08 (Hu & Bentler, 1999). As the chi-square test is very sensitive for sample size, the main conclusions about the model fit were drawn upon the other fit criteria. Lower Akaike Information Criterion (AIC) values indicated a better fit. Changes in fit between the three models were examined using a chi-square difference test and evaluated as substantial if ΔCFI ≥ -0.010, ΔRMSEA ≥ 0.015, and ΔSRMR ≥ 0.010 (Chen, 2007).

Direct effects of attention biases and interpretation bias on social anxiety

Model 1 had an appropriate model fit according to most fit indices except the chi-square, $\chi^2(90) = 221.98$, $p < .001$, RMSEA = 0.04, CFI = 0.95, SRMR = 0.08, AIC = 22382.03. Autoregressive effects for social anxiety, interpretation bias, self-esteem, and loneliness indicated moderate to high stability across grades (ranging between $\beta = 0.48$-0.64). Attention bias disengagement was weakly to moderately stable over time ($\beta = 0.12$-0.22), while autoregressive effects for attention bias engagement were all non-significant.

Interpretation bias in grade 7 negatively predicted the level of social anxiety symptoms in grade 8 ($\beta = -0.08$). This effect was only weak, but indicated that adolescents with a higher negative interpretation bias experienced increased social anxiety one year later. However, this effect was not found from interpretation bias in grade 8 to social anxiety in grade 9 ($\beta = -0.06$, $p = .08$). None of the attention bias parameters predicted social anxiety over time. Within-grade correlations are not interpreted, for that we would like to refer to the findings of the Pearson correlations.

Associations among attention biases and interpretation bias

Model 2 encompassing the direct effects between different biases had a comparable fit to Model 1, $\chi^2(82) = 217.16$, $p < .001$, RMSEA = 0.05, CFI = 0.95, SRMR = 0.08, AIC = 22393.21. Including the direct effects between attention biases and interpretation bias did not lead to a significant or substantial improvement in model fit compared to Model 1, $\Delta\chi^2(8) = 4.82$, $p = .777$, ΔCFI = 0.001, ΔRMSEA = −0.003, ΔSRMR = 0.001, and ΔAIC = 11.19. Attention bias engagement and disengagement did not predict interpretation bias levels, nor did interpretation bias predict attention biases over time.

Interaction effect attention biases and interpretation bias on social anxiety

When adding the interaction terms between attention biases and interpretation bias in Model 3, the model fit remained comparable to the first and second model, $\chi^2(126) = 309.79$, $p < .001$, RMSEA = 0.04, CFI = 0.93, SRMR = 0.07, and AIC = 28805.56. The model fit was significantly and substantially (according to CFI) worse than Model 1 ($\Delta\chi^2(36) = 87.81$, $p < .001$, ΔCFI = −0.019, ΔRMSEA = 0.000, ΔSRMR = −0.009, and ΔAIC = 6423.53) and Model 2 ($\Delta\chi^2(44) = 92.62$, $p < .001$, ΔCFI = −0.018, ΔRMSEA = −0.003, ΔSRMR = −0.008, and ΔAIC = 6412.345). All four interaction effects were non-significant, indicating that attention biases and interpretation bias did not mutually predict social anxiety over time.

To summarize, Models 2 and 3 did not significantly improve the model fit, nor were these paths significant. Therefore, Model 1 functioned as our final model (see Fig. 2).

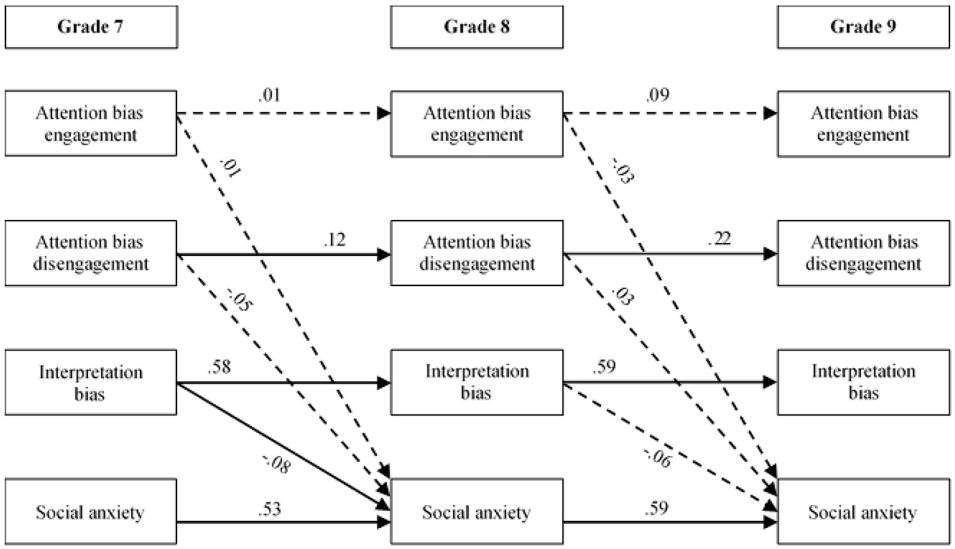

Fig. 2 Graphic Representation of Model 1 (Final Model) with its Standardized Regression Estimates (Beta Coefficients).Note: Dashed paths represent non-significant paths; solid paths represent significant paths, $p < .05$. $\beta < 0.20$ was considered as weak, $\beta = 0.20\text{-}0.50$ as moderate, and $\beta > 0.50$ as strong effects (Acock, 2014). For clarity of presentation, concurrent correlations between the variables, and the covariate paths with self-esteem and loneliness are not presented in this figure.

