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Attentional Control Moderates the Relationship between Social Anxiety Symptoms and Attentional Disengagement from Threatening Information

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Abstract

Background and Objectives—Social anxiety is characterized by biased attentional processing of social information. However, heterogeneity of extant findings suggests that it may be informative to elucidate individual difference factors that modulate the processing of emotional information. The current study examined whether individual differences in components of attentional control (AC – shifting and focusing) moderated the link between social anxiety and attentional engagement and disengagement biases for threat-relevant cues.

Methods—Seventy-five undergraduate students completed well-established measures of social anxiety symptoms, AC, and attentional bias for social threat information (modified probe detection task).

Results—Moderation analyses revealed that at low levels of AC-shifting, increased social anxiety was associated with slower disengagement from threat-relevant compared to neutral social cues. In contrast, at high levels of AC-shifting, social anxiety was associated with faster disengagement from threat-relevant compared to neutral stimuli. Individual differences in AC-focusing did not moderate the social anxiety-attentional bias link.

Limitations—Causal inferences cannot be made given the cross-sectional study design. The sample comprised individuals displaying a range of self-reported social anxiety symptoms; thus, generalizability to clinical samples remains to be established. The measurement of AC relied on subjective participant report.

Conclusions—The current findings underscore the importance of AC processes in understanding the nature of attentional bias mechanisms in anxiety.

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Keywords

Attentional bias; attentional control; disengagement; engagement; individual differences; social anxiety

1. Introduction

The tendency to preferentially attend to threat-relevant social information is hypothesized to play an important role in the onset and maintenance of social anxiety disorder (SAD; Clark, 2001; Clark & Wells, 1995; Hofmann, 2007; Rapee & Heimberg, 1997). Although research generally supports this proposal (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoom, 2007; Cisler & Koster, 2010), the corpus of extant studies points to variability in both the nature and magnitude of attentional biases that characterize individuals with elevated social anxiety symptoms (Chen, Ehlers, Clark, & Mansell, 2002; Gotlib et al., 2004; Mansell, Clark, Ehlers, & Chen, 1999; Ononaiye, Turpin, & Reidy, 2007; Pineles & Mineka, 2005; Yuen, 1994). To the extent that attentional processes are important in understanding the etiology and/or persistence of SAD, it may be informative to elucidate individual difference variables that account for differential patterns of attentional responding to threat cues. Thus, the goal of the present study was to examine whether individual differences in components of attentional control, i.e., the capacity to use attentional resources to modulate processing of emotional stimuli (Derryberry & Reed, 2002), account in part for differential patterns of attentional biases observed across individuals with elevated social anxiety symptoms.

A commonly used paradigm to assess attentional bias for emotional information is the modified probe detection task (MacLeod, Mathews, & Tata, 1986; for a review see Bar-Haim et al. 2007). In this task, response latencies to identify a visual probe replacing one of two simultaneously presented stimuli are used to measure prioritization of attentional allocation for emotional compared to neutral stimuli. Although prior studies tend to support a link between social anxiety and preferential attentional allocation toward social threat relative to neutral information (Asmundson & Stein, 1994; Mogg & Bradley, 2002; Mogg, Philippot, & Bradley, 2004; Pishyar, Harris, & Menzies, 2004; see Bar-Haim et al., 2007 for a meta-analysis), there is also evidence to suggest that socially anxious individuals display an attentional bias *away* from threat-relevant social information (Chen et al., 2002; Mansell et al., 1999; Yuen, 1994), or do not display biased attentional responding to social threat versus neutral stimuli when compared to non-anxious control participants (Gotlib et al., 2004; Ononaiye et al., 2007; Pineles & Mineka, 2005). Together, these findings suggest that individual differences may contribute to varying patterns of attentional processing across individuals who experience elevated social anxiety symptoms.

Aside from examining the general association between social anxiety and attentional biases for threat, researchers have attempted to disentangle subcomponents of attentional mechanisms using variants of the probe detection task, namely enhanced engagement with threat-related stimuli (i.e., an attentional shift toward threat-related stimuli), or impaired disengagement from threat-related stimuli (i.e., difficulties shifting attention away from threat-related stimuli; Grafton, Watkins, & MacLeod, 2012; Grafton & MacLeod, 2014).

Klumpp and Amir (2009) found that socially anxious individuals displayed increased engagement with threat-relevant faces in comparison to individuals without social anxiety. In contrast, other studies using similar methodology found that increased trait anxiety was associated with difficulty disengaging from threat-related information, but not engagement for threat-related stimuli (e.g., Koster, Crombez, Verschuere, & De Houwer, 2004; Salemink, Van den Hout, & Kindt, 2007; see also Amir, Elias, Klumpp, & Przeworski, 2003 for similar findings using a spatial cueing task in a socially anxious sample). More recent refinements of the probe detection task designed to better disambiguate attentional engagement and disengagement mechanisms (Clarke, MacLeod, & Guastella, 2013) revealed that anxiety was associated with *both* increased attentional engagement with negative images as well as increased impairment with disengaging attention from negative images (Rudaizky, Basanovic, & MacLeod, 2014).

To summarize, previous studies suggest that (1) social anxiety is associated with distinct patterns of attentional processing in the context of threat-relevant social information in comparison to non-anxious individuals, including biases either toward or away from threat-relevant information; (2) these patterns of attentional processing may reflect enhanced engagement with and/or difficulties disengaging attention from threat-relevant information, or both; and (3) even within socially anxious samples, individuals vary considerably in the nature and degree of biased attentional processing. What might account for individual variability in patterns of attentional processing associated with social anxiety? As a step toward addressing this question, and to further understand the nature of extant findings and clarify the role of attentional processes in social anxiety, we drew on attentional control theory (Eysenck, Derakshan, Santos, & Calvo, 2007) as a model for understanding and making predictions about individual variation in attentional bias patterns associated with social anxiety.

