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Impact of Attention Biases to Threat and Effortful Control on Individual Variations in Negative Affect and Social Withdrawal in Very Young Children

Claire E. Cole[1], **Daniel J. Zapp**[1], **Nicole B. Fettig**[1], and **Koraly Pérez-Edgar**[2]

[1]George Mason University, Department of Psychology

[2]The Pennsylvania State University, Department of Psychology

Abstract

Early temperamental sensitivity may form the basis for the later development of socioemotional maladjustment. In particular, temperamental negative affect places children at risk for the development of anxiety. However, not all children who show negative affect go on to develop anxiety or extreme social withdrawal. Recent research indicates that reactive control, in the form of attention to threat, may serve as a bridge between early temperament and the development of later social difficulties. In addition, variation in effortful control may also modulate this trajectory. Children ($Mean_{Age}$=5.57 years) were assessed for attention bias to threatening and pleasant faces using a dot-probe paradigm. Attention bias to threatening (but not happy) faces moderated the direct *positive* relation between negative affect and social withdrawal. Children with threat biases showed a significant link between negative affect and social withdrawal, while children who avoided threat did not. In contrast, effortful control did not moderate the relation between negative affect and social withdrawal. Rather, there was a direct *negative* relation between effortful control and social withdrawal. The findings from this short report indicate that the relation amongst temperament, attention bias, and social withdrawal appears early in life and point to early emerging specificity in reactive and regulatory functioning.

Keywords

Social withdrawal; Temperament; Attention bias; Dot-Probe; Anxiety

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Early temperamental sensitivity may lay the foundation for the later development of social anxiety (Biederman et al., 2001; Chronis-Tuscano et al., 2009; Rosenbaum, et. al., 1993; Rubin & Burgess, 2001), particularly for children who display negative affect. The antecedents of social anxiety are marked by high levels of social withdrawal prior to the emergence of the disorder (Rapee & Spence, 2004). However, not all children who show increased negative affect go on to develop anxiety or extreme social withdrawal (Degnan &

Correspondence to: Claire E. Cole.

Fox, 2007). Recent research indicates that attention may act as a developmental tether linking early temperamental risk to the later emergence of social difficulties (Pérez-Edgar, McDermott, et. al., 2010; Pérez-Edgar, Taber-Thomas, Auday, & Morales, 2014). Attention to threat may reflect individual differences in reactive control (Rueda, 2012), which can take on a regulatory function (Todd, Cunningham, Anderson & Thompson, 2012). In addition, strong effortful control skills may also impact this developmental link (Lonigan & Vasey, 2009). This paper aims to examine the association between early temperament (negative affect), attention bias to salient stimuli (reactive control), effortful control, and levels of social withdrawal in a normative sample of young children. These data provide insight into varied regulatory mechanisms involved in typically observed patterns of socioemotional functioning that may also subserve maladaptive patterns of anxious behavior (Fox & Pine, 2012).

Rothbart and Derryberry (1981) characterized temperament as a set of stable, biologically-based individual differences in reactivity and regulation. In this model, emotional reactivity works in concert with regulation processes to provide the basis of observed behavior in children (Goldsmith et al., 1987). These two components of temperament, along with environmental factors and individualized experiences, shape the child's personality (Rothbart, 2012). Much of the literature investigating the development of psychopathology has focused on negative reactivity -- negative emotional and motoric responses produced when a person is exposed to novel environmental stimuli (Derryberry & Reed, 2002). These can include feelings of anger, distress, agitation, sadness, fear, and associated behaviors (Davidson, Putnam, & Larson, 2000; Rothbart, Ahadi, Hershey, & Fisher, 2001). Observed patterns of negative reactivity are supported by specific patterns of functioning in both the central nervous system and the limbic system, often marked by a hyperactive amygdala response (Pérez-Edgar et. al., 2007; Thomas et al., 2001).

Although negative affect has been directly linked to the development of anxiety, this trait does not work alone to shape observed patterns of behavior. Rather, individual differences in initial reactivity are coupled with individual differences in regulatory skills, which can serve as variably effective or robust checks on reactivity. Regulation processes emerge relatively slowly over the course of childhood (Cole, Michel, & Teti, 1994). As children grow, they shift from using external sources to provide regulation of their emotions (such as parents, pacifiers, etc.) to employing internal regulatory mechanisms (such as attention shifting, thought suppression, etc.) to control their immediate emotional responses (Rueda, 2012).

Functionally, one can parse regulatory behavior into reactive and effortful control mechanisms. Reactive control is motivated by immediate incentives and is sufficiently spontaneous to not be considered deliberate (Martel & Nigg, 2006). This implicit evaluation then triggers relatively automatic or reflexive response strategies, which can indicate approach or withdrawal behavior (Rueda, 2012). Todd and colleagues (Todd et al., 2012) suggest that affect-biased attention can act as a reactive form of emotion regulation. This bias may be particularly acute for social (versus nonsocial) threats (LoBue & Pérez-Edgar, 2014). Negatively reactive individuals are also slower to disengage their attention from these stimuli relative to less reactive individuals (Fox, Russo, Bowles, & Dutton, 2001). Negative affect, coupled with reactive threat bias, may place individuals at even greater risk for anxiety and social withdrawal (Pérez-Edgar & Fox, 2005; Pérez-Edgar et al., 2014).

Emerging data suggest that threat avoidance, marked by attention bias *away* from threat, is also associated with the development of anxiety (Shechner et al., 2012). Direction may reflect diagnostic boundaries, as distress disorders have shown a significant bias towards threat, whereas children with fear disorders show an attention bias away from threat (Waters, Bradley, & Mogg, 2014). Patterns of anxiety-linked vigilance and avoidance are also evident in the temperament literature, as 5-year-old children characterized for Dysregulated Fear as toddlers displayed attentional avoidance of emotion faces (Morales, Pérez-Edgar, & Buss, in press-a). However, bias scores were still positively associated with anxiety. Consistent biases toward or away from threat may have distinct implications for adaptive functioning, resulting in heightened or diminished exposure to threat when processing social information, respectively.

Effortful control mechanisms, in contrast, bring to bear more deliberate or conscious processing, interpretation, and manipulation of these initial reactive tendencies (Rothbart & Bates, 2007). may ameliorate the relation between negative affect and social withdrawal, as well as the relation between negative affect and attention bias. In particular, Lonigan and colleagues (Lonigan, Vasey, Phillips, & Hazen, 2004) suggest that when stimuli are consciously perceived (presentation times of 500ms or greater), individuals can employ effortful control mechanisms to shift their attention away from anxiety-producing stimuli. Indeed, Lonigan and Vasey (2009) found that attention biases to threat were only evident in children who were both negatively reactive and had low levels of effortful control. Children who were negatively reactive but had high levels of effortful control did not show a bias to threatening stimuli. In turn, others have found that attention bias is associated with anxiety only in children with low levels of attentional control (Susa, Pitic[abreve], Benga & Miclea, 2012). Thus negative affect, reactive control, and effortful control reflect distinct (but linked) components of our response to environmental stimuli.

