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BRIEF REPORT

Links between neuroticism, emotional distress, and disengaging attention: Evidence from a single-target RSVP task

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Anxiety and depression are often associated with attention control deficits, but few studies have explored whether neuroticism can account for these links. In the present study, undergraduate students ($n = 146$) completed self-report measures of neuroticism, worry, anxious arousal, and anhedonic depression and also completed a visual attention task in which they were asked to identify a red target letter embedded within a rapid sequence of items. Neuroticism was associated with detection of the target when it was preceded by a distracter with which it shared a feature in common (a green letter). Specifically, these distracters produced longer attentional blinks in individuals with elevated levels of neuroticism. In contrast, target detection was not significantly associated with worry, anxious arousal, or anhedonic depression. We discuss the implications of this link between neuroticism and attention for cognitive models of emotional distress and disorders.

Keywords: Neuroticism; Attention; Disengagement; Anxiety; Depression.

Neuroticism is associated with risk for both anxiety and depressive disorders (e.g., Clark, Watson, & Mineka, 1994), which in turn are associated with deficits in attention control (e.g., Eysenck, Derakshan, Santos, & Calvo, 2007; Mathews & MacLeod, 2005; Mialet, Pope, & Yurgelun-Todd, 1996; Mogg & Bradley, 2005). Yet, links between neuroticism and attention are not well understood. Given that elevated levels of neuroticism are associated with a myriad of health problems (see Lahey, 2009), it is important to understand the nature of any associated attention

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deficits. To this end, we examined relations between attention, neuroticism, and several facets of emotional distress.

Most clinical research examining the relations between attention and depressive and anxiety disorders has focused on the processing of emotional stimuli (see Mathews & MacLeod, 2005; Mogg & Bradley, 2005, for reviews). Such studies are premised on the idea that unpleasant mood states facilitate processing of negative information (e.g., Bower, 1981). Until recently, the mechanisms responsible for the links between emotional distress and attention to negative emotional stimuli were unclear. They could result either from greater attention capture by negative stimuli or from difficulty disengaging attention from negative stimuli (or both). An emerging consensus is that people suffering from depression or anxiety have trouble disengaging their attention from negative stimuli (e.g., Koster, Raedt, Goeleven, Franck, & Crombez, 2005; Yiend & Mathews, 2001).

Notably, these deficits in disengaging attention might not be limited to emotional stimuli. Anxiety is associated with general attentional control deficits (see Eysenck et al., 2007), and depressed individuals show impaired performance on attentionally demanding tasks that involve neutral stimuli (see Mialet et al., 1996). These general attention deficits could account for the biased attention found in studies using emotional stimuli (Fox, 1993; Moriya & Tanno, 2009).

Neuroticism, which can be conceptualised as a predisposition to experience negative affect states (Costa & McCrae, 1980), is positively correlated with anxiety and depressive disorders (e.g., Clark et al., 1994), as well as with most other psychological disorders (e.g., Ormel, Rosmalen, & Farmer, 2004). Given that elevated levels of neuroticism are common to both anxiety and depression, this trait might help to explain attention deficits common to both.

Consistent with this speculation, elevated levels of neuroticism are associated with increased variability in performance on cognitive tasks, which has led to the hypothesis that elevated levels of neuroticism are characterised by increased "mental noise" (Robinson & Tamir, 2005). Though the mechanisms responsible for this phenomenon are not completely clear, some have speculated that variability in task performance could reflect lapses in attention (e.g., Weissman, Roberts, Visscher, & Woldorff, 2006). In fact, neuroticism and self-reported attentional control are negatively correlated (Derryberry & Rothbart, 1988). Wallace and Newman (1997) have proposed that neuroticism is associated with facilitated automatic orienting of attention, which impairs control of self-regulatory processes.

Only a handful of studies have directly explored the relation between neuroticism and attentional performance, and none have simultaneously examined the links between different aspects of attention, neuroticism, and dimensions of emotional distress. Indirect evidence supports the notion that neuroticism is associated with general attention deficits. Moriya and Tanno (2009) found that measures of anxiety and depression showed comparable associations with a general deficit in the attention-orienting network (encompassing shifting, engagement, and disengagement), which they attributed to negative affect. Similarly, Compton (2000) found that negative affect is associated with difficulty disengaging attention in a spatial cuing task involving non-emotional stimuli.

