Always Look on the Bright Side of Life: The Attentional Basis of Positive Emotional Disposition

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Abstract

The principal aim of the present research program was to determine the attentional basis of individual differences in positive emotional disposition. There were three phases in the research program. Each phase built on the findings obtained in the previous phases, in ways that was shed further light on the patterns of attentional selectivity that characterise variation in positive emotional disposition. The key issues, and the manner in which they were addressed in each phase of the research program, are described below.

The key purpose of the first phase of research program was to test the hypothesis that an attentional bias to positive information is characteristic of high positive emotional disposition. This hypothesis was addressed by making use of the experimental methodologies that have previously been employed to investigate whether high negative emotional disposition is characterised by an attentional bias to negative information. The findings obtained in the reported study were fully consistent with the hypothesis that an attentional preference for positive information is characteristic of high positive emotional disposition.

The key purpose of the second phase of the research program was to evaluate the veracity of the hypothesis that an attentional bias to positive information causally contributes to positive emotional disposition. The studies reported in this phase were designed to examine whether a transiently induced change in attentional response to positive information serves to subsequently impact positive emotional reactivity to a positive event. The experimental approaches used to investigate the parallel issue in individuals who differ in terms of their negative emotional disposition were drawn upon for this purpose. Specifically, training variants of the attentional assessment task, developed in the first phase, were
employed to temporarily modify selective attentional responses to positive information. Participants were then exposed to a novel anagram success task, designed to induce an elevation in positive emotion, to enable the assessment of positive emotional reactivity. Across the reported studies, it was found that the attentional training task was capable of differentially modifying attentional response to positive information, and that such modification differentially impacted the degree to which positive emotional reactivity was increased following a positive event. Hence, the findings were consistent with the hypothesis that an attentional bias to positive information causally contributes to variation in positive emotional disposition.

The key purpose of the third and final phase of the research program was to more closely examine the patterns of positive emotional disposition-linked attentional selectivity, by seeking to investigate the attentional mechanisms that underpin such attentional selectivity. Specifically, the reported study was designed to determine whether high positive emotional disposition is characterised by facilitated attentional engagement with positive information, or impaired attentional disengagement from positive information. A novel variant of an attentional probe task recently was developed to assess these two facets of attentional selectivity. The results obtained did not, however, fully resolve the issue under consideration.

The theoretical and applied implications of the present research are discussed in detail. A number of suggestions concerning how future research may profitably build on the findings obtained in this research program are also outlined.
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In the past few days I have come to see a PhD candidature like a good drinking session. Going out with your friends and indulging your taste buds with litres of the amber ale is great fun (as is designing experiments, analysing the data, and making exciting new discoveries). Of course, inevitably the hangover hits (writing up your thesis), and you can’t wait for it to be over. But like any drinker (and researcher), it won’t be long before you’re indulging yourself that one more time.

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Author Contributions

The author played a significant role in all aspects of the studies reported within this thesis. This included experimental design and development, participant recruitment and testing, data entry, data analysis and interpretation, and the preparation and revision of manuscripts. Honours students carried out some of the testing conducted for the studies reported in Chapters 5, 6, and 7. The published manuscripts reported in Chapters 6 and 9 were both written in collaboration with the author’s supervisor, Professor Colin MacLeod.
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Chapter 1

General Introduction to the Research Program

Throughout much of its history, the empirical focus of psychological research on emotional disposition has been squarely placed on identifying the psychological mechanisms that characterise, and make a causal contribution to, variation in negative emotional disposition (i.e. variation in the degree to which negative emotion is elevated following negative events; Seligman & Csikszentmihalyi, 2000). The turn of this century, however, brought with it a burgeoning interest in positive psychology, and an attendant vigour to more fully examine the psychological mechanisms that characterise, and functionally contribute to, individual differences in positive emotional disposition (i.e. variation in the degree to which positive emotion is elevated following positive events; c.f. Linley, Joseph, Harrington, & Wood, 2006). It may be tempting to assume that these two types of emotional disposition are simply two ways of describing the same emotional disposition, however, there is considerable evidence, most of which is based on self-report data, to demonstrate that these two emotional dispositions in fact represent highly distinctive orthogonal dimensions (c.f. Watson, Wiese, Vaidya, & Tellegen, 1999).

Using questionnaire measures, numerous factor analytic studies have shown that these two types of emotional disposition emerge as orthogonal factors across a broad array of descriptors, time frames, response formats, and rotational approaches (Watson & Naragon-Gainey, 2009). For example, Watson and Tellegen (1985) reanalysed data obtained from more than 10 studies in which participants had been asked to report their tendency to experience different types of mood. Using principal component factor analysis, it was found that two higher order factors emerged, which corresponded to the dimensions of dispositional
positive emotion, and dispositional negative emotion, respectively. Mayer and Gaschke (1988) recruited 1,572 participants who completed one of three different mood scales (the Brief Mood Introspection Scale, the Mood-State Introspection Scale, or the Russell Adjective Scale). Again, using principal component factor analysis, these investigators also showed that a positive emotional disposition factor, and a negative emotional disposition factor, emerged across all of the three scales. Such findings have been replicated a number of times (e.g. Meyer & Shack, 1989; Tellegen, 1985; Zevon & Tellegen, 1982), and similar results using questionnaire approaches have been observed across a number of different cultures including Japan (Watson, Clark, & Tellegen, 1984), Israel (Almagor & Ben-Porath, 1989), and Russia (Balatsky & Diener, 1993). Hence, the findings obtained across these questionnaire studies provide strong evidence that these two types of emotional dispositions represent distinctive orthogonal dimensions.

Given the weight of evidence suggests that variation in negative emotional disposition is independent from variation in positive emotional disposition, it cannot therefore be assumed that identifying the psychological mechanisms that characterise and make a causal contribution to the former disposition, will necessarily lead to a better understanding of the psychological mechanisms that characterise and make a causal contribution to the latter disposition. Indeed, the conclusion that these two types of emotional disposition are independent highlights the potential importance of research programs that are specifically designed to shed light on the psychological factors that underpin positive emotional disposition.

As previously mentioned, there has been a strong recent push towards furthering our understanding of the factors that contribute to such positive emotional disposition (McNulty
But it is worth noting that, across the decades, many psychological researchers have previously shared this same objective. For example, it is possible to trace an interest in emotional well-being back to William James’ notion of ‘healthy mindedness’ (James, 1902), and to the work of other psychological luminaries such as Abraham Maslow, who focused on self-actualisation and healthy persons (e.g. Maslow, 1954), and Carl Rogers, who emphasised the importance of the fully functioning individual (Rogers, 1961). Nevertheless, despite this historical thread of interest in the disposition to experience positive emotion, it is clear that while we now have a relatively sophisticated understanding of the psychological factors that underpin variation in negative emotional disposition, we are yet to develop a parallel understanding of the factors that underpin variation in positive emotional disposition (Gable & Haidt, 2005; Joseph & Wood, 2010).

Some investigators have suggested the heavy emphasis that psychological research on emotional disposition has historically placed on examining individual differences in the tendency to experience negative emotion, relative to individual differences in the tendency to experience positive emotion, has been detrimental from both a theoretical and applied perspective (Wood & Tarrier, 2010). Indeed, there is growing evidence that supports the proposal that research on emotional disposition should be broadened to more fully take account of positive emotional disposition. In the following review, three distinct lines of research on positive emotional disposition will be discussed in turn. Such research concerns the contribution of positive emotional disposition to: i) the prediction of emotional functioning; ii) the determination of the impact of adverse life events; and iii) the determination of the impact of favourable life events. These three lines of work collectively underscore the potential value of research programs specifically designed to illuminate the
psychological mechanisms that underpin individual differences in positive emotional disposition.

It is important that the distinction between negative emotional disposition and positive emotional disposition is not confused with the somewhat different distinction between maladaptive and adaptive emotional functioning. It is widely recognised that both types of emotional disposition can make a contribution to both types of emotional functioning (Barlow, Allen, & Choate, 2004; Clark & Watson, 1991; Watson, Clark, Weber, Assenheimer, Strauss, & McCormick, 1995), and so it follows that a better understanding of the factors that underpin positive emotional disposition, may be accompanied by a corresponding improvement in our understanding of maladaptive and adaptive emotional functioning. Indeed, one influential line of research on positive emotional disposition has demonstrated that the assessment of this emotional disposition can significantly enhance the prediction of the symptoms of maladaptive emotional functioning. Such research is important as it contributes to the key clinical goal of improving the identification of individuals at risk of developing emotional disorders, such as, anxiety and depression (Munoz, Cuijpers, Smit, Barrera, & Leykin, 2010). For example, in a meta-analysis of 13 studies, Kashdan (2007) demonstrated that, after controlling for depression and related constructs such as negative emotional disposition, individual differences in positive emotional disposition predicted significant additional variance in social anxiety symptoms. In a 7-month longitudinal study of 270 children and adolescents, Lonigan, Phillips, and Hooe (2003) found that the assessment of variation in positive emotional disposition served to enhance the prediction of anxiety and depressive symptoms over this time period. Results obtained in other studies have shown that by measuring positive emotional disposition, it is possible to also enhance
the prediction of schizophrenia (c.f. Horan, Blanchard, Clark, & Green, 2008), and schizotypy (e.g. Chmielewski & Watson, 2008; Kerns, 2006). Hence, these findings show that the assessment of positive emotional disposition may be critical to achieving the key clinical goal of improving the identification of individuals who are most at risk of developing emotional dysfunction, and it is likely that progress towards this important objective will be furthered by a better understanding of the psychological factors that underpin variation in such positive emotional disposition.

Another area of research that highlights the potential value in developing a better understanding of positive emotional disposition has been focused on the detrimental impact of negative life events. In this work, it has been found that an elevated tendency to experience high levels of positive emotional disposition can serve as a buffer against the impact of such negative life events. For example, Chen, David, Thompson, Smith, Lea, and Fahy (1996) found that higher levels of positive emotional disposition were associated with improved coping in women who were undergoing a biopsy for suspected breast cancer. Similar findings have also been reported in other studies (e.g. Carver, Pozo, Harris, Noriega, Scheier, & Robinson, 1993). In a longitudinal study of 256 undergraduate psychology students, Park, Cohen, and Murch (1996) found that higher levels of dispositional positive emotion were associated with higher levels of personal growth following exposure to negative life events, such as, relationship difficulties, academic performance difficulties, illness or accident, or the death of a significant other. Other investigators, such as, Zautra, Johnson, and Davies (2005), have shown that high positive emotional disposition is associated with relatively lower levels of pain following diagnosis of chronic health conditions (e.g. fibromyalgia or osteoarthritis). These findings provide strong support for the
contention that a heightened disposition to experience positive emotion can help to protect against the detrimental impact of negative life events, which again underscores the importance of research that can serve to illuminate the psychological mechanisms which underpin such emotional disposition.