Attentional control (AC) is defined as the ability to effortfully regulate attention to override automatic emotional responses (Derryberry & Reed, 2002). Corbetta and Shulman (2002) found evidence for stimulus-driven (i.e., a bottom-up process driven by salient information) and goal-directed (i.e., a top-down process directed by knowledge and current goals) attentional systems. AC theory posits that anxiety disturbs the equilibrium between these two systems, such that the stimulus-driven system is more influential on attentional processing than the goal-directed system (Eysenck et al., 2007). By this account, a stimulus-driven attentional system characterized by hyper-responsiveness to emotionally salient stimuli paired with decreased regulation by the goal-driven system may lead to biased processing of salient, threat-relevant stimuli for anxious individuals.

Researchers have found that AC plays an important role in the relationship between anxiety and the processing of emotional information. In an influential study, Derryberry and Reed (2002) found that attentional bias for threat-related stimuli exhibited by individuals with elevated trait anxiety was moderated by AC. Individuals with higher AC were better at disengaging from threat in comparison to individuals with lower AC. Most relevant to the current study, past research has examined the role of AC in the relationship between anxiety and attentional bias to threat using probe detection paradigms. For example, Bardeen and Orcutt (2011) found that self-reported AC moderated the relationship between attentional bias for threat and posttraumatic stress symptoms (PTSS) such that individuals with low AC and high PTSS were more likely to attend to threat relative to neutral stimuli at a shorter (i.e., 150 ms) stimulus presentation durations. Similarly, other studies have also shown AC as a moderator of the relationship between anxiety and attentional bias for threat-related stimuli (Hou et al., 2014; Schoorl, Putman, Van Der Werff, & Van Der Does, 2014). These findings converge with a growing literature across numerous paradigms and measures suggesting that AC plays a role in the relationship between anxiety and the processing of emotional information (Reinholdt-Dunne, Mogg, & Bradley, 2009).

Despite growing evidence supporting the role of AC in modulating anxiety-related attentional processes, several questions remain unanswered. First, although AC has been shown to modulate affective and behavioral responses in relation to social anxiety (Jones, Fazio, & Vasey, 2012; Morrison & Heimberg, 2013), no studies to our knowledge, have examined the influence of AC on the relationship between social anxiety and attentional processes. Addressing this issue may explain, in part, variability in extant studies investigating the relationship between social anxiety and attentional biases. Second, AC has not been examined in relation to subcomponents of attentional processes linked to anxiety, namely attentional engagement and disengagement from threat-relevant stimuli. Thus, it remains to be established whether AC modulates specific attentional mechanisms (e.g., disengagement) or exerts more generic control over attentional processing. Third, AC itself is a multifaceted construct, and prior research supports empirically distinct dimensions underlying AC. Most relevant to the current study, factor analytic studies of the Attention Control Scale (ACS; Derryberry & Reed, 2002), a well-established self-rated measure of AC, revealed two dimensions underlying AC, namely shifting and focusing (Judah, Grant, Mills, & Lechner, 2014; Olafsson et al., 2011). The *shifting* dimension measures the ability to flexibly distribute attentional processes across multiple tasks that compete for cognitive processing resources (e.g., "It is easy for me to read or write while I'm also talking on the phone"), whereas the *focusing* dimension measures the ability to maintain attentional resources on task-relevant demands (e.g., "My concentration is good even if there is music in the room around me"). Examining subcomponents of both AC and threat-related attentional biases may provide a more precise understanding of information processing mechanisms that characterize social anxiety.

The goal of the present study was to examine whether dimensions of AC moderate the relationship between social anxiety symptoms and subcomponents of attentional engagement and disengagement for threat-relevant information. A cross-section of individuals endorsing a range of social anxiety symptoms completed the ACS to measure shifting and focusing dimensions of AC as well as a modified probe detection paradigm designed to measure engagement and disengagement components of attentional allocation for social-threat stimuli (negative faces). Drawing on AC theory (Eysenck et al., 2007) and prior findings (Derryberry & Reed, 2002), we predicted that individual differences in the capacity to shift attentional allocation would moderate the relationship between level of social anxiety and attentional disengagement from threat-relevant information, such that individuals endorsing elevated social anxiety symptoms and low levels of AC shifting would display greater difficulty disengaging from threat cues relative to high anxious participants

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with higher AC shifting scores. AC shifting, however, was expected to be less sensitive in moderating the relationship between social anxiety and attentional engagement threat biases given that attentional engagement (cf. disengagement) biases are hypothesized to reflect more bottom-up (stimulus-driven) processes compared to top-down cognitive control mechanisms (Corbetta & Shulman, 2002). The thematic content of the ACS-focusing scale, namely the capacity to maintain attentional allocation on a specific task or target stimuli, does not clearly map onto engagement and disengagement mechanisms as measured by probe detection tasks. Thus, we did not make predictions about its relationship with our measure of attentional engagement and disengagement, and consider such analyses exploratory.

2. Material and Methods

2.1. Participants

Participants were 75 individuals (34 men, 40 women)[1] drawn from a pool of undergraduate students at a large university (mean age = 20.66, *SD* = 4.43; mean years of education = 14.05, *SD* = 1.25). These individuals responded to an advertisement for "individuals with difficulty giving speeches". We expected that although this recruitment strategy would yield a sample of individuals scoring higher than non-anxious samples on mean levels of social anxiety, it would also allow for a wide range of social anxiety symptoms. See Table 1. Participants were offered course credit for their participation.