We hypothesised that a general deficit (i.e., non-valence-specific) in disengaging attention would be associated with elevated levels of neuroticism and that after accounting for neuroticism, attention disengagement would not be associated with emotional distress. This hypothesis was based on evidence that: (a) elevated levels of neuroticism are common to both anxiety and depression; (b) both anxiety and depression are associated with difficulty disengaging from negative emotional stimuli; (c) the link between distress and attention is not limited to emotional stimuli; and (d) negative affect is associated with difficulty disengaging attention from non-emotional stimuli.

Testing this hypothesis requires the use of measures that target the "disengagement" component of attention orienting. However, most studies have used measures of attention that provide

limited insight into the nature of observed deficits (see Barnard, Ramponi, Battye, & Mackintosh, 2005; Mialet et al., 1996; Mogg, Millar, & Bradley, 2000; Rokke, Arnell, Koch, & Andrews, 2002, for more detailed discussion of this issue). One more informative approach uses "online" measures such as eye tracking to assess the time course of attention (e.g., Mogg et al., 2000). Another approach measures attention by manipulating the timing of critical stimuli. In rapid serial visual presentation (RSVP) paradigms, stimuli are presented in a rapid sequence (e.g., 10 items/second) at a single location, and participants are asked to report something about one or more items in the sequence (i.e., "targets"). Since these tasks are attention demanding but involve minimal demands on memory, they are well suited for exploring individual differences in attention control (Rokke et al., 2002). Such an approach is also notable because it indexes non-spatial aspects of attention closely linked with identification and awareness.

To see a target in an RSVP task, participants must first disengage attention from any previously attended item. Perception of a second target is impaired when it appears close in time to the first target, an effect known as "the attentional blink" (AB; Raymond, Shapiro, & Arnell, 1992). Notably, a salient but task-irrelevant distracter can capture attention and induce an AB for a subsequent target (e.g., Folk, Leber, & Egeth, 2002; Maki & Mebane, 2006; Most, Chun, Widders, & Zald, 2005; Spalek, Falcon, & Di Lollo, 2006).

RSVP paradigms may be useful for exploring the specific mechanisms of attention that are biased or impaired in a particular population (Barnard et al., 2005; Most et al., 2005). The presence of a spontaneous AB in some participants but not others would suggest differences in susceptibility to attention capture across participants. Furthermore, for those participants who exhibit an AB, increased blink duration would suggest greater difficulty disengaging attention from the distracter.

A few studies have examined individual differences in the AB. For example, dysphoria is positively associated with AB magnitude (Rokke et al., 2002), but this link might have been due to unmeasured differences in neuroticism. In fact, in two recent investigations (MacLean & Arnell, 2010; MacLean, Arnell, & Busseri, 2010), elevated levels of neuroticism/negative affect were associated with larger ABs. However, these two studies only examined the overall magnitude of the AB effect, so it is unclear whether these associations were driven by differences in capture, disengagement, or both. Furthermore, all of these studies used a traditional two-target RSVP task in which participants were instructed to search for the first target, and thus did not explore individual differences in spontaneous attention capture.

Our study used an RSVP task with non-emotional stimuli to explore attention deficits associated with neuroticism and three facets of emotional distress (worry, anxious arousal, and anhedonic depression). Participants completed a single-target RVSP task in which salient distracters appeared at some point in the sequence. When the distracter appears 1–3 items before the target (i.e., at a lag of 1, 2, or 3),[1] detection of the target is impaired, reflecting an AB. If neuroticism is associated with a general deficit in disengaging attention, individuals reporting elevated levels of neuroticism should exhibit longer ABs. More specifically, neuroticism should be positively correlated with blink magnitude at lags 2 and/or 3. In contrast, neuroticism should not be associated with performance at lag 1, since lag 1 effects likely reflect susceptibility to attention capture by salient distracters rather than difficulty disengaging attention. Similarly, individual differences should disappear at lag 7 given that the AB typically has dissipated by that point. If links between disengagement and emotional distress are secondary to links between

[1] In traditional (two-target) RSVP tasks, target detection is generally not suppressed when the first target appears immediately before the second—a phenomenon referred to as "lag 1 sparing". However, we did not expect to observe lag 1 sparing in our task since this effect was not present in the study upon which the task was based (Spalek et al., 2006).

disengagement and neuroticism, any comparable patterns that emerge for measures of emotional distress should be relatively weak.

METHODS

Participants

One hundred forty-six college students (55% female),[2] ages 18–28 ($M = 19.4$; $SD = 1.4$), participated in the study for course credit. Most (57.5%) reported being European American, 14.4% Asian American, 4.8% African American, 11.6% Latino/a, 3.4% Biracial, and 8.2% "other". All reported normal or correct-to-normal vision (including normal colour vision).