A third line of investigation has demonstrated that high levels of positive emotional disposition are not only associated with enhanced psychological functioning in the face of adversity, but are also associated with increased access to positive situations and events (c.f. Lyubomirsky, King, & Diener, 2005). For example, Roberts, Caspi, and Moffitt (2003) have shown that different measures of positive emotional disposition can prospectively predict a number of positive life outcomes, such as, financial independence, occupational attainment, and work autonomy. A growing number of studies have demonstrated that high positive emotional disposition is related to improved physical health and longevity (c.f. Pressman and Cohen, 2005). The heightened disposition to experience positive emotional disposition has been shown to be associated with better quality romantic relationships (Berry and Willingham, 1997), and peer relationships (Cooper, Okamura & Gurka, 1992). Finally, from a broader societal perspective, there is evidence to demonstrate that individuals with higher levels of positive emotional disposition are more willing to become involved in community service (Magen & Aharoni, 1991), and to spend time helping others (e.g. Csikszentmihalyi, Patton, & Lucas, 1997; Lucas, 2001).

Given the growing theoretical interest in, and the potentially significant applied benefits that may come from, developing a deeper understanding of psychological factors that may underpin positive emotional disposition, it is not surprising that a number of investigators have called for a greater emphasis on research that is focused on elucidating
such factors (e.g. Wood & Tarrier, 2010; Duckworth, Steen, & Seligman, 2005; Maddux, Snyder, & Lopez, 2004). The present research program responds to this call. In this introductory review, a candidate theoretical approach that may serve to explain individual differences in positive emotional disposition will first be described, before a brief overview of the present research program is then outlined.

**Candidate Theoretical Approach for Explaining of Individual Differences in Positive Emotional Disposition**

One category of theoretical approach employed to account for variation in emotional experience, which has proven particularly fruitful in explaining variation in the disposition to experience negative emotion and related emotional psychopathology, draws heavily on concepts adopted from cognitive psychology (Wilson & MacLeod, 2007). Cognitive accounts of negative emotional disposition were initially motivated by the clinical observation that patients diagnosed with emotional dysfunction (e.g. anxiety or depressive disorders), tend to report distinctive patterns of negative thought that plausibly may contribute to the onset and maintenance of such emotional dysfunction (Lamberton & Oei, 2008). In cognitive accounts of negative emotional disposition, the genesis of negative thought content is attributed to biases in selective information processing, such as selective attention, which operate at a low level within the cognitive system, and may not themselves be accessible to introspective awareness (c.f. Mathews & MacLeod, 1994). While a number of different accounts have been put forward, they all share two common hypotheses. The first hypothesis is that biases in selective attention, which favor the processing of negative information, will be characteristic of an elevated disposition to experience negative emotion. The second hypothesis is that such attentional selectivity will make a causal contribution to
negative emotional disposition (e.g. Bower, 1981; Beck & Clark, 1997; Williams, Watts, MacLeod & Mathews, 1997).

Over the past three decades, a wealth of evidence has accumulated, which demonstrates that elevated anxiety vulnerability, and elevated depressive vulnerability, are both characterised by an attentional bias to negative information. As will be expanded upon in more detail in Chapter 2, researchers have developed a number of different methodologies in order to assess such attentional bias (c.f. Cisler & Koster, 2010). One of the first techniques developed to assess attentional bias was the emotional Stroop task (Mathews & MacLeod, 1985). In this task, participants are required to quickly colour name words (either negative or neutral in emotional tone) that are displayed in differing ink colours, while ignoring their semantic content. The degree to which such colour naming is disproportionately slow on negative words, relative to neutral words, is taken as a measure of attentional preference for negative information, as it indicates particular difficulty ignoring the negative content of these words. Numerous studies have shown that both anxious and depressed participants are relatively slow to colour name negative words compared to control participants who do not report such emotional dysfunction, consistent with the hypothesis that an attentional bias to negative information is characteristic of high negative emotional disposition (Bryant & Harvey, 1995; Dunn, Mathews, & Trower, 1997; Spector, Pecknold, & Libman, 2003; Gotlib & McCann, 1984).

Another commonly used assessment procedure is a visual search task. In this approach, participants are required to locate a target stimulus embedded among an array of distracters. An attentional bias favouring negative information is inferred from the speeding to detect negative targets embedded in arrays of neutral distractor stimuli, relative to neutral
targets embedded in arrays of negative distractor stimuli (e.g. Matsumoto, 2010). Consistent with the hypothesis that high negative emotional disposition is characterised by an attentional bias to negative information, such visual search tasks have revealed that both anxious and depressed individuals are relatively speeded to detect negative targets in a matrix of neutral distractors, compared to individuals who report low levels of negative emotion (Olatunji, Cisler, & Deacon, 2010; Rinck & Becker, 2005).

But perhaps the most widely used assessment approach is the attentional probe task (MacLeod, Mathews, & Tata, 1986). In the task, participants are briefly exposed to stimulus pairs, comprising one negative member and one neutral member, before a small visual probe is presented in the locus where either member of the stimulus pair was just displayed. The participant must quickly execute a discriminatory response to the probe, and the degree to which this response is speeded for probes appearing in the locus of the negative compared to neutral members of the stimulus pairs provides an index of attentional preference for negative information. Using this task, it has been found that anxious individuals, and also depressed individuals, are disproportionately fast to discriminate probes presented in the locus of the negative members of such stimulus pairs, indicating an attentional preference for negative information (Donaldson, Lam, & Mathews, 2007; Frewen, Dozois, Joanisse, & Neufeld, 2008; Joormann & Gotlib, 2007; Kroeze & van den Hout, 2000; MacLeod et al., 1986; Mathews, Ridgeway, & Williamson, 1996). Indeed, on the basis of research employing these different assessment procedures, it is now widely accepted that individuals with high levels of negative emotional disposition, whether indicated by their high levels of anxiety or depression, exhibit an attentional preference for negative information, consistent with the
hypothesis put forward in cognitive accounts of negative emotional disposition (c.f. Cisler & Koster, 2010).

The findings obtained from these assessment studies confirm an association between an attentional bias to negative information and high levels of negative emotional disposition, but they do not enable the appraisal of the second hypothesis generated by cognitive accounts, which concerns the causal contribution of such attentional selectivity to negative emotional disposition. More direct evidence for this contention has come from two lines of research. First, some studies have investigated the capacity of initial measures of attentional selectivity to predict later negative emotional reactions to subsequent negative events (prediction studies). Second, other studies have examined the impact of directly manipulating such patterns of selective attention upon subsequently observed negative emotional disposition (manipulation studies). These two types of research approach will now be briefly reviewed, and will be expanded upon more fully in Chapter 3 of the present thesis.

Prediction studies have confirmed that early measures of attentional bias to negative information can powerfully predict the intensity of negative emotion to subsequent negative events. For example, MacLeod and Hagan (1992) assessed attentional bias to negative information, using the emotional Stroop task, in women who were awaiting a colposcopy examination. It was found that this initial measure of attention bias predicted the intensity of negative emotional response elicited by the subsequent diagnosis of cervical pathology. In a similar study, using the emotional Stroop task, Pury (2002) assessed patterns of attentional preference for negative information in undergraduate students approximately 1-month before an important upcoming exam. It was found that higher initial attentional bias to negative information scores were associated with more pronounced anxiety symptoms in the week
before the exam. Taken together, these findings show that measures of attentional bias to negative information can prospectively predict the degree to which negative events can serve to elicit negative emotional responses, consistent with the hypothesis that such attentional selectivity makes a causal contribution to negative emotional disposition.

While the results of such prediction studies are encouraging, the findings obtained only show that the association between attentional selectivity and negative emotional disposition is stable across extended periods of time. This does not necessitate the conclusion that the relationship between these two variables is causal. It is possible, for example, that a third variable may independently mediate both attentional bias and negative emotional response to stressful events. To most rigorously test the hypothesis that an attentional bias to negative information causally contributes to negative emotional disposition, it is necessary to directly manipulate such attentional selectivity, to determine whether there is a corresponding change in negative emotional disposition. A rapidly growing number of studies have confirmed that training approaches designed to directly alter attentional response to negative information serve to significantly modify negative emotional reactivity (Amir, et a., 2009; Beard, Wiseberg, & Amir, 2011; Hazen, Vasey, & Schmidt, 2009; MacLeod, Rutherford, Campbell, Holker, & Ebsworthy, 2002; Schmidt, Richey, Buckner, & Timpano, 2009). Such findings provide strong converging support for the hypothesis that an attentional preference for negative information can make a causal contribution to negative emotional disposition (MacLeod & Mathews, 2012).

As illustrated in this review, there is now considerable empirical evidence that demonstrates that a high disposition to experience negative emotion, such as, anxiety or depression, is amenable to cognitive explanation (c.f. Mathews & MacLeod, 2005). Hence,
given the success that such cognitive accounts have shown in furthering understanding of individual differences in negative emotional disposition, it is plausible that a cognitive approach also could usefully be employed to generate testable hypotheses concerning the cognitive basis of individual differences in positive emotional disposition. Some theorists have recently taken this step, proposing that an attentional bias to positive information is characteristic of, and also causally contributes to, the disposition to experience positive emotion (Tamir & Robinson, 2007; Wadlinger & Isaacowitz, 2010). In contrast to the considerable empirical support for the hypotheses that an attentional bias to negative information is characteristic of, and makes a functional contribution to negative emotional disposition, the empirical validity of the hypotheses that attentional bias to positive information is characteristic of, and causally contributes to, positive emotional disposition has, however, not yet been adequately addressed.

**Overview of the Present Research Program**

The studies that comprise the present research program were designed to illuminate the two hypotheses put forward by recent investigators (e.g. Wadlinger & Isaacowitz, 2010) concerning the attentional basis of positive emotional disposition. The first hypothesis is that an attentional bias to positive information will be characteristic of elevated positive emotional disposition, and the second hypothesis is that such attentional selectivity will play a causal role in positive emotional disposition. The manner in which these two hypotheses are to be addressed in the different phases of the present research program will now be outlined.
Phase 1 – Determining Whether High Positive Emotional Disposition is Characterised by an Attentional Bias to Positive Information

The hypothesis under test in phase one is that an attentional bias to positive information is characteristic of elevated positive emotional disposition. This hypothesis will be addressed by making use of the experimental methodologies that have previously been employed to investigate whether elevated negative emotional disposition is associated with an attentional preference for negative information. Specifically, attentional preference for positive information will be assessed using an attentional probe task to determine whether individual differences in positive emotional disposition are associated with variation in such attentional selectivity.

Phase 2 – Determining Whether Attentional Bias to Positive Information Makes a Causal Contribution to Positive Emotional Disposition

If it can be demonstrated that elevated positive emotional disposition is associated with an attentional bias to positive information, then the key purpose of the second phase will be to evaluate the veracity of the hypothesis that an attentional bias to positive information causally contributes to positive emotional disposition. Specifically, the studies in this phase will be designed to determine whether a transiently induced change in attentional bias to positive information subsequently impacts on positive emotional reactivity to a positive event. The experimental approaches that have been employed to investigate the parallel issue in individuals who differ in terms of their negative emotional disposition will be drawn upon for this purpose. Training variants of the attentional assessment task, developed in the first phase, will be employed to temporarily modify selective attentional response to positive information. Participants will then be exposed to a novel anagram success task, designed to
induce an elevation in positive mood, to enable the assessment of positive emotional reactivity. If the attentional training tasks are capable of modifying attentional response to positive information, then the mood data obtained from the anagram success task can be examined to determine the validity of the hypothesis that positive attentional bias causally contributes to variation in positive emotional disposition.