Few studies have concurrently examined the interaction between temperament (negative affect), attention bias to salient stimuli (reactive control), effortful control, and levels of social withdrawal within a young normative sample. This could provide insight into the role they play in shaping typically-observed variations in behavior prior to, or independent of, the emergence of disorder. This refinement is important as reactive and regulatory mechanisms may differentially impact developmental trajectories (Mogg et al., in press; Rueda, 2012).

In order to examine the impact of these factors on social withdrawal, children were asked to perform a dot-probe task incorporating threatening, happy, and neutral faces. Faces were used in order to capture social concerns in an ecologically valid manner (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). Generally, studies have focused on patterns of attention bias to threat. Studies including happy or positive faces often do so in order to have a comparison condition. Among children, many studies have found that the relation between attention bias to happy and temperamental negative affect is fairly weak, with generally non-significant relations pointing both towards and away

(Morales et al., in press-a; Pérez-Edgar et al., 2011). However, others have found that attention bias away from happy increases risk for anxiety (White et al., in press) and training attention towards happy decreases risk (Britton et al., 2013; Waters, Pittaway, Mogg, Bradley, & Pine, 2013). Previous work has found stronger connections between attention bias to happy faces and temperamental exuberance (Frewen, Dozois, Joanisse, & Neufeld, 2008; Morales et al., in press-b; Shechner et al., 2012). In the current study, separate bias scores were created for happy and threatening faces to probe for affective specificity.

Given our young sample and moderate sample size, we took a measured approach to the analyses, examining only core relations supported by the current literature. Based on past research indicating that negative affect is related to attention biases toward threat (Hadwin, Donnelly, French, Richards, Watts, & Daley, 2003; Öhman, Flykt, & Esteves, 2001), we predicted that higher levels of negative affect would be associated with greater attention biases toward threatening (but not pleasant) stimuli. We hypothesized that attention bias to threatening faces would serve as a moderator between negative affect and social withdrawal, such that children higher in negative affect who display biases towards threatening faces would be more socially withdrawn (Perez-Edgar et al., 2011). Previous work (Lonigan & Vasey, 2009; Susa et al., 2012) suggests that higher levels of effortful control can disrupt the relation between negative affect and social withdrawal, as well as the link between negative affect and attention bias. However, we were cautious with respect to the impact of EC in the current study as the available data have focused on older children and effortful control processes may be fragile or unreliable in young children (Luna, Padmanabhan, & O'Hearn, 2010; Rueda, 2012).

Methods

Participants

The sample consisted of 53 children (30 males), age 4 to 7 years (M=5.57 years, SD=.64). Based on parental identification, 79.2% of participants were white non-Hispanic, 9.4% were Asian-Pacific Islander, 7.5% were Hispanic, and 3.8% were African American. Participants were recruited from mailing lists provided by Experian Marketing Solutions (Schaumburg, IL) and we requested contact information for households in designated zip codes with children in our age range of interest. Parents were monetarily compensated for their family's participation in a larger study. Child participants received a small toy as a prize for their assistance in the study. The University Institutional Review Board approved all procedures and families consented to participate.

After excluding children with poor dot-probe performance (see below), 47 children were included in the analyses (27 males; M_{Age} = 5.57, SD=0.65). The children who did not reach accuracy criterion did not significantly differ from the included sample in age (p=.68), or on measures of negative affect, effortful control, or social withdrawal (p's>.45). They also did not differ in reaction times (RTs) across trials (p's>.35), suggesting that poor performance was not due to an underlying accuracy-speed tradeoff.

Negative Affect

In order to construct a robust measure of negative affect, we applied a multi-method approach, integrating maternal report and laboratory observations of behavior. Parents completed the Child Behavior Questionnaire-Short Form (CBQ; Putnam & Rothbart, 2006), which consists of 94 questions scored on a 7 point Likert scale from 1 *extremely untrue* to 7 *extremely true*. The questionnaire asked caregivers to decide whether each listed statement was like or unlike a behavior their child had displayed in the previous 6 months. A score was created to assess participants' level of negative reactivity by combining the subscales of Discomfort, Sadness, Fear, Anger/Frustration, and Soothability (reverse scored) and then standardized (Cronbach's α= .843).

As part of the larger study, participants also completed a disappointing toy task (Saarni, 1984). Upon arrival to the lab, children were asked to rank-order attractive and broken toys and were told that they would receive their highest-ranked prize after completing the full lab visit. The children were then given the lowest ranked toy at the completion of the visit. Based on video recording, positive, negative, and transitional behaviors were coded in five-second intervals as one/zero events (i.e., a 1 was given if the behavior occurred at any time within the window and a 0 was given if the behavior did not occur) across the task. Interrater reliability showed good agreement (Kappa = .70).

Given the relation between the negative affect measures (r=.399, p=.003), scores from each were standardized and then averaged to create a Negative Affect score.

Effortful Control

Based on the literature (Putnam & Rothbart, 2006), we assessed Effortful Control by combining the CBQ subscales of Inhibitory Control, Attention Focusing, Low Intensity Pleasure, and Perceptual Sensitivity (Cronbach's α = .837).

Social Withdrawal

The Child Behavior Checklist Pre-School Version (CBCL; Achenbach & Rescorla, 2000) consists of 99 parental report questions scored on a 3-point Likert scale from 0 *Not True* to 2 *Very True/Often True*. The checklist asked parents to rate a list of behaviors in relation to their child's actions in the previous 2 months. We focused on the Withdrawn subscale of the Syndrome Scale, which consisted of 8 items and included behaviors such as “withdrawn, doesn't get involved with others”; “avoids looking others in the eye”; and “doesn't answer when people talk to him/her”.

Dot-Probe Task

Participants completed a computer-based Dot-Probe task, which consisted of 96 presentation trials split into two 48-trial blocks. At the beginning of each trial, participants were presented with a fixation cross for 500ms and then presented with a pair of adult faces oriented in a side-by-side format. Face pairs consisted of a happy face paired with a neutral face, an angry face paired with a neutral face, or two neutral faces. Faces (50% male) were taken from the NimStim collection of stimuli (Tottenham et al., 2009). The face pairs were presented for 500ms after which a probe (white asterisk) appeared in one of the previous face locations. Participants were instructed to press a button as quickly as possible to indicate if the probe location was on the right or left side of the computer screen.

Trials were characterized as congruent or incongruent. On congruent trials, the probe appeared in the location of the emotive face (either happy or angry). On incongruent trials, the probe appeared in the location of the neutral face. Trials with two neutral faces appearing simultaneously were used as control trials. Trial congruency was counterbalanced throughout the task. Raw behavioral data were cleaned to remove incorrect trials and outliers (+/−2 SD's from the child's mean RTs). Children with less than 60% accuracy on the Dot-Probe task were removed from the full analyses (3 male, 3 female).