2.2. Measures

2.2.1. Social Anxiety—The Liebowitz Social Anxiety Scale–Self-report version (Liebowitz, 1987) was used to assess level of social anxiety. The LSAS-SR consists of 24 social situations (e.g., public speaking, going to parties, meeting strangers) and asks the individual to rate their level of *Fear* and *Avoidance* for each situation on a 4-point scale (where 0 is 'none/never' and 3 is 'severe/usually'). Items are summed to create a total score reflecting level of social anxiety symptoms (current sample Cronbach's α = .96). The LSAS-SR displays strong psychometric properties that converge with the interviewer-administered LSAS (Fresco et al., 2001).

2.2.2. Depression—The Beck Depression Inventory – II (BDI-II; Beck, Steer, & Brown, 1996) is a 21-item self-report inventory that assesses severity of depression during the past two weeks. The BDI–II demonstrates excellent psychometric properties (e.g., Beck et al., 1996; Dozois, Dobson, & Ahnberg, 1998; current sample Cronbach's α = .89) and was used to examine whether co-occurring symptoms of depression accounted for the predicted outcomes.

2.2.3. Attentional Control—The Attentional Control Scale (ACS; Derryberry & Reed, 2002) is a 20-item self-report questionnaire used to measure individual differences in attentional regulation and asks the individual to rate how they feel about situations related to concentrating and attentional flexibility on a 4-point scale (where 1 is 'almost never' and 4

[1]Demographic information was missing for one participant. We reanalyzed the data in the sub-sample of participants who had complete demographic data. Results of these analyses did not differ from those reported for the entire sample.

is ‘always’). This questionnaire has shown to be a valid measure of attentional regulation (Judah et al., 2014; Olafsson et al. 2011) and to have good internal consistency (α = .88; Derryberry & Reed, 2002). Following prior factor analytic research (Olafsson et al., 2011), we used the two subscales of the ACS, attentional shifting (10 items) and attentional focusing (9 items). In the current study, Cronbach's alphas were .67 and .78 for the shifting and focusing scales, respectively.

2.2.4. Attention Bias Assessment Task—To measure attentional allocation for social threat information, participants completed a modified probe detection task (MacLeod et al., 1986). The stimuli comprised a standardized set of four male and four female faces portraying either a disgust and neutral expression or a happy[2] and neutral expression (Matsumoto & Ekman, 1989)[3]. Disgust faces have been shown to be threat-relevant stimuli for socially anxious individuals (Amir, Najmi, Bomyea, & Burns, 2010). Each face measured 640 x 480 pixels with a resolution of 72,000 pixels per inch. Faces were positioned 3.0 cm from the top of the screen and separated by 1.5 cm between the bottom of the top image and the top of the bottom image. Both faces were centered horizontally and 17.5 cm from the left edge of the screen. Faces were 3.75 cm tall x 5 cm wide.

Each attentional bias assessment trial began with a centered fixation cross presented on the computer screen for 500ms. Next, this cross was replaced by a face-pair presented in the center of the screen for 500ms, one face above the other. Consistent with prior probe detection studies (e.g., Asmundson & Stein, 1994; Klumpp & Amir, 2009; MacLeod et al., 1986) and to control for individual differences in initial orienting to one of two stimuli (i.e., top vs. bottom), we asked participants to attend to the top picture at the start of every trial, thereby anchoring their attention to the top locus (Rudaizky et al., 2014). On trials in which a disgust face was present, it appeared in the top position 50% of the time. The faces then disappeared and a probe (i.e., the letter “E” or “F”) appeared immediately in the location of one of the two faces. The probe was either distal or proximal to the original locus of the participant’s attention. Participants were instructed to indicate whether the letter was an E or an F by pressing the corresponding mouse button. The importance of both speed and accuracy was emphasized to participants. The letter probe remained on the screen until participants responded. Response latencies to identify the probe were recorded from the onset of the letter probe to the button press. Trials were separated by 500ms intervals of a blank screen, and subsequent trials began with the presentation of a fixation cross. See Figure 1.

There were two critical trials of interest: (1) Trials in which both the disgust face and probe were presented distal to (i.e., bottom locus) the participant's original locus of attention. Such trials permitted an assessment of the speed with which participants' attention shifted to engage with threat-relevant information relative to maintaining attention in the vicinity of neutral information; (2) Trials in which the disgust face was presented in the same locus as

[2]Only disgust-neutral face pairs were analyzed for the current study because happy-neutral face pairs were not relevant to the study hypotheses.

[3]Participants were randomly assigned to view one of two face sets (A or B) during the attention bias assessment task. We repeated the analyses entering face set as a covariate. Results did not differ according to face set, i.e., all main and interaction effects including face set were not significant (all $p > .10$). Thus, we report findings for both groups combined in the main text.

the participant's initial focus of attention (i.e., top) and the probe was presented distal to the participant's original locus of attention (i.e., bottom). Such trials permitted an assessment of the speed with which participants' attention shifted from the location occupied by the disgust face to a distal location occupied by the neutral face. See Figure 1.

The assessment consisted of 96 trials: 64 trials included one neutral face and one emotional face (e.g., disgust) and 32 trials included only neutral faces. Trials were presented in a new random order to each participant. Participants were seated approximately 30cm from the computer screen. The computer program was written in Delphi (Embarcadero, Inc.) for this experiment.

2.3. Procedure

Upon arriving to the laboratory, participants provided informed written consent and completed the self-report questionnaires (i.e., demographics questionnaire, LSAS-SR, BDI-II, and ACS). Next, participants completed the probe detection task to assess attentional bias for social information. Participants subsequently completed a number of other tasks intended to address a different research question reported elsewhere.

