IMPACT OF AFFECTIVE TRAITS ON RESPONSE INTERFERENCE: MODULATIONS BY TRAIT NEGATIVE AFFECT, ANXIOUS AROUSAL, AND ANXIOUS APPREHENSION

BY

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THESIS

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ABSTRACT

Research suggests that elevated state negative affect (NA) reduces attentional scope and increases interference by distracting information. However, it is unclear whether and how trait NA contributes to this effect. 153 undergraduates completed the MASQ Anhedonic Depression 8-item scale to measure NA and a modified Flanker task. They also completed measures of anxious apprehension (AP; Penn State Worry Questionnaire) and anxious arousal (AA; MASQ), known to influence attention processing. Participants identified one of two target letters (X or N) among five non-target letters arranged on a circle. Non-targets were homogeneous in low perceptual load (Os) and heterogeneous in high perceptual load (K,V,S,R,J). Additionally, a foil (X or N) was presented in the center or periphery (left or right) of the display.

It was predicted 1) that flanker interference would increase with increasing trait NA, and 2) that attentional scope would decrease with higher NA. Results indicated that NA did not modulate attentional scope. However, affective traits interacted to predict flanker interference under high load central-foil conditions. Higher NA and AD were associated with increased interference, but higher AA mitigated this effect. Positive affect was also found to predict interference in high load central-foil conditions. These results highlight the role of diverse affective traits on various aspects of non-emotional attentional processing.

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1. INTRODUCTION

The ability to selectively attend to and filter out unnecessary information is an important characteristic of attentional control. Individuals are constantly faced with having to choose between stimuli that compete for attentional resources, and such choices are repeatedly shaped by bottom-up (e.g., stimulus properties; Forster & Lavie, 2008) as well as top-down influences (e.g., memory, Desimone & Duncan, 1995). A considerable amount of research in selective attention is informed by perceptual load theory (Lavie & Tsal, 1994; Lavie, 1995).

Perceptual load is manipulated in tasks of selective attention by increasing the complexity of visual stimulation in a display. For instance, in a low perceptual load condition, participants are asked to report the identity of the target letter (X or N), presented among a set of homogeneous non-target letters (e.g, five Os). In contrast, in a high perceptual load condition, the target is presented among more complex non-target letters (e.g., V, X, N, T, K). In addition to the target letter and non-target letters (presented for instance in a circular arrangement), the visual display also contains a task-irrelevant stimulus (e.g., an X or N presented at fixation or in the periphery), henceforth referred to as a foil stimulus (Lleras, Buetti, & Mordkoff, 2014). According to perceptual load theory, under conditions of low perceptual load the target identification task is sufficiently simple that it will leave enough attentional resources to process the foil stimulus (Lavie, 2005). In contrast, the complexity of visual information to be processed in conditions of high perceptual load depletes all attentional resources and consequently, the foil stimulus will not be processed.

Attentional processing of foil stimuli results in interference effects known as the Flanker effect (Eriksen & Eriksen 1974). Typically, a response conflict is observed in incompatible trials because the target (e.g., X) and foil stimulus (e.g., N) activate different responses (e.g., press button 1 for X and button 2 for N). In compatible trials, the target and foil (e.g., both Xs or both Ns) activate the same response, leading to response facilitation. The Flanker effect is computed as the difference in reaction time between incompatible and compatible trials. Under conditions of low perceptual load the foil stimulus leads to consistent interference effects, whereas conditions of high perceptual load result in reduced or null interference effects (Forster & Lavie, 2008a; Lavie & Cox, 1997; Lavie, 2005).

Importantly, the magnitude of the flanker effect has been proposed to be a robust measure of distractibility (Forster & Lavie, 2007, 2008b; Lavie, 2010) particularly at low perceptual load. For instance, higher scores on the Cognitive Failures Questionnaire (Broadbent, Cooper, FitzGerald, & Parkes, 1982) are associated with larger flanker effects at low perceptual load (Forster & Lavie, 2007). Also, individuals who score higher on a self-report measure of childhood ADHD symptomatology tend to show greater interference from rarely occurring cartoon foils (appearing in 10% of trials) in low perceptual load conditions (Forster, Robertson, Jennings, Asherson, & Lavie, 2014). Thus, the magnitude of the flanker effect at low perceptual load has been interpreted as indicative of a failure in cognitive control (Lachter, Forster, & Ruthruff, 2004; Yiğit-Elliott et al., 2011).

However, the presence of a flanker effect has also been proposed to be an indication of appropriate feature selectivity; individuals process the foil precisely because it matches the attentional template for the targets in the task (Buetti, Lleras, & Moore, 2014; Lleras et al., 2014). Thus, the magnitude of the flanker effect might instead measure failures of spatial inhibition, such as an inability to inhibit task-relevant information appearing at non-target locations (Max & Tsal, 2015), or an inability to inhibit the response activation elicited by the flankers (Lleras et al., 2014).

Of particular interest is the finding that distracting, non-emotional foils presented at fixation result in larger flanker effects and slowed reaction times compared to foils presented in the periphery (Beck & Lavie, 2005). Inhibiting attention to foils at fixation might be more difficult than inhibiting attention those in the periphery, resulting in larger filtering costs compared to peripherally presented distractors. The ability to selectively filter out information appearing in the periphery is consistent with evidence that the breadth of attentional space can be narrowed or broadened based on the location of information in the visual field (Ahmed & de Fockert, 2012; Castiello & Umiltá, 1990; Eriksen & St James, 1986).

Influence of Affective Traits on Selective Attention

Affective traits and states can also influence selective attention (Vuilleumier, Armony, & Dolan, 2003) and the scope of attention. An early hypothesis linking affect and attention affirms that symptoms of anxiety, such as high physiological arousal and negative valence, reduce perceptual attention space (Easterbrook, 1959). This theory has been extended to include evidence regarding the ways in which affective states influence stimulus feature processing – for example, that details are processed locally under negative mood and globally under positive mood (Basso, Schefft, Ris, & Dember, 1996; Kimchi & Palmer, 1982). Current research also suggests a relationship between affect and attention such that negative affect (NA) narrows, and positive affect (PA) broadens the scope of attention (Fredrickson & Branigan, 2005; Fredrickson, 2001; Friedman & Förster, 2010; Gasper & Clore, 2002; Gasper, 2004). However, several studies have found little or no effects of PA on attentional broadening in response to emotional face stimuli (Grol & De Raedt, 2014) and in non-emotional flanker task paradigms (Bruyneel et al., 2013; Huntsinger, 2013; Huntsinger, 2012).

Several experiments have employed mood induction paradigms to investigate the relationships between affective state and distracting emotional stimuli (see Yiend, 2010 for a review). Studies of negative mood induction have reported differences in attention towards (Chepenik, Cornew, & Farah, 2007; Donaldson, Lam, & Mathews, 2007; Farach, Treat, & Jungé, 2014) and difficulty disengaging from negatively-valenced stimuli (e.g., words, faces; Bradley, Mogg, & Lee, 1997; Morrison & O'Connor, 2008). However, it remains unclear whether these differences are due to stimulus valence, the induced emotional state, or an interaction between the two. Additionally, mood induction experiments currently do not consider how affective traits contribute to attentional broadening or narrowing above and beyond state mood inductions.

Elevated NA is a fundamental characteristic of depression, which is known to impact several aspects of executive functioning (see Snyder, 2013 for a review), including inhibition and cognitive control (Joormann & Vanderlind, 2014; Lyubomirsky, Kasri, & Zehm, 2003; Nolen-Hoeksema & Morrow, 2008). Symptoms of depression also impact selective attention. For example, individuals with depression show greater impairments disengaging from negative stimuli (Koster, Raedt, Verschuere, Tibboel, &

De Jong, 2009), and are more likely to avoid directing their attention towards positive stimuli (Gotlib, Krasnoperova, Neubauer Yue, & Joormann, 2004; see Joorman & Vanderlind, 2014 for a review). Higher depression and rumination scores are associated with increased interference by negative distractors, and with decreased interference by positive distractors in emotional word flanker tasks (Pe, Vandekerckhove, & Kuppens, 2013; Zetsche & Joormann, 2011). Taken together, these results indicate that individuals with higher depressive symptoms experience greater interference effects, especially in the presence of negative emotional stimuli.

On a neural level, it has been reported that in conditions of high perceptual load and peripheral letter distractors, individuals with unipolar depression showed greater deactivation of visual cortical regions and less functional connectivity between visual and fronto-parietal regions compared to non-depressed controls during a pop-out task (Desseilles et al., 2009). This result provides evidence that individuals with depression demonstrate abnormal patterns of brain activity during relatively simple attention tasks, which may negatively impact the deployment of attentional resources for processing information. Other studies have found that individuals with higher levels of depressive symptoms demonstrate greater amygdala activation and less activation in dorsolateral prefrontal cortex– a region thought to be involved with allocation of attention resources – in response to emotional stimuli (e.g., words, faces) than individuals with lower levels of depressive symptoms (Crocker et al., 2012; Fales et al., 2008; Iordan, Dolcos, & Dolcos, 2013). These findings suggest that individuals with depressive symptomatology likely experience greater bottom-up interference from distracting emotional words and faces than non-depressed individuals.