Attention bias scores were calculated by subtracting mean RTs on congruent trials from mean RTs on incongruent trials. Positive values indicated that participants were directing their attention towards the emotional stimuli (vigilance), and negative values indicated that the participants were directing their attention away from the affective stimuli (avoidance). Attention bias scores were calculated for both angry-neutral and happy-neutral face pairs.

Results

Based on the work of Preacher, Rucker, and Hayes (2007) we assessed moderation and mediation patterns between negative affect, attention bias, effortful control, and social withdrawal. Data were analyzed using the SPSS (version 22; Chicago IL) macro PROCESS with 5,000 bootstrap samples (Preacher et al., 2007; Hayes, 2012), mean centering predictive variables before analysis. Table 1 and Figure 1 present the zero-order correlations among the variables of interest.

As expected, negative affect was positively associated with social withdrawal (p=.006) and at trend level with attention bias to threat (p=.075). Attention bias to threat showed no other relations approaching significance. Effortful control, in turn, was significantly negatively associated with social withdrawal (p=.022) and attention bias to happy faces (p=.016).

The initial analysis (PROCESS Model 74) probed moderated-mediation relations between negative affect, attention bias to threat, and social withdrawal (Table 2, Figure 2). As expected, there was a significant relation between negative affect and social withdrawal (=. 005). While the mediation relation was not supported, there was a negative affect by attention bias interaction (p=.018), such that negative affect was associated with social withdrawal only at high levels of attention bias (see Figure 3).

Modifying the model to examine the interaction between negative affect and effortful control on social withdrawal found no significant interaction effects (p=.099; Table 3). However, the data suggest that the relation between negative affect and social withdrawal is not evident at high levels of effortful control. The individual effects of effortful control (p=. 021) and negative affect (p=.002) were significant. Again, there was no indication of mediation.

Given the initial findings, we then probed the impact of effortful control on the relation between negative affect, attention bias to threat, and social withdrawal (PROCESS Model 2;

Table 4).[1] As expected, social withdrawal was positively associated with negative affect (*p*=.004) and negatively associated with effortful control (*p*=.025). While the negative affect by attention bias interaction was again significant (*p*=.025), the negative affect by effortful control interaction was not (*p*=.426).

To examine the specificity of affect, the first and third models were re-run using attention bias to happy faces as a predictor (Tables 2 & 4). There were no significant effects involving bias to happy faces (*p*'s>.49).

Discussion

Previous research has indicated that individuals with anxiety display altered patterns of attention bias (Fox, Russo, & Dutton, 2002; Hadwin et al., 2003; Rapee & Heimberg, 1997) that may play an important role in the development of anxiety by sustaining anxious traits from early childhood through adolescence (Fox & Pine, 2012; White, Helfinstein, Reeb-Sutherland, Degnan, & Fox, 2009). Attention patterns also underlie normative variations in socioemotional behavior (LoBue, 2013; Todd et al., 2012).

The current study sought to build upon previous research by examining the separate roles reactive and effortful control mechanisms may play in shaping patterns of social behavior. While negative affect was significantly associated with social withdrawal, this relation was moderated by attention bias to threat. Importantly, the positive relation between negative affect and attention bias to threat, while non-significant, was in line with the larger literature. Although studies have indicated that individuals with greater levels of anxiety or anxious temperaments exhibit greater attention bias to threat (Hadwin et al., 2003; MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002; Mogg et al., 1995; Pérez-Edgar, Bar-Haim et al., 2010), other studies have not (Hardee et al., 2013; Pérez-Edgar et al., 2011; Monk et al., 2006). The current non-significant trend between negative affect and attention bias to threat may reflect limited power due to sample size or to the fact that we examined a non-clinical sample. Alternately, this may reflect developmental differences in these core relations, as indicated by relatively weak associations with attention bias to threat in two independent studies of 5-year-olds at-risk for depression (Kujawa et al., 2011) and anxiety (Pérez-Edgar et al., 2011), and a follow-up study with 7-year-olds at risk for anxiety (White et al., in press).

Consistent with previous findings (Morales et al., in press-a; Pérez-Edgar et al., 2011; White et al., in press), attention bias to threat moderated the relation between negative affect and social withdrawal, in that a significant link was only evident at increased levels of attention bias to threat. In contrast, effortful control did not interact with negative affect to impact social withdrawal. Effortful control begins to rapidly develop in childhood (Cole et al., 1994) and is linked to corresponding physiological developments in brain structures related to the regulation of emotion and behavior (Rothbart & Posner, 2006; Rothbart et al., 2007). Because effortful control mechanisms emerge over the course of childhood, it is possible

[1]The sample size precluded a direct examination of the omnibus three-way interaction. An additional analysis examining the interaction between attention bias and effortful control did not significantly predict social withdrawal (*p*=0.27).

that our young sample was too immature to display effective or stable use of effortful control processes to regulate responses to emotional stimuli. Although Lonigan and Vasey (2009; Lonigan et al., 2004) and Susa et al., (2012) have found evidence that effortful control mechanisms moderate the relation between negative reactivity, attention biases, and anxiety, these samples incorporated children considerably older (9-18 years) than the children in our sample.

Interestingly, the current data replicate recent findings (Morales et al., in press-b) indicating a negative association between effortful control and attention bias to happy faces in kindergarten-age children. The focus of the Morales et al. study was on the impact of effortful control and attention bias on the relation between temperamental exuberance and externalizing difficulties. Researchers suggested that this relation supports the conceptualization of exuberance as increased activity in the behavioral approach system (attention bias to happy) coupled with diminished activity from the behavioral inhibition system (low effortful control). Our sample was not characterized in such a way that we could test these relations. However, the Morales et al. study does suggest that our sample (assessed with the same parental report measures and behavioral task) is capturing a fairly robust relation in early childhood. It may be that the functional significance of the relation between effortful control and attention bias on outcome is dependent on individual differences in risk profile.

As a whole, the pattern of results from these analyses suggests that the relations between temperament, attention bias and social behaviors emerges early in childhood. Our data suggest that individual differences in attention bias are linked to patterns of socioemotional functioning in children as young as 5. Further work will need to incorporate early childhood timepoints in longitudinal studies in order to capture these relations. Developmental models (Field & Lester, 2010) suggest that the relations amongst temperament, attention, and social behavior should be evident across the lifespan (integral bias model) based on the presence of predisposing traits (e.g., negative affect) or the relation emerges as the presence of negative affect modulates developmental trajectories (moderation model). Finally, the acquisition model suggests that developmental experiences shape the acquisition of an attention bias gradually over time, either in tandem or subsequent to the emergence of fear and anxiety. Given that the models point directly to patterns of bias in early infancy, new, developmentally appropriate tasks (e.g., LoBue & Rakison, 2013) will need to be designed and validated.