**Phase 3 – Determining Whether High Positive Emotional Disposition is Characterised by Increased Attentional Engagement With, or Disengagement From, Positive Information**

If it can be demonstrated that high positive emotional disposition is associated with (and perhaps also causally contributes to) an attentional bias to positive information, then the key purpose of the third and final phase of the current research program will be to more closely examine this pattern of attentional selectivity, by seeking to determine the attentional mechanisms that underpin such attentional bias. Specifically, the aim of the reported study will be to determine whether elevated positive emotional disposition is characterised by facilitated attentional engagement with positive information, or impaired attentional disengagement from positive information. A novel variant of an attentional probe task recently introduced by Grafton and MacLeod (in press), which has been shown to be capable of discretely assessing engagement and disengagement bias in anxious individuals, will be employed to assess these two facets of attentional selectivity in individuals characterised by high and low levels of positive emotional disposition.
Chapter 2

Research Phase 1 - Abstract

The study reported in this first research phase was designed to determine whether high positive emotional disposition is characterised by an attentional bias to positive information. Participants high and low in positive emotional disposition were exposed to a conventional attentional probe task in order to assess such attentional selectivity. The findings demonstrated that participants who reported high levels of positive emotional disposition compared those who reported low levels of positive emotional disposition, were disproportionately speeded to discriminate probes that appear in the locus of positive information, relative to neutral information, consistent with the hypothesis that such individuals preferentially assign attention to positive information.
Introduction to Research Phase 1

In the forthcoming review, the experimental approaches that have been employed to assess attentional bias to negative information in individuals characterised by high negative emotional disposition will be outlined, in order to identify a candidate assessment task that could be employed to index variation in attentional bias to positive information, in individuals who differ in terms of their dispositional positive emotion. It will be argued that the task best suited for this purpose is the conventional attentional probe task, hence the study reported in this phase of the research program will make use of this assessment approach.

Candidate Experimental Tasks for the Assessment of Attentional Bias in Positive Emotional Disposition

A wealth of evidence has demonstrated that individuals characterised by an elevated disposition to experience negative emotion, such as, those who report high levels of trait anxiety or depression, or those who suffer from emotional psychopathology (e.g. anxiety or depressive disorders), display an attentional bias to negative information (c.f. Yiend, 2010). A number of different methodologies have been employed to assess patterns of attentional selectivity in such individuals. The approaches most often used are the emotional Stroop task (Mathews & MacLeod, 1985; Williams, Mathews, & MacLeod, 1996), the visual search task (Olatunji, Cisler, & Deacon, 2010; Matsumoto, 2010), and the attentional probe task (MacLeod, Mathews, & Tata, 1986; Frewen, Dozois, Joanisse, & Neufeld, 2008). In the following section, an overview of these three experimental methodologies, and the findings obtained when delivered to participants who differ in terms of their negative emotional disposition, will be provided, along with a critical appraisal of their capacity to sensitively index attentional bias to negative information. It will be argued that the most rigorous
methodology for assessing such attentional selectivity is the attentional probe task. Hence, if appropriately amended, this procedure should enable the evaluation of the hypothesis that high positive emotional disposition is characterised by an attentional bias to positive information, in this first research phase.

*The Assessment of Attentional Bias in Negative Emotional Disposition Using the Emotional Stroop Task*

The emotional Stroop task was one of the first approaches employed in the assessment of attentional bias in negative emotional disposition (Williams, Mathews, & MacLeod, 1996), and is based on the classic Stroop colour-naming paradigm (Stroop, 1935). In the classic Stroop task, participants are presented with a single word printed in coloured ink, and are instructed to rapidly name the colour the word is printed in, while ignoring its semantic content. On some trials, the single word is a colour name that is printed in the matching coloured ink, for example, the word ‘blue’ printed in blue ink. On other trials, the single word is a colour name that is printed in an ink colour different from the colour name, for example, the word ‘blue’ printed in yellow ink. It has been consistently demonstrated that participants are relatively slower to colour-name the ink when the ink colour is different from the colour name communicated by the semantic content of the word (MacLeod, 1991). This pattern of results is taken to reflect a relative difficulty in inhibiting attention to the semantic content of the word.

This classic Stroop task was adapted by cognitive psychologists in the 1980s to create an emotional variant designed to investigate the patterns of attentional selectivity that characterise anxious individuals. In such emotional Stroop tasks, participants are required to rapidly name the colour of emotionally toned words, displayed in differing ink colours, while
ignoring their semantic content. In this approach, the degree to which colour naming is disproportionately slow on negative words, relative to neutral words, is taken as a measure of attentional bias to negative information, as it indicates particular difficulty ignoring the negative content of these words. The first to employ such an emotional Stroop task were Mathews and MacLeod (1985). The task was administered to 24 patients diagnosed with generalised anxiety disorder (GAD), and 24 matched non-anxious control participants. The findings showed that the anxious patients, unlike the control participants, were slowed to colour-name negative words, relative to neutral words, consistent with the hypothesis that they have an attentional bias to negative information.

The pattern of results obtained by Mathews and MacLeod has since been replicated in generalised anxiety disorder (Golombok, Stavrou, Bonn, Mogg, Critchlow, & Rust, 1991; Martin, Williams, & Clark, 1991), and across the spectrum of anxiety disorders including specific phobias (Lavy, van den Hout, & Arntz, 1993), panic disorder (Ehlers, Margraf, Davies, & Roth, 1988; McNally, Amir, Louro, Lukach, Riemann, & Calamari, 1994), post-traumatic stress disorder (Thrasher, Dalgleish, & Yule, 1993; Bryant & Harvey, 1995), social anxiety disorder (Hope, Rapee, Heimberg, & Dombeck, 1990; Spector, Pecknold, & Libman, 2003; Mattia, Heimberg, & Hope, 1993), and obsessive compulsive disorder (Lavy, van Oppen, & van den Hout, 1994). A number of studies using the emotional Stroop task have demonstrated that, like anxious patients, individuals diagnosed with clinical depression also exhibit an attentional bias to negative information compared to their non-depressed counterparts (Gotlib & Kane, 1987; Segal, Truchon, Horowitz, Gemar, & Guirguis, 1995; Segal & Vella, 1990).
The patterns of attentional bias to negative information revealed by the emotional Stroop task, however, are not restricted to individuals who suffer from emotional pathology. Non-clinical participants who report high levels of trait anxiety or depression show a similar pattern of attentional selectivity compared to participants who report low levels of such emotions. For example, MacLeod and Rutherford (1992) showed that high trait anxious undergraduate students displayed disproportionately long colour naming latencies on negative words, relative to their low trait anxious counterparts, consistent with the hypothesis that high anxiety vulnerability is characterised by an attentional preference for negative information. A number of other studies examining such patterns of attentional selectivity in both high trait anxious and depressed populations have reported a similar pattern of results (e.g. Fox, 1993; Mogg, Kentish, & Bradley, 1993; Richards, French, Johnson, Naparstek, & Williams, 1992; Williams & Nulty, 1986; Klieger & Cordner, 1990).

The findings obtained from studies employing the emotional Stroop task are consistent with the hypothesis that elevated negative emotional disposition is characterised by an attentional bias to negative information. Hence, such findings suggest that the emotional Stroop task could be used to investigate the patterns of selective attention that characterise variation in dispositional positive emotion. It is important to note, however, that some investigators have criticised the emotional Stroop task. One such criticism concerns the possibility that the disproportionate slowing to colour name negative words displayed by individuals who report high levels of negative emotional disposition may not reflect increased attention to the semantic content of negative information, but may instead reflect a more general response slowing in the presence of negative information (e.g. Lavy & van den Hout, 1994). But perhaps a more serious criticism is that the disproportionate slowing to
colour name negative words may be because participants with a more negative emotional disposition tend to direct their attentional resources away from the more negative word stimuli altogether, thereby impairing the apprehension of word colour (Wilson & MacLeod, 2007). Hence, this second criticism suggests that the pattern of results obtained using the emotional Stroop task may reflect attentional avoidance of negative information, rather than attentional vigilance for negative information, as claimed. Given such criticisms, investigators have sought to employ alternative methods of assessing attentional selectivity, designed to overcome the problems associated with the emotional Stroop task, and these are discussed below.

**The Assessment of Attentional Bias in Negative Emotional Disposition Using the Visual Search Task**

Another approach used to assess selective attention, although one that has tended to be employed less often, is the visual search task. In this task, participants are required to rapidly determine the location of a target stimulus embedded among an array of distracters. The degree to which participant is speeded to detect negative targets embedded in arrays of neutral distractors relative to neutral targets embedded in arrays of negative distractors, is taken as an index of attentional bias to negative information. For example, Gilboa-Schechtman, Foa, and Amir (1999) recruited 16 participants who had been diagnosed with generalised social anxiety disorder and 17 non-anxious control participants. It was found that the anxious participants were relatively speeded to detect negative targets embedded in arrays of neutral distractor stimuli compared to neutral targets embedded in arrays of negative distractor stimuli. These findings are consistent with the hypothesis that high negative emotional disposition is characterised by an attentional bias to negative information. Other
studies involving clinically anxious and depressed populations have replicated this pattern of results (Rinck & Becker, 2005; Rinck, Becker, Kellermann, & Roth, 2004), and similar findings have also been reported in studies that have recruited non-clinical participants who report high levels of trait anxiety (Hadwin, Donnelly, French, Richards, Watts, & Daley, 2003; Matsumoto, 2010).

Unfortunately, a serious criticism of the visual search task is that, like the emotional Stroop task, the observed pattern of effects could, in principle, reflect attentional avoidance of, rather than attentional vigilance for, negative information. Specifically, if individuals who report high negative emotional disposition tend to altogether direct their attention away from visual displays that contain more negative information, then they would be relatively slower to detect a single neutral target embedded in an array of negative distractors compared to a single negative target embedded in an array of neutral distractors. Hence, this effect would not reflect attentional vigilance for negative information, but would instead reflect attentional avoidance of negative information. The attentional probe task (MacLeod, et al., 1986), however, serves to overcome the problems associated with both the emotional Stroop task, and the visual search task, and so is described in detail below.

**The Assessment of Attentional Bias in Negative Emotional Disposition Using the Attentional Probe Task**

In the attentional probe task, participants are exposed to pairs of stimuli, usually for 500 ms but sometimes for 1000 ms, whose members differ in emotional valence. Immediately following the termination of this stimulus display, a small visual probe is presented in the locus of one of the previously displayed stimuli. Participants are required to quickly execute a discriminatory response upon detection of the probe. In previous research,
unrelated to attentional processing in negative emotional disposition, it has been consistently shown that participants tend to more rapidly discriminate probes presented in the locus of attended areas, relative to unattended areas, of a visual display (e.g. Hoffman & Nelson, 1981; Navon & Margalit, 1983). Hence, in the attentional probe task, the degree to which probe discrimination responses are speeded to probes that appear in the locus of the negative information, relative to probes that appear in the locus of neutral information, provides an index of attentional bias to negative information.