3. Results

3.1. Preliminary Analyses and Data Preparation

3.1.1. Computation of Attentional Engagement and Disengagement Indices— Prior to the main analyses, one participant was removed from analysis due to low trial accuracy (44.75% of trials incorrect). Response latency [reaction time (RT)] data from the attention bias assessment were prepared in keeping with recommendations from Ratcliff (1993). First, trials with incorrect responses were removed (3.35%). Response latencies less than 200ms or greater than 3000ms were eliminated from analysis of the assessment task (0.20% of trials with correct responses). Response latencies ±3.0 SD from each participant’s mean response latency were also eliminated from analysis of the assessment task, respectively (1.56% of remaining trials). See Table 2 for means and standard deviations of response latencies by trial type.

Attentional engagement and disengagement bias scores were computed following recommendations underscoring the importance of anchoring the participant’s attention in a specified spatial location and presenting the target emotional stimuli in a location either proximal or distal to the initial focus of the participant’s attention (Clarke, MacLeod, & Guastella, 2013; see also Rudaizky et al., 2014).

Attentional *engagement* trials were trials in which both the target emotional face and probe were presented distal to (i.e., bottom locus) the participant's original locus of attention (i.e., top face). Thus, on disgust-neutral trials, the target emotional face (i.e., disgust face) was presented in the bottom location; and on neutral-neutral trials, the target emotional face (i.e., neutral face) was also presented in the bottom location. On engagement trials, the speed to respond to the probe appearing in the location of the disgust face on disgust-neutral trials, in comparison to the probe appearing in the locus of the target neutral face on neutral-neutral trials, will be relatively fast to the extent that attention shifts to engage with the disgust face.

If attention is faster to engage with disgust faces compared to neutral faces, then this is indicative of an attentional engagement bias towards disgust (threat-relevant) faces.

The engagement bias index was calculated using trials in which the disgust face was presented distal to the participant's original locus of attention as follows: *Engagement bias index*: (Neutral face at top of screen and disgust face at bottom: RT for probe distal to disgust face *minus* RT for probe proximal to disgust face) *minus* (Neutral face top and bottom of screen: RT for probe on bottom *minus* RT for probe on top). Higher scores reflect selectively enhanced shifting of attention towards initially unattended threat faces relative to neutral faces.[4]

Attentional *disengagement* trials were trials in which the target emotional disgust face was presented in the same locus as the participant's initial locus of attention (i.e., top face) and the probe was presented distal to the participant's original locus of attention (i.e., bottom locus). Thus, on disgust-neutral trials, the target emotional face (i.e., disgust face) was presented in the top location; and on neutral-neutral trials, the target emotional face (i.e. neutral face) was also presented in the top location. On disengagement trials, the speed to respond to the probe appearing in the location of the neutral face on disgust-neutral trials, in comparison to the probe appearing in the location of the bottom neutral face on neutral-neutral trials, will be relatively slowed to the extent that attention has been held in the location of the initially presented disgust face. If attention is slower to disengage from disgust faces compared to neutral faces, then this is indicative of impairment with disengaging from disgust (threat-relevant) faces.

The disengagement bias index was calculated using trials in which the disgust face was presented in the same locus as the participant's initial focus of attention as follows: *Disengagement bias index*: (Disgust face at top of screen and neutral face at bottom: RT for probe distal to disgust face *minus* RT for probe proximal to disgust face) *minus* (Neutral face top and bottom of screen: RT for probe on bottom *minus* RT for probe on top). Higher scores reflect a greater tendency for attention to be held in the spatial location of initially attended threat faces relative to neutral faces. [4]

The means, standard deviations, and ranges of the measures are presented in Table 1. Bivariate correlations between measures are presented in Table 3. Social anxiety symptoms were not significantly associated with attentional engagement or disengagement indices, $r(71) = -.22$ and .11, respectively, both $p > .05$. Higher levels of social anxiety were associated with lower scores on both ACS focusing and shifting subscales, $r(71) = -.37$ and −.35, respectively, both $p < .01$.

3.2. Main Analyses

3.2.1. Overview of Regression Analyses—Hierarchical regression analyses were used to test the hypothesis that individual differences in AC would moderate the relationship

[4]Upon examining frequency distributions of attentional bias indices, we detected one participant with attentional engagement and disengagement scores that were noticeably detached from the rest of the distribution. This participant also had standardized residual scores greater than 3 SDs from the predicted scores across all regression analyses predicting attentional bias indices. Accordingly, this person was removed from the analysis.

between social anxiety symptoms and attentional processing of negative social information. Given the specificity of our hypotheses regarding the influence of subfacets of AC on subcomponents of attentional processing of threat, separate regression models were tested for attentional disengagement and engagement bias indices as well as AC shifting and focusing subscales. In each model, level of social anxiety (LSAS total score) and AC subscale scores (shifting or focusing) served as predictors. Attentional disengagement and engagement scores served as the dependent variables. Prior to the analyses, continuous predictor variables included in interaction terms were centered (Aiken & West, 1991). The two predictor variables, LSAS and ACS (shifting or focusing), were entered separately in steps one and two of the regression equation, respectively. The LSAS × ACS interaction term was entered in step three of the regression analysis. Significant interactions were probed by conducting a regions of significance analysis using the Johnson-Neyman technique (Johnson & Neyman, 1936). This approach identifies the specific values of the moderator variable (ACS) at which the relationship between social anxiety symptoms and attentional bias for negative social information become statistically significant at $\alpha = .05$. This analysis was implemented using an SPSS macro developed by Hayes and Matthes (2009).