The core study measures were assessed concurrently and therefore, we cannot say with certainty that it is attention bias that is moderating the relation between negative affect and social withdrawal. A longitudinal analysis of these three constructs captured at separate time-points would provide stronger support for the proposed directionality of this relation. Interestingly, one of the first longitudinal studies of attention bias in children found that attention bias to threat was less stable than attention bias to happy faces (White et al, in press), suggesting that threat bias may be more sensitive to the child's current developmental or socioemotional state. In addition, the current sample size limited the complexity and scope of our analyses. Larger samples would be needed to examine higher order relations across measures. However, the data presented here are in line with the current literature and contribute to our understanding of how patterns of reactive and effortful control impact early profiles of socioemotional functioning.

The current study provides evidence for the appropriateness of the dot-probe task as a measure of attention bias in very young children. Additionally, it adds to our current understanding of the relations between components of temperament, cognitive control, attention bias, and social behaviors, extending these relations to a normative young sample. The current study replicated previous findings (Morales et al., in press-a; Pérez-Edgar, Bar-Haim et al., 2010; Pérez-Edgar et al., 2011; White et al., in press) indicating that attention bias to threat moderates the relation between negative reactivity and social withdrawal. These findings suggest that the relation between negative components of temperament, attention bias, and social behavior emerges early in childhood. Although the relative strength of this trajectory has been suggested by other studies, further research is needed to examine the long-term stability of these findings and the contribution of attention biases to socioemotional profiles throughout development as new regulatory skills emerge (Rueda, 2012; Todd et al., 2012).

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References

Achenbach, T.; Rescorla, L. Manual for the ASEBA Preschool Forms & Profiles. Burlington, VT: University of Vermont, Research Center for Children, Youth, & Families; 2000.

Bar-Haim Y, Lamy D, Pergamin L, Bakermans-Kranenburg M, van IJzendoorn M. Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. Psychological Bulletin. 2007; 133:1–24.10.1037/0033-2909.133.1.1 [PubMed: 17201568]

Biederman J, Hirshfeld-Becker D, Rosenbaum J, Hérot C, Friedman D, Snidman N, Kagan J, Faraone S. Further evidence of association between behavioral inhibition and social anxiety in children. American Journal of Psychiatry. 2001; 158:1673–1679.10.1176/appi.ajp.158.10.1673 [PubMed: 11579001]

Britton JC, Bar-Haim Y, Clementi MA, Sankin LS, Chen G, Shechner T, Norcross MA, Spiro CN, Lindstrom KM, Pine DS. Training-associated changes and stability of attention bias in youth: Implications for Attention Bias Modification Treatment for pediatric anxiety. Developmental Cognitive Neuroscience. 2013; 4:52–64.10.1016/j.dcn.2012.11.001. [PubMed: 23200784]

Chronis-Tuscano A, Degnan K, Pine D, Pérez-Edgar K, Henderson H, Diaz Y, Raggi V, Fox NA. Stable early maternal report of behavioral inhibition predicts lifetime social anxiety disorder in adolescence. Journal of the American Academy of Child & Adolescent Psychiatry. 2009; 48:928–935.10.1097/CHI.0b013e3181ae09df [PubMed: 19625982]

Cole P, Michel M, Teti L. The development of emotion regulation and dysregulation: A clinical perspective. Monographs of the Society for Research in Child Development. 1994; 59:73–100.10.1111/1540-5834.ep9502132765 [PubMed: 7984169]

Dalgleish T, Taghavi R, Neshat-Doost H, Moradi A, Canterburry R, Yule W. Patterns of processing bias for emotional information across clinical disorders: A comparison of attention, memory, and prospective cognition in children and adolescents with depression, generalized anxiety, and posttraumatic stress disorder. Journal of Clinical Child and Adolescent Psychology. 2003; 32:10–21.10.1207/15374420360533022 [PubMed: 12573928]

Davidson R, Putnam K, Larson C. Dysfunction in the neural circuitry of emotional regulation: A possible prelude to violence. Science. 2000; 289:591–594.10.1126/science.289.5479.591 [PubMed: 10915615]

Degnan K, Fox NA. Behavioral inhibition and anxiety disorders: Multiple levels of a resilience process. Development and Psychopathology. 2007; 19:729–746.10.1017/S0954579407000363 [PubMed: 17705900]

Dennis T, Brotman L, Huang K, Gouley K. Effortful control, social competence, and adjustment problems in children at risk for psychopathology. Journal of Clinical Child and Adolescent Psychology. 2007; 36:442–454.10.1080/15374410701448513 [PubMed: 17658987]

Derryberry D, Reed MA. Anxiety-related attentional biases and their regulation by attentional control. Journal of Abnormal Child Psychology. 2002; 111:225–236.10.1037/0021-843X.111.2.225

Field A, Lester K. Is there room for ‘development’ in developmental models of information processing biases to threat in children and adolescents? Clinical Child and Family Psychology Review. 2010; 13:315–322.10.1007/s10567-010-0078-8 [PubMed: 20811944]

Fox E, Russo R, Bowles R, Dutton K. Do threatening stimuli draw or hold visual attention in subclinical anxiety? Journal of Experimental Psychology: General. 2001; 130:681. http://dx.doi.org/10.1037/0096-3445.130.4.681. [PubMed: 11757875]

Fox E, Russo R, Dutton K. Attentional bias for threat: Evidence for delayed disengagement from emotional faces. Cognition and Emotion. 2002; 16:355–379.10.1080/02699930143000527 [PubMed: 18273395]

Fox NA, Pine DS. Temperament and the emergence of anxiety disorders. Journal of the American Academy of Child and Adolescent Psychiatry. 2012; 51:125–128.10.1016/j.jaac.2011.10.006 [PubMed: 22265356]

Frewen PA, Dozois DJA, Joanisse MF, Neufeld RWJ. Selective attention to threat versus reward: Meta-analysis and neural-network modeling of the dot-probe task. Clinical Psychology Review. 2008; 28(2):307–337.10.1016/j.cpr.2007.05.006 [PubMed: 17618023]

Goldsmith H, Buss A, Plomin R, Rothbart M, Thomas A, Chess S, Hind R, McCall R. Roundtable: What is temperament? Four approaches. Child Development. 1987; 58:505–559.10.2307/1130527 [PubMed: 3829791]

Hadwin J, Donnelly N, French C, Richards A, Watts A, Daley D. The influence of children's self-report trait anxiety and depression on visual search for emotional faces. Journal of Child Psychology and Psychiatry. 2003; 44:432–444.10.1111/1469-7610.00133 [PubMed: 12635972]

Harrison AJ, Gibb BE. Attentional biases in currently depressed children: An eye-tracking study of biases in sustained attention to emotional stimuli. Journal of Clinical Child & Adolescent Psychology. :1–7. in press. ahead-of-print. 10.1080/15374416.2014.930688