Discussion

In this study, we investigated how negative attention biases (enhanced engagement to threat and delayed disengagement from threat) and negative interpretation bias were related to social anxiety during three years in adolescence. Additionally, we investigated whether attention biases and interpretation bias were related to each other, and individually and/or mutually predicted social anxiety as assumed by the Combined Cognitive Bias Hypothesis (Hirsch et al., 2006). In this prospective longitudinal study, we found support for the role of negative interpretation bias in social anxiety during adolescence. However, neither one of the attention bias types were able to predict social anxiety. Moreover, no evidence was found for the CCBH, as attention biases and interpretation bias were not related and did not interact with each other in relation to social anxiety.

Individual Effects of Attention Biases and Interpretation Bias on Social anxiety

Attention biases (i.e., enhanced engagement to threat and delayed disengagement from threat) were not related to social anxiety, thereby adding to the current field of research showing mixed and inconclusive evidence for the role of attention bias in social anxiety in youth (Morren et al., 2004; Puliafico & Kendall, 2006; Roy et al., 2008; Waters et al., 2011). Interpretation bias, on the other hand, did negatively relate to social anxiety, with higher negative interpretation bias predicting an increase in social anxiety. This finding was in line with cognitive models (e.g., Beck et al., 2005; Wong & Rapee, 2016) and previous research in children and adolescents (Stuijfzand et al., 2018). The effect of interpretation bias was only present from grade 7 to grade 8, which was contrary to the suggestion that the link between interpretation bias and social anxiety actually increased with age (Stuijfzand et al., 2018). The absence of an effect from grade 8 to grade 9 could possibly be explained by the fact that adolescents stayed in the same class in grade 7 and 8, but switched classes in grade 9. Entering a new peer context involves establishing new friendships and social ties, and it calls for a new social ranking of the peer group. A new peer context could elevate social fears (as adolescents have to meet new peers which could be threatening), but could also bring positive opportunities to adolescents (e.g., if adolescents are bullied in their previous context, they could form more positive peer relationships in the new context). These social contextual changes may have complicated our findings as it is unsure how the new peer context impacts the relationship between interpretation bias and social anxiety.

The different effects of attention bias versus interpretation bias in relation to social anxiety may also have something to do with the different conceptualization of attention and interpretation biases, and the developmental time frame under investigation. While interpretation bias is found to be a stable trait-like characteristic (Creswell & O'Connor, 2011), researchers argue that attention biases are fluctuating over time (which was also confirmed by our results), being highly context-dependent, and could be better understood as state processes (Zvielli et al., 2015). Indeed, a previous study showed that stressful situations may alter attention biases (Bar-Haim et al., 2010), and in fact, attention biases for threat were already unstable across 7 days (Li et al., 2008). Perhaps, the yearly time interval of the current study was thus too large to find effects of attention biases related to social anxiety. Future research could benefit from

measurement burst designs with multiple measurement moments with short time-intervals (Sliwinski, 2008).

In our study, we used an unselected community sample. As expected, the percentage of individuals with clinically social anxiety levels was rather small, ranging between 10.8% and 14.7% across grades (scores of 50 or higher as described by La Greca & Lopez 1998). Re-examining the descriptive statistics for this subsample of clinically anxious adolescents showed that this subgroup had the tendency to negatively interpret situations compared to non-anxious adolescents who showed a positive interpretation bias. However, the attention bias patterns were similar for the entire normative sample compared to the socially anxious subgroup. This suggests that maybe a negative attention bias does not exist for these individuals at all, or that the sample size of this subgroup was too small to find a negative attention bias. To conclude, our results suggest that attention bias does not play an important role in explaining individual differences in social anxiety in a normative sample of adolescents, while interpretation bias did. Replicating this study in a large (sub-)clinical sample of socially anxious adolescents could help to investigate the generalization of findings from analogue samples such as in our study (Chen et al., 2020), and to formally test whether the Combined Cognitive Bias Hypothesis does apply differently to individuals with heightened social fears.

The lack of findings with regards to attention bias in social anxiety could be because of certain other methodological factors. For instance, there is much doubt regarding the adequacy of the psychometric properties of reaction-time based paradigms for measuring attention bias in children (e.g., Brown et al., 2014; Wermes et al., 2017). In contrast, some studies provided evidence that the visual search task was successful for detecting attentional threat biases in youth, and actually better in doing so than other measures of attention bias such as the dot-probe task (de Voogd et al., 2016). Not only the visual search task in itself raises questions, but there is also some discussion about the type of stimuli used in this task. Some argue that especially angry facial expressions may be ecologically valid threat stimuli for adolescents with social anxiety, as it reflects the fear of rejection (Rinck & Becker, 2005). However, others suggested that it would also be interesting to investigate attention to different negative emotional expressions, such as disgust, as that may convey the desire to avoid or reject (Buckner et al., 2010). Future research should formally test the reliability and validity of the task and stimuli.

In our study, the visual search task seemed to be unreliable, seen by the high standard deviations and the weak or non-significant correlations between the attention bias variables across and within grades. This unreliability could be due to two competing explanations. On the one hand, participants could have become fatigued during the attention bias task and may have not responded to the later trials in a concentrated manner. This explanation seems plausible as several adolescents complained that the task was long and repetitive, and that they were easily distracted. However, our results showed that there was no difference between data from the first and the second half of the task (in fact, scores between block 1 and 2 were moderately correlated), and previous studies with adolescents even successfully included more trials (72 compared to 48 trials in our study; De Voogd et al., 2017). On the other hand, we may have not included enough trials in our task, since a higher amount of trials increases the stability of effects. When developing a task there is an important trade-off between the amount of trials necessary to find stable effects and the feasibility of the task for participants (Price et al., 2015). Due to the fact that our data collection procedure consisted of many measures, we decided to keep the attention bias task relatively short. Future research should determine the minimum amount of trials necessary to retrieve reliable attention bias data.