Despite the wealth of evidence supporting impaired attentional functioning among individuals with depressive symptoms, few studies to date have incorporated manipulations of perceptual load into emotional attention paradigms. Note, however, that there is also evidence of increased vigilance and improved behavioral performance during non-emotional flanker tasks (Dillon et al., 2015; Rowe, Hirsh, & Anderson, 2007) and tasks of verbal selection (Snyder et al., 2014) among individuals with depression, which highlights a discrepancy in the understanding of how depressive symptomatology impacts selective attention.

It is possible that the increased vigilance and interference effects observed among individuals with high depressive symptoms might be partially explained by the impairing effects of co-occurring anxiety on attention. Research has shown that in conditions of high perceptual load, higher trait anxiety was associated with greater interference by non-emotional distractors, while under conditions of low and moderate perceptual load, lower trait anxiety was associated with greater interference (Sadeh & Bredemeier, 2011). However, it has also been reported that in conditions of low perceptual load (but not high perceptual load), individuals with high trait anxiety were slower to identify targets surrounded by incompatible, non-emotional distractors (Bishop, 2009). This result was coupled with neuroimaging findings that high trait-anxious individuals showed less activation of the dorsolateral prefrontal cortex in conditions of low perceptual load with incompatible distractors and targets (Bishop, 2009). Overall, these findings indicate that increased trait anxiety appears to be associated with disrupted prefrontal activation and behavioral differences in responding to targets in the face of incompatible foil distractors.

It is worth mentioning that many studies of anxiety and attention do not distinguish between types of anxiety, specifically, anxious arousal (AA) or anxious apprehension (AP), which have been shown to capture two separable dimensions of anxiety (Nitschke, Heller, Imig, McDonald, & Miller, 2001). AA reflects a more somatic response to stimuli (i.e., physiological arousal, hypervigilance) (Clark & Watson, 1991; Watson, Weber, et al., 1995) and is associated with a unique set of symptoms and neural circuitry (Engels et al., 2010; Heller, Nitschke, Etienne, & Miller, 1997). AP is characterized by the experience of worry, primarily regarding future outcomes, and is considered a distinct cognitive process from rumination (Fresco, Frankel, Mennin, Turk, & Heimberg, 2002; Nolen-Hoeksema, 2008). AP is also associated with activity in set of neural circuits distinguishable from AA (Engels et al., 2007; Heller et al., 1997; Nitschke et al., 1999). AA and AP have been shown to modulate the degree to which unexpected stimuli are noticed during tests of inattentional blindness – for example, it was reported that high scores of anhedonic depression (AD) in the presence of either high AA or high AP (but not both) were associated with increased noticing (Bredemeier, Hur, Berenbaum, Heller, & Simons, 2014). It seems possible that trait AA and AP exert differential effects on attentional scope in the face of varying perceptual loads and distractor locations, yet these relationships have not been studied. As depression and anxiety symptoms commonly co-occur, it seems reasonable to determine whether these traits, along with trait NA or AD, contribute to moderating the scope of attention.

Current study

The present study employed the modified flanker task used by Beck and Lavie (2005), in which perceptual load was manipulated by varying the complexity of the search displays. Set size was held constant during the experiment while perceptual load was manipulated. This practice reduces possible concerns proposed by dilution theory (Tsal & Benoni, 2010), which states that changing set sizes alters the degree of dilution created by the non-target letters. Also, note that the present study only manipulated perceptual load and not cognitive load (see Lavie, Hirst, de Fockert, & Viding, 2004).

In line with previous findings supporting the relationship between high NA, attentional narrowing, and greater interference for information in central field of view, it was predicted that interference would be positively associated with trait NA, particularly for centrally located foils under conditions of high perceptual load. Second, it was expected that attentional scope would be narrowed in the presence of increasing trait NA, as measured by decreased interference by peripheral foils under low perceptual load compared to individuals with lower trait NA. Finally, because symptoms of depression and anxiety subtypes are known to co-occur across individuals, exploratory analyses using linear mixed-effects models were also conducted. More precisely, the impacts of NA, AD, AA, and AP on low and high perceptual load conditions were evaluated separately for centrally and peripherally presented foils. As foils appearing at fixation are always within the attention span in the task, analyses of these conditions may reveal difficulties in inhibiting the response activated by foils. In contrast, foils appearing in the periphery might create effects that depend on the size of the breadth of attention.

2. METHODS

Participants. A power analysis revealed that a sample size of N=153 was required to obtain a significant correlation of 0.20 with 80% power. The first 153 participants that met the inclusion criteria (listed below) were included in analyses. Participants were recruited from the University of Illinois at Urbana-Champaign for course credit. Twenty-eight participants were compensated for their participation in the present study in lieu of course credit. All of the participants had normal color vision and normal or corrected-to-normal visual acuity. The final sample submitted to analyses consisted of 153 participants (58% female) with an average age of 19.4 years (range 18-31). Participants reported their race or ethnicity as White (39.9%), Asian (44.4%), Latino/a (8.5%), Black (5.9%), or other (1.4%).

Self-report measures. To better evaluate depressive and anxiety trait-like symptoms, anhedonic depression (AD) and anxious arousal (AA) were distinguished from anxious apprehension (AP) using scales from the Mood and Anxiety Symptoms Questionnaire (MASQ, Watson, Clark, et al., 1995; Watson, Weber, et al., 1995). This is in line with previous research supporting the distinction and utility of these scales in capturing dimensions of depression and anxiety (Bredemeier et al., 2010; Nitschke et al., 2001). Furthermore, depression is characterized by the unique presence of low PA in concert with high NA (Clark & Watson, 1991). Thus, the AD scale was decomposed into an 8-item NA subscale and a 14-item PA subscale, based on previous research that confirms the relationship between these factors (Nitschke et al., 2001; Bredemeier et al., 2010). Items in the NA subscale include “Felt withdrawn from other people,” and “Felt like nothing was very enjoyable.” Items in the PA subscale include “Felt optimistic,” “Felt like I had a lot of energy.” The PA items are typically reverse-scored, but for the analyses presented here, raw scores were used such that low scores reflected low PA. Item 38 of the MASQ (“thought about death or suicide”) was not administered. Thus, the AD score reflects the sum of 21 items and the NA subscale the sum of 7 items. Last, personality traits were assessed using a 50-item scale constructed from the International Personality Item Pool (IPIP; Goldberg et al., 2006), which is closely aligned with the Five Factor Model of personality traits (Costa & McCrae, 1992). Specific personality factors assessed include trait Extraversion, Agreeableness, Emotional Stability, Intellect and Imagination, and Conscientiousness, although these data were not evaluated in the present study. The final sample consisted of 83 participants who received the Google version of the questionnaires, and 70 participants who completed the measures in E-Prime and did not meet the exclusion criteria below for missing data. Values for any missing items among included participants were interpolated using the subscale average.

The Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990) was administered to assess trait anxious apprehension (AP; Brown, Antony, & Barlow, 1992). Note that the MASQ-AA and PSWQ have been established as complimentary scales that capture two separable dimensions of anxiety (Nitschke et al., 2001). While the use of these measures does not confer clinical diagnoses, research indicates that these measures are relatively accurate at distinguishing individuals with depression and/or anxiety from healthy individuals (Nitschke et al., 2001; Bredemeier et al., 2010; Fresco et al., 2003). The use of multiple symptom measures also supports a dimensional framework for understanding symptoms that tend to co-occur across diagnoses, as in depression and anxiety.

Exclusion criteria. Participants were removed if accuracy at the Flanker task was below 70% (N = 18). Participants were also removed if they (accidentally or voluntarily) skipped more than one item on subscales of the MASQ and PSWQ (N = 25), and on the trait Extraversion, Emotional Stability, or Conscientiousness subscales from the IPIP (N=26; data not reported here). The reason why so many participants failed to respond to one or more items is because the Self-report measures were initially administered electronically using the E-Prime 2.0 software ("E-Prime," 2012). Participants were instructed to press the space bar to advance to the next item. As the computer program was not waiting for a number to be entered before advancing, this caused some participants to inadvertently (or perhaps voluntarily) skip items on the self-report measures. Missing more than one item on subscales of the MASQ, PSWQ, or trait scales from the IPIP may threaten the internal reliability of individual subscale scores, which explains the exclusion criteria above.

Stimuli and Apparatus. The experiment was run on a PC, using Matlab, and programmed in the Psychophysics Toolbox, version 3 (Brainard, 1997; Pelli, 1997). Stimuli were presented on a 20-inch CRT monitor with a 1024×768 resolution. The viewing distance for stimuli was 50cm, and participants were stabilized by a chinrest to ensure consistency across the experiment.

Stimuli were shown in light grey and were presented on a black background. All letters were presented in font type "Arial" and the target and distractor letters suspended 0.54° (vertically) while the foil distractor suspended 0.67° (vertically) of visual angle. The foil appeared 1.3 times larger than target and distractor letters. Each trial began with a small fixation circle on the center of the screen, which subtended 0.23 degrees of visual angle, and was followed by a search display of letters positioned in the form of a circle with a radius of 2 degrees. The search display contained five of six possible non-target letters (S,K,V,J,R, or Os), and one target letter (X or N). In addition, a foil (X or N) was also presented on the display. The foil was presented either in the periphery (3.5 degrees to the left or the right of fixation) or at fixation. Compatible trials occurred when the target and foil letters matched; incompatible trials occurred when the target and foil letter did not match.