Hayes, AF. PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling [White paper]. 2012. Retrieved from http://www.afhayes.com/public/process2012.pdf

Kagan J, Snidman N. Early childhood predictors of adult anxiety disorders. Biological Psychiatry. 1999; 46:1536–1541.10.1016/S0006-3223(99)00137-7 [PubMed: 10599481]

Kujawa A, Torpey D, Kim J, Hajcak G, Rose S, Gotlib I, Klein D. Attention bias for emotional faces in young children of mothers with chronic or recurrent depression. Journal of Abnormal Child Psychology. 2011; 35:125–135.10.1007/s10802-010-9438-6 [PubMed: 20644991]

LoBue V. What are we so afraid of? How early attention shapes our most common fears. Child Development Perspectives. 201310.1111/cdep.12012

LoBue V, Pérez-Edgar K. Sensitivity to social and non-social threats in temperamentally shy children at-risk for anxiety. Developmental Science. 2014; 17:239–247.10.1111/desc.12110 [PubMed: 24283271]

LoBue V, Rakison DH. What we fear most: A developmental advantage for threat-relevant stimuli. Developmental Review. 2013; 33:285–303. http://dx.doi.org/10.1016/j.dr.2013.07.005.

Lonigan C, Vasey M, Phillips B, Hazen R. Temperament, anxiety, and the processing of threat-relevant stimuli. Journal of Clinical Child & Adolescent Psychology. 2004; 33:8–20.10.1207/S15374424JCCP3301_2 [PubMed: 15028537]

Lonigan C, Vasey M. Negative affectivity, effortful control, and attention to threat-relevant stimuli. Journal of Abnormal Child Psychology. 2009; 37:387–399.10.1007/s10802-008-9284-y [PubMed: 19043783]

Luna B, Padmanabhan A, O'Hearn K. What has fMRI told us about the development of cognitive control through adolescence? Brain and Cognition. 2010; 72:101–113.10.1016/j.bandc.2009.08.005 [PubMed: 19765880]

MacLeod C, Rutherford E, Campbell L, Ebsworthy G, Holker L. Selective attention and emotional vulnerability: Assessing the causal basis of their association through the experimental manipulation of attentional bias. Journal of Abnormal Psychology. 2002; 111:107–123.10.1037/0021-843X.111.1.107 [PubMed: 11866165]

Martel MM, Nigg JT. Child ADHD and personality/temperament traits of reactive and effortful control, resiliency, and emotionality. Journal of Child Psychology & Psychiatry. 2006; 47:1175–1183.10.1111/j.1469-7610.2006.01629.x [PubMed: 17076757]

Mogg, K.; Salum, GA.; Bradley, BP.; Gadelha, A.; Pan, P.; Alvarenga, P.; Rohde, LA.; Pine, DS.; Manfro, GG. Attention network functioning in children with anxiety disorders, attention-deficit/hyperactivity disorder and non-clinical anxiety. Psychological Medicine. in pressdoi: http://dx.doi.org/10.1017/S0033291715000586

Monk C, Nelson E, McClure E, Mogg K, Bradley B, Leibenluft E, Blair R, et al. Pine D. Ventrolateral prefrontal cortex activation and attentional bias in response to angry faces in adolescents with generalized anxiety disorder. The American Journal of Psychiatry. 2006; 163:1091–1097.10.1176/appi.ajp.163.6.1091 [PubMed: 16741211]

Morales S, Pérez-Edgar K, Buss KA. Attention biases towards and away from threat mark the relation between early dysregulated fear and the later emergence of social withdrawal. Journal of Abnormal Child Psychology. in press-a. 10.1007/s10802-014-9963-9

Morales S, Pérez-Edgar K, Buss KA. Longitudinal relations among exuberance, externalizing behaviors, and attentional bias to reward: the mediating role of effortful control. Developmental Science. in press-b. 10.1111/desc.12320

Neshat-Doost H, Moradi A, Taghavi M, Yule W, Dalgleish T. Lack of attentional bias for emotional information in clinically depressed children and adolescents on the dot probe task. Journal of Child Psychology and Psychiatry. 2000; 41:363–368.10.1111/1469-7610.00620 [PubMed: 10784083]

Öhman A, Flykt A, Esteves F. Emotion drives attention: Detecting the snake in the grass. Journal of Experimental Psychology: General. 2001; 130:466–478.10.1037/0096-3445.130.3.466 [PubMed: 11561921]

Pérez-Edgar K, Bar-Haim Y, McDermott J, Chronis-Tuscano A, Pine D, Fox NA. Attention bias to threat and behavioral inhibition in early childhood shape adolescent social withdrawal. Emotion. 2010; 10:349–357.10.1037/a0018486 [PubMed: 20515224]

Pérez-Edgar K, Fox NA. Temperament and anxiety disorders. Child Adolescence Psychiatric Clinics of North America. 2005; 14:681–706.10.1016/j.chc.2005.05.008

Pérez-Edgar K, McDermott J, Korelitz K, Degnan K, Curby T, Pine D, Fox NA. Patterns of sustained attention in infancy shape the developmental trajectory of social behavior from toddlerhood through adolescence. Developmental Psychology. 2010; 46:1723–1730.10.1037/a0021064 [PubMed: 20873921]

Pérez-Edgar K, Reeb-Sutherland B, McDermott J, White L, Henderson H, Degnan K, Hane A, Pine D, Fox NA. Attention biases to threat link behavioral inhibition to social withdrawal over time in very young children. Journal of Abnormal Child Psychology. 2011; 39:885–895.10.1007/s10802-001-9495-5 [PubMed: 21318555]

Pérez-Edgar K, Roberson-Nay R, Hardin M, Poeth K, Guyer A, Nelson E, et al. Ernst M. Attention alters neural responses to evocative faces in behaviorally inhibited adolescents. NeuroImage. 2007; 35:1538–1546.10.1016/j.neuroimage.2007.02.006 [PubMed: 17376704]

Pérez-Edgar, K.; Taber-Thomas, B.; Auday, E.; Morales, S. Temperament and attention as core mechanisms in the early emergence of anxiety. In: Lagattuta, K., editor. Children and Emotion: New Insights into Developmental Affective Science, Contributions to Human Development. Vol. 26. Karger Publishing; 2014. p. 42-56.