Importantly, this approach overcomes the problem of general response slowing (associated with the emotional Stroop task), because if some participants more than others exhibited such response slowing in the presence of negative information, then this would equally slow their discrimination latencies for probes in the location of negative information and neutral information, leaving the measure of attentional bias unaffected. It also overcomes the problem of interpreting the direction of the observed attentional effects (associated with both the emotional Stroop task and the visual search task), because if some participants more than others were to altogether direct their attention away from visual displays containing negative information, then this would also equally slow their discrimination latencies for probes in the location of negative and neutral information, thus again not affecting the measure of attentional bias.

MacLeod, Mathews and Tata (1986) introduced the attentional probe task in a study recruiting 16 patients diagnosed with generalised anxiety disorder (GAD), and 16 matched non-anxious control participants. The findings showed that the GAD patients were speeded to process probes appearing in the locus of negative words, relative to probes appearing in the locus of neutral words. In contrast, the control participants displayed the reverse pattern
of response latencies, being slower to process probes appearing in the locus of negative words, relative to probes that appearing in the locus of neutral words. Hence, it was concluded that the former participants are characterised by an attentional preference for negative information, whereas the latter participants may be characterised by attentional avoidance of such information.

A number of subsequent studies have replicated the finding that GAD patients are characterised by an attentional bias to negative information (e.g. Bradley, Mogg, White, Groom, & Bono, 1999; Mogg & Bradley, 2005; Mogg, Mathews, & Eysenck, 1992), and similar results have been demonstrated across the anxiety disorder spectrum including social anxiety disorder (Asmundson & Stein, 1994; Musa, Lepine, Clark, Mansell, & Ehlers, 2003), post-traumatic stress disorder (Bryant & Harvey, 1997), panic disorder (Beck, Stanley, Averill, Baldwin, & Deagle, 1992; Kroeze & van den Hout, 2000), and obsessive compulsive disorder (Tata, Leibowitz, Prunty, Cameron, & Pickering, 1996). Likewise, studies involving individuals diagnosed with major depression have shown that such depressive pathology is also characterised by an attentional preference for negative information (Donaldson, Lam, & Mathews, 2007; Gotlib, Krasnoperova, Yue, & Joormann, 2004; Joormann & Gotlib, 2007).

Evidence of a negative emotional disposition-linked attentional preference for negative information, obtained using the attentional probe task, is not restricted to emotionally dysfunctional patients alone. When this approach has been employed to assess attentional bias in non-clinical participants who report high levels of trait negative emotion (e.g. anxiety or depression) compared to participants who report low levels of such negative emotion, it has repeatedly been found that the former participants display a relatively higher attentional preference for negative information than the latter participants (e.g. Bradley,
Mogg, & Lee, 1997; Broadbent & Broadbent, 1988; MacLeod & Mathews, 1988). Hence, these findings again demonstrate that an attentional bias to negative information is not simply a characteristic of emotional pathology, but is a characteristic of negative emotional disposition more generally.

It is now widely accepted that the attentional probe task can provide a robust measure of attentional bias (MacLeod, Soong, Rutherford & Campbell, 2004). However, it should be noted that not all variants of the probe task are the same. Some investigators have, on occasion, employed variants of the attentional probe task that require participants to indicate the screen location (left or right) in which the probe stimulus appeared, rather than the conventional, and most commonly used approach, which requires participants to instead execute a discriminatory response to the probe stimulus e.g. whether it is a single dot or a pair of adjacent dots (Bradley, Mogg, Falla, & Hamilton, 1998). Because the response participants are required to execute in such location variants does not necessitate processing of the probe content, it need not be influenced by the degree to which attention is located in the region of the probe. Hence, location variants of the attentional probe task cannot provide a rigorous assessment of individual differences in attentional selectivity. The conventional attentional probe task does provide such rigorous assessment, as participants must execute a discriminatory response to the probe, which requires apprehension of information contained within the probe, and so the discriminatory response will be influenced by the degree to which attention is located in the region of the probe.
Summary and Proposed Approach for Assessing Attentional Bias in Positive Emotional Disposition

The findings obtained from studies that have employed the emotional Stroop task, and the visual search task, are consistent with the hypothesis that an attentional bias to negative information is characteristic of negative emotional disposition. But both of these approaches can readily be criticised in terms of their capacity to adequately index such attentional selectivity, rendering the conclusions drawn from studies in which they have been employed dubious. The conventional attentional probe task overcomes the problems associated with these two assessment procedures, and so has enabled investigators to conclude with much greater confidence that an attentional bias to negative information is a reliable characteristic of high negative emotional disposition. Hence, given the attentional probe task represents the most rigorous methodology for assessing attentional selectivity, this approach will be employed in the first phase of the present research program to determine the empirical validity of the hypothesis that high positive emotional disposition is characterised by an attentional bias to positive information.
Chapter 3

Study 1

Introduction

As described in Chapter 1, there has been growing interest in determining the attentional characteristics of positive emotional disposition. Recently, some investigators have put forward the hypothesis that an attentional bias to positive information is characteristic of high positive emotional disposition (e.g. Wadlinger & Isaacowitz, 2010). To date, however, only a handful of studies have sought to test the empirical veracity of this hypothesis. As will be seen, the findings of these studies are consistent with the idea that high positive emotional disposition is characterised by an attentional preference for positive information. But the experimental methodologies used to assess selective attention in these studies have not been optimal for this purpose, and so it remains unknown whether variation in positive emotional disposition is indeed characterised by such a bias.

Using the emotional Stroop task, Mauer and Borkenau (2007) found that individuals who reported higher levels of approach temperament, a personality factor on which dispositional positive emotion loads heavily, displayed a disproportionate slowing to colour name positive words compared to non-positive words, consistent with the hypothesis that high positive emotional disposition is characterised by an attentional preference for positive information. Similar findings using the emotional Stroop task have also been reported by Segerstrom (2001) who recruited participants differing in terms of their levels of trait optimism. While such results are promising, the use of the emotional Stroop task to assess attentional bias to positive information in these two studies raises doubts concerning whether
the observed effects actually reflect biased attentional responding to positive information (e.g. Lavy et al., 1994; Wilson & MacLeod, 2007), and so compromises the conclusion that a high level of positive emotional disposition is characterised by an attentional bias to positive information.

In an effort to confirm the conclusion drawn from studies using the emotional Stroop task, Tamir and Robinson (2007) instead employed an attentional probe task, as this approach can, in principle, provide a more rigorous assessment of attentional selectivity than the emotional Stroop task. The researchers used word pairs, exposed for 500 ms, which each comprised one positive member and one neutral member. The findings showed that higher levels of positive emotion, which was assessed once a day for over a period of one week, were associated with higher attentional bias to positive information index scores. Hence, these results provide converging support for the conclusion that elevated positive emotional disposition is characterised by an attentional preference for positive information.

Like the findings obtained by Mauer and Borkenau (2007), and Segerstrom (2001), who employed the emotional Stroop task, the results obtained by Tamir and Robinson are quite encouraging. But, unfortunately, the attentional probe task employed by Tamir and Robinson was a location variant of the probe task. As noted, the problem with such location variants of the attentional probe task is that participants need not attend to the location of the probe stimulus to accurately respond on the task, and so the observed patterns of response latencies may not be influenced by selective attention. Indeed, it is possible that a participant could successfully complete a location variant of the attentional probe task simply by focusing their attention to only one side of the screen. For example, if a participant focused their attention only to the left side of the screen during the task, then whenever the probe
appeared on the left side of the screen, they would always be able to respond correctly. But if the probe appeared on the right side of the screen, then they still would always be able to respond correctly (i.e. if a probe does not appear on the left side of the screen, then there is only one other location it can be). Hence, the findings obtained by Tamir and Robinson do not adequately resolve the issue of whether high positive emotional disposition is characterised by an attentional preference for positive information.

To overcome the problem associated with location variants of the attentional probe task, it must be the case that participants execute a discriminatory response to probes that requires processing of information contained within the probe. Doing so ensures that participants must shift their attention to the locus of the probe to accurately respond, and that the observed response latencies are influenced by selective attention. Hence, this was the approach adopted in the present study. Specifically, participants high and low in dispositional positive emotion were recruited, and exposed to a conventional attentional probe task, in which word pairs comprising one positive member and one neutral member were displayed for 500 ms, before a probe stimulus was presented in the location of one of the previously displayed words. Participants were required to execute a discriminatory response to this probe stimulus, in this case indicating whether the probe was a single dot or a pair of adjacent dots. By using an attentional probe task that required participants to execute discriminatory responses to the probe content, it was possible to overcome the problems associated with both the emotional Stroop task, and location variants of the attentional probe task. Thus, the present study provides the most rigorous assessment of the attentional characteristics of positive emotional disposition to date.
Method

Participants

Approximately 800 first year psychology students at the University of Western Australia were screened using the trait version of the Positive Affectivity Schedule (PAS; Watson et al., 1988). 30 students were recruited from the lower third of the PAS score distribution (scoring 29 or below), and were designated the Low Positive Emotional Disposition group. A further 30 students were recruited from the upper third of the PAS score distribution (scoring 36 or above), and were designated the High Positive Emotional Disposition group. The High Positive Emotional Disposition group comprised 7 males and 23 females, whereas the Low Positive Emotional Disposition group comprised 9 males and 21 females. In the former group, mean age was 18.42 yrs (SD = 1.72), while in the latter group mean age was 18.85 yrs (SD = 2.11). There was a significant group difference in terms of positive emotional disposition scores, $F(1, 58) = 201.80, p < .001$ (High Positive Emotional Disposition group: $M = 38.69, SD = 3.44$; and Low Positive Emotional Disposition group: $M = 25.04, SD = 3.48$). The two groups did not differ in terms of age, $F(1, 58) = .63, ns$, or gender ratio, $\chi^2(1, n = 60) = .84, ns$.

Materials

Experimental Stimuli

In the present study, word pairs comprising one member that was positive in emotional valence, and one member that was neutral in emotional valence, were required. A final set of 96 word pairs was selected from a larger initial pool of 200 candidate word pairs, which had been rated by 6 clinical psychologist judges on the basis of emotional valence.
However, it was recognised that, if the emotional material presented to the judges was only of one type (i.e. positive), then they may begin to base their ratings only on very minor perceived differences in positivity, which could compromise the rating procedure. Thus, 100 of the candidate word pairs comprised members that were thought to be positive and neutral in emotional valence, whereas the other 100 candidate word pairs comprised members that were thought to be negative and neutral in emotional valence. The members of the candidate word pairs were matched in word frequency (according to Kucera & Francis, 1967), and word length (expressed in terms of letters).