Another methodological explanation comes from the suggestion that attention bias consists of many different subcomponents that unfold from moment-to-moment across time (Rodebaugh et al., 2016; Zvielli et al., 2015). A previous study only found a negative attention bias in anxious individuals during the first 500 milliseconds of stimulus presentation (Gamble & Rapee, 2009). Our visual search task, in which participants were allowed to view the stimuli as long as they needed, did not allow for determining the time course of various attention bias processes. Future studies including for instance eye-tracking would be better able to determine the time frame in which these processes should occur (Armstrong & Olatunji, 2012; Roy et al., 2015), and eye-tracking was found to be a successful method for children and adolescents (In-Albon & Schneider, 2010).

Finally, the difference in the results of attention bias and interpretation bias could also be accounted for by the difference in self-relevance between both tasks. The interpretation bias task specifically instructs participants to imagine themselves being in the situation. However, the attention bias task did not induce any form of self-relevance with the task, but simply asked to detect a face. Previous findings show that negative biases are mostly triggered when faced with stress or in self-relevant situations (Vassilopoulos & Banerjee, 2012). Future research could thus examine whether different attention bias results would be found if a stress induction is used or if the self-relevance with the attention bias task is increased.

Combined Cognitive Bias Hypothesis

Finally, attention biases were not related to interpretation bias, neither directly nor in interaction when predicting social anxiety, showing no support for the Combined Cognitive Bias Hypothesis for social anxiety in adolescents (Hirsch et al., 2006). This is contrary to two previous studies showing a link between attention and interpretation biases in youth anxiety, including social anxiety (Rozenman et al., 2014; Watts & Weems, 2006), and research showing the effectiveness of combined Cognitive Bias Modification (CBM) techniques in reducing social anxiety (Beard et al., 2011; Lisk et al., 2018). There are two possible interpretations of these findings. On the one hand it could be that there is simply no support for the CCBH in adolescence. Attention bias and interpretation bias may just not be related, and rather function as two independent processes. This suggestion could theoretically be supported by neurological models arguing that automatic (i.e., attention bias) and more effortful controlled (i.e., interpretation bias) regulatory processing are managed in a partly different way by the brain (Cunningham et al., 2004). In line with this reasoning, it would then be important to study attention bias and interpretation bias as separate processes in order to understand the development of social anxiety.

On the other hand, it could also be that the different biases were not related to each other because of the methodological difficulties with measuring attention bias in particular (as extensively discussed earlier). In addition, the result that different cognitive biases were not related to each other, could also be attributed to another methodological issue, namely the different modalities used for the attention bias and interpretation bias task. Specifically, in our study, interpretation bias was measured with textual vignettes, while attention bias was assessed using pictures of emotional faces. The use of visual versus verbal stimuli may have complicated the possibility to find a relationship between these different cognitive biases, particularly because the degree of social fears was also assessed with a textual (verbal) measure. Future research should develop comparable cognitive bias tasks to assess both attention bias as well as interpretation bias, ideally in the same modality. An attempt for this has already been made, with two studies integrating attention bias paradigms in a standard textual interpretation task. Specifically, participants completed a scrambled sentence task to see whether they would complete the sentence in a positive or negative way (as an indication of interpretation bias), and tracked the time spent at the positive versus negative words (as an indication of attention bias) (Sanchez et al., 2015; Sanchez-Lopez et al., 2019). Another study also showed the utility of a pictorial task to assess interpretation bias, to ensure that the modality of the task is similar to that of classical attention bias tasks in which visual stimuli are also often used (Henricks et al., 2022). Equalizing the assessment of attention bias and interpretation bias in terms of modality also led to stronger associations between the two biases, with Pearson correlations ranging between $r = .30$ and $r = .32$, $p < .05$ (Sanchez et al., 2015), as compared to the non-significant correlations found in the present study.

Strengths, Limitations, and Future Research

This pre-registered, prospective longitudinal study was one of the first to investigate the link between different cognitive biases across three years in adolescence. Including multiple measurement moments across different years allowed for the longitudinal investigation of these cognitive processes during an age period which is critical for social cognitive development (Choudhury et al., 2006) and the rise of psychopathology, including social anxiety (Mesa et al., 2011). Another strength of the study was its relatively large sample size, allowing for well-powered statistical analyses (i.e., in our most complex model we had at least 10 observations per parameter; Kline 2015).

However, there were also some limitations to this study. As discussed extensively earlier, the reliability of the attention bias task needs further improvement. In addition, we investigated two components of attention bias: enhanced engagement to threat (in other studies referred to as early vigilance to threat) and delayed disengagement from threat, which is in line with recent attention bias frameworks (Richards et al., 2014). However, other theories suggest that after detecting threat, socially anxious individuals are characterized by the quick visual avoidance of threat (e.g., the hypervigilance-avoidance model; Mogg & Bradley 1998). It might be that this attentional avoidance is the key process in attention bias and accounts for the maintenance of social fears because it prevents the exposure, and therefore the habituation and objective evaluation of socially threatening information (Amir & Bomyea, 2010; Mogg et al., 1997). Unfortunately, the visual search task used, did not allow for this avoidance process to be captured. It is important for future research to focus on all three attention bias mechanisms to fully understand attention bias as a whole, for instance by using eye-tracking (Cisler & Koster, 2010). Third, in our study we focused specifically on adolescence as this is the age period in which stable social cognitions emerge (Lakdawalla et al., 2007). However, there are also studies supporting the existence of attention biases related to depression in 5-years old children (Kujawa et al., 2011). As recommended by Platt et al. (2017) future studies should concentrate on investigating cognitive biases across a wide developmental period to better understand the emergence