Preacher K, Rucker D, Hayes A. Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. Multivariate Behavioral Research. 2007; 42:185–227.10.1080/00273170701341316

Putnam SP, Rothbart MK. Development of short and very short forms of the Children's Behavior Questionnaire. Journal of Personality Assessment. 2006; 87:102–112. [PubMed: 16856791]

Rapee R, Heimberg R. A cognitive-behavioral model of anxiety in social phobia. Behaviour Research and Therapy. 1997; 35:741–756.10.1016/S0005-7967(97)00022-3 [PubMed: 9256517]

Rapee R, Spence S. The etiology of social phobia: Empirical evidence and an initial model. Clinical Psychology Review. 2004; 24:737–767.10.1016/j.cpr.2004.06.004 [PubMed: 15501555]

Rosenbaum J, Biederman J, Bolduc-Murphy E, Faraone S, Chaloff J, Hirshfield D, Kagan R. Behavioral inhibition in childhood: A risk factor for anxiety disorders. Harvard Review of Psychiatry. 1993; 1:2–16.10.3109/10673229309017052 [PubMed: 9384823]

Rothbart, MK. Advances in temperament: History, concepts, and measures. In: Zentner, M.; Shiner, RL., editors. Handbook of Temperament. New York: Guilford Press; 2012. p. 3-20.

Rothbart M, Ahadi S, Hershey K, Fisher P. Investigations of temperament at 3-7 years: The children's behavior questionnaire. Child Development. 2001; 72:1394–1408.10.1111/1467-8624.0035 [PubMed: 11699677]

Rothbart, MK.; Bates, JE. Temperament. In: Damon, W.; Eisenberg, N., editors. Handbook of Child Psychology: Vol 3 Social, Emotional, and Personality Development. New York: Wiley; 2007. p. 105-176.

Rothbart, M.; Derryberry, D. The development of individual differences in temperament. In: Lamb, M.; Brown, A., editors. Advances in Developmental Psychology: Volume 1. Hillsdale, Jew Jersey: Lawrence Erlbaum Associates; 1981. p. 37-87.

Rothbart, M.; Posner, M. Temperament, attention, and developmental psychopathology. In: Cicchetti, D.; Cohen, DJ., editors. Developmental Psychopathology 2nd Edition Vol 2 Developmental Neuroscience. Hoboken, NJ: John Wiley & Sons; 2006. p. 465-501.

Roy A, Vasa R, Bruck M, Mogg K, Bradley B, Sweeney M, Bergman R, McClure-Tone E, Pine D. Attention bias toward threat in pediatric anxiety disorders. Journal of the American Academy of Child and Adolescent Psychiatry. 2008; 47:1189–1196.10.1097/CHI.0b013e3181825ace [PubMed: 18698266]

Rubin, K.; Burgess, K. Social withdrawal. In: Vasey, MW.; Dadds, MR., editors. The Developmental Psychopathology of Anxiety. Oxford, UK: Oxford University Press; 2001. p. 407-434.

Rueda, MR. Effortful Control. In: Zentner, M.; Shiner, RL., editors. Handbook of Temperament. New York: Guilford Press; 2012. p. 145-168.

Saarni C. An observational study of children's attempt to monitor their expressive behavior. Child Development. 1984; 55:1504–1513.10.2307/1130020

Salum GA, Mogg K, Bradley BP, Gadelha A, Pan P, Tamanaha AC, et al. Pine DS. Threat bias in attention orienting: evidence of specificity in a large community-based study. Psychological Medicine. 2013; 43(4):733–45. doi: http://dx.doi.org/10.1017/S0033291712001651. [PubMed: 22850475]

Shechner T, Britton J, Pérez-Edgar K, Bar-Haim Y, Ernst M, Fox NA, Leibenluft E, Pine DS. Attention biases, anxiety, and development: Toward or away from threats or rewards? Depression & Anxiety. 2012; 29:282–294.10.1002/da.20914 [PubMed: 22170764]

Susa G, Pitic I, Benga O, Miclea M. The self regulatory effect of attentional, control in modulating the relationship between attentional biases toward threat and anxiety symptoms in children. Cognition & Emotion. 2012; 26(6):1069–1083.10.1080/02699931.2011.638910 [PubMed: 22404477]

Thomas K, Drevets W, Dahl R, Ryan N, Birmaher B, Eccard C, et al. Casey B. Amygdala response to fearful faces in anxious and depressed children. Archives of General Psychiatry. 2001; 58:1057–1063.10.1001/archpsyc.58.11.1057 [PubMed: 11695953]

Todd RM, Cunningham WA, Anderson AK, Thompson E. Affect-biased attention as emotion regulation. Trends in Cognitive Sciences. 2012; 16:365–372.10.1016/j.tics.2012.06.003 [PubMed: 22717469]

Tottenham N, Tanaka J, Leon A, McCarry T, Nurse M, Hare T, et al. Nelson CA. The NimStim set of facial expressions: Judgments from untrained research participants. Psychiatry Research. 2009; 168:242–249.10.1016/j.psychres.2008.05.006 [PubMed: 19564050]

Waters AM, Bradley BP, Mogg K. Biased attention to threat in paediatric anxiety disorders (generalized anxiety disorder, social phobia, specific phobia, separation anxiety disorder) as a function of ‘distress’ versus ‘fear’ diagnostic categorization. Psychological Medicine. 2014; 44:607–616.10.1017/S0033291713000779 [PubMed: 23591000]

Waters AM, Henry K, Mogg B, Bradley, Pine D. Attentional bias for emotional faces in children with generalized anxiety disorder. Journal of the American Academy of Child and Adolescent Psychiatry. 2010; 47:435–422.10.1097/CHI.0b013e3181642992 [PubMed: 18388762]

Waters AM, Pittaway M, Mogg K, Bradley BP, Pine DS. Attention training towards positive stimuli in clinically anxious children. Developmental Cognitive Neuroscience. 2013; 4:77–84.10.1016/j.dcn.2012.09.004 [PubMed: 23063461]

White LK, Degnan KA, Henderson HA, Pérez-Edgar K, Walker OL, Shechner T, Leibenluft E, Bar-Haim Y, Pine DS, Fox NA. Developmental relations between behavioral inhibition, anxiety, and attention biases to threat and positive information. Child Development. in press.

White LK, Helfinstein S, Reeb-Sutherland B, Degnan KA, Fox NA. Role of attention in the regulation of fear and anxiety. Developmental Neuroscience. 2009; 31:309–317.10.1159/000216542 [PubMed: 19546568]

Highlights

- Reactive and Effortful Control (EC) mechanisms may differentially contribute to social withdrawal (SW).
- Attention bias (AB) to threat moderated the relation between negative affect (NA) and SW.
- Only children with AB showed a link between NA and SW.
- EC was directly associated with SW levels.
- EC did not moderate the relation between NA and SW.