The judges were asked to rate the emotional valence of each the 400 candidate words, which were presented in random order, using a 7-point scale ranging from -3 (extremely negative) to +3 (extremely positive). In the final set of 96 word pairs, the mean emotional rating for the positive word pair member was 1.98 (SD = .60), and the mean emotional rating for the neutral word pair member was .07 (SD = .20). A t-test carried out on these ratings confirmed that, across this final set of word pairs, the valence of the two word pairs members significantly differed in terms of emotionality, $t (190) = 29.96$, $p < .001$, as required.

**Positive Affectivity Schedule**

The present study required participants who were high and low in terms of their dispositional positive emotion. No questionnaire instrument has been designed to specifically measure this disposition. But the trait version of the Positive Affectivity Schedule (PAS) has previously been employed as a measure for such positive emotional disposition (c.f. Lyubomirsky, King, & Diener, 2005), and so it was used to assess this emotional disposition throughout the research program. The PAS is a sub-scale of the Positive and Negative Affect
Schedule (PANAS; Watson, Clark, & Tellegen, 1988), comprising 10 items designed to assess positive emotional disposition. For each item, participants are instructed to rate “to what extent you generally feel this way; that is, how you feel on average.” This instrument has been shown to have acceptable reliability and validity (Crawford & Henry, 2004).

**Experimental Hardware**

A Hewlett-Packard Compaq dc7800 with a 22-inch colour monitor (Hewlett-Packard Company, Palo Alto, CA, USA), and a standard two button mouse was used to deliver the attentional assessment task.

**Attentional Probe Task**

Each trial commenced with the 500 ms presentation of a fixation cross (+) in the centre of the screen. The screen was then cleared, and a word pair was displayed for 500 ms, with one member appearing 1.5 cm above, and the other member appearing 1.5 cm below, the fixation cue. The positive word pair member appeared, with equal probability, in the upper or lower screen location. Following termination of the word pair, a small visual probe stimulus was presented in the location previously occupied by the one of the word pair members. On half the trials the probe stimulus was a single red dot, and on the remaining trials the probe stimulus was a pair of closely adjacent red dots. Participants were required to discriminate the identity of the probe stimulus as rapidly as possible. The participant responded using the mouse, a left-click and right-click respectively indicating that the probe stimulus was a single or double dot. The speed and accuracy of this probe discrimination response was recorded. Upon detection of the participant’s response, the screen was cleared, and the next trial began after a 500 ms inter-trial interval.
In total, 768 trials were presented across the attentional assessment task. Each of the 96 word pairs was presented eight times, in random order, with the constraint that each word pair was exposed once, before any word pair was presented for a second time. In keeping with previous studies that have employed the attentional probe task (e.g. MacLeod, Mathews, & Tata, 1986), the probe discrimination latencies obtained from the present task were used to calculate an index of attentional bias to positive information. This index reflects the speeding to process probes in the locus of positive words, relative to probes in the locus of neutral words, and was computed using the following equation:

\[ \text{Attentional Bias to Positive Information Index} = \text{RT for probes opposite positive word locus} - \text{RT for probes in positive word locus}. \]

On the attentional probe task, a low accuracy score would indicate that the participant had not closely complied with the task instructions. Hence, an 85% criterion level of overall probe discrimination accuracy was set for participant exclusion.

**Procedure**

Each participant was tested individually. The test session commenced with the participant being seated approximately 60 cm in front of the computer screen, and provided with the instructions for the attentional assessment task. As the probe discrimination latencies obtained from the attentional probe task were used to compute attentional bias scores, which were the dependent variable of interest, the instructions emphasised that the participant should respond as quickly as possible, without compromising accuracy. Next, a short practice task was given, comprising 48 trials that used only non-word letter strings. The participant
then completed the attentional assessment task, before being debriefed about the purpose of the study and thanked for their participation.

**Results**

No participant was excluded on the basis of low probe discrimination accuracy. Indeed, participants displayed reassuringly high levels of accuracy on the attentional probe task, averaging less than 3% errors, suggesting that they closely complied with the task instructions. Accuracy rates did not differ between the two positive emotional disposition groups ($F < 1$). Mean probe discrimination latencies for accurate responses were computed under each experimental condition, after removing latencies less than 200ms and greater than 2000ms, and outliers using a 95% confidence interval. This led to the exclusion of 5.3% of latencies. The mean probe discrimination latencies obtained under each condition are shown in Table 1. The attentional bias to positive information index scores were then computed by subtracting the mean discrimination latency for probes in the locus of positive words from the mean discrimination latency for probes in the locus of neutral words. A higher score on this attentional bias index reflects a greater attentional bias to positive, relative to neutral, information.
Table 1. Mean and standard deviation of probe discrimination latencies, in milliseconds, under each experimental condition.

<table>
<thead>
<tr>
<th>Positive Word Position</th>
<th>Probe Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Emotional Disposition Group</td>
<td>Probe Upper</td>
</tr>
<tr>
<td>High Positive Emotional Disposition</td>
<td>Mean: 585.61</td>
</tr>
<tr>
<td></td>
<td>SD: 81.06</td>
</tr>
<tr>
<td>Low Positive Emotional Disposition</td>
<td>Mean: 589.14</td>
</tr>
<tr>
<td></td>
<td>SD: 83.82</td>
</tr>
</tbody>
</table>

These attentional bias to positive information index scores were subjected to a one-way ANOVA that considered the between-group factor Positive Emotional Disposition Group (Low Positive Emotional Disposition vs. High Positive Emotional Disposition). This analysis revealed a strong trend towards a main effect of Positive Emotional Disposition Group, $F (1, 46) = 3.80, p = .06$, partial-$\eta^2 = .08$. Inspection of the attentional bias scores revealed that the high positive emotional disposition participants displayed higher attentional
bias to positive information index scores ($M = 1.50$, $SD = 14.32$), than were displayed by the low positive emotional disposition participants ($M = -6.60$, $SD = 18.00$). Hence, this pattern of findings suggests that participants high in positive emotional disposition compared to those low in positive emotional disposition, were disproportionately inclined to focus their attention towards the locus of positive information.

**Discussion**

There has been growing interest in determining the psychological factors that contribute to individual differences in dispositional positive emotion (c.f. Linley, Joseph, Harrington, & Wood, 2006). Drawing on the types of cognitive accounts put forward to explain individual differences in negative emotional disposition, some investigators have recently posited that an attentional bias to positive information is characteristic of high positive emotional disposition (e.g. Wadlinger & Isaacowitz, 2010). The evidence obtained in previous studies investigating this issue is consistent with the possibility that an attentional bias to positive information is characteristic of high positive emotional disposition (Segerstrom, 2001; Mauer & Borkenau, 2007; Tamir & Robinson, 2007). Unfortunately, the experimental methodologies used in these previous studies (the emotional Stroop task and a location variant of the attentional probe task) have not been optimal in terms of their capacity to assess such attentional bias, and so it has not yet been properly established whether such attentional selectivity really is characteristic of high positive emotional disposition. In the present study, a discrimination variant of the attentional probe task was employed, as this approach provides a more robust assessment of attentional selectivity than the tasks used in previous studies. The current findings show that participants high in dispositional positive emotion displayed higher attentional bias to positive information index scores than
participants low in dispositional positive emotion. Thus, the present results are consistent with the hypothesis that an attentional bias to positive information is characteristic of high positive emotional disposition.

As outlined in the General Introduction, cognitive accounts of negative emotional disposition have generated quite influential hypotheses concerning the attentional basis of this negative disposition (e.g. Bower, 1981; Williams, Watts, MacLeod, & Mathews, 1997). Indeed, there is now a substantial body of empirical data obtained from numerous studies carried out to test the veracity of these hypotheses, and the findings of such work have been particularly valuable in furthering our understanding of individual differences in negative emotional disposition (c.f. Mathews & MacLeod, 2005). The current results suggest that such cognitive accounts may also prove to be a powerful framework for building and refining our understanding of individual differences in positive emotional disposition. While there is still much research to be carried out, the findings of the present study provide some optimism that work designed to test cognitive accounts of positive emotional disposition will bear fruit, and in the following discussion a number of potential lines of such future research will be outlined.

One way in which future researchers may build upon the present study is by seeking to obtain converging support for the current findings. It is widely accepted that the probe task provides a robust measure of attentional selectivity, and so it is not surprising that it has been employed across many studies (c.f. Bar Haim, et al., 2007). However, like any measure, it has both its strengths and its limitations. But by drawing on different experimental approaches, whose strengths compliment the limitations of this approach, it may be possible to draw stronger conclusions concerning the effects of interest. Two candidate approaches
(which of course are not without their own limitations) which could be employed in future research, motivated to obtain converging evidence for the present findings, respectively involve the use of eye-movement technology and electroencephalogram (EEG) recordings. These two approaches will be briefly discussed in turn, as they will be reviewed more fully in the final chapter. Eye-movement procedures involve exposing participants to visual displays, while tracking and recording the direction of their eye-gaze (c.f. Findlay & Gilchrist, 2003). In recent years, such eye-movement procedures have become more widely used in the assessment of attentional selectivity in individuals characterised by high negative emotional disposition, and the findings obtained from studies employing these procedures have provided converging support for the hypothesis that such negative emotional disposition is characterised by an attentional bias to negative information (Cisler & Koster, 2010). Hence, it is likely that eye-movement procedures also may represent a useful approach for assessing the patterns of attentional bias that characterise individual differences in positive emotional disposition, and so could be exploited in future research for this purpose.

Another experimental technique that could serve to provide converging support for the present findings relies on a phenomenon that has become known as a steady-state visual evoked potential (ssVEP). It has been shown that a visual stimulus, which is repeatedly presented at a fixed rate of greater than 5 – 6 Hz (e.g. a flickering light), elicits a response in brain activity at the same fundamental frequency as the modulated stimulus (Regan, 1966). A number of studies have shown that the amplitude of the ssVEP is significantly increased when attentional focus is directed towards the flickering stimulus (e.g. Muller, Picton, Valdes-Sosa, Riera, Teder-Salejarvi, & Hillyard, 1998; Muller & Hubner, 2002), and so ssVEPs have been used to assess the deployment of selective attention to emotional
information. For example, in a recent study, Wieser, M'Teague, and Keil (2011) measured ssVEPs in high and low socially anxious participants exposed to stimulus pairs comprising negative and neutral faces. For the former participants, it was found that the magnitude of the ssVEP evoked by negative information was greater than that evoked by the neutral information. The latter participants did not show any evidence of this effect. Thus, the findings are consistent with the hypothesis that negative emotional disposition is characterised by an attentional bias to negative information. Hence, these results suggest that ssVEPs may also be usefully employed to assess attentional bias to positive information in participants who differ in terms of their positive emotional disposition.