3.2.2. Attentional Control and Disengagement Bias—Table 4 presents the results of the hierarchical regression analyses predicting attentional disengagement bias scores. Our main hypothesis involved examining the relationship between individual differences in AC shifting abilities and disengagement from negative social information. Results of this analysis revealed a significant LSAS × ACS-shifting interaction, $\Delta R^2 = .069$, $p = .023$, which indicated that individual differences in AC shifting abilities moderated the relationship between level of social anxiety and attentional disengagement bias for negative social stimuli. [5] A regions of significance analysis identified 20.88 and 31.44 on the ACS-shifting measure as points of transition between a statistically significant and a statistically non-significant relationship between social anxiety and attentional disengagement scores. Specifically, this analysis revealed that for ACS-shifting scores less than 20.88 to the lowest value observed (16), level of social anxiety was positively associated with attentional disengagement scores. That is, higher levels of social anxiety symptoms were associated with significantly greater attentional disengagement bias scores for negative compared to neutral social cues. In contrast, for ACS-shifting scores greater than 31.44 to the largest observed value (38), level of social anxiety was negatively associated with attentional disengagement scores. That is, higher levels of social anxiety symptoms were associated with significantly faster attentional disengagement from negative compared to neutral social information. For ACS-shifting scores between 20.88 to 31.44, the relationship between social anxiety symptoms and attentional disengagement bias scores was not significant.

[5]Depression is also associated with difficulties in attentional control (Olafsson et al., 2011) and frequently co-occurs with social anxiety (Schneier, Johnson, Hornig, Liebowitz, & Weissman, 1992). At the suggestion of an anonymous reviewer, we conducted a sensitivity analysis in which we modeled the main effect of depression (BDI-II scores), the interaction of depression with social anxiety (LSAS), and the three-way interaction of depression by social anxiety by ACS-shifting scores in the regression equation predicting attentional disengagement biases. Results revealed that neither the main nor interactive effects of depression accounted for significant variance in explaining attentional disengagement scores for threat stimuli, $R^2 = .060$, $p = .19$. Moreover, ACS-shifting remained a robust moderator of the social anxiety-attentional disengagement bias relationship when accounting for the effects of depression in the regression model, $B = -.24$, $t = -2.01$, $p = .049$. Thus, the current pattern of findings cannot be accounted for by co-occurring symptoms of depression.

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These findings are illustrated in Figure 2. Note that the specific values obtained from the regions of significance analysis are estimates based on the current sample, and thus, should *not* be interpreted as an absolute threshold that is generalizable beyond the current sample.

The regression analysis examining ACS-focusing as a moderator of the relationship between social anxiety and attentional disengagement scores revealed that the LSAS × ACS-focusing interaction was not significant, $\Delta R^2 = .001$, $p = .77$. These findings indicated that individual differences in AC focusing abilities did not influence the relationship between social anxiety symptoms and attentional disengagement scores. See Table 4.

3.2.3. Attentional Control and Engagement Bias—Table 5 presents the results of the hierarchical regression analyses predicting attentional engagement bias scores. In both regression models, the LSAS × ACS interaction was not significant, $\Delta R^2 = .03$, $\Delta R^2 = .001$, both $p > .10$, respectively. These findings indicated that individual differences in self-reported AC did not influence the relationship between social anxiety symptoms and attentional engagement for negative social information.

4. Discussion

Dysregulation of attention is considered an important mechanism of social anxiety development and maintenance. The aim of the current study was to examine whether individual differences in subcomponents of attentional control (AC) moderated the relationship between level of social anxiety and attentional engagement and disengagement tendencies during processing of threat-relevant stimuli. The main finding was that individual variability in the self-rated capacity to flexibly shift attentional allocation moderated the association between social anxiety and attentional disengagement from, but not engagement with, social threat stimuli. This study adds to a growing literature underscoring the importance of AC processes in understanding the nature of anxiety-related attentional mechanisms (Bardeen & Orcutt, 2011; Derryberry & Reed, 2002; Hou et al., 2014; Reinholdt-Dunne et al., 2009; Schoorl et al., 2014). The current findings extend the extant literature, however, by pointing to the potential value of investigating subcomponents of both AC and attentional bias mechanisms in anxiety.

Social anxiety symptoms were not directly related to attentional engagement or disengagement threat bias indices. These findings are consistent with prior studies that did not find evidence of an association between social anxiety and attentional biases for threat (Gotlib et al., 2004; Ononaiye et al., 2007; Pineles & Mineka, 2005). Consistent with our prediction and prior studies (Bardeen & Orcutt, 2011; Derryberry & Reed, 2002; Hou et al., 2014; Reinholdt-Dunne et al., 2009; Schoorl et al., 2014), however, AC moderated the social anxiety-attentional bias relationship. Individual differences in the shifting (but not focusing) subscale of the ACS were associated with differential patterns of attentional disengagement for threat cues at high levels of social anxiety. A regions of significance analysis revealed two distinct patterns of attentional processing: (1) At low levels of AC-shifting, higher levels of social anxiety were associated with greater difficulties disengaging attention from social threat cues. These findings converge with prior cross-sectional studies demonstrating a link between social anxiety and attentional disengagement biases for social threat information (e.g., Amir et al., 2003; Buckner, Maner, & Schmidt, 2010). (2) In contrast, at high levels of AC-shifting, increasing levels of social anxiety were associated with faster attentional disengagement from threat-relevant cues. Taken together, this pattern of findings mirrors those reported in a recent study (Gorlin & Teachman, in press) in which general inhibitory control (a component of attentional control) measured using the color-word Stroop paradigm moderated the relationship between threat interference biases (measured using the emotional Stroop task) and indices of trait and state social anxiety (e.g., anxiety and negative cognitions during a laboratory speech task). Specifically, among participants with weaker inhibitory control, greater social threat interference was associated with higher anxiety, whereas among participants with stronger inhibitory control, lower social threat interference was associated with greater anxiety. All in all, the current findings suggest that individual differences in AC may be important in understanding both the nature and magnitude of attentional biases in individuals with elevated social anxiety symptoms, and may in part explain variability in extant findings regarding the link between social anxiety and attentional biases for threat.