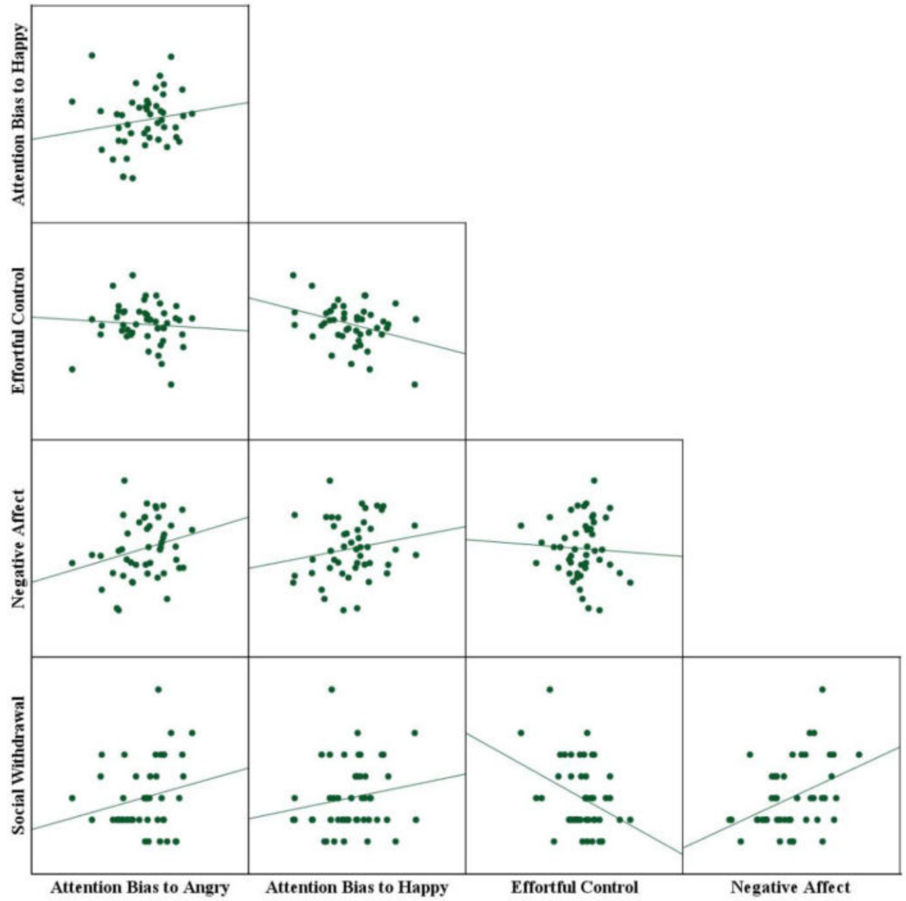

Figure 1.
Scatter plot matrix of negative affect, social withdrawal, effortful control, and attention bias to angry and happy faces.

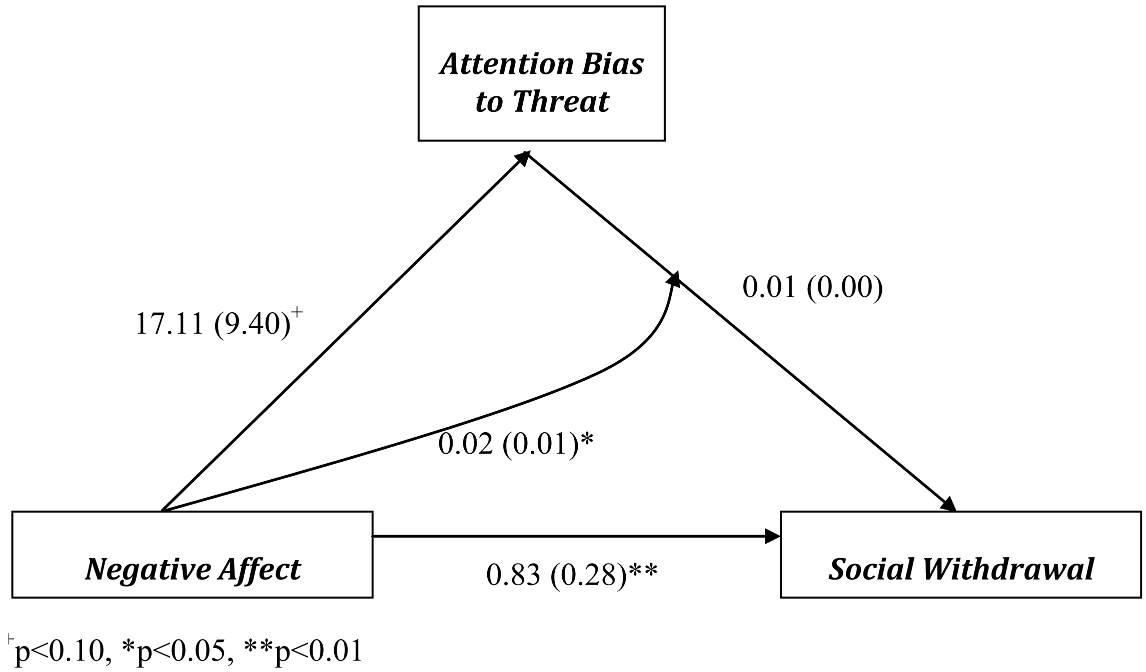

Figure 2.
Results for the moderated-mediation model (Hayes, 2012; Model 74) examining the relations between negative affect, attention biases to angry faces, and social withdrawal at age 5. Noted are the effect coefficients with standard errors in parentheses.