of cognitive biases, and their role in the onset and maintenance of psychopathology. Fourth and finally, another important suggestion for future research would be to examine individual differences in our conceptual model. Due to the heterogeneity among socially anxious individuals (Binelli et al., 2015), it could be that the Combined Cognitive Bias Hypothesis only applies to a specific subsample. For instance, concepts such as self-esteem or social competence could play a moderating role, as they are found to be related to cognitive biases and social anxiety (Miers et al., 2013; Tran et al., 2011; Van Tuijl et al., 2014). Other statistical analyses such as Latent Class Growth Modeling and network analyses could be more beneficial to investigate individual differences than the cross-lagged panel models used in the current study.

Conclusions

The current study showed that negative interpretation bias predicted higher levels of social anxiety one year later. Attention bias did not predict social anxiety. No support was found for the Combined Cognitive Bias Hypothesis (Hirsch et al., 2006). Attention bias and interpretation bias were not longitudinally related to each other, nor did they interact with each other in predicting social anxiety. Taking the limitations into account, our results indicate that interpretation bias rather than attention biases contribute to the increase of social anxiety over time. Future research should, apart from improving attention bias tasks for adolescents, continue to focus on the role of different cognitive processes, and how they relate and interact with each other when predicting social anxiety. This is needed to provide conclusive evidence whether or not the Combined Cognitive Bias Hypothesis does apply to adolescents, and may set important guidelines for current treatments. For instance, if our results are replicated and only interpretation bias is found to play a role in social anxiety, clinical practice should focus more on Cognitive Bias Modification techniques for interpretation (CBM-I) than for attention bias (CBM-A) or combined CBM.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10608-022-10304-1.

Funding No funding was received for conducting this study.

Declarations

Conflict of Interest The authors declare that they have no conflict of interest.

References

Acock, A. C. (2014). *A Gentle Introduction to Stata*. Stata Press

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders*. American Psychiatric Publishing

Amir, N., & Bomyea, J. (2010). Cognitive Biases in Social Anxiety Disorder. In S. G. Hofmann, & P. M. DiBartolo (Eds.), *Social Anxiety: Clinical, Developmental, and Social Perspectives* (pp. 373–393). Elsevier Ltd. (Second Edihttps://doi.org/10.1016/B978-0-12-375096-9.00014-6

Armstrong, T., & Olatunji, B. O. (2012). Eye tracking of attention in the affective disorders: A meta-analytic review and synthesis. *Clinical Psychology Review*, 32(8), 704–723. https://doi.org/10.1016/j.cpr.2012.09.004

Bar-Haim, Y., Holoshitz, Y., Eldar, S., Frenkel, T. I., Muller, D., Charney, D. S. … Wald, I. (2010). Life-threatening danger and suppression of attention bias to threat. *American Journal of Psychiatry*, 167(6), 694–698. https://doi.org/10.1176/appi.ajp.2009.09070956

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin*, 133(1), 1–24. https://doi.org/10.1037/0033-2909.133.1.1

Beard, C., Weisberg, R. B., & Amir, N. (2011). Combined cognitive bias modification treatment for social anxiety disorder: A pilot trial. *Depression and Anxiety*, 28(11), 981–988. https://doi.org/10.1002/da.20873

Beck, A. T., Emery, G., & Greenberg, R. L. (2005). *Anxiety Disorders and Phobias: A Cognitive Perspective*. Basic Books

Beesdo, K., Bittner, A., Pine, D. S., Stein, M. B., Höfler, M., Lieb, R., & Wittchen, H. U. (2007). Incidence of social anxiety disorder and the consistent risk for secondary depression in the first three decades of life. *Archives of General Psychiatry*, 64(8), 903–912. https://doi.org/10.1001/archpsyc.64.8.903

Beesdo, K., Knappe, S., & Pine, D. S. (2011). Anxiety and anxiety disorders in children and adolescents: Developmental issues and implications for DSM-V. *Psychiatric Clinics of North America*, 32(3), 483–524. https://doi.org/10.1016/j.psc.2009.06.002.Anxiety

Binelli, C., Muñiz, A., Sanches, S., Ortiz, A., Navines, R., Egmond, E. … Martín-Santos, R. (2015). New evidence of heterogeneity in social anxiety disorder: Defining two qualitatively different personality profiles taking into account clinical, environmental and genetic factors. *European Psychiatry*, 30(1), 160–165. https://doi.org/10.1016/j.eurpsy.2014.09.418

Blicher, A., Reinholdt-Dunne, M. L., Hvenegaard, M., Winding, C., Petersen, A., & Vangkilde, S. (2020). Engagement and disengagement components of attentional bias to emotional stimuli in anxiety and depression. *Journal of Experimental Psychopathology*, 11(3), https://doi.org/10.1177/2043808720943753

Blöte, A. W., Miers, A. C., Van den Bos, E., & Westenberg, P. M. (2019). Negative social self-cognitions: How shyness may lead to social anxiety. *Journal of Applied Developmental Psychology*, 63(February), 9–15. https://doi.org/10.1016/j.appdev.2019.05.003