Procedure. All participants completed the self-report measures on a computer before starting the flanker task. During the flanker task, a fixation circle was displayed on the center of the screen for 2000ms at the start of each trial. Then, the circular search display (containing the target and non-target letters) and the foil were then presented for 200ms. Participants were asked to search for the target letter (X or N) on the circular display of letters while ignoring the peripheral or central foil. The target letter could appear at any position on the circle. Participants reported the identity of the target letter with the right or left arrow keys, using the right and left index fingers. In low perceptual load conditions, the non-target letters were all homogeneous (i.e., they were all Os, Figure 1). In high perceptual load conditions, the non-target letters were heterogeneous (S, K, V, J, R, Figure 1). The foil was always an X or N.

Design. Participants first completed a practice block of 96 trials and then two experimental blocks of 288 trials each (576 trials total). Assignment of each target letter to the response keys was counterbalanced across participants. One block of trials contained foils presented at fixation, and another block of trials contained foils presented in the periphery. The presentation of these blocks was counterbalanced across participants. Four experimental conditions were then counterbalanced within each block: (1) low perceptual load display with incompatible foil; (2) low perceptual load display with compatible foil; (3) high perceptual load display with incompatible foil; (4) high perceptual load display with compatible foil.

Figures

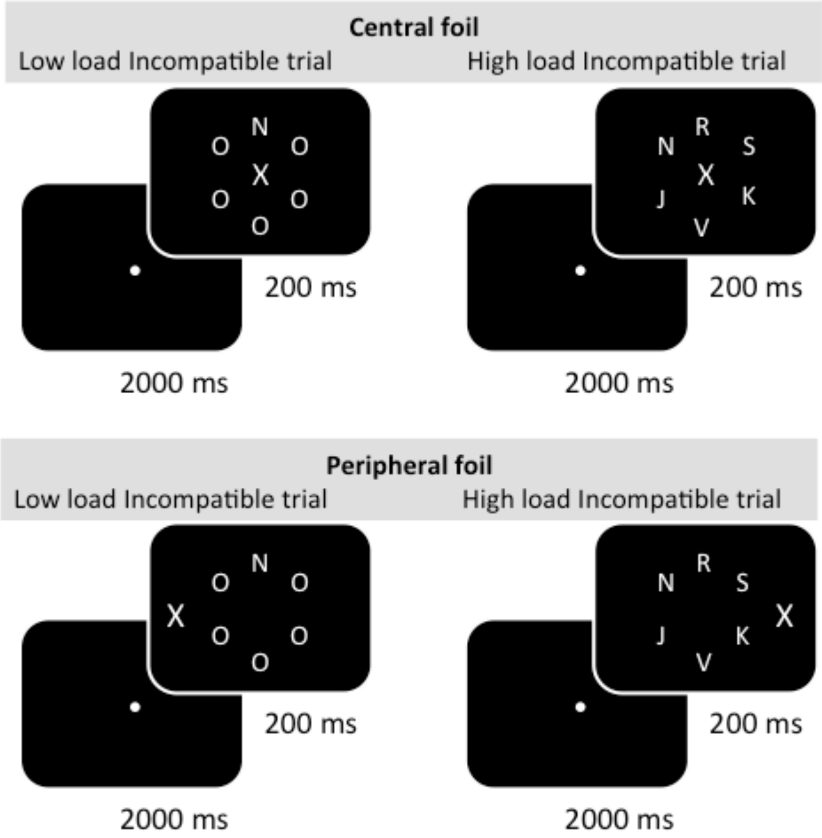


Figure 1. Example of displays (not drawn to scale) with central foils (top panel) and peripheral foils (bottom panel). Participants were asked to search for the letter X or N among the non-target letters on the circle while ignoring the foil. Examples of low and high perceptual load conditions and incompatible trials are depicted.

3. RESULTS

All raw scores from questionnaire data were transformed into Z scores. The MASQ-AD scale was split into two subscales: a 7-item negative affect (NA) and 14-item positive affect (PA) scale to examine the effects of these subscales on the level of flanker interference. RTs that were ± 2SD from each participant's average RT for correct trials were truncated. The level of interference (i.e., flanker effect) was calculated by subtracting the reaction time for compatible trials from incompatible trials on correct trials only (8.4% of trials were excluded). Table 1 shows the means and standard deviations of the flanker effect in all four interference conditions (Low Load Central; High Load Central; Low Load Peripheral; High Load Peripheral) and the affective trait scales.

Analyses of the Flanker Effect

To verify that the manipulations of load and distractor location were successful, repeated-measures ANOVA was conducted with load and location as within-subjects factors. The results indicated significant main effects of load, $F(1,152) = 15.5$, $p < .001$, $\omega_p^2 = 0.086$, and foil location, $F(1,152) = 87.4$, $p < .001$, $\omega_p^2 = .359$, confirming previous findings in the literature. Interference was greater in conditions of low perceptual load compared to high perceptual load, and also in trials with central foil distractors compared to peripheral distractors. The load by location interaction was not significant, $F(1,152) = 0.273$, $p = 0.602$.

Following the first hypothesis, the relationship between trait NA and flanker interference under conditions of high perceptual load with central foils was tested.

Bivariate correlations indicated that the NA subscale was not significantly correlated with any of the interference variables (Table 2; all *r*s < 0.2, all *p*s > 0.1). Results of regression analysis indicated that the NA subscale did not significantly predict interference for High Load Central, $R^2= .002$, F(1,151)=.001, *p*=.98, β = -.11. Regression analyses using the full AD score also did not significantly predict interference for High Load Central condition, $R^2= .004$, F(1,151)=.63, *p*=.43, β =3.87.

The second hypothesis tested was that attentional scope would decrease with higher NA, as evidenced by decreased interference scores in conditions with peripheral foils under conditions of low perceptual load. Results of regression analysis indicated that the NA subscale did not significantly predict interference for Low Load Peripheral, $R^2< .001$, F(1,151)=.009, *p*=.92, β = -.008. Regression analyses using the full AD score also did not significantly predict interference for Low Load Peripheral, $R^2< .001$, F(1,151)=.048, *p*=.83, β = -.018

Exploratory Analyses

Linear mixed-effects models were used to test the impacts of NA, AD, AA, and AP on low and high perceptual load conditions. This was done separately for central and peripheral foils using the 'lme' function in RStudio (version 0.99.902, http://www.rstudio.com). A total of 16 models were evaluated and maximum-likelihood selection was used to identify the model of best fit. Model 1 consists of the simple main effect of Load, which is the typical effect analyzed in the literature. Models 2-5 evaluated the interaction between perceptual load and combinations of anhedonic depression (AD) and anxiety (AA and AP) to investigate the role of these components in modulating flanker interference; Models 6-9 evaluate the interaction between Load and combinations of negative affect (NA) and anxiety (AA and AP); Models 10-13 evaluate the interaction between positive affect (PA) and anxiety (AA and AP); Models 14-16 evaluate the interaction between Load and combinations of anxiety (AA, and PA).

For each set of models (Models 1, 2-5, Models 1, 6-9. Models 1,10-13, and Models 1,14-16), the best fitting model was identified as the model with the highest Akaike weights (w_{model}) computed from AIC values (Wagenmakers & Farrell, 2004). Evidence ratios were computed within each subset of models (Models 2-5, 6-9, 10-13, and 14-16, e.g., Snipes & Taylor, 2014) by dividing the Akaike weight of best fitting model by the weight of each remaining model in the subset, $(\frac{w_{best}}{w_i})$ (Wagenmakers & Farrell, 2004). This step verifies the strength of the evidence from the Akaike weights in favor of one model over another. Normalized probabilities were then computed between individual models and the best model within each group of models, so as to quantify the likelihood that the preferred model was the best fit, $(\frac{w_{best}}{w_{best}+w_i})$ (Wagenmakers & Farrell, 2004). Likelihood ratios (LR) were also calculated to indicate whether a model that includes affective traits is preferred over the reduced model (i.e., Model 1) by subtracting the -2(log) likelihood of the reduced model from the -2(log) likelihood of the model of interest. Tables 3 and 4 report the results of model selection and the computed statistics. Finally, ANOVA was conducted in RStudio with the best fitting models to understand the impact of perceptual load and affective traits on Flanker interference. Only the significant statistics including the interactions between perceptual load and affective traits are discussed below (though all statistics are provided in Table 5), because these tests are theoretically relevant to answer the question of whether affective traits modulate flanker interference.

Results for Central foils: For Models 2-5, the model including the interaction between Load, AD, and AA (Model 3) was the best fit among all models including affective traits ($w_{3(AIC)}$ = 0.389). The normalized probability values also indicated that Model 3 was 62% more likely than a simpler model including the interaction between Load and AD ($w_{2(AIC)}$ = 0.235) and 54% more likely than Model 1 ($w_{1(AIC)}$ = 0.338, LR= 12.3) to be the best fitting model. For Models 6-9, the model including the interaction between Load, NA, and AA (Model 7) was the preferred model among all models including affective traits ($w_{7(AIC)}$ = 0.455). Normalized probability values indicated that Model 7 was 87% more likely than a simpler model including the interaction between Load and NA ($w_{6(AIC)}$ = 0.07). When compared to Model 1, Model 7 was 55% more likely to be the best fitting model ($w_{1(AIC)}$ = 0.459, LR=12.0).