Self-report measures

Neuroticism was measured using a 10-item scale from the International Personality Item Pool (Goldberg, 1999). For each item (e.g., "often feel blue", "have frequent mood swings"), participants rate how accurately the statement describes them now (relative to others of the same age and gender) on a scale from 1 (*very inaccurate*) to 5 (*very accurate*). Thus, scores can range from 10 to 50. This scale has good psychometric properties and reasonable evidence of convergent and discriminant validity (e.g., Goldberg, 1999; Lim & Ployhart, 2006).

One potential reason that the mechanisms responsible for links between attention, anxiety, and depression remain unclear is that previous research generally has not differentiated among different facets of anxiety and depression. Whereas both anxiety and depressive disorders are characterised by elevated levels of negative emotionality (i.e., neuroticism), depression (but not anxiety) is associated with diminished motivation and pleasant mood (i.e., anhedonic depression), and anxiety (but not depression) is associated with increased physiological arousal (see Clark & Watson, 1991). Furthermore, anxiety can be divided into two types: somatic anxiety (i.e., anxious arousal) and cognitive anxiety (i.e., worry; see Heller, Nitschke, Etienne, & Miller, 1997), which are distinct from one another and from anhedonic depression and negative emotionality (Nitschke, Heller, Imig, McDonald, & Miller, 2001). These three dimensions of emotional distress—worry, anxious arousal, and anhedonic depression[3]—have different biological and behavioural correlates (e.g., Heller et al., 1997; Larson, Nitschke, & Davidson, 2007). Thus, in the present study, we administered instruments specifically designed to tap these constructs.

Worry was measured using the Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990). Participants rate how typical each of 16 statements (e.g., "My worries overwhelm me") is of them on a scale from 1 (*not at all typical*) to 5 (*very typical*). Thus, scores can range from 16 to 80. The PSWQ has excellent test–retest reliability and good convergent and discriminant validity (Meyer et al., 1990; Nitschke et al., 2001).

Anxious arousal and anhedonic depression were measured using the relevant subscales from the Mood and Anxiety Symptom Questionnaire (MASQ; Watson et al., 1995), on which individuals indicate how frequently they have experienced certain symptoms during the past week on a scale from 1 (*not at all*) to 5 (*extremely*). The 17-item anxious arousal subscale focuses on somatic tension and hyperarousal (e.g., "hands were shaky", "startled easily"). The 22-item anhedonic depression subscale focuses on experiences of pleasant mood (e.g., "felt like nothing was very enjoyable") and other symptoms that distinguish depression from anxiety (e.g., "felt

[2] In light of evidence that the relation between neuroticism and attention may vary by gender (e.g., Wallace & Newman, 1998), we also ran our analyses separately for males and females. However, no significant gender differences emerged.

[3] While we conceptualise worry, anxious arousal, and anhedonic depression as symptoms of distress, all three have modest to strong temporal stability (Meyer et al., 1990; Watson et al., 1995), suggesting they fall somewhere between states and traits (see Clark et al., 1994, for a more detailed discussion of this issue). Further, though anxiety and depression are often conceptualised in categorical terms, research suggests that both are dimensional in nature (see Brown & Barlow, 2009).

Table 1. *Descriptive statistics from, and zero-order correlations between, the four self-report measures*

	Descriptive statistics				*Correlations between the self-report scales*			
Self-report scale	*M*	*SD*	*Min.*	*Max.*	*1*	*2*	*3*	*4*
1. Neuroticism	26.7	7.7	11	47	**.86**			
2. Worry	45.8	13.6	20	80	.74**	**.93**		
3. Anxious arousal	26.7	7.9	17	58	.37**	.26**	**.84**	
4. Anhedonic depression	54.5	12.4	24	87	.44**	.30**	.17*	**.90**

Notes: *$p < .05$; **$p < .01$. Internal consistency for each self-report scale (in terms of Cronbach's alpha) is shown in **bold**.

really slowed down"). Scores on the anxious arousal subscale range from 17 to 85 and scores of the anhedonic depression subscale range from 22 to 110. Both subscales have good convergent and discriminant validity (Nitschke et al., 2001; Watson et al., 1995).