The present results extend the extant literature by pointing to the potential importance of investigating subfacets of AC and threat-related biases in anxiety, and provide evidence to support the discriminant predictive validity of ACS dimensions reported in previous research (Judah et al. 2014; Olafsson et al. 2011). Prior studies have treated AC as a unitary construct. However, the current findings suggest that specific subfacets of AC, namely AC-shifting, account for the link between social anxiety and attentional disengagement biases. The AC-focusing subscale did not explain the pattern of attentional engagement or disengagement biases. Tasks that require sustained attentional focus (e.g., continuous performance task; Conners, 2002) may be more sensitive to revealing links between social anxiety, AC-focusing, and attentional processes (Kane et al., 2007; Stawarczyk, Majerus, Catale, & D'Argembeau, 2014). Future research is needed to address that issue.

How would impoverished AC contribute to difficulties disengaging attention from threat relative to benign stimuli in individuals with high levels of social anxiety? According to dual process models of cognition and emotion (Corbetta & Shulman, 2002; Eysenck et al. 2007), anxiety is associated with a hyper-responsiveness of the bottom-up stimulus driven attentional system that facilitates processing of salient, i.e., threat-relevant information (Derakshan & Eysenck, 2009; see Taylor & Amir, 2010 for a review). To the extent that negative social information is salient for individuals with heightened social anxiety given their fears of negative evaluation, such information is likely to preferentially demand attentional resources. However, under conditions in which threatening social information is task-irrelevant (e.g., the probe follows the non-threat stimulus), individuals with poor AC will have difficulties removing their attention from threat to efficiently respond to the task at hand. Consistent with this proposal, a recent study found that individuals with elevated social anxiety symptoms displayed difficulties disengaging their attention from threat stimuli, but only under conditions of high working memory load, ostensibly when attentional control resources were taxed (Judah, Grant, Lechner, & Mills, 2013). Thus, the current and prior data demonstrate the important role of AC in the expression of anxiety-related attentional biases. These findings are consistent with neurocognitive accounts of AC in which anxious individuals have been shown to display decreased activation of prefrontal brain regions (e.g., dorsolateral prefrontal cortex) thought to play a role in down-regulating amygdala activation when processing threat-relevant information (Bishop, Duncan, Brett, & Lawrence, 2004; Bishop, 2008, 2009).

The present findings also beg the question: Can AC be maladaptive in anxiety? One might argue that individuals in the current study with high levels of social anxiety and greater AC-shifting scores demonstrated attentional avoidance of threat-relevant cues; that is, enhanced atttentional disengagement from threat vs. neutral cues. Attentional avoidance has been proposed as a putative maintaining factor in anxiety. For example, vigilance-avoidance models of anxiety (Mogg & Bradley, 1998) suggest that attentional avoidance could result in repeated brief exposures to threat stimuli, which may impede emotional processing and thereby lead threat-relevant stimuli to retain their anxiety-provoking properties (e.g., Foa & Kozak, 1986; Foa, Huppert, & Cahill, 2006). By this account, AC may facilitate strategic attentional avoidance of cues initially appraised as threat relevant [(Heeren, De Raedt, Koster, & Philippot, 2013; Mogg & Bradley, 1998; see Price and Mohlman (2007) for a similar account regarding a potential maladaptive function of strong inhibitory control in anxiety. Note, however, that attentional avoidance of threat cues has also been shown to occur in individuals with poorer shifting ability, suggesting that avoidance may not always be a controlled or strategic response to threat (Booth, 2014)]. Considered together, social anxiety may be maintained by one of two attentional mechanisms: (1) poor AC that interferes with attentional disengagement from threat stimuli under conditions in which threat cues are task-irrelevant, or (2) high AC that facilitates strategic avoidance of threat-related cues and therefore prevents adequate emotional processing of that material (see also Gorlin & Teachman, in press). To the extent that these distinct mechanisms perpetuate social anxiety, they underscore the importance of investigating AC-informed treatment targets. Experimental studies designed to manipulate different subcomponents of AC are needed to test these hypotheses.

Given that the current study design was cross-sectional, causal inferences cannot be made. However, to the extent that AC regulates the expression of biased patterns of attentional responding implicated in the development and/or maintenance of anxiety, it may serve as an important target in prevention or treatment programs. Indeed, research supports the efficacy of numerous interventions that target attention processes in treatment (see Taylor & Amir, 2010 for a review). Moreover, modulating activity in brain regions implicated in AC may influence anxiety reactivity and attentional biases (Heeren et al., 2013). For example, experimentally manipulating attentional allocation away from threat-relevant stimuli in individuals with elevated social anxiety symptoms was found to enhance activation in prefrontal brain regions implicated in AC (i.e., ventromedial prefrontal cortex; vmPFC) as well as decrease activation in limbic regions (e.g., amygdala) implicated in biased attentional responding for salient (e.g., threat-relevant) stimuli (Taylor et al., 2014; see also Britton et al., in press). Moreover, greater increases in vmPFC activation following the attentional manipulation were associated with larger reductions in attentional disengagement scores for threat cues as well as attenuated anxiety reactivity to a subsequent laboratory stressor (Taylor et al.). All in all, the current findings warrant further investigation regarding the causal role of AC and attentional biases in anxiety, and suggest that it may be informative to understand how different subcomponents of AC mechanisms confer vulnerability to anxiety.

Future research could build upon the current study in several ways. First, the present sample comprised undergraduate students, and generalizability to community and clinical samples is needed. Moreover, a non-anxious control group is needed to establish a benchmark for the seemingly enhanced attentional disengagement from threat cues observed in participants with high levels of social anxiety and greater AC-shifting scores. Second, although AC was assessed using a validated instrument, it relied on subjective participant report. Moreover, consistent with prior studies (Olafsson et al., 2011), the internal consistency of the ACS-shifting subscale was low, which suggests that all of the items may not be measuring the same latent variable, in this case, attentional shifting. It is promising, however, that prior studies found relationships between the ACS-shifting scale and cognitive-experimental tasks designed to measure attentional shifting abilities (Judah et al., 2014), supporting its convergent validity. Nevertheless, additional work is needed to strengthen the psychometric properties of the ACS. Accordingly, future research is needed to assess AC using more objective measures (e.g., Attentional Network Task; Fan, McCandliss, Sommer, Raz, & Posner, 2002).