ANOVA with Model 3 (Load by AD by AA) and Model 7 (Load by NA by AA) indicated a significant interaction between Load, AD, and AA, F(1,149) = 4.74, *p* = 0.031, ω_p^2 = .024, and between Load, NA, and AA, F(149) = 7.04, *p* = 0.009, ω_p^2 = .038. The interaction between AD and AA (Fig. 2a), and between NA and AA (Fig. 2b) showed similar effects on performance: affective traits only impacted performance under high load conditions and not under low load conditions.

To better understand this pattern of results and quantify the magnitude of the effects, multiple regression analyses were conducted (Table 6) and interaction plots were generated (Figure 3). Interaction plots were created using simple slopes analyses according to previously established methods (Aiken & West, 1991; Dawson & Richter, 2006). Unstandardized regression coefficients from each model tested were used to see how the interference at high load varied at different combinations of low and high trait scores. Scores that are considered “low” or “high” (Figure 3a, b) refer to scores that are ± 1 SD.

A multiple regression model including NA, AA and their interaction to predict interference in High Load Central trials was significant, explaining 5.3% of the variance in interference, and the NA x AA interaction term significantly predicted interference (Fig. 3a). Multiple regression analysis predicting interference in High Load Central trials with AD, AA, and their interaction indicated that the full model explained 4.6% of the variance, reaching trend-level significance. The interaction of AD and AA significantly predicted interference (Fig. 3b). In both panels of the interaction plots, a similar pattern emerged whereby the presence of high AA resulted in increased interference in the presence of low NA or low AD, and decreased interference in the presence of high NA or high AD. Regression analyses with both models did not significantly predict interference in the Low Load Central condition.

For Models 10-13, the model including the interaction between Load and PA (Model 10) was the best fit among all models including affective traits ($w_{10(AIC)} = 0.455$). Normalized probability values indicated that Model 10 was 79%, 90%, and 99% more likely than Models 11-13, respectively, to be the best fitting model. Note that Models 11-13 consist of interaction terms between PA, AA, and AP. The evidence ratio for Model 10 indicated that it was 1.2 times more likely than Model 1 to be the best fitting model ($w_{1(AIC)} = 0.372$, LR=4.4). ANOVA with Model 10 indicated a significant interaction between Load and PA, $F(1,151) = 4.38$, $p = 0.038$ Under conditions of high perceptual load, interference was negatively associated with PA, whereas under conditions of low perceptual load, interference was positively associated with PA (Figure 4).

Finally, for Models 14-16, there was no best fitting model ($w_{14(AIC)}$ = 0.138, $w_{15(AIC)}$ = 0.141, $w_{16(AIC)}$ = 0.121), and the normalized probabilities indicated that Model 1 was 81% more likely than Models 14 and 15 and 83% more likely than Model 16 to be the best fitting model.

Results for peripheral foils: None of the sets of models tested were more parsimonious than Model 1, so no further analyses were conducted.

Figures and Tables

Table 1. Descriptive statistics

	M (SD)
Low Load Central	73.6 (51.7)
High Load Central	61.5 (59.8)
Low Load Peripheral	36.9 (44.6)
High Load Peripheral	21.4 (50.0)
AA	39.8 (6)
AD	44.4 (17.8)
AP	52.4 (14)
NA	15.6 (3.59)
PA	46.1 (11.7)

Table 2. Correlations of Flanker effect as a function of Load (high vs. low) and Location (central vs. periphery with trait measures.

	Low Load Central	High Load Central	Low Load Peripheral	High Load Peripheral
AD	-.105	.065	-.018	.021
AA	.073	.064	-.021	.028
AP	.033	.079	.125	.127
NA	-.04	-.002	-.008	.001
PA	.115	-.081	.02	-.027
* *p* <.05 (2-tailed)				

Table 3. Maximum likelihood comparisons among linear mixed effects models of flanker interference in trials with central foil distractors. The best fitting model for each subset of models is presented in boldface. ER values indicate the strength of evidence for the preferred model over others; N Pr values indicate the normalized probability that the preferred model provides the best fit. LR values compare models with affective traits to Model 1.

Model			Model Selection Statistics						
	Fixed effects	df	AIC	LL	BIC	w_i (AIC)	ER_i	N Pr	LR
1	flanker~Load	5	3320.4	-1655.2	3339.0	.338	1.15	.535	.00
2	flanker~Load* AD	7	3321.1	-1653.6	3347.2	.235	1.66	.624	3.28
3	**flanker~Load* AD* AA**	**11**	**3320.1**	**-1649.1**	**3361.1**	**.389**	**1.00**		**12.3**
4	flanker~Load* AD* AP	11	3324.9	-1651.5	3365.9	.036	10.8	.916	7.52
5	flanker~Load* AD* AA* AP	19	3330.7	-1646.4	3401.5	.002	199	.995	17.7
1	flanker~Load	5	3320.4	-1655.2	3339.0	.459	1.00	.501	.00
6	flanker~Load* NA	7	3324.2	-1655.1	3350.3	.070	6.60	.868	.232
7	**flanker~Load* NA* AA**	**11**	**3320.4**	**-1649.2**	**3361.4**	**.461**	**1.00**		**12.0**
8	flanker~Load* NA* AP	11	3329.0	-1653.5	3370.0	.006	72.9	.986	3.43
9	flanker~Load* NA* AA* AP	19	3330.2	-1646.1	3401.0	.003	135	.993	18.2
1	flanker~Load	5	3320.4	-1655.2	3339.0	.373	1.22	.550	.00
10	**flanker~Load* PA**	**7**	**3320.0**	**-1653.0**	**3346.1**	**.455**	**1.00**		**4.40**
11	flanker~Load* PA* AA	11	3322.7	-1650.3	3363.7	.119	3.81	.792	9.73
12	flanker~Load* PA* AP	11	3324.4	-1651.2	3365.3	.052	8.75	.897	8.06
13	flanker~Load* PA* AA* AP	19	3332.1	-1647.1	3402.9	.001	421	.998	16.3
1	**flanker~Load**	**5**	**3320.4**	**-1655.2**	**3339.0**	**.599**	**1.00**		**.00**
14	flanker~Load* AA	5	3323.4	-1654.7	3349.4	.138	4.33	.813	1.07
15	flanker~Load* AP	11	3323.3	-1654.7	3349.4	.141	4.25	.810	1.06
16	flanker~Load* AA* AP	11	3323.6	-1650.8	3364.6	.121	4.94	.832	8.80

df: degrees of freedom; AIC: Akaike Information Criteria; LL: -2log likelihood; BIC: Bayesian Information Criteria; w_i(AIC): Akaike weights; ER_i: Evidence Ratio; N Pr: Normalized Probability; LR: Likelihood Ratio

Table 4. Maximum likelihood comparisons among linear mixed effects models of flanker interference in trials with peripheral foil distractors. The best fitting model for each subset of models is presented in boldface. ER values indicate the strength of evidence for the preferred model over others; N Pr values indicate the normalized probability that the preferred model provides the best fit. LR values compare models with affective traits to Model 1.

Model			Model Selection Statistics						
	Fixed effects	df	AIC	LL	BIC	w_i (AIC)	ER_i	N Pr	LR
1	**flanker~Load**	**5**	**3222.2**	**-1606.1**	**3240.9**	**.851**	**1.00**		**.00**
2	flanker~Load*AD	7	3226.1	-1606.0	3252.1	.125	6.79	.872	.169
3	flanker~Load* AD* AA	11	3232.8	-1605.4	3273.7	.004	195	.995	1.46
4	flanker~Load* AD* AP	11	3229.8	-1603.9	3270.8	.019	44.5	.978	4.41
5	flanker~Load* AD* AA* AP	19	3240.2	-1601.1	3311.0	.000	8022	1.00	10.0
1	**flanker~Load**	**5**	**3222.2**	**-1606.1**	**3240.9**	**.824**	**1.00**		**.00**
6	flanker~Load* NA	7	3226.2	-1606.1	3252.3	.112	7.36	.880	.010
7	flanker~Load* NA* AA	11	3231.7	-1604.9	3272.7	.007	114	.991	2.53
8	flanker~Load* NA* AP	11	3227.6	-1602.8	3268.6	.056	14.7	.936	6.62
9	flanker~Load* NA* AA* AP	19	3238.8	-1600.4	3309.5	.000	3919	1.00	11.5
1	**flanker~Load**	**5**	**3222.2**	**-1606.1**	**3240.9**	**.844**	**1.00**		**.00**
10	flanker~Load* PA	7	3226.0	-1606.0	3252.1	.129	6.53	.867	.247
11	flanker~Load* PA* AA	11	3233.3	-1605.6	3274.2	.003	248	.996	.975
12	flanker~Load* PA* AP	11	3229.6	-1603.8	3270.6	.021	39.5	.975	4.65
13	flanker~Load* PA* AA* AP	19	3235.0	-1598.5	3305.8	.001	590	.998	15.2
1	**flanker~Load**	**5**	**3222.2**	**-1606.1**	**3240.9**	**.484**	**1.00**		**.00**
14	flanker~Load* AA	7	3226.0	-1606.0	3252.0	.074	6.58	.868	.278
15	flanker~Load* AP	7	3222.4	-1604.2	3248.5	.428	1.13	.531	3.80
16	flanker~Load* AA* AP	11	3229.3	-1603.6	3270.2	.014	34.6	.972	4.96

df: degrees of freedom; AIC: Akaike Information Criteria; LL: -2log likelihood; BIC: Bayesian Information Criteria; w_i(AIC): Akaike weights; ER_i: Evidence Ratio; N Pr: Normalized Probability; LR: Likelihood Ratio