RSVP task

Participants completed a single-target RSVP task (see Spalek et al., 2006, Experiment 4) in which they searched for one red letter in a rapid sequence of 20 items (100 ms/item) and identified it at the end of the trial. On control trials, all of the non-target items were white numbers. In the Green Spots condition, a randomly generated set of green spots (creating a box the size of a capital letter) appeared at some point before the target; these distracters were salient because they differed in colour from the rest of the sequence. In the Green Letters condition, a green letter appeared instead of the spots; the green letters were salient both because of their unique colour and because, like the target, they were letters. In both of these conditions, the distracter could appear 1, 2, 3, or 7 items before the target (the Lag).

Participants completed 16 practice trials and 240 experimental trials (80 control trials and 20 for each lag in the distracter conditions, with all trial types randomly intermixed). In addition to measuring percent accuracy for each condition, we computed blink magnitude by measuring the difference between accuracy at each lag in the distracter conditions and accuracy across all of the control trials.

Procedure

Participants were tested in groups of six or fewer. They completed the visual attention task (administered using VisionEgg; www.visionegg.org) and the self-report questionnaires in counterbalanced order.

RESULTS

Descriptive statistics for all four self-report measures, including internal consistencies and correlations between the scales, are shown in Table 1. Although the mean levels of distress in our sample were not particularly high, the ranges of scores were large, with at least some participants reporting high levels of distress. As expected, these measures were positively correlated, with the size of these correlations ranging from .17 to .74.

Consistent with earlier results (Spalek et al., 2006), the Green Letter condition produced an AB, suggesting that the green letter captured attention. However, the Green Spots condition did not produce an AB (see Figure 1). A mixed-model repeated-measures analysis of variance (ANOVA) with Distracter (control, Green Spots, Green Letters) and Lag (1, 2, 3, 7) as within-subject variables (with Geisser–Greenhouse corrections for violations of sphericity) revealed significant effects of Distracter, $F(1.24, 180.26) = 66.4$, $p < .01$, $\eta_p^2 = .31$, and Lag, $F(2.82, 405.94) = 46.5$, $p < .01$, $\eta_p^2 = .24$, as well as a significant Distracter × Lag interaction, $F(3.94, 571.44) = 45.8$, $p < .01$, $\eta_p^2 = .24$.

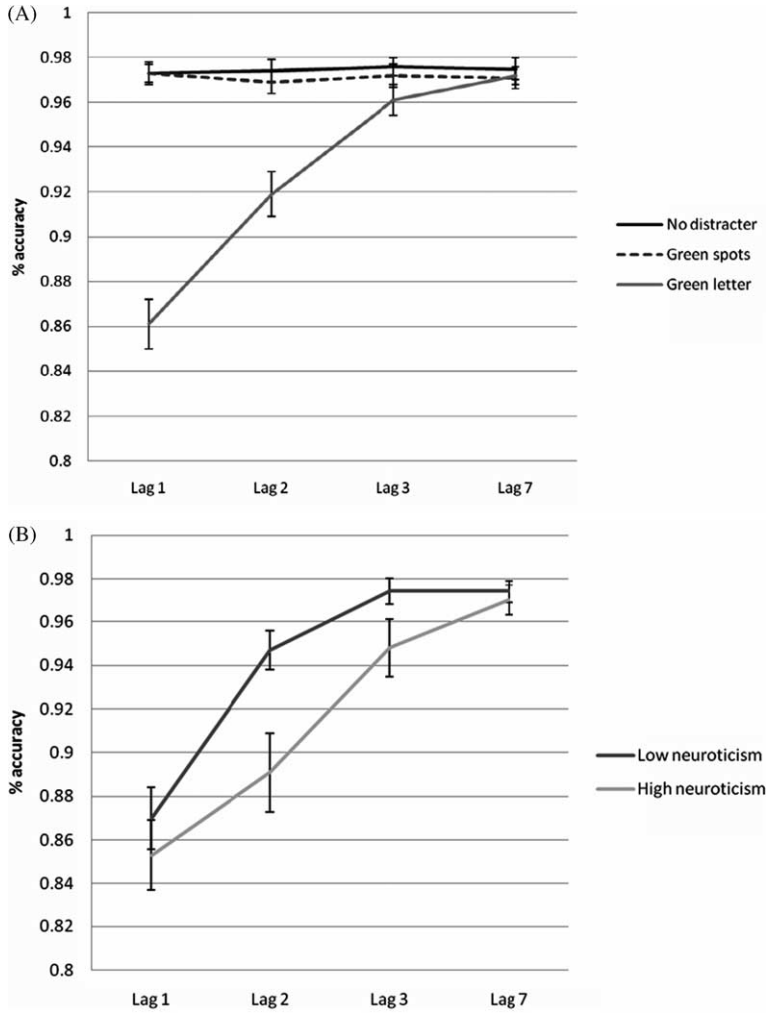

Figure 1. *(A) Mean percentage accuracy at lags 1, 2, 3, and 7 for the control (no distracter) condition, the Green Spots condition, and the Green Letters condition. (B) Mean percent accuracy for individuals reporting low and high levels of neuroticism at lags 1, 2, 3, and 7 for the Green Letters condition.*