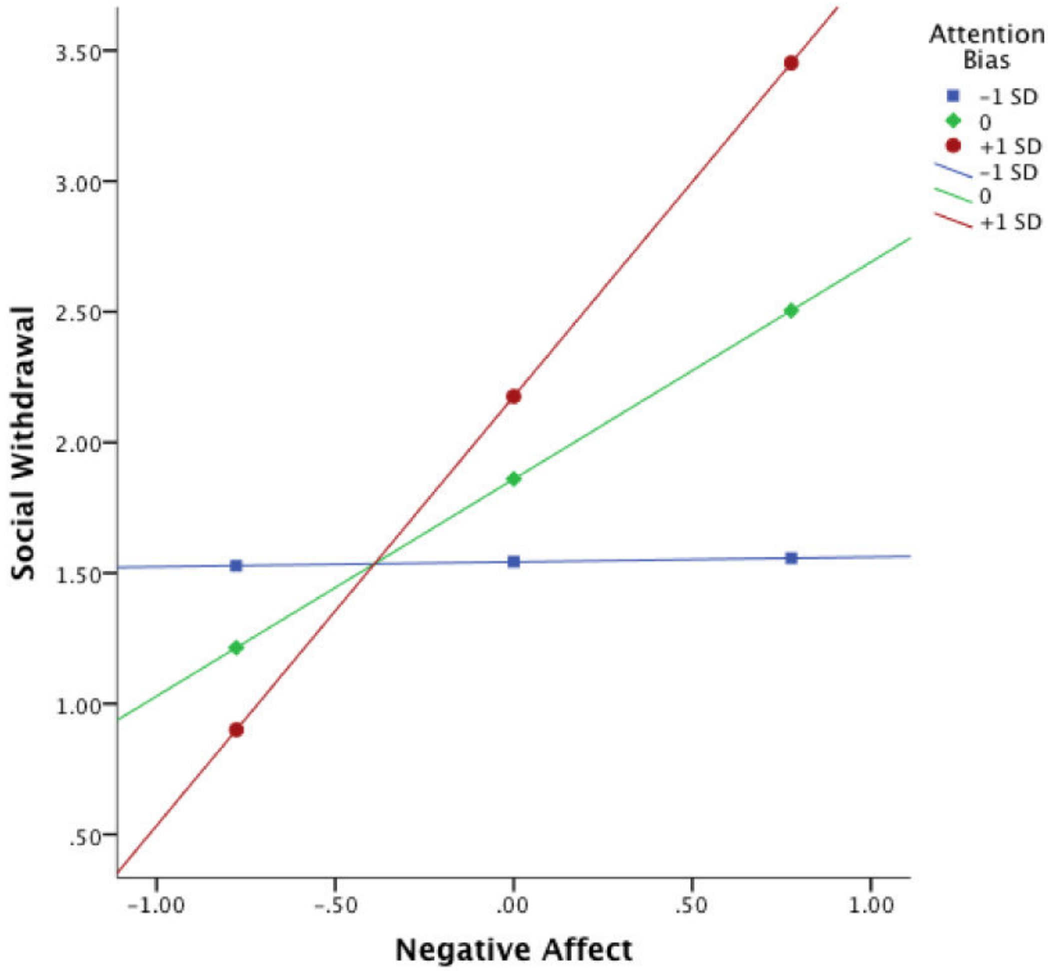

Figure 3.
The conditional effect of negative affect on social withdrawal probed at -1 SD, mean, and +1 SD for attention bias to threat.

Table 1

Correlations among negative affect, social withdrawal, attention bias to angry and happy faces, and effortful control.

Variable	1.	2.	3.	4.	5.
1. Negative Affect	--				
2. Social Withdrawal	0.396**	--			
3. Attention Bias to Threat	0.262+	0.211	--		
4. Attention Bias to Happy	0.181	0.166	0.157	--	
5. Effortful Control	-0.054	-0.332*	-0.079	-0.350*	--

+ p<0.10,

* p<0.05,

** p<0.01

Table 2

Results for the model (PROCESS Model 74, illustrated in Figure 2) examining potential moderated-mediation relations between negative affect, social withdrawal, and attention biases to (a) angry and (b) happy faces. AB=Attention Bias; NA=Negative Affect

(a)

Outcome Measure	Predictors	Coefficient (SE)	*t*	LLCI, ULCI
Attention Bias to Angry	Constant	0.00 (7.23)	0.00	-14.55, 14.55
	Negative Affect	17.11 (9.40)	1.82^{+}	-1.82, 36.05
	$F(1,45)=3.31$, $p=0.075$, $R^2=0.07$			
Social Withdrawal	Constant	1.86 (0.22)	8.63**	1.43, 2.29
	Negative Affect	0.83 (0.28)	2.98**	0.27, 1.39
	AB to Angry	0.01 (0.00)	1.43	-0.00, 0.02
	NA X AB Angry	0.02 (0.01)	2.47*	0.00, 0.03
	$F(3,43)=5.36$, $p=0.003$, $R^2=0.27$			

(b)

Outcome Measure	Predictors	Coefficient (SE)	*t*	LLCI, ULCI
Attention Bias to Happy	Constant	0.00 (7.98)	0.00	-16.08, 16.08
	Negative Affect	12.86 (10.39)	1.24	-8.06, 33.78
	$F(1,45)=1.53$, $p=0.222$, $R^2=0.03$			
Social Withdrawal	Constant	2.00 (0.22)	8.96**	1.55, 2.45
	Negative Affect	0.81 (0.30)	2.73**	0.21, 1.40
	AB to Happy	0.00 (0.00)	0.69	-0.01, 0.01
	NA X AB Happy	0.00 (0.01)	0.50	-0.01, 0.01
	$F(3,43)=2.96$, $p=0.043$, $R^2=0.17$			

$^{+}p<0.10$,

$^{*}p<0.05$,

$^{**}p<0.01$

Table 3

Results for the model (PROCESS Model 74) examining potential moderated-mediation relations between negative affect, social withdrawal, and effortful control. EC=Effortful Control; NA=Negative Affect

Outcome Measure	Predictors	Coefficient (SE)	*t*	LLCI, ULCI
Effortful Control	Constant	0.00 (0.40)	0.00	-0.80, 0.80
	Negative Affect	-0.19 (0.52)	-0.36	-1.23, 0.86
$F(1,45)=3.31$, $p=0.719$, $R^2=0.003$				
Social Withdrawal	Constant	2.00 (0.20)	9.91**	1.89, 2.41
	Negative Affect	0.94 (0.28)	3.37**	0.38, 1.50
	Effortful Control	-0.18 (0.08)	-2.39*	-0.33, -0.03
	NA X EC	-0.20 (0.12)	-1.69+	-0.44, 0.04
$F(3,43)=5.36$, $p=0.001$, $R^2=0.30$				

+ $p<0.10$,

* $p<0.05$,

** $p<0.01$

Table 4

Results for the model (PROCESS Model 2) examining potential moderation between attention biases to (a) angry and (b) happy faces, negative affect, effortful control, and social withdrawal in early childhood. AB=Attention Bias; EC=Effortful Control; NA=Negative Affect

(a)

Outcome Measure	Predictors	Coefficient (SE)	*t*	LLCI, ULCI
Social Withdrawal	Constant	1.86 (0.21)	9.02**	1.44, 2.28
	Negative Affect	0.82 (0.27)	3.06**	0.28, 1.35
	Effortful Control	-0.17 (0.07)	-2.32*	-0.32, -0.02
	AB to Angry	0.00 (0.00)	0.85	-0.01, 0.01
	NA X EC	-0.10 (0.13)	-0.81	-0.36, 0.16
	NA X AB Angry	0.02 (0.01)	2.33*	0.00, 0.03
	$F(5,41)=4.78$, $p=0.002$, $R^2=0.37$			

(b)

Outcome Measure	Predictors	Coefficient (SE)	*t*	LLCI, ULCI
Social Withdrawal	Constant	1.98 (0.22)	9.01**	1.54, 2.43
	Negative Affect	0.81 (0.29)	2.84**	0.23, 1.39
	Effortful Control	-0.18 (0.09)	-2.15*	-0.36, -0.01
	AB to Happy	0.00 (0.00)	-0.07	-0.01, 0.01
	NA X EC	-0.21 (0.13)	-1.54	-0.48, 0.07
	NA X AB Happy	0.00 (0.01)	0.42	-0.01, 0.01
	$F(5,41)=2.92$, $p=0.024$, $R^2=0.26$			

+ $p<0.10$,

* $p<0.05$,

** $p<0.01$