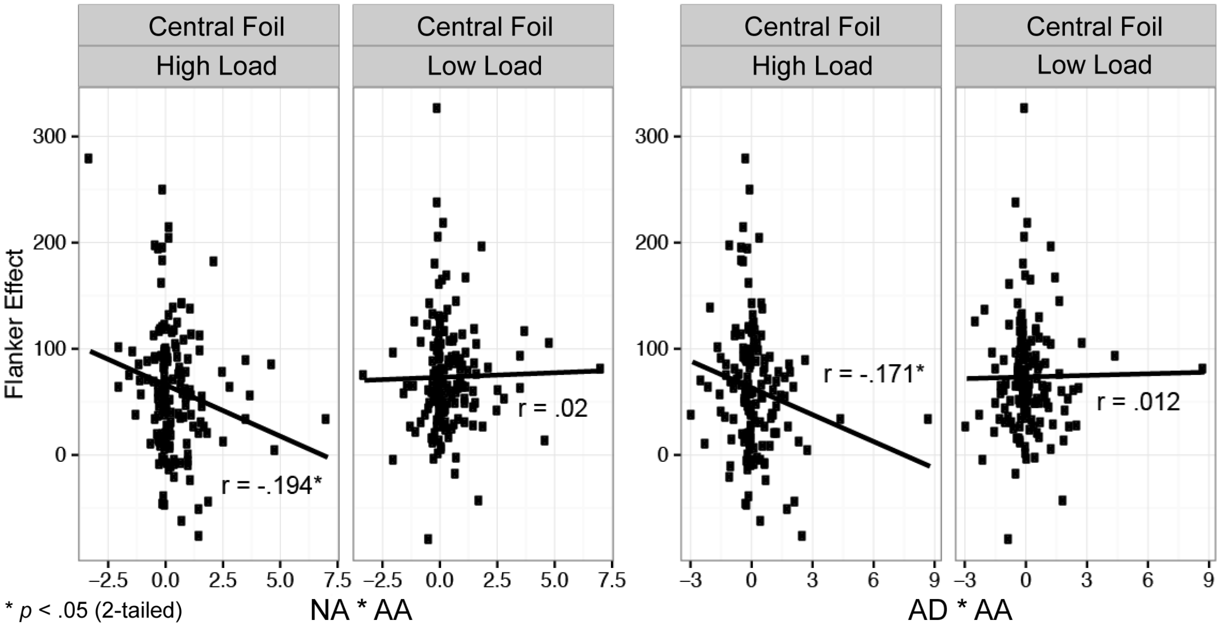
Table 5. Results of ANOVA for the best fitting models

Model		F	*p*	Partial ω^2	df	df_e
3	Intercept	335	< .001	.689	1	149
Load, AD, AA	Load	5.55	.020	.029	1	
Central foils	AD	.045	.832	-.006	1	
	AA	1.21	.274	.001	1	
	AD * AA	2.82	.095	.012	1	
	Load *AD	3.28	.072	.015	1	
	Load * AA	.134	.715	-.006	1	
	Load * AD * AA	4.74	.031	.024	1	
7	Intercept	337	< .001	.690	1	149
Load, NA, AA	Load	5.52	.020	.029	1	
Central foils	AA	.176	.187	-.005	1	
	NA	.088	.767	-.006	1	
	AA * NA	2.86	.093	.012		
	Load * AA	.034	.853	-.006	1	
	Load * NA	.147	.702	-.005	1	
	Load * NA * AA	7.05	.009	.039	1	
10	Intercept	331.4	< .001	.680	1	151
Load, PA	Load	5.49	.020	.029	1	
Central foils	PA	.021	.884	-.006	1	
	Load * PA	4.38	.038	.022	1	

Table 6. Regression analyses predicting interference under high perceptual load and central foils.

	B	SE(B)	β	t	*p*	R^2	F	df	Overall *p*
Model 1									
Constant	63.6	4.85		13.1	< .001	.046	2.38	3, 149	.072
AD	2.95	4.89	.049	.603	.547				
AA	6.79	5.10	.113	1.33	.186				
AD * AA	-10.1	4.11	-.206	-2.47	.015				
Model 2									
Constant	66.5	5.14		13.0	< .001	.053	2.79	3, 149	.043
NA	-.264	5.45	-.004	-.048	.960				
AA	7.94	5.50	.133	1.44	.150				
NA * AA	-11.5	4.19	-.231	-2.74	.007				

Figure 2. Scatter plot showing the interactions of perceptual load by negative affect (NA) by anxious arousal (AA) (a), and load by anhedonic depression (AD) by AA (b) for central foil trials. Correlation coefficients between the interaction terms and interference condition are shown in each panel.



* *p* < .05 (2-tailed)

Figure 3. Interaction of NA, AA under high perceptual load with central foils (a) and the interaction of AD, AA in high perceptual load with central foils (b)

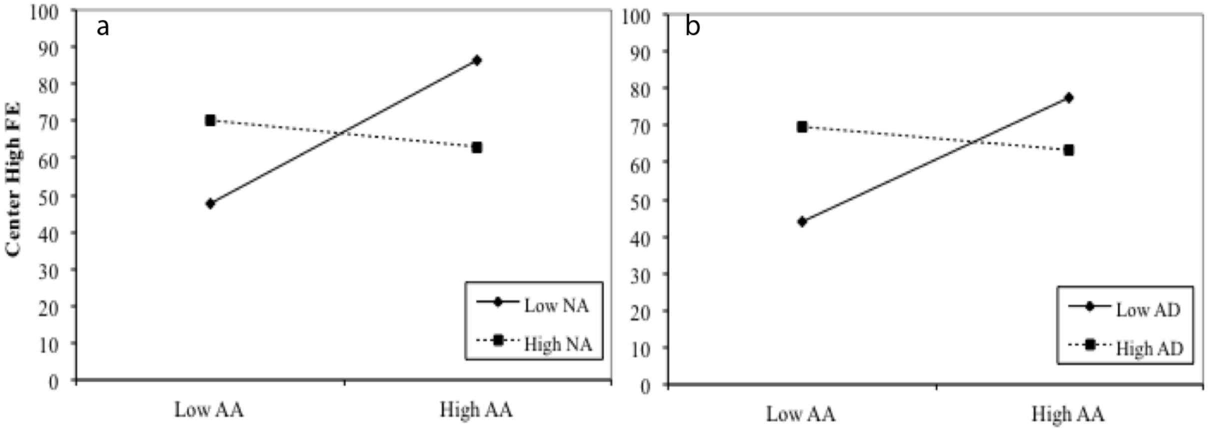
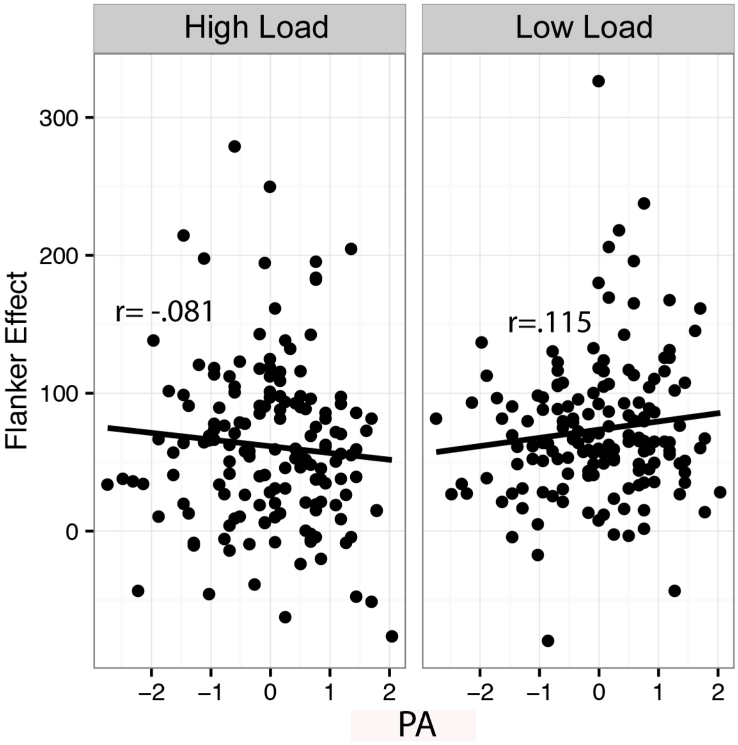


Figure 4. The interaction between positive affect (PA) score and perceptual load for trials with central foils



4. DISCUSSION

In the present study, it was predicted that for central foils, interference would be positively associated with trait NA or AD under conditions of high perceptual load. Second, it was expected that for peripheral foils, attentional scope would be narrowed in the presence of increasing trait NA or AD under conditions of low perceptual load. Overall, the results reported here indicate that, considered individually, neither negative affect nor anhedonic depression modulated the level of interference resulting from central or peripheral foils.