Bögels, S. M., & Zigterman, D. (2000). Dysfunctional cognitions in children with social phobia, separation anxiety disorder, and generalized anxiety disorder. *Journal of Abnormal Child Psychology*, 28(2), 205–211. https://doi.org/10.1017/CBO9781107415324.004

Brown, H. M., Eley, T. C., Broeren, S., MacLeod, C., Rinck, M., Hadwin, J. A., & Lester, K. J. (2014). Psychometric properties of reaction time based experimental paradigms measuring anxiety-related information-processing biases in children. *Journal of Anxiety Disorders*, 28(1), 97–107. https://doi.org/10.1016/j.janxdis.2013.11.004

Buckner, J. D., Maner, J. K., & Schmidt, N. B. (2010). Difficulty disengaging attention from social threat in social anxiety. *Cognitive Therapy and Research*, 34(1), 99–105. https://doi.org/10.1007/s10608-008-9205-y

Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling: A Multidisciplinary Journal*, 14(3), 464–504. https://doi.org/10.1080/10705510701301834

Chen, J., Short, M., & Kemps, E. (2020). Interpretation bias in social anxiety: A systematic review and meta-analysis. *Journal of Affective Disorders*, 276, 1119–1130. https://doi.org/10.1016/j.jad.2020.07.121

Choudhury, S., Blakemore, S. J., & Charman, T. (2006). Social cognitive development during adolescence. *Social Cognitive and Affective Neuroscience*, 1(3), 165–174. https://doi.org/10.1093/scan/nsl024

Cisler, J. M., & Koster, E. H. W. (2010). Mechanisms of attentional biases towards threat in anxiety disorders: An integrative review. *Clinical Psychology Review*, 30(2), 203–216. https://doi.org/10.1016/j.cpr.2009.11.003

Clarke, P. J. F., MacLeod, C., & Guastella, A. J. (2013). Assessing the role of spatial engagement and disengagement of attention in anxiety-linked attentional bias: a critique of current paradigms and suggestions for future research directions. *Anxiety, Stress and Coping*, 26(1), 1–19. https://doi.org/10.1080/10615806.2011.638054

Cohen, J. (1988). *Statistical Power Analysis for the Behavioural Sciences* (2nd ed.). Lawrence Erlbaum

Creswell, C., & O'Connor, T. G. (2011). Interpretation bias and anxiety in childhood: Stability, specificity and longitudinal associations. *Behavioural and Cognitive Psychotherapy*, 39(2), 191–204. https://doi.org/10.1017/S1352465810000494

Cunningham, W. A., Raye, C. L., & Johnson, M. K. (2004). Implicit and explicit evaluation: fMRI correlates of valence, emotional intensity, and control in the processing of attitudes. *Journal of Cognitive Neuroscience*, 16(10), 1717–1729. https://doi.org/10.1162/0898929042947919

de Voogd, E. L., Wiers, R. W., Prins, P. J. M., de Jong, P. J., Boendermaker, W. J., Zwitser, R. J., & Salemink, E. (2016). Online attentional bias modification training targeting anxiety and depression in unselected adolescents: Short- and long-term effects of a randomized controlled trial. *Behaviour Research and Therapy*, 87, 11–22. https://doi.org/10.1016/j.brat.2016.08.018

De Voogd, E. L., Wiers, R. W., Prins, P. J. M., & Salemink, E. (2014). Visual search attentional bias modification reduced social phobia in adolescents. *Journal of Behavior Therapy and Experimental Psychiatry*, 45(2), 252–259. https://doi.org/10.1016/j.jbtep.2013.11.006

De Voogd, E. L., Wiers, R. W., & Salemink, E. (2017). Online visual search attentional bias modification for adolescents with heightened anxiety and depressive symptoms: A randomized controlled trial. *Behaviour Research and Therapy*, 92, 57–67. https://doi.org/10.1016/j.brat.2017.02.006

Donnelly, N., Hadwin, J. A., Menneer, T., & Richards, H. J. (2010). The use of visual search paradigms to understand attentional biases in childhood anxiety. In *Information Processing Biases and Anxiety: A Developmental Perspective* (pp. 109–127). https://doi.org/10.1002/9780470661468.ch5

Dudeney, J., Sharpe, L., & Hunt, C. (2015). Attentional bias towards threatening stimuli in children with anxiety: A meta-analysis. *Clinical Psychology Review*, 40, 66–75. https://doi.org/10.1016/j.cpr.2015.05.007

Egger, H. L., Pine, D. S., Nelson, E., Leibenluft, E., Ernst, M., Towbin, K. E., & Angold, A. (2011). The NIMH Child Emotional Faces Picture Set (NIMH-ChEFS): A new set of children's facial emotion stimuli. *International Journal of Methods in Psychiatric Research*, 20(3), 145–156. https://doi.org/10.1002/mpr.343

Erath, S. A., Flanagan, K. S., & Bierman, K. L. (2007). Social anxiety and peer relations in early adolescence: Behavioral and cognitive factors. *Journal of Abnormal Child Psychology*, 35(3), 405–416. https://doi.org/10.1007/s10802-007-9099-2

Field, A. P. (2009). *Discovering Statistics Using SPSS*. SAGE Publication

Gamble, A. L., & Rapee, R. M. (2009). The time-course of attentional bias in anxious children and adolescents. *Journal of Anxiety Disorders*, 23(7), 841–847. https://doi.org/10.1016/j.janxdis.2009.04.001

Henricks, L. A., Lange, W. G., Luijten, M., & Becker, E. S. (2022). A new social picture task to assess interpretation bias related to social fears in adolescents. *Research on Child and Adolescent Psychopathology*.https://doi.org/10.1007/s10802-022-00915-3