A different way in which future researchers may endeavour to extend findings of the present study is by seeking to more fully examine the nature of the observed positive emotional disposition-linked attentional bias to positive information. In the following, three lines of research will be briefly discussed, as these will be expanded upon in greater depth in the latter chapters of the thesis. The present study is limited by the fact that it is not possible to draw any conclusions concerning the nature of the attentional processes that underlie this positive emotional disposition-linked attentional preference for positive information. Hence, it will be of theoretical importance to determine, for example, whether such attentional selectivity reflects the involvement of automatic information processing or strategic information processing (Shiffrin & Schneider, 1977). Some researchers have sought to address this issue, in individuals who differ in terms of their negative emotional disposition, by manipulating the exposure duration of stimuli, as it is often argued that automatic processes are likely to be more evident when processing time is most restricted, and strategic processes more evident when processing time is less restricted (c.f. Teachman, Joormann,
Steinman, & Gotlib, 2012). The present study cannot shed any light on this issue, as it is widely accepted that the patterns of attentional selectivity revealed when attention is assessed 500 ms after stimulus onset may reflect the involvement of automatic processing, strategic processing, or both (McNally, 1995). Thus, it will be important for future researchers to adopt designs that are capable of distinguishing whether this positive emotional disposition-linked attentional bias reflects the involvement of automatic or strategic processes.

A second issue is that, in the present study, the high trait positive emotion participants will likely have differed from the low trait positive emotion participants in terms of their state positive emotion during the experimental session. No measure of positive mood state was obtained in the present study, however, if this were the case, then the pattern of attentional bias to positive information exhibited by the former participants may have reflected the direct influence of state positive emotion, rather than the direct influence of trait positive emotion. Some researchers have suggested that this pattern of selective attention is characteristic of state, rather than trait, positive emotion (e.g. Goetz, Goetz, & Robinson, 2007), but other have suggested that such positive attentional selectivity is characteristic of trait, rather than state, positive emotion (e.g. Wadlinger & Isaacowitz, 2010). Hence, it will be important for future researchers to attempt to tease apart the influence of state and trait variables in the expression of this bias, in order to distinguish these competing theoretical accounts.

A third issue concerns the attentional mechanisms that may underpin this pattern of attentional selectivity. Specifically, it could be the case that elevated positive emotional disposition is characterised by facilitated attentional engagement with positive information or impaired disengagement from positive information. It has been correctly noted that the
patterns of attentional selectivity revealed by experimental approaches such as the conventional attentional probe task, could reflect individual differences either in engagement bias or disengagement bias (Clarke, MacLeod, Guastella, 2012). Hence, to address this issue it is necessary to employ experimental techniques capable of dissociating these two facets of attentional selectivity. Recently, in a supplementary study conducted during the course of the author’s PhD candidature, Grafton and MacLeod (in press) developed the Attentional Response to Distal and Proximal Emotional Information (ARDPEI) task, and have shown that it is capable of dissociating engagement and disengagement biases in anxious individuals (see also Rudaizky, Basanovic, & MacLeod, 2013). Thus, appropriately amended variants of the ARDPEI task could be employed to determine whether the positive emotional disposition-linked attentional bias to positive information reflects increased attentional engagement with, or impaired attentional disengagement from, such information.

Of course, further research will be required to address these issues, but for the moment, it can be concluded that an attentional bias to positive information is characteristic of high positive emotional disposition. In terms of the present research program, it is most important to now address the hypothesis that such attentional selectivity makes a causal contribution to positive emotional disposition. Specifically, while the findings of the present study have established that there is an association between high positive emotional disposition and attentional bias to positive information, the causal status of this relationship is indeterminate. To test this hypothesis it is necessary to directly manipulate attentional response to positive information, to determine whether such modification significantly alters subsequent positive emotional disposition. Hence, the studies reported in phase two of this research program will make use of training variants of the attentional probe task, which are
designed to modify attentional response to positive information, in order to determine the subsequent impact of such attentional manipulation on positive emotional disposition. Such research will not only enable the evaluation of the hypothesis that an attentional bias to positive information causally contributes to positive emotional disposition, but could also give rise to novel future approaches for remediating the symptoms of emotional disorders that are characterised, in particular, by a deficit in positive emotion.
The studies reported in this second research phase were designed to determine whether an attentional preference for positive information makes a causal contribution to positive emotional disposition. In each study, participants reporting mid-range positive emotional disposition were exposed to an attentional training task, in which a systematic contingency between the position of the positive words and the position of probes was introduced. This training contingency was designed either to induce attentional vigilance for positive information (‘attend positive’ training), or to induce attentional avoidance of such information (‘avoid positive’ training). A conventional attentional assessment task, in which the training contingencies were eliminated, was delivered before and after the attentional manipulation, to determine the efficacy of the training procedure in modifying attentional response to positive information. The impact of this attentional manipulation on positive emotional reactivity was then assessed by exposing participants to a subsequent anagram success task designed to elevate positive mood. As will be seen, the findings obtained across these three studies are consistent with the hypothesis that an attentional bias to positive information makes a causal contribution to positive emotional disposition.
Introduction to Research Phase 2

Given it has been demonstrated that high positive emotional disposition is characterised by attentional bias to positive information, it is now critically important to determine whether such attentional selectivity makes a causal contribution to positive emotional disposition. Of course, finding that variation in attentional preference for positive information is related to variation in dispositional positive emotion cannot sustain the conclusion that such attentional difference functionally contributes to variability in positive emotional disposition. Hence, it is necessary to adopt an experimental approach that enables the more direct evaluation of the hypothesis that an attentional bias to positive information makes a causal contribution to positive emotional disposition. Two such experimental approaches will now be outlined.

Candidate Experimental Approaches for the Investigating the Causal Contribution of Positive Attentional Bias to Positive Emotional Disposition

A number of researchers have previously sought to address the hypothesis that an attentional bias to negative information makes a causal contribution to negative emotional disposition, with the focus of this work being almost exclusively on anxiety. One type of experimental approach adopted in such work has been to investigate whether initial measures of attentional selectivity can prospectively predict the degree to which later negative events elicit increases in negative emotional reactions (prediction studies). Another type of experimental approach has been to determine the impact of directly manipulating attentional response to negative information upon subsequently observed negative emotional disposition (manipulation studies). As will be seen, manipulation studies represent the most powerful experimental approach for addressing the hypothesis that an attentional bias to negative
information makes a causal contribution to negative emotional disposition. Hence, it will be argued that the studies reported in this second phase of the research program should make use of such manipulation approaches, to test the empirical veracity of the hypothesis that an attentional bias to positive information makes a causal contribution to positive emotional disposition.

**Determining the Causal Contribution of Negative Attentional Bias to Negative Emotional Disposition: Prediction Studies**

As noted, one way in which researchers have sought to address the hypothesis that an attentional bias to negative information makes a causal contribution to negative emotional disposition has involved examining whether initial measures attentional selectivity can predict subsequent negative emotional reactions to negative events. Such prediction studies have shown that early measures of attentional bias to negative information can powerfully predict negative emotional reactivity following exposure to a negative event. MacLeod and Hagan (1992), using the emotional Stroop task, assessed attentional bias to negative information in 31 women who were awaiting a colposcopy investigation. 15 women later received a diagnosis of cervical pathology, and reported the degree to which this diagnosis had impacted on their emotional functioning. Notwithstanding the criticisms of the emotional Stroop task, it was shown that the initial measure of attention bias best predicted the intensity of the subsequent negative emotional response elicited by the diagnosis of cervical pathology, consistent with the hypothesis that such attentional selectivity makes a causal contribution to negative emotional disposition. Indeed, none of the conventional questionnaire measures of dispositional negative emotion administered by the investigators were capable of significantly predicting this later negative emotional response. These results
were replicated in a study by Van den Hout, Tenney Huygens, Merckelbach, and Kindt (1995), who found that higher negative attentional bias scores were associated with higher self-reported ratings of negative emotion to a number of different negative life events.

Pury (2002), using the emotional Stroop task, assessed patterns of attentional bias to negative information in undergraduate students approximately four weeks prior to an important exam. It was found that the initial attentional bias to negative information scores were the best predictor of anxiety symptoms in the week before the exam. Interestingly, like MacLeod and Hagan, none of the conventional questionnaire measures of negative emotional disposition delivered by the investigator were capable of significantly predicting this later negative emotional response. Hence, this finding again demonstrates that initial measures of attentional bias to negative information can prospectively predict the degree to which negative events serve to elicit negative emotional responses, consistent with the hypothesis that such attentional selectivity can make a functional contribution to negative emotional disposition.

While the results of such prediction studies provide encouraging support for the hypothesis that an attentional bias to negative information makes a causal contribution to negative emotional disposition, they do not, however, offer conclusive proof for this position. That is, the findings only show that the relationship between attentional bias and negative emotional disposition is stable across an extended interval of time, and so do not require the conclusion that the association between these two variables is causal one. For example, it may be the case that a third variable independently mediates the association between attentional bias and negative emotional response to negative events (i.e. the ‘third’ variable problem; Pearl, 2000). The most powerful way of evaluating the hypothesis that variation in
one dimension causally influences variation in a second dimensions, is to systematically
manipulate the first dimension to test the prediction that scores on the second dimension will
change. A number of investigators have adopted such a manipulation approach to test the
hypothesis that an attentional bias to negative information makes a causal contribution to
negative emotional disposition. Specifically, researchers have sought to experimentally
modify attentional response to negative information to test the prediction that such
manipulation of attentional selectivity will significantly alter negative emotional disposition.
In such studies, investigators have used training variants of conventional attentional
assessment tasks that are designed to systematically induce an attentional bias away from, or
towards, negative information (c.f. MacLeod & Mathews, 2012).

Clearly, the same methodological approach could readily be adapted to instead
scrutinise the empirical veracity of the hypothesis that an attentional bias to positive
information causally contributes to positive emotional disposition. Hence, in the following
section, the manner in which conventional attentional assessment tasks have been amended
to render them capable of modifying attentional selectivity will first be described, before the
results of studies that have employed attentional training procedures to determine the causal
nature of the association between attentional bias to negative information and negative
emotional disposition are reviewed. As will be seen, such manipulation approaches have
enabled researchers to draw strong conclusions concerning the causal contribution of
negative attentional bias to negative emotional disposition.
Determining the Causal Contribution of Negative Attentional Bias to Negative Emotional Disposition: Manipulation Studies

The earliest approach developed to directly modify attentional selectivity, which has since become the most frequently used procedure, is a training variant of the attentional probe task. In the assessment version of this task, probes are presented equally often in the locus of the negative, or neutral, member of each stimulus pair. However, to modify attentional response to negative information, researchers have introduced a training contingency into this task. In such training variants of the task, probes are either consistently presented in the opposite locus to the negative stimuli, to encourage attentional avoidance of negative information (avoid negative training), or else probes are consistently presented in the same locus as the negative stimuli, to encourage attentional vigilance for negative information (attend negative training).