Follow-up analyses showed a significant Lag effect in the Green Letters condition, $F(2.56, 371.23) = 67.12$, $p < .01$, $\eta_p^2 = .32$, and one-sample t-tests on blink magnitude scores revealed a reliable blink for lag 1: $t(145) = 11.74, p < .01$; lag 2: $t(145) = 6.11$, $p < .01$; and lag 3: $t(145) = 2.43$, $p = .02$, but not for lag 7: $t(145) = 0.82, p = .42$. In contrast, there was not a significant Lag effect for the Green Spots condition, $F(2.72, 394.96) = 0.35$, $p = .77$).

In order to explore individual differences in task performance, we re-ran the repeated-measures ANOVA treating each continuous self-report score as a between-subject covariate (separate analyses were conducted for each measure). When neuroticism was entered as a between-subject variable, the results revealed a significant Distracter × Lag × Neuroticism interaction, $F(3.94, 568.17) = 2.8$, $p < .05$, $\eta_p^2 = .02$. Follow-up analyses revealed a significant

Lag × Neuroticism interaction for the Green Letters condition, $F(2.54, 365.89) = 4.8$, $p < .01$, $\eta_p^2 = .03$, but not for the Green Spots condition. To further explore the nature of this effect, we computed zero-order correlations between neuroticism scores and blink magnitude at each lag in the Green Letters condition. Consistent with our predictions, neuroticism was significantly correlated with blink magnitude at lag 2 ($r = .28$, $p < .01$) and lag 3 ($r = .22$, $p < .05$) but not lag 1 ($r = .05$) or lag 7 ($r = .03$). These findings are illustrated in Figure 1B, using a median-split on neuroticism scores. These groups showed comparable blinks at lag 1, suggesting that the green letters captured attention in both groups. However, the high neuroticism group had larger blinks at lags 2 and 3, suggesting that they were slower to disengage their attention from these distracters, relative to the low neuroticism group. In contrast to neuroticism, there were no significant main effects or interactions involving any of the other three self-report scores. Furthermore, none of the self-report scores were significantly associated with performance in the control (no distracter) condition.

Given that our Green Spots condition did not replicate earlier findings (Spalek et al., 2006), it is not surprising that performance in this condition was not associated with neuroticism. The most likely explanation for this failure to replicate an AB in the Green Spots condition is that distracter type was a within-subject variable in our study. This may have caused participants to adopt a more refined attention set when performing the task, which in turn allowed them to successfully "filter out" the green spots distracters. Though inconsistent with the findings reported by Spalek and colleagues (2006), this pattern is consistent with other studies showing that unique distracter items only produce an AB if they share some feature in common with the target (e.g., Folk et al., 2002; Maki & Mebane, 2006). Thus, even if a unique but salient distracter in an RSVP stream can capture attention in an exogenous fashion (as Spalek and colleagues suggested), our findings suggest that it is possible to override this via top-down control. Our task differed from the traditional (two-target) AB paradigm in that the effects were induced by irrelevant distracters rather than by a first target that requires its own response. Consequently, we examined an AB that reflects spontaneous attention capture, which in this case seems to depend on participants' attentional set. As a result, our task allowed us to separate the effects of capture and disengagement in a way that is more straightforward than in traditional AB tasks.

DISCUSSION

Self-reported levels of neuroticism were positively associated with blink magnitude at lags 2 and 3 but not at lags 1 or 7 in the Green Letters condition. This pattern of results expands upon previous research showing that elevated levels of neuroticism are associated with increased AB magnitude (MacLean & Arnell, 2010), and is consistent with our hypothesis that neuroticism is associated with difficulty disengaging attention.