The number of trials per trial type used in the computation of attentional bias scores is lower compared to some prior probe detection studies. Although the optimal number of trials needed to maximize reliability of attentional bias indices has not been established, this question is an important one for future research. It is also important to note that although we instructed participants to fixate their attention on a predetermined spatial location during the presentation of stimuli in order to anchor their attention, it was not possible to verify whether participants' initial attentional allocation was in the vicinity of the top face as instructed. Extensions of this research could implement recently developed variants of the probe detection task in which participants' initial attentional allocation is verified by requiring correct identification of a cue probe at the end of each trial (Rudaizky et al., 2014).

5. Conclusion

This study suggests that individual differences in AC may be important in understanding both the nature and magnitude of attentional biases in social anxiety. The current results point to the potential value of investigating subcomponents of both AC and anxiety-related attentional bias mechanisms. Future experimental research is needed to examine the causal role of AC in anxiety development and maintenance in order to inform AC-targeted intervention approaches.

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Highlights

- We assessed the link between social anxiety and threat engagement and disengagement.
- We examined whether attentional control (AC) moderated those relationships.
- Increased social anxiety related to slower threat disengagement at low levels of AC.
- Increased social anxiety related to faster threat disengagement at high levels of AC.
- AC may be an important process underlying variability in attentional bias in anxiety.

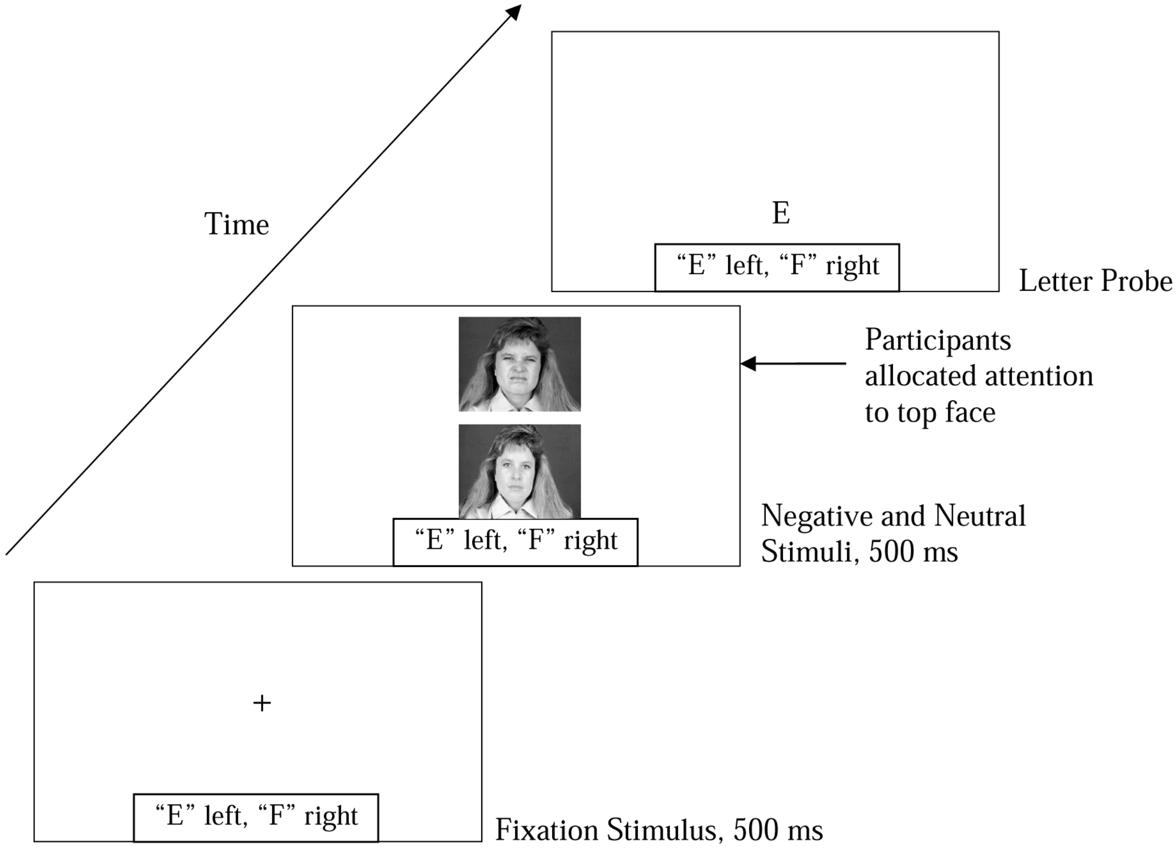

Figure 1.

This is an example of a trial in which participants must disengage from the negative stimulus to attend to the letter probe. Initial attention was anchored to the top locus by instructing participants to look at the top picture.