Hirsch, C. R., Clark, D. M., & Mathews, A. (2006). Imagery and interpretations in social phobia: Support for the combined cognitive biases hypothesis. *Behavior Therapy*, 37(3), 223–236. https://doi.org/10.1016/j.beth.2006.02.001

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1–55. https://doi.org/10.1080/10705519909540118

In-Albon, T., & Schneider, S. (2010). Using eye tracking methodology in children with anxiety disorders. In J. A. Hadwin & A. P. Field (Eds.), *Information Processing Biases and Anxiety: A Developmental Perspective* (pp. 129–149). https://doi.org/10.1002/9780470661468.ch6

Klein, A. M., de Voogd, L., Wiers, R. W., & Salemink, E. (2018). Biases in attention and interpretation in adolescents with varying levels of anxiety and depression. *Cognition and Emotion*, 32(7), 1478–1486. https://doi.org/10.1080/02699931.2017.1304359

Kline, R. B. (2015). *Principles and practice of structural equation modeling*. Guilford publications

Kujawa, A. J., Torpey, D., Kim, J., Hajcak, G., Rose, S., Gotlib, I. H., & Klein, D. N. (2011). Attentional biases for emotional faces in young children of mothers with chronic or recurrent depression. *Journal of Abnormal Child Psychology*, 39(1), 125–135. https://doi.org/10.1007/s10802-010-9438-6

La Greca, A. M., & Lopez, N. (1998). Social anxiety among adolescents: Linkages with peer relations and friendships. *Journal of Abnormal Child Psychology*, 26(2), 83–94. https://doi.org/10.1023/A:1022684520514

Lakdawalla, Z., Hankin, B. L., & Mermelstein, R. (2007). Cognitive theories of depression in children and adolescents: A conceptual and quantitative review. *Clinical Child and Family Psychology Review*, 10(1), 1–24. https://doi.org/10.1007/s10567-006-0013-1

Lau, J. Y. F., Shariff, R., & Meehan, A. J. (2021). Are biased interpretations of ambiguous social and non-social situations a precursor, consequence or maintenance factor of youth loneliness?

Behaviour Research and Therapy, *140*(August 2020), 103829. https://doi.org/10.1016/j.brat.2021.103829

Li, S., Tan, J., Qian, M., & Liu, X. (2008). Continual training of attentional bias in social anxiety. *Behaviour Research and Therapy*, 46(8), 905–912. https://doi.org/10.1016/j.brat.2008.04.005

Liang, C. W., Tsai, J. L., & Hsu, W. Y. (2017). Sustained visual attention for competing emotional stimuli in social anxiety: An eye tracking study. *Journal of Behavior Therapy and Experimental Psychiatry*, 54, 178–185. https://doi.org/10.1016/j.jbtep.2016.08.009

Lisk, S. C., Pile, V., Haller, S. P. W., Kumari, V., & Lau, J. Y. F. (2018). Multisession Cognitive Bias Modification Targeting Multiple Biases in Adolescents with Elevated Social Anxiety. *Cognitive Therapy and Research*, 42(5), 581–597. https://doi.org/10.1007/s10608-018-9912-y

Maes, M., Klimstra, T., Van den Noortgate, W., & Goossens, L. (2015). Factor Structure and Measurement Invariance of a Multidimensional Loneliness Scale: Comparisons Across Gender and Age. *Journal of Child and Family Studies*, 24(6), 1829–1837. https://doi.org/10.1007/s10826-014-9986-4

Maes, M., Nelemans, S. A., & Danneel, S. (2019). Loneliness and Social Anxiety Across Childhood and Adolescence: Multilevel Meta-Analyses of Cross-Sectional and Longitudinal Associations. *Developmental Psychology*, 55(7), 1548–1565. https://doi.org/10.1037/dev0000719

Mesa, F., Nieves, M. M., & Beidel, D. C. (2011). Clinical presentation of social anxiety disorder in adolescents and young adults. In C. A. Alfano, & D. C. Beidel (Eds.), *Social Anxiety in Adolescents and Young Adults: Translating Developmental Science into Practice* (pp. 11–27). American Psychological Association

Miers, A. C., Blöte, A. W., Bögels, S. M., & Westenberg, P. M. (2008). Interpretation bias and social anxiety in adolescents. *Journal of Anxiety Disorders*, 22(8), 1462–1471. https://doi.org/10.1016/j.janxdis.2008.02.010

Miers, A. C., Blöte, A. W., De Rooij, M., Bokhorst, C. L., & Westenberg, P. M. (2013). Trajectories of social anxiety during adolescence and relations with cognition, social competence, and temperament. *Journal of Abnormal Child Psychology*, 41(1), 97–110. https://doi.org/10.1007/s10802-012-9651-6

Mobach, L., Rinck, M., Becker, E. S., Hudson, J. L., & Klein, A. M. (2019). Content-specific interpretation bias in children with varying levels of anxiety: The role of gender and age. *Child Psychiatry and Human Development*, 50(5), 803–814. https://doi.org/10.1007/s10578-019-00883-8

Mogg, K., & Bradley, B. P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour Research and Therapy*, 36(9), 809–848. https://doi.org/10.1016/S0005-7967(98)00063-1

Mogg, K., Bradley, B. P., De Bono, J., & Painter, M. (1997). Time course of attentional bias for threat information in non-clinical anxiety. *Behaviour Research and Therapy*, 35(4), 297–303. https://doi.org/10.1016/S0005-7967(96)00109-X