As previously noted, anxiety and depression are associated with difficulty disengaging attention from negative emotional stimuli (e.g., Koster et al., 2005; Yiend & Mathews, 2001). Our findings suggest that this commonality might be accounted for by elevated levels of neuroticism, rather than specific dimensions of anxiety or depression (worry, anxious arousal, or anhedonic depression). Furthermore, given that elevated levels of neuroticism are a common feature of most psychological disorders (Ormel et al., 2004), our results suggest that difficulty disengaging attention from negative stimuli may occur in individuals with a broad range of mental-health problems. In line with this hypothesis, biased attention to negative stimuli is associated with a range of psychological disorders (see Williams, Mathews, & MacLeod, 1996).

Importantly, our findings also suggest that this difficulty disengaging attention in individuals with elevated levels of neuroticism is not specific to negative stimuli, as deficits of this nature were observed in a task involving non-emotional distracters. Our findings thus converge with previous research showing that negative affect is associated

with difficulty disengaging attention from non-emotional stimuli that capture attention in the spatial domain (Compton, 2000). One possible explanation for findings from research involving emotional stimuli is that negative stimuli are motivationally salient, and thus are particularly effective at capturing attention (see Öhman, Flykt, & Esteves, 2001). By this account, individuals with elevated levels of neuroticism struggle to disengage attention from negative stimuli because these stimuli are more likely (than neutral or positive stimuli) to capture attention (see Moriya & Tanno, 2009). This argument is consistent with the idea that elevated levels of neuroticism are associated with general attention control deficits (see Wallace & Newman, 1997), although our study only shows a deficit in disengaging attention from stimuli that have captured attention, and further research is needed to determine if any additional differences in attention (e.g., facilitated orienting) are associated with neuroticism.

The suggestion that anxiety- and depression-related disengagement deficits might be accounted for by elevated levels of neuroticism does not imply that neuroticism accounts for all cognitive biases/deficits associated with anxiety and depression. In fact, other biases or deficits may be unique to anxiety or depression. For example, anxious individuals show increased attention capture by negative stimuli, whereas depressed individuals do not (e.g., Mogg et al., 2000). Likewise, depression is associated with decreased attention to positive stimuli (e.g., Koster et al., 2005) and explicit memory biases for negative information, but anxiety is not (see Mathews & MacLeod, 2005). Finally, specific anxiety and depressive disorders have been linked to concern-specific processing biases (e.g., physical threat words in people with excessive worries about physical health, self-referential stimuli in depressed individuals; see Mogg & Bradley, 2005), which has led to the development of integrative theories that aim to account for both general and specific biases (e.g., Mogg & Bradley, 1998). Future research should continue to explore cognitive biases/deficits associated with common and unique dimensions of anxiety and depression in order to further inform such theories.

Since the present study utilised a college sample, our results warrant replication in samples that are more diverse in terms of age and education, as well as samples that include more individuals experiencing elevated levels of emotional distress. Furthermore, given the cross-sectional, correlational nature of our data, the nature of the observed relation between neuroticism and disengagement is not completely clear. For example, "regulative temperament" is associated with, and may contribute to, both neuroticism and impaired target identification in an RSVP task (Peers & Lawrence, 2009). Future research should examine such possibilities, and could use longitudinal or experimental designs to explore whether the relation between neuroticism and disengagement is causal. There are reasons to suspect that disengagement deficits could play a causal role in the development of elevated levels of neuroticism. For example, the strategy of disengaging attention may be an effective way to regulate negative affect (see Werner & Gross, 2009), in that disengaging from unpleasant thoughts or stimuli can help people down-regulate their emotional responses (see Gotlib & Joormann, 2010). Consequently, a deficit in the ability to disengage attention might lead to more frequent, intense, and/or persistent negative emotions.

Although our results are consistent with the hypothesis that elevated levels of neuroticism are associated with a general deficit in disengaging attention, one alternative interpretation stems from the theory that the AB results from a temporary loss of control over one's "attentional filter" (Di Lollo, Kawahara, Shahab Ghorashi, & Enns, 2005). Within this framework, individuals with elevated levels of neuroticism may simply take longer to re-establish control. Another possibility is that when a person repeatedly has to ignore a particular stimulus while performing a task, that stimulus begins to take on a negative valence (see Fenske & Raymond, 2006). Consequently, individuals who have difficulty disengaging their attention from negative stimuli will have difficulty disengaging their attention from

any item that they repeatedly attempt to ignore. Future research should examine these alternatives. In summary, our study highlights the potential importance of attention for understanding the personality trait of neuroticism, as well as the value of examining common and unique aspects of distress and utilising cutting-edge methods from cognitive science in clinical research.

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