This type of attentional training procedure was introduced by MacLeod, Rutherford, Campbell, Holker, and Ebsworthy (2002). They exposed participants to a single session of either one of the two training contingencies. The probe discrimination latency data obtained from a conventional version of the attentional probe task, in which the training contingency was removed, showed that the attentional training manipulation was effective in differentially modifying attentional response to negative information. Importantly, such modification was evident on negative stimulus material that had not been presented during the attentional training trials, suggesting that the induced attentional bias reflected a more general attentional response to negative information, rather than a specific attentional response to those stimuli presented within the training procedure.
MacLeod et al. then exposed participants to an anagram failure task. In this task, participants were told that they had 3 minutes to complete as many anagrams as possible. The anagram letters strings employed were either very difficult to solve, or did not actually have a legitimate English solution, and so were considered insoluble. Once the 3-minute time period had expired, all participants were informed that their performance was in the lower 10th percentile. The participant’s negative mood was assessed before and after the anagram failure task using visual analogue mood scales (VAMS). VAMS have been shown to be a reliable and valid measure of mood (Nyenhuis, Yamamoto, Stern, Luchetta, & Arruda, 1997). Importantly, when participants were subsequently exposed to this anagram task, the degree to which it served to elicit negative mood was dependent on training condition. Specifically, participants who had been exposed to the training condition that reduced attentional bias to negative information showed an attenuated negative emotional response to the anagram task compared to participants who had been exposed to the training condition that increased attentional vigilance for negative information. These findings lend strong support to the hypothesis that negative attentional bias can make a causal contribution to negative emotional disposition, and highlight the capacity of such attentional manipulation approaches in enabling conclusions about the functional contribution of attentional selectivity to emotional disposition.

A similar pattern of results was obtained by Amir, Weber, Beard, Bomyea, and Taylor (2008) who exposed participants to a single session of either avoid negative training, or a control condition in which no training contingency was present. Immediately upon completion of the training, participants were required to give an impromptu speech that was video recorded by the experimenter. Consistent with the hypothesis that attentional bias to
negative information can causally contribute to social anxiety, participants who had been exposed to the avoid negative training condition displayed lower levels of negative emotional response to the speech task than did participants who had been exposed to the no-training control condition. This finding demonstrates that negative attentional bias can causally contribute to social anxiety symptoms, and has since been replicated in several other attentional training studies (e.g. Heeren, Lievens, & Philippot, 2011; Heeren, Reese, McNally, & Philippot, 2012). Taken together, these studies clearly demonstrate that manipulation approaches can enable investigators to draw quite strong conclusions concerning the causal contribution of negative attentional bias to social anxiety.

In a recent replication attempt of the Amir et al. (2008) study, however, Julian, Beard, Schmidt, Powers, and Smits (2012) found that participants who received an attentional training condition intended to reduce attentional bias to negative information did not come to display any differential attentional bias than was shown by participants who received a control condition. Perhaps unsurprisingly, the participants who completed this training condition also did not display attenuated social anxiety symptoms compared to participants who completed the no-training control condition. These results show that it is not always possible to manipulate attentional bias, but it should be emphasised that given the attentional training procedure did not differentially modify attentional response to negative information, these null results do not contradict the hypothesis that an attentional bias to negative information can causally contribute to social anxiety symptoms.

Hayes, Hirsch, and Mathews (2010) recruited participants who reported high levels of worry on a conventional worry questionnaire. Half of these participants were given an attentional training procedure that delivered both the probe training task, and a novel dichotic
attentional training task, configured to induce attentional avoidance of negative information. The remaining participants were given control versions of these tasks, in which the training contingency was removed. The probe discrimination latency data obtained from a conventional version of the attentional probe task, in which the training contingencies were eliminated, demonstrated that the training manipulation was successful in differentially modifying attentional response to negative information, as intended. A thought sampling procedure then was employed to assess negative thought intrusions before and after a final worry induction. The results showed that there was no significant difference between the groups in terms of negative thought intrusions immediately before the worry induction. The control participants, however, evidenced a disproportionate increase in such intrusions following this worry manipulation compared to the experimental participants. Hence, the finding that participants who received the avoid negative training experienced less negative thought intrusions than did those who received the no-training control procedure, verifies that attentional bias can make a casual contribution to worry. Once again, these results show that attentional manipulation studies represent a particularly powerful approach for determining whether variation in attentional selectivity exerts a causal influence on variation in emotional disposition.

**Summary and Proposed Approach for Determining the Causal Contribution of Positive Attentional Bias to Positive Emotional Disposition**

The findings obtained from studies employing training variants of the attentional probe task have shown that when attentional selectivity is modified, then such modification serves to subsequently impact on negative emotional reactivity to a negative event, consistent with the hypothesis that an attentional bias to negative information makes a causal
contribution to negative emotional disposition. Hence, it seems plausible that appropriately amended training variants of the type of attentional probe tasks could be used to manipulate positive attentional selectivity. It cannot be assumed on the basis of studies that have sought to modify attentional response to negative information, however, that it will be possible to modify attentional response to positive information. Indeed, it may well be the case that such attentional manipulation is not possible. But, if it does nevertheless prove possible to manipulate attentional response to positive information, then this will enable the examination of whether such attentional modification exerts a subsequent impact on positive emotional reactivity to a positive event, which, if this is found to be the case, would offer compelling support for the hypothesis that an attentional bias to positive information can make a causal contribution to positive emotional disposition.
Chapter 5

Study 2

Introduction

The findings obtained in Study 1 demonstrated that high positive emotional disposition is associated with an attentional bias to positive information. Such findings cannot, however, sustain the conclusion that this pattern of attentional selectivity makes a causal contribution to such positive emotional disposition. As described in the Introduction to this second research phase, addressing this issue requires a methodological framework paralleling that employed to investigate the functional contribution of negative attentional bias to negative emotional disposition (e.g. Eldar, Ricon, & Bar-Haim, 2008; MacLeod et al., 2002). This was the approach adopted in the present study.

Participants reporting mid-range positive emotional disposition were exposed to an attentional training task, in which a systematic contingency between the position of the positive words and the position of probes was introduced. For some participants, this training contingency was that probes always appeared in the same locus as the positive words, with the intention of inducing attentional vigilance for positive information (‘attend positive training), and for other participants, the training contingency was that probes always appeared in the opposite locus to the positive words, with the intention of inducing attentional avoidance of positive information (‘avoid positive training). The efficacy of this training procedure in modifying attentional response to positive information was determined by examining probe discrimination latencies obtained from attentional assessment trials presented before and after the attentional training, in which the training contingencies were
eliminated. Consistent with previous research, evidence that the training procedure was effective in differentially modifying positive attentional bias will be revealed by a two-way interaction between training condition and attentional assessment point. Specifically, participants trained to attend to positive information should display a relative increase in attentional preference for positive information from pre- to post-training, while participants trained to avoid positive information should display the reverse pattern of change, reflecting a relative reduction in attentional preference for positive information pre- to post-training.

Following this attentional training procedure, participants were exposed to an anagram success task, designed to elicit an increase in positive emotional reactivity. In this task, participants were provided with false feedback indicating that they performed particularly well. Of course, it remains to be seen whether the attentional training task is capable of modifying attentional response to positive information, but if this is found to be the case, then the mood data obtained from the success task can be examined to determine the validity of the hypothesis that an attentional bias to positive information causally contributes to variation in positive emotional disposition. If this hypothesis is correct, then following exposure to the attentional training procedure, but not before, participants trained to attend towards positive information will display significantly greater positive emotional reactivity to the success task than will participants trained to avoid positive information.

Method

Participants

Thirty-six introductory psychology students at the University of Western Australia accepted an invitation to participate in the study. Participants who were not characterised by
unusually high or low tendencies to experience positive emotion, and who were relatively homogeneous with respect to such positive emotional disposition, were targeted for recruitment. Hence, participant recruitment was guided by a mass screening of approximately 800 introductory psychology students using the trait version of the Positive Affectivity Schedule (PAS; Watson, Clark, & Tellegen, 1988). Students invited to participate in the study were those who had scored in the middle 50 percent of trait PAS scores (i.e. 30 - 36) obtained by this population.

Participants were randomly allocated to one of two groups, with the constraint that an equivalent gender ratio (12 female and 6 male) was maintained across both groups. Eighteen participants were exposed to the training contingency designed to induce an attentional preference towards positive information, and were designated the ‘attend positive’ group. The remaining participants were instead exposed to the training contingency designed to induce an attentional avoidance of positive information, and were designated the ‘avoid positive’ group. This gave rise to a between-group factor of Training Condition (attend positive vs. avoid positive). In the attend positive group, the mean PAS score was 33.11 (SD = 2.11) and the mean age was 17.72 yrs (SD = 0.89). In the avoid positive group, the mean PAS score was 33.06 (SD = 2.18) and the mean age was 18.00 yrs (SD = 1.85). The groups did not differ in terms of trait PAS scores, t (34) = .08, ns, or age, t (34) = .57, ns.

Materials

Experimental Stimuli

Emotional Word Pairs. The emotional word pairs employed in this study were identical to those used in Study 1. This set of 96 word pairs was, however, now divided into two word
pair subsets that each contained 48 word pairs. For each participant, one subset was to be used in the pre-training attentional assessment trials and the attentional training trials. The other subset was to be used in the post-training attentional assessment trials. The two subsets of word pairs did not differ significantly in terms of their emotional characteristics, word lengths or frequencies (all $p’s > .05$).

**Anagram Task Letter Strings.** The anagram success task was delivered twice, before and after completion of the attentional training task. An initial set of 120 letter strings were generated for use in this anagram success task. Each letter string was a soluble anagram, in that the letters could be rearranged to form a legitimate English word. To ensure that participants were able to complete the task with a high degree of ease, the letter strings were only three or four letters in length. The initial set of 120 letter strings was then divided into two anagram string subsets, each containing 60 letter strings. Each subset comprised 35 three-letter strings, and 25 four-letter strings.

**Emotional Assessment Instruments**

**Positive and Negative Affectivity Schedule.** As in Study 1, the Positive Affectivity Schedule (PAS) of the Positive and Negative Affectivity Schedule (PANAS; Watson, et al, 1988) was employed to assess dispositional positive emotion.

**Visual Analogue Mood Scale.** In keeping with the approach adopted in previous research (e.g. MacLeod, et al., 2002) a visual analogue mood scale was programmed for computer delivery to measure positive mood state before and after the anagram success task. This scale consisted of a 15cm horizontal line, divided into 60 equal partitions, with the terminal labels sad and happy. Using the mouse, participants completed the scale by moving a cursor along
the line to a point that corresponded with their current level of happiness, and responses were registered by pressing the left mouse button. This resulted in a score between 1 and 60, with a higher score indicating a higher level of positive emotional reactivity.

**Experimental Hardware**

The hardware employed in this study was identical to that used in Study 1.