Morren, M., Kindt, M., van den Hout, M., & van Kasteren, H. (2004). Anxiety and the processing of threat in children: Further examination of the cognitive inhibition hypothesis. *Behaviour Change*, 20(3), 131–142. https://doi.org/10.1375/bech.20.3.131.24833

Muthén, L. K., & Muthén, B. O. (n.d.). *Mplus User's Guide, Eighth Edition*. Muthén & Muthén

Neisser, U. (1967). *Cognitive Psychology*. Appleton-Century-Crofts

Newman, D. A. (2014). Missing Data: Five Practical Guidelines. *Organizational Research Methods*, 17(4), 372–411. https://doi.org/10.1177/1094428114548590

Piaget, J. (1971). The theory of stages in cognitive development. In *Measurement and Piaget.* (pp. ix, 283–ix, 283). McGraw-Hill

Platt, B., Waters, A. M., Schulte-Koerne, G., Engelmann, L., & Salemink, E. (2017). A review of cognitive biases in youth depression: attention, interpretation and memory. *Cognition and Emotion*, 31(3), 462–483. https://doi.org/10.1080/02699931.2015.1127215

Price, R. B., Kuckertz, J. M., Siegle, G. J., Ladouceur, C. D., Silk, J. S., Ryan, N. D. … Amir, N. (2015). Empirical recommendations for improving the stability of the dot-probe task in clinical research. *Psychological Assessment*, 27(2), 365–376. https://doi.org/10.1037/pas0000036

Puliafico, A. C., & Kendall, P. C. (2006). Threat-related attentional bias in anxious youth: A review. *Clinical Child and Family Psychology Review*, 9(3–4), 162–180. https://doi.org/10.1007/s10567-006-0009-x

Rapee, R. M., & Spence, S. H. (2004). The etiology of social phobia: Empirical evidence and an initial model. *Clinical Psychology Review*, 24(7), 737–767. https://doi.org/10.1016/j.cpr.2004.06.004

Richards, H. J., Benson, V., Donnelly, N., & Hadwin, J. A. (2014). Exploring the function of selective attention and hypervigilance for threat in anxiety. *Clinical Psychology Review*, 34(1), 1–13. https://doi.org/10.1016/j.cpr.2013.10.006

Rinck, M., & Becker, E. S. (2005). A comparison of attentional biases and memory biases in women with social phobia and major depression. *Journal of Abnormal Psychology*, 114(1), 62–74. https://doi.org/10.1037/0021-843X.114.1.62

Rodebaugh, T. L., Scullin, R. B., Langer, J. K., Dixon, D. J., Huppert, J. D., Bernstein, A. … Lenze, E. J. (2016). Unreliability as a threat to understanding psychopathology: The cautionary tale of attentional bias. *Journal of Abnormal Psychology*, 125(6), 840–851. https://doi.org/10.1037/abn0000184

Rosenberg, M. (1965). *Society and the adolescent self-image*. Princeton University Press

Roy, A. K., Dennis, T. A., & Warner, C. M. (2015). A Critical Review of Attentional Threat Bias and Its Role in the Treatment of Pediatric Anxiety Disorders. *Journal of Cognitive Psychotherapy*, 29(3), 171–184. https://doi.org/10.1891/0889-8391.29.3.171

Roy, A. K., Vasa, R. A., Bruck, M., Mogg, K., Bradley, B. P., Sweeney, M. … Pine, D. S. (2008). Attention Bias Toward Threat in Pediatric Anxiety Disorders. *Journal of the American Academy of Child & Adolescent Psychiatry*, 47(10), 1189–1196. https://doi.org/10.1097/CHI.0b013e3181825ace

Rozenman, M., Amir, N., & Weersing, V. R. (2014). Performance-based interpretation bias in clinically anxious youths: Relationships with attention, anxiety, and negative cognition. *Behavior Therapy*, 45(5), 594–605. https://doi.org/10.1016/j.beth.2014.03.009

Salum, G. A., Mogg, K., Bradley, B. P., Gadelha, A., Pan, P., Tamanaha, A. C. … Pine, D. S. (2013). Threat bias in attention orienting: Evidence of specificity in a large community-based study. *Psychological Medicine*, 43(4), 733–745. https://doi.org/10.1017/S0033291712001651

Sanchez, A., Everaert, J., De Putter, L. M. S., Mueller, S. C., & Koster, E. H. W. (2015). Life is… great! Emotional attention during instructed and uninstructed ambiguity resolution in relation to depressive symptoms. *Biological Psychology*, 109, 67–72. https://doi.org/10.1016/j.biopsycho.2015.04.007

Sanchez-Lopez, A., De Raedt, R., van Put, J., & Koster, E. H. W. (2019). A novel process-based approach to improve resilience: Effects of computerized mouse-based (gaze)contingent attention training (MCAT)on reappraisal and rumination. *Behaviour Research and Therapy*, 118(April), 110–120. https://doi.org/10.1016/j.brat.2019.04.005

Schmidtendorf, S., Wiedau, S., Asbrand, J., Tuschen-Caffier, B., & Heinrichs, N. (2018). Attentional Bias in Children with Social Anxiety Disorder. *Cognitive Therapy and Research*, 42(3), 273–288. https://doi.org/10.1007/s10608-017-9880-7

Seefeldt, W. L., Krämer, M., Tuschen-Caffier, B., & Heinrichs, N. (2014). Hypervigilance and avoidance in visual attention in children with social phobia. *Journal of Behavior Therapy and Experimental Psychiatry*, 45(1), 105–112. https://doi.org/10.1016/j.jbtep.2013.09.004