The goal of the exploratory analyses was to investigate whether combinations of affective traits play a role in modulating interference effects. For central foils, the linear mixed-effects model comparisons revealed that indeed, anhedonic depression and anxious arousal interacted to affect interference under conditions of high perceptual load. Specifically, interference was increased among individuals with higher levels of one trait (e.g., high anhedonic depression or high anxious arousal), suggesting that after processing the high perceptual load display, additional attentional resources were available to process the central foil. Alternatively, it is possible that features unique to either anxious arousal (e.g., hypervigilance) or anhedonic depression (e.g., negative, self-referential thoughts) might have enhanced individuals' ability to orient towards the entire task display, including the foil. Such enhancement may be indicative of attentional biases (e.g., priming, threat evaluation) for the foil and target letter stimuli (Donaldson et al., 2007; Yiend, 2010). Additionally, symptoms of depression and anxiety have been associated with deficits in attentional control (e.g., Dillon et al., 2015; Sadeh & Bredemeier, 2011), so increased interference in the presence of higher levels of anhedonic depression or anxious arousal might have reflected poor attentional control in the face of central foils.

In contrast, individuals with high levels of both traits (e.g., high anhedonic depression and high anxious arousal) experienced less interference under conditions of high perceptual load. The results were very similar when negative affect was combined with anxious arousal and overall were not expected. Interestingly, previous research suggests that children and adolescents with comorbid depression and anxiety lack an attentional bias for emotional information (i.e., faces) that was observed in depression and anxiety alone (Hankin, Gibb, Abela, & Flory, 2010). It is possible that the interaction between high levels of these traits in predicting interference for non-emotional foil stimuli captures a similar effect, albeit among young adults without clinical diagnoses.

Regarding models for central foils including positive affect, the analyses reported here also indicated that positive affect alone interacted with perceptual load to predict interference. Specifically, it was found that in the presence of central foils, positive affect differentially impacted the effect of perceptual load on performance: when load was low, interference was positively associated with positive affect, whereas when load was high, interference was negatively associated with positive affect (see Figure 4). The results suggest that positive affect might have a slight impairing effect on the ability to selectively filter foils presented at fixation under conditions of low perceptual load. Whereas negative affective traits impact interference under high perceptual load conditions only, positive affect seems to impact interference with both high and low load. Taken together, the findings reported here suggest that the presence of high levels of anxious arousal, anhedonic depression, negative affect, or positive affect have the ability to alter the typical effect of perceptual load on attentional processes. Little research to date has examined the effects of co-occurring affective traits in the context of selective attention, and future studies should consider investigating which specific attentional biases or attentional control mechanisms contribute the most to interference in Flanker task paradigms.

Another important consideration in parsing the effects of affect on attentional processing relates to ways in which affective traits are measured. Affect is often measured along the dimensions of arousal (low, high) and valence (positive, negative), though recent research suggests the value in considering motivational intensity (e.g., approach, avoidance) as comprising a third dimension of affect (Harmon-Jones, Gable, & Price, 2013). Approach and avoidance motivational tendencies have been implicated in research of temperament and personality traits, as well as traits associated with psychopathology (e.g., positive and negative emotionality, Elliot & Thrash, 2002).

Recent work suggests that the intensity of trait approach motivation (e.g., low, high) is key to understanding the relationships between affect and attentional scope (Gable & Harmon-Jones, 2008; Gable & Harmon-Jones, 2010; Harmon-Jones, Gable, & Price, 2011, 2012). In one particular study, it was demonstrated that negative affect that is low in motivational intensity (e.g., sadness) broadens attentional scope, and negative affect that is high in motivational intensity (e.g., anger) narrows attentional scope (Gable & Harmon-Jones, 2010). This finding might help explain the result in the present study that neither high negative affect nor anhedonic depression scores were directly associated with attentional narrowing. For example, the MASQ-AD scale items assess sadness, apathy, and loss of pleasure, which represent affective states or traits that are low in approach motivation and might facilitate attentional broadening instead of narrowing. Such considerations of motivational intensity may also explain some of the results observed in experiments that used negative mood induction paradigms and warrant future investigation.

As the lifetime prevalence of a mood disorder is 20.8% (Kessler et al., 2005), non-clinical researchers should be increasingly aware that variation in task performance within general participant samples might be confounded by the presence of trait affective patterns or symptoms that may be indicative of psychological distress. These considerations are likely novel and unfamiliar to researchers from other fields within psychology. Without an adequate knowledge of symptom variation or the trait models of mood disorders, the potential for researchers to misinterpret data and make incorrect assumptions about attentional processing within groups increases. Thus, the need for psychometrically sound methods for evaluating and distinguishing trait behaviors and symptoms related to mood and anxiety disorders within study populations is significant. Fortunately, the development and extension of trait assessments of negative and positive affect and approach-avoidance motivation provides an ample starting point for these endeavors, provided researchers are willing to accept the importance of these discussions concerning affective traits within their own selective attention paradigms.

Limitations

There are a few limitations in the present study that should be noted. First, the sample was limited to college students, and continuing to test paradigms of selective attention with older adult populations would add to the understanding of how attentional scope varies in the presence of affective traits across adulthood. Also, it is unknown whether any participants in the present study had clinical diagnoses of depression and/or anxiety, or other disorders (e.g., personality, substance use disorders), which limits the conclusions that can be drawn from measures of depression and anxiety on performance. Participants were not screened for medication use, which may also impact attention abilities. Future studies should consider including individuals with known diagnostic status to increase understanding of how trait affect influences attentional scope. Additionally, measures of approach/avoidance motivation (e.g., BIS/BAS, Carver & White, 1994) were not included in the current study. The ability to understand affect across the three proposed dimensions of arousal, valence, and motivation might result in a more accurate depiction of how affective traits impact selective attention.

In conclusion, the present study utilizes a multivariate assessment of trait affect across several distinct dimensions of psychopathology in a sample of undergraduates who were not selected for particular affective trait expressions. The emphasis on using trait affective measures in a non-clinical sample may allow researchers to identify “baseline” levels of attention processing without the use of mood induction paradigms. The use of the flanker paradigm reported here utilized non-emotional stimuli, thus removing potential confounds related to attentional biases for negatively-valenced information that also appears among individuals with higher levels of depression or anxiety symptoms. That interactions were observed between various affective traits in predicting the level of interference in under high perceptual load with central foils suggests that samples similar to the one reported here are actually quite diverse regarding trait presentation and attentional processing abilities.

REFERENCES

Ahmed, L., & de Fockert, J. W. (2012). Focusing on Attention: The Effects of Working Memory Capacity and Load on Selective Attention. *PLoS ONE*, *7*(8). doi:10.1371/journal.pone.0043101

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testin and interpreting interactions*. *Multiple regression: Testing and interpreting interactions*.

Basso, M. R., Schefft, B. K., Ris, M. D., & Dember, W. N. (1996). Mood and global-local visual processing. *Journal of the International Neuropsychological Society : JINS*, *2*(3), 249–255. doi:10.1017/S1355617700001193

Bishop, S. J. (2009). Trait anxiety and impoverished prefrontal control of attention. *Nature Neuroscience*, *12*(1), 92–98. doi:10.1038/nn.2242

Bradley, B. P., Mogg, K., & Lee, S. C. (1997). Attentional biases for negative information in induced and naturally occurring dysphoria. *Behaviour Research and Therapy*, *35*(10), 911–927. doi:10.1016/S0005-7967(97)00053-3

Brainard, D. H. (1997). The Psychophysics Toolbox. *Spatial Vision*, *10*, 433–436. doi:10.1163/156856897X00357

Bredemeier, K., Hur, J., Berenbaum, H., Heller, W., & Simons, D. J. (2014). Individual differences in emotional distress and susceptibility to inattentional blindness. *Psychology of Consciousness: Theory, Research, and Practice*, *1*(4), 370–386. doi:10.1037/a0022474

Bredemeier, K., Spielberg, J., Silton, R., Berenbaum, H., Heller, W., & Miller. (2010). Screening for depressive disorders using the MASQ anhedonic depression scale: A receiver-operator characteristic analysis. *Psychological Assessment*, *22*(3), 702–710. doi:10.1037/a0019915.Screening

Broadbent, D. E., Cooper, P. F., FitzGerald, P., & Parkes, K. R. (1982). The Cognitive Failures Questionnaire (CFQ) and its correlates. *The British Journal of Clinical Psychology / The British Psychological Society*, *21 (Pt 1)*, 1–16. doi:10.1111/j.2044-8260.1982.tb01421.x

Brown, T. a., Antony, M. M., & Barlow, D. H. (1992). Psychometric properties of the Penn State Worry Questionnaire in a clinical anxiety disorders sample. *Behaviour Research and Therapy*, *30*(1), 33–37. doi:10.1016/0005-7967(92)90093-V

Bruyneel, L., van Steenbergen, H., Hommel, B., Band, G. P. H., De Raedt, R., & Koster, E. H. W. (2013). Happy but still focused: Failures to find evidence for a mood-induced widening of visual attention. *Psychological Research*, *77*(3), 320–332. doi:10.1007/s00426-012-0432-1

Buetti, S., Lleras, A., & Moore, C. M. (2014). The flanker effect does not reflect the processing of “task-irrelevant” stimuli: Evidence from inattentional blindness. *Psychonomic Bulletin & Review*, 1231–1237. doi:10.3758/s13423-014-0602-9

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS Scales. *Journal of Personality and Social Psychology*. doi:10.1037/0022-3514.67.2.319

Castiello, U., & Umiltá, C. (1990). Size of the Attentional Focus and Efficiency of Processing. *Acta Psychologica*, *73*, 195–209.