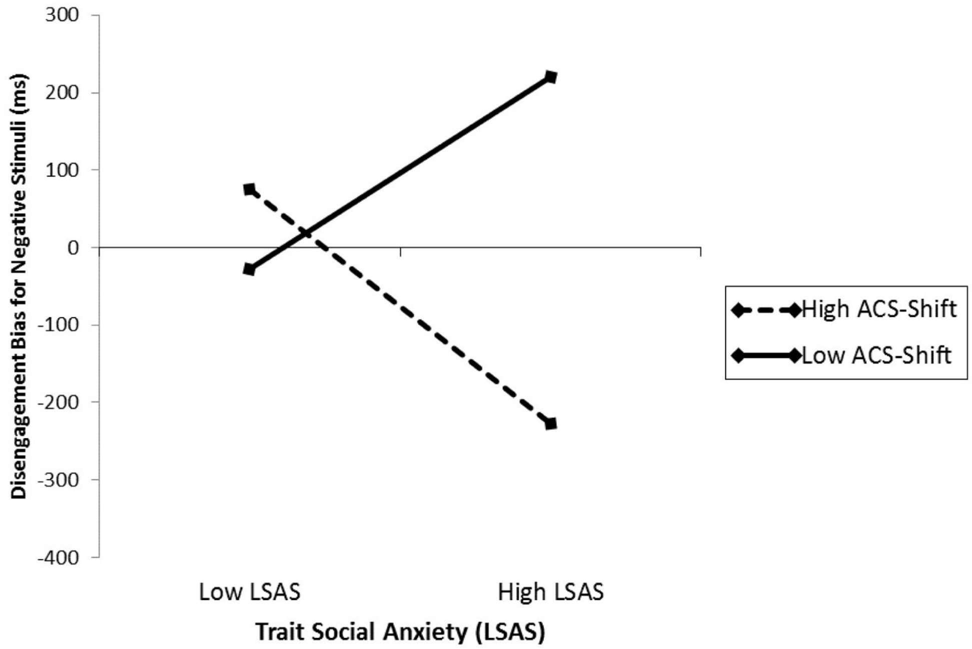

Figure 2.
Simple regression slopes of levels of attentional control – shifting (ACS – Shift) predicting disengagement bias for negative stimuli at levels of trait social anxiety (LSAS).

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Table 1

Means, standard deviations, and range of scores for the primary measures.

Measure	Mean	*SD*	Minimum	Maximum
LSAS-SR	44.58	26.19	0	128
ACS-Shifting	25.99	4.17	16	38
ACS-Focusing	21.59	4.60	11	31
Disengagement Bias	−3.77	106.45	−207.91	310.55
Engagement Bias	3.04	117.03	−309.77	295.04

Note. LSAS-SR = Liebowitz Social Anxiety Scale – Self-report; ACS = Attentional Control Scale.

Table 2

Means and standard deviations of response latencies (in milliseconds) by trial type.

	DNT	DNB	NDT	NDB	NNT	NNB
Mean	573.52	572.55	574.66	574.42	564.02	566.81
SD	126.87	134.31	134.91	135.24	120.43	111.43

Note. DNT = Disgust face top, neutral face bottom, probe replaces top face; DNB = Disgust face top, neutral face bottom, probe replaces bottom face; NDT = Neutral face top, disgust face bottom, probe replaces top face; NDB = Neutral face top, disgust face bottom, probe replaces bottom face; NNT = Neutral face top and bottom, probe replaces top face; NNB = Neutral face top and bottom, probe replaces bottom face.

Table 3

Bivariate correlations between social anxiety, attentional control, engagement and disengagement bias indices for threat stimuli.

Measure	1	2	3	4	5
1. LSAS-SR	1.00				
2. ACS-Shifting	−.35**	1.00			
3. ACS-Focusing	−.37**	−.50**	1.00		
4. Disengagement Bias	.11	−.24*	.07	1.00	
5. Engagement Bias	−.22	.19	.01	−.63**	1.00

Note. LSAS-SR = Liebowitz Social Anxiety Scale – Self-report; ACS = Attentional Control Scale.

* $p < .05$.

** $p < .01$.

Table 4

Hierarchical Regression Analyses of Individual Differences in Social Anxiety and (a) Attentional Control – Shifting and (b) Attentional Control – Focusing Predicting **Attentional Disengagement** Bias Scores for Threat Stimuli.

Moderator	**(a) ACS-Shifting**				**(b) ACS-Focusing**			
	B	***SE B***	β	**Δ*R*²**	***B***	***SE B***	β	**Δ*R*²**
Step 1				.01				.01
LSAS	.45	.48	.11		.45	.48	.11	
Step 2				.05				.01
LSAS	.13	.50	.031		.64	.52	.16	
Moderator	-5.88	3.16	−.23		2.93	2.94	.13	
Step 3				.07*				.001
LSAS	−.33	.53	−.08		.69	.54	.17	
Moderator	−6.41	3.07	−.25*		2.96	2.96	.13	
LSAS × Moderator	−.26	.11	−.28*		.03	.10	.04	

Note. ACS = Attentional Control Scale; LSAS = Liebowitz Social Anxiety Scale.

* $p < .05$.

** $p < .01$.

*** $p <$ 001.

Table 5

Hierarchical Regression Analyses of Individual Differences in Social Anxiety and (a) Attentional Control – Shifting and (b) Attentional Control – Focusing Predicting **Attentional Engagement** Bias Scores for Threat Stimuli.

Moderator	(a) ACS-Shifting				(b) ACS-Focusing			
	B	***SE B***	**β**	**ΔR^2**	***B***	***SE B***	**β**	**ΔR^2**
Step 1				.05				.05
LSAS	−.97	.52	−.22		−.97	.52	−.22	
Step 2				.02				.01
LSAS	−.77	.55	−.17		−1.11	.56	−.25	
Moderator	3.65	3.47	.13		−2.08	3.19	−.08	
Step 3				.03				.001
LSAS	−.43	.59	−.10		−1.16	.59	−.26	
Moderator	4.04	3.44	.14		−2.11	3.21	−.08	
LSAS × Moderator	.20	.13	.19		−.03	.11	−.04	

Note. ACS = Attentional Control Scale; LSAS = Liebowitz Social Anxiety Scale.

* $p < .05$.

** $p < .01$.

*** $p <$ 001.

There were no significant main or interaction effects in predicting attentional engagement bias scores for negative stimuli.