Shechner, T., Jarcho, J. M., Britton, J. C., Leibenluft, E., Pine, D. S., & Nelson, E. E. (2013). Attention bias of anxious youth during extended exposure of emotional face Pairs: An eye-tracking study. *Depression and Anxiety*, 30(1), 14–21. https://doi.org/10.1002/da.21986

Sliwinski, M. J. (2008). Measurement-Burst Designs for Social Health Research. *Social and Personality Psychology Compass*, 2(1), 245–261. https://doi.org/10.1111/j.1751-9004.2007.00043.x

Sportel, B. E., de Hullu, E., de Jong, P. J., & Nauta, M. H. (2013). Cognitive Bias Modification versus CBT in Reducing Adolescent Social Anxiety: A Randomized Controlled Trial. *PLoS ONE*, 8(5), https://doi.org/10.1371/journal.pone.0064355

Stuijfzand, S., Creswell, C., Field, A. P., Pearcey, S., & Dodd, H. (2018). Research review: Is anxiety associated with negative interpretations of ambiguity in children and adolescents? A systematic review and meta-analysis. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 59(11), 1127–1142. https://doi.org/10.1111/jcpp.12822

Tran, T. B., Siemer, M., & Joormann, J. (2011). Implicit interpretation biases affect emotional vulnerability: A training study. *Cognition and Emotion*, 25(3), 546–558. https://doi.org/10.1080/02699931.2010.532393

Van Tuijl, L. A., De Jong, P. J., Sportel, B. E., De Hullu, E., & Nauta, M. H. (2014). Implicit and explicit self-esteem and their reciprocal relationship with symptoms of depression and social anxiety: A longitudinal study in adolescents. *Journal of Behavior Therapy and Experimental Psychiatry*, 45(1), 113–121. https://doi.org/10.1016/j.jbtep.2013.09.007

Vassilopoulos, S. P., & Banerjee, R. (2008). Interpretations and judgments regarding positive and negative social scenarios in childhood social anxiety. *Behaviour Research and Therapy*, 46(7), 870–876. https://doi.org/10.1016/j.brat.2008.03.008

Vassilopoulos, S. P., & Banerjee, R. (2012). Social anxiety and content specificity of interpretation and judgemental bias in children. *Infant and Child Development*, 21(3), 298–309. https://doi.org/10.1002/icd.746

Vassilopoulos, S. P., Banerjee, R., & Prantzalou, C. (2009). Experimental modification of interpretation bias in socially anxious children: Changes in interpretation, anticipated interpersonal anxiety, and social anxiety symptoms. *Behaviour Research and Therapy*, 47(12), 1085–1089. https://doi.org/10.1016/j.brat.2009.07.018

Voncken, M. J., Bögels, S. M., & de Vries, K. (2003). Interpretation and judgmental biases in social phobia. *Behaviour Research and Therapy*, 41(12), 1481–1488. https://doi.org/10.1016/S0005-7967(03)00143-8

Waters, A. M., Mogg, K., Bradley, B. P., & Pine, D. S. (2008). Attentional bias for emotional faces in children with generalized anxiety disorder. *Journal of the American Academy of Child and Adolescent Psychiatry*, 47(4), 435–442. https://doi.org/10.1097/CHI.0b013e3181642992

Waters, A. M., Mogg, K., Bradley, B. P., & Pine, D. S. (2011). Attention Bias for Angry Faces in Children with Social Phobia. *Journal of Experimental Psychopathology*, 2(4), 475–489. https://doi.org/10.5127/jep.018111

Waters, A. M., Wharton, T. A., Zimmer-Gembeck, M. J., & Craske, M. G. (2008). Threat-based cognitive biases in anxious children: Comparison with non-anxious children before and after cognitive behavioural treatment. *Behaviour Research and Therapy*, 46(3), 358–374. https://doi.org/10.1016/j.brat.2008.01.002

Watts, S. E., & Weems, C. F. (2006). Associations among selective attention, memory bias, cognitive errors and symptoms of anxiety in youth. *Journal of Abnormal Child Psychology*, 34(6), 841–852. https://doi.org/10.1007/s10802-006-9066-3

Weil, L. G., Fleming, S. M., Dumontheil, I., Kilford, E. J., Weil, R. S., Rees, G. … Blakemore, S. J. (2013). The development of metacognitive ability in adolescence. *Consciousness and Cognition*, 22(1), 264–271. https://doi.org/10.1016/j.concog.2013.01.004

Wermes, R., Lincoln, T. M., & Helbig-Lang, S. (2017). How Well Can We Measure Visual Attention? Psychometric Properties of Manual Response Times and First Fixation Latencies in a Visual Search Paradigm. *Cognitive Therapy and Research*, 41(4), 588–599. https://doi.org/10.1007/s10608-016-9830-9

Westenberg, P. M., Drewes, M. J., Goedhart, A. W., Siebelink, B. M., & Treffers, P. D. A. (2004). A developmental analysis of self-reported fears in late childhood through mid-adolescence: Social-evaluative fears on the rise? *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 45(3), 481–495. https://doi.org/10.1111/j.1469-7610.2004.00239.x

Wong, Q. J. J., & Rapee, R. M. (2016). The aetiology and maintenance of social anxiety disorder: A synthesis of complimentary theoretical models and formulation of a new integrated model. *Journal of Affective Disorders*, 203, 84–100. https://doi.org/10.1016/j.jad.2016.05.069

Zvielli, A., Bernstein, A., & Koster, E. H. W. (2015). Temporal Dynamics of Attentional Bias. *Clinical Psychological Science*, 3(5), 772–788. https://doi.org/10.1177/2167702614551572