Chepenik, L. G., Cornew, L. a., & Farah, M. J. (2007). The influence of sad mood on cognition. *Emotion*, *7*(4), 802–811. doi:10.1037/1528-3542.7.4.802

Clark, L., & Watson, D. (1991). Tripartite model of anxiety and depression: psychometric evidence and taxonomic implications. *Journal of Abnormal Psychology*, *100*, 316–336. doi:10.1037/0021-843X.100.3.316

Costa, P. T., & McCrae, R. R. (1992). Normal personality assessment in clinical practice: The NEO Personality Inventory. *Psychological Assessment*, *4*, 5–13.

Crocker, L., Heller, W., Spielberg, J., Warren, S., Bredemeier, K., Sutton, B., … Miller, G. (2012). Neural mechanisms of attentional control differentiate trait and state negative affect. *Frontiers in Psychology*, *3*(August), 298. doi:10.3389/fpsyg.2012.00298

Dawson, J. F., & Richter, A. W. (2006). Probing three-way interactions in moderated multiple regression: development and application of a slope difference test. *The Journal of Applied Psychology*, *91*(4), 917–26. doi:10.1037/0021-9010.91.4.917

Desimone, R., & Duncan, J. (1995). Neural Mechanisms of Selective Visual Attention. *Annual Review of Neuroscience*, *18*, 193–222.

Desseilles, M., Balteau, E., Sterpenich, V., Dang-Vu, T. T., Darsaud, A., Vandewalle, G., … Schwartz, S. (2009). Abnormal neural filtering of irrelevant visual information in depression. *The Journal of Neuroscience : The Official Journal of the Society for Neuroscience*, *29*(5), 1395–1403. doi:10.1523/JNEUROSCI.3341-08.2009

Dillon, D. G., Wiecki, T., Pechtel, P., Webb, C., Goer, F., Murray, L., … Pizzagalli, D. a. (2015). A computational analysis of flanker interference in depression. *Psychological Medicine*, (2014), 1–12. doi:10.1017/S0033291715000276

Donaldson, C., Lam, D., & Mathews, A. (2007). Rumination and attention in major depression. *Behaviour Research and Therapy*, *45*(11), 2664–2678. doi:10.1016/j.brat.2007.07.002

E-Prime. (2012). Psychology Software Tools, Inc.

Easterbrook, J. a. (1959). The effect of emotion on cue utilization and the organization of behavior. *Psychological Review*, *66*(3), 183–201. doi:10.1037/h0047707

Elliot, A. J., & Thrash, T. M. (2002). Approach-avoidance motivation in personality: Approach and avoidance temperaments and goals. *Journal of Personality and Social Psychology*, *82*(5), 804–818. doi:10.1037//0022-3514.82.5.804

Engels, A. S., Heller, W., Mohanty, A., Herrington, J. D., Banich, M. T., Webb, A. G., & Miller, G. A. (2007). Specificity of regional brain activity in anxiety types during emotion processing. *Psychophysiology*, *44*(3), 352–363. doi:10.1111/j.1469-8986.2007.00518.x

Engels, A. S., Heller, W., Spielberg, J. M., Warren, S. L., Sutton, B. P., Banich, M. T., & Miller, G. A. (2010). Co-occuring anxiety influences patterns of brain activity in depression. *Cognitive Affective Behavioral Neuroscience*, *10*(1), 141–156. doi:10.1002/cncr.29075.Familial

Eriksen, C. W., & St James, J. D. (1986). Visual attention within and around the field of focal attention: a zoom lens model. *Perception & Psychophysics*, *40*(4), 225–240. doi:10.3758/BF03211502

Fales, C. L., Barch, D. M., Rundle, M. M., Mintun, M. A., Snyder, A. Z., Cohen, J. D., … Sheline, Y. I. (2008). Altered Emotional Interference Processing in Affective and

Cognitive-Control Brain Circuitry in Major Depression. *Biological Psychiatry*, *63*(4), 377–384. doi:10.1016/j.biopsych.2007.06.012

Farach, F. J., Treat, T. a., & Jungé, J. a. (2014). Effects of induced and naturalistic mood on the temporal allocation of attention to emotional information. *Cognition and Emotion*, *28*(6), 993–1011. doi:10.1080/02699931.2013.866937

Forster, S., & Lavie, N. (2007). High Perceptual Load Makes Everybody Equal. *Psychological Science*, *18*(5), 377–381. doi:ISSN: 0956-7976 ; E-ISSN: 1467-9280

Forster, S., & Lavie, N. (2008a). Attentional capture by entirely irrelevant distractors. *Visual Cognition*, *16*(2-3), 200–214. doi:10.1080/13506280701465049

Forster, S., & Lavie, N. (2008b). Failures to ignore entirely irrelevant distractors: the role of load. *Journal of Experimental Psychology. Applied*, *14*(1), 73–83. doi:10.1037/1076-898X.14.1.73

Forster, S., Robertson, D. J., Jennings, A., Asherson, P., & Lavie, N. (2014). Plugging the attention deficit: perceptual load counters increased distraction in ADHD. *Neuropsychology*, *28*(1), 91–97. doi:10.1037/neu0000020

Fredrickson, B. L. (2001). The Role of Positive Emotions in Positive Psychology. *American Psychologist*, *56*(3), 218–226. doi:10.1037/0003-066X.56.3.218

Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition & Emotion*, *19*(3), 313–332. doi:10.1080/02699930441000238

Fresco, D. M., Frankel, A. N., Mennin, D. S., Turk, C. L., & Heimberg, R. G. (2002). Distinct and overlapping features of rumination and worry: The relationship of cognitive production to negative affective states. *Cognitive Therapy and Research*, *26*(2), 179–188. doi:10.1023/A

Friedman, R. S., & Förster, J. (2010). Implicit affective cues and attentional tuning: an integrative review. *Psychological Bulletin*, *136*(5), 875–893. doi:10.1037/a0020495

Gable, P. a, & Harmon-Jones, E. (2010). The effect of low versus high approach-motivated positive affect on memory for peripherally versus centrally presented information. *Emotion*, *10*(4), 599–603. doi:10.1037/a0018426

Gable, P. A., & Harmon-Jones, E. (2010). The Blues Broaden, but the Nasty Narrows: Attentional Consequences of Negative Affects Low and High in Motivational Intensity. *Psychological Science*, *21*(2), 211–215. doi:10.1177/0956797609359622

Gable, P., & Harmon-Jones, E. (2008). Approach-motivated positive affect reduces broadening of attention. *Psychological Science*, *19*(May), 476–483.

Gasper, K. (2004). Do you see what I see? Affect and visual information processing. *Cognition & Emotion*, *18*(3), 405–421. doi:10.1080/02699930341000068

Gasper, K., & Clore, G. L. (2002). Attending to the big picture: mood and global versus local processing of visual information. *Psychological Science : A Journal of the American Psychological Society / APS*, *13*(1), 34–40. doi:10.1111/1467-9280.00406

Goldberg, L. R., Johnson, J. a., Eber, H. W., Hogan, R., Ashton, M. C., Cloninger, C. R., & Gough, H. G. (2006). The international personality item pool and the future of public-domain personality measures. *Journal of Research in Personality*, *40*, 84–96. doi:10.1016/j.jrp.2005.08.007

Gotlib, I. H., Krasnoperova, E., Neubauer Yue, D., & Joormann, J. (2004). Attentional

Biases for Negative Interpersonal Stimuli in Clinical Depression. *Journal of Abnormal Psychology*, *113*(1), 127–135. doi:10.1037/0021-843X.113.1.127

Grol, M., & De Raedt, R. (2014). Effects of positive mood on attentional breadth for emotional stimuli. *Frontiers in Psychology*, *5*(May), 1–10. doi:10.3389/fpsyg.2014.01277

Hankin, B. L., Gibb, B. E., Abela, J. R. Z., & Flory, K. (2010). Selective attention to affective stimuli and clinical depression among youths: role of anxiety and specificity of emotion. *Journal of Abnormal Psychology*, *119*(3), 491–501. doi:10.1037/a0019609

Harmon-Jones, E., Gable, P. A., & Price, T. F. (2011). Toward an understanding of the influence of affective states on attentional tuning: comment on Friedman and Förster (2010). *Psychological Bulletin*, *137*(3), 508–12; discussion 513–6. doi:10.1037/a0022744

Harmon-Jones, E., Gable, P. a., & Price, T. F. (2012). The influence of affective states varying in motivational intensity on cognitive scope. *Frontiers in Integrative Neuroscience*, *6*(September), 1–5. doi:10.3389/fnint.2012.00073

Harmon-Jones, E., Gable, P. a., & Price, T. F. (2013). Does Negative Affect Always Narrow and Positive Affect Always Broaden the Mind? Considering the Influence of Motivational Intensity on Cognitive Scope. *Current Directions in Psychological Science*, *22*(4), 301–307. doi:10.1177/0963721413481353

Heller, W., Nitschke, J. B., Etienne, M. a, & Miller, G. a. (1997). Patterns of regional brain activity differentiate types of anxiety. *Journal of Abnormal Psychology*, *106*(3), 376–385. doi:10.1037/0021-843X.106.3.376

Huntsinger, J. (2013). Does Emotion Directly Tune the Scope of Attention? *Current Directions in Psychological Science*, *22*(4), 265–270. doi:10.1177/0963721413480364

Huntsinger, J. R. (2012). Does positive affect broaden and negative affect narrow attentional scope? A new answer to an old question. *Journal of Experimental Psychology: General*, *141*(4), 595–600. doi:10.1037/a0027709

Iordan, A., Dolcos, S., & Dolcos, F. (2013). Neural signatures of the response to emotional distraction: a review of evidence from brain imaging investigations. *Frontiers in Human Neuroscience*, *7*(June), 200. doi:10.3389/fnhum.2013.00200

Joormann, J., & Vanderlind, W. M. (2014). Emotion Regulation in Depression: The Role of Biased Cognition and Reduced Cognitive Control. *Clinical Psychological Science*, *2*(4), 402–421. doi:10.1177/2167702614536163

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime Prevalence and Age-of-Onset Distributions of. *Arch Gen Psychiatry*, *62*(June), 593–602. doi:10.1001/archpsyc.62.6.593

Kimchi, R., & Palmer, S. E. (1982). Form and texture in hierarchically constructed patterns. *Journal of Experimental Psychology: Human Perception and Performance*, *8*(4), 521–35. doi:10.1037/0096-1523.8.4.521

Koster, E. H. W., Raedt, R. De, Verschuere, B., Tibboel, H., & De Jong, P. J. . (2009). Negative information enhances the attentional blink in dysphoria. *Depression and Anxiety*, *26*(1), E16–E22. doi:10.1002/da.20420

Lachter, J., Forster, K. I., & Ruthruff, E. (2004). Forty-five years after Broadbent (1958):

still no identification without attention. *Psychological Review*, *111*(4), 880–913. doi:10.1037/0033-295X.111.4.880

Lavie, N. (1995). Perceptual load as a necessary condition for selective attention. *Journal of Experimental Psychology: Human Perception and Performance*, *21*(3), 451–468. doi:10.1037/0096-1523.21.3.451

Lavie, N. (2005). Distracted and confused?: Selective attention under load. *Trends in Cognitive Sciences*, *9*(2), 75–82. doi:10.1016/j.tics.2004.12.004

Lavie, N. (2010). Attention, Distraction, and Cognitive Control Under Load. *Current Directions in Psychological Science*, *19*(3), 143–148. doi:10.1177/0963721410370295

Lavie, N., & Tsal, Y. (1994). Perceptual load as a major determinant of the locus of selection in visual attention. *Perception & Psychophysics*, *56*(2), 183–197. doi:10.3758/BF03213897

Lleras, A., Buetti, S., & Mordkoff, J. T. (2014). *When do the effects of distractors provide a measure of distractibility? Psychology of Learning and Motivation - Advances in Research and Theory* (Vol. 59). doi:10.1016/B978-0-12-407187-2.00007-1

Lyubomirsky, S., Kasri, F., & Zehm, K. (2003). Dysphoric rumination impairs concentration on academic tasks. *Cognitive Therapy and Research*, *27*(3), 309–330.

Max, R., & Tsal, Y. (2015). The mutations paradigm: Assessing the time course of distractor processing. *Attention, Perception, {&} Psychophysics*, *77*(7), 2344–2355. doi:10.3758/s13414-015-0928-z

Meyer, T. J., Miller, M. L., Metzger, R. L., & Borkovec, T. D. (1990). Development and validation of the Penn State Worry Questionnaire. *Behaviour Research and Therapy*, *28*, 487–495. doi:10.1016/0005-7967(90)90135-6

Morrison, R., & O'Connor, R. C. (2008). The role of rumination, attentional biases and stress in psychological distress. *British Journal of Psychology*, *99*(2), 191–209. doi:10.1348/000712607X216080

Nitschke, J., Heller, W., Imig, J., McDonald, R., & Miller, G. (2001). Distinguishing Dimensions of Anxiety and Depression. *Cognitive Therapy and Research*, *25*(1), 1–22. doi:10.1023/A:1026485530405

Nitschke, J., Heller, W., Palmieri, P., & Miller, G. (1999). Contrasting patterns of brain activity in anxious apprehension and anxious arousal. *Psychophysiology*, *36*(5), 628–637. doi:10.1017/S0048577299972013

Nolen-Hoeksema, S. (2008). Rethinking rumination. *Perspectives on Psychological Science*, *3*(5).

Nolen-Hoeksema, S., & Morrow, J. (2008). Effects of rumination and distraction on naturally occurring depressed mood. *Cognition and Emotion*, *7*(6), 561–570. doi:10.1080/02699939308409206

Pe, M. L., Vandekerckhove, J., & Kuppens, P. (2013). A diffusion model account of the relationship between the emotional flanker task and rumination and depression. *Emotion (Washington, D.C.)*, *13*(4), 739–47. doi:10.1037/a0031628

Pelli, D. G. (1997). The VideoToolbox software for visual psychophysics: transforming numbers into movies. *Spatial Vision*, *10*(4), 437–442. doi:10.1163/156856897X00366

Rowe, G., Hirsh, J., & Anderson, A. (2007). Positive affect increases the breadth of attentional selection. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(1), 383–388. doi:10.1073/pnas.0605198104

Sadeh, N., & Bredemeier, K. (2011). Individual differences at high perceptual load: The relation between trait anxiety and selective attention. *Cognition & Emotion*, *25*(4), 747–755. doi:10.1080/02699931.2010.500566

Snipes, M., & Taylor, D. C. (2014). Model selection and Akaike Information Criteria: An example from wine ratings and prices. *Wine Economics and Policy*, *3*(1), 3–9. doi:10.1016/j.wep.2014.03.001

Snyder, H. R. (2013). Major depressive disorder is associated with broad impairments on neuropsychological measures of executive function: a meta-analysis and review. *Psychological Bulletin*, *139*(1), 81–132. doi:10.1037/a0028727

Snyder, H. R., Kaiser, R. H., Whisman, M. A., Turner, A. E. J., Guild, R. M., & Munakata, Y. (2014). Opposite effects of anxiety and depressive symptoms on executive function: the case of selecting among competing options. *Cognition & Emotion*, *28*(5), 893–902. doi:10.1080/02699931.2013.859568

Tsal, Y., & Benoni, H. (2010). Diluting the burden of load: Perceptual load effects are simply dilution effects. *Journal of Experimental Psychology: Human Perception and Performance*, *36*(6), 1645–1656. doi:10.1037/a0018172

Vuilleumier, P., Armony, J., & Dolan, R. (2003). Reciprocal Links Between Emotion and Attention. In R. Frackowiak, J. Ashburner, W. Penny, A. Zeki, K. Friston, C. Frith, … C. Price (Eds.), *Human brain function* (2nd ed., pp. 419–444). Academic Press. doi:10.1016/B978-012264841-0/50022-6

Wagenmakers, E.-J., & Farrell, S. (2004). AIC model selection using Akaike weights. *Psychonomic Bulletin & Review*, *11*(1), 192–196. doi:10.3758/BF03206482

Watson, D., Clark, L. A., Weber, K., Assenheimer, J. S., Strauss, M. E., & McCormick, R. A. (1995). Testing a tripartite model: II. Exploring the symptom structure of anxiety and depression in student, adult, and patient samples. *Journal of Abnormal Psychology*, *104*, 15–25. doi:10.1037/0021-843X.104.1.15

Watson, D., Weber, K., Assenheimer, J. S., Clark, L. A., Strauss, M. E., & McCormick, R. A. (1995). Testing a tripartite model: I. Evaluating the convergent and discriminant validity of anxiety and depression symptom scales. *Journal of Abnormal Psychology*, *104*, 3–14. doi:10.1037/0021-843X.104.1.3

Yiend, J. (2010). The effects of emotion on attention: A review of attentional processing of emotional information. *Cognition & Emotion*, *24*(1), 3–47. doi:10.1080/02699930903205698

Yiğit-Elliott, S., Palmer, J., Moore, C. M., Yigit-Elliott, S., Palmer, J., & Moore, C. M. (2011). Distinguishing blocking from attenuation in visual selective attention. *Psychological Science*, *22*(6), 771–780. doi:10.1177/0956797611407927

Zetsche, U., & Joormann, J. (2011). Components of interference control predict depressive symptoms and rumination cross-sectionally and at six months follow-up. *Journal of Behavior Therapy and Experimental Psychiatry*, *42*(1), 65–73. doi:10.1016/j.jbtep.2010.06.001