**Experimental Tasks**

*Attentional Probe Task.* The attentional probe task used to assess and manipulate attentional responding to positive information was closely based on the task previously employed by MacLeod et al. (2002) to manipulate attentional responding to negative information. Each trial commenced with the central presentation of the signal “Next Trial” for 500 ms, which served as a fixation cue. The screen was then cleared and a word pair was presented for 500 ms, with one word member appearing 1.5 cm above, and the other word member appearing 1.5 cm below, the fixation cue. The position of the positive word was random, such that it appeared with equal probability in the upper or lower screen location. Immediately upon termination of the word pair display, a small probe stimulus appeared in a randomly determined position previously occupied by a letter of one of the word pair members. This probe stimulus was either a single red dot, or a pair of closely adjacent red dots, with equal frequency. Participants were required to discriminate the identity of the probe as rapidly as possible. Responses were made using the left or right mouse button, to indicate that the probe was either a single dot or a double dot, respectively. The probe remained on the screen until the participant’s response was detected, and the probe discrimination latency recorded. The screen was then cleared, and the next trial commenced after a 500 ms inter-trial interval.
In total, the attentional probe task comprised 768 trials, of which the first 96 and final 96 were attentional assessment trials, giving rise to a within-group factor Attentional Assessment Point (pre-training assessment vs. post training assessment). The intervening 576 were attentional training trials. The distinction between these two types of trials was as follows:

**Attentional training trials.** In the attentional training trials, the screen location in which the probes appeared depended upon training group. For participants in the attend positive group, the probe always appeared in the locus of the previously presented positive word. For participants in the avoid positive group, the probe always appeared in the locus of the previously presented neutral word. For each participant, only one of the two word pair subsets was employed during the attentional training trials, though across participants, each word pair subset was used an equal number of times during the attentional training trials. In the training trials, the 48 word pairs were exposed a total of 12 times. The order of word pair presentation was random, with the constraint that each word pair was exposed once before any was presented for a second time, and was exposed for a third time only after having been repeated once, and so on.

**Attentional assessment trials.** In the attentional assessment trials, for all participants, probes appeared in the locus of the previously presented positive word, and in the locus of the previously presented neutral word, with equal frequency. To determine whether the impact of the training procedure on attentional bias represented a general attentional response to positive information, the post-training attentional assessment trials employed only word pairs not previously encountered during the attentional training trials. The pre-training attentional assessment instead used the other word pair subset, which also was employed in the
attentional training trials. Across the pre- and post-training attentional assessment trials, each of the 48 word pairs was presented twice, in random order, with the constraint that each of the 48 word pairs was exposed once, before any were presented for a second time. For each word pair, the probe appeared once in the screen locus previously occupied by the positive word, and once in the screen locus previously occupied by the neutral word. The probe discrimination latency data obtained from the attentional assessment trials was used calculate an index of attentional bias to positive information. This index reflects the relative speeding to process probes appearing in the locus of positive words, relative to probes in the locus of neutral words, and was computed using the same equation as described in Study 1:

Attentional Bias to Positive Information Index = RT for probes opposite positive word locus – RT for probes in positive word locus.

On the attentional assessment trials, a low accuracy score would indicate that the participant had not closely complied with the task instructions. Hence, an 85% criterion level of overall probe discrimination accuracy was again set for participant exclusion.

**Anagram Success Task.** The anagram task developed by MacLeod et al. (2002), which was originally designed to provide a failure experience to elicit a negative mood state, was modified to create an anagram task that instead delivered a success experience to elicit a positive mood state. Participants were informed that the anagram task was part of ongoing research investigating the association between academic achievement and performance on cognitive tasks, and was designed to measure individual differences in the rate of solutions of anagrams. They were advised that individual anagrams would appear in the middle of the computer screen, and that they had 3 minutes to complete as many as possible. On
presentation of each anagram, the participant responded by first pressing the spacebar, which enabled them to input the correct answer. The participant then pressed the enter key to register their response, and proceed to the next anagram. If the participant was unable to solve the anagram, they were instructed to press the mouse button to skip to the next anagram.

To render the task capable of elevating positive mood state, not only were the anagrams easy to solve, but false feedback was also provided online to the participant, which was designed to ensure that their efforts were eventually successful in achieving a level of performance that was excellent. To deliver this feedback, a graph was presented in the bottom, left-hand corner of the screen. Participants were informed that the red bar on the graph corresponded to their rate of solution of anagrams, while the yellow bar on the graph corresponded to the average rate of solution of anagrams at that point in time, based on the results of other students who had previously completed the task. A percentile rank, indicating the participant’s supposed rank among these previous students, was also displayed above the graphs. Performance feedback was such that each participant began the task with both bars at zero, and with a percentile rank that read ‘Average.’ As the participant progressed, their performance bar elevated each time they made a correct response. The program ensured that the bar supposedly displaying the average performance of previous participants was initially in front of, but eventually fell behind, the bar showing the participant’s own performance. As the discrepancy between both bars widened, the percentile label changed accordingly, indicating a progressively higher percentile rank for the participant. All participants finished with a percentile rank that read ‘Upper 10%’. The anagram success task was administered both before and after the attentional training task, giving rise to a within-group factor of
Anagram Test Phase (pre-training vs. post training). A different anagram letter string subset was used on each occasion the anagram task was delivered, with the letter strings being presented in random order.

Mood state was assessed on the analogue mood scale immediately before and immediately after each delivery of the anagram task, giving rise to a within-group factor of Mood Assessment Point (pre-anagram vs. post-anagram). From these scores an index of positive emotional disposition was calculated. This index reflects the heightened tendency to respond to a positive event with greater elevation of positive mood state, and was computed using the following equation:

Positive Emotional Disposition Index = post-anagram positive mood score - pre-anagram positive mood score.

Procedure

Each participant was tested individually. The test session commenced with the participant being seated approximately 60cm from the computer screen, and provided with instructions for both the analogue mood scale and the anagram task. The participant then completed the analogue mood scale, followed by the anagram task, and then the second administration of the analogue mood scale. Next, the participant was briefed about the requirements of the attentional probe task. The instructions stressed the need for the participant to respond as quickly as possible, without compromising accuracy. Following completion of the attentional probe task, the session continued with delivery of the analogue mood scale, the anagram task, and the repeated administration of the analogue mood scale.
At the end of the session, the participant was debriefed as to the purpose of the study, and thanked for their participation.

**Results**

Two sequential issues were addressed in the analysis of the data. First, in order to determine whether the attentional training procedure was effective in differentially modifying attentional response to positive information, the probe discrimination latency data obtained from the attentional training trials was analysed. Second, the analogue mood scale data can be analysed to determine whether exposure to the attentional training task, designed to differentially modify attentional response to positive information, resulted in differential positive emotional reactivity to the post-training anagram success task.

**Impact of Attentional Training Manipulation on Attentional Response to Positive Information**

One participant from the attend positive group displayed an accuracy rate below the 85% criterion level, and so was removed from further analysis. The remaining participants displayed high levels of accuracy across the attentional assessment trials, averaging less than 6% errors, indicating good compliance with the task instructions. Accuracy rate did not differ between the two attentional training conditions ($F < 1$).

In order to determine the efficacy of the attentional training procedure in modifying attentional response to positive information, the probe discrimination latencies obtained from the attentional assessment trials were examined. The mean probe discrimination latencies were first computed for accurate responses under each experimental condition, after removing latencies less than 200ms and greater than 2000ms, and outliers using a 95%
confidence interval. This led to the exclusion of 5.6% of latencies. The mean probe
discrimination latencies, obtained under each experimental condition, are shown in Table 1.
The attentional bias to positive information index scores, shown in Table 2, were then
computed by subtracting the mean discrimination latency for probes in the locus of positive
words from the mean discrimination latency for probes in the locus of neutral words. A
higher score on this attentional bias index reflects a greater attentional bias towards positive,
relative to neutral, information.
Table 1. Mean and standard deviation of probe discrimination latencies, in milliseconds, under each experimental condition.

<table>
<thead>
<tr>
<th>Attentional Assessment Point</th>
<th>Pre-Training Assessment</th>
<th>Post-Training Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive Word Upper</td>
<td>Positive Word Lower</td>
</tr>
<tr>
<td>Attend Positive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>678.07</td>
<td>712.43</td>
</tr>
<tr>
<td>SD</td>
<td>76.62</td>
<td>68.83</td>
</tr>
<tr>
<td>Avoid Positive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>700.41</td>
<td>708.34</td>
</tr>
<tr>
<td>SD</td>
<td>101.96</td>
<td>78.83</td>
</tr>
</tbody>
</table>
These attentional bias scores were subjected to a mixed-design 2 x 2 ANOVA that considered the between-group factor Training Condition (attend positive training vs. avoid positive training), and the within-group factor Attentional Assessment Point (pre-training assessment vs. post training assessment). As described, if the training is effective in differentially modifying attentional response to positive information, then this will give rise to a two-way interaction of Training Condition x Attentional Assessment Point. The ANOVA did not reveal a significant main effect of Training Condition, $F(1, 33) = 2.70$, $ns$, $\eta^2 = 0.08$, or Attentional Assessment Point, $F < 1$. Of more importance to the issue under consideration, however, the interaction between these two factors also did not reach statistical significance, $F(1, 33) = 3.48$, $ns$, $\eta^2 = 0.09$. Hence, no evidence that the attentional training procedure served to differentially modify attentional response to positive information was obtained.

Table 2. Mean and standard deviation of attentional bias to positive information index scores under each experimental condition.

<table>
<thead>
<tr>
<th>Attentional Training Condition</th>
<th>Attentional Assessment Point</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Training Assessment</td>
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<tr>
<td>Attend Positive</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>29.51</td>
</tr>
<tr>
<td>SD</td>
<td>59.63</td>
</tr>
<tr>
<td>Avoid Positive</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>-16.44</td>
</tr>
<tr>
<td>SD</td>
<td>42.79</td>
</tr>
</tbody>
</table>
Consequently, analysis of the analogue mood scale data cannot enable appraisal of the hypothesis that an attentional bias to positive information makes a causal contribution to positive emotional disposition. But the analogue mood scale data was nevertheless analysed for two reasons: i) to determine whether the anagram success task was generally successful in inducing elevations in positive mood, which would indicate that it could be used for this purpose in subsequent studies; and ii) to ensure that, in the absence of attentional change, mere exposure to the two attentional training conditions did not serve to differentially modify positive emotional reactivity.

Impact of Attentional Training on Positive Emotional Disposition

The positive mood scores obtained from the analogue mood scale for each of the participant groups are shown in Table 3. To determine whether the anagram success task was generally effective in elevating positive mood, average positive mood scores were computed for each participant, when such positive mood state was assessed before and after the anagram success task. These average mood scores were subjected to a repeated measure ANOVA that considered the within-group factor Mood Assessment Point (pre-anagram vs. post-anagram). The analysis revealed a significant main effect of Mood Assessment Point, $F(1, 33) = 12.22, p < .01, \eta^2 = 0.26$, reflecting the fact that positive mood scores obtained at the post-anagram success assessment were higher ($M = 43.37, SD = 8.63$) than those at the pre-anagram success assessment ($M = 39.43, SD = 9.26$). This confirms that the anagram success task was generally effective in elevating positive mood, as intended.
Table 3. Mean and standard deviation of positive mood scores under each experimental condition.

<table>
<thead>
<tr>
<th>Attentional Training Condition</th>
<th>Pre-attentional training</th>
<th>Post-attentional training</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anagram Test Phase</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attend Positive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>40.41</td>
<td>43.00</td>
</tr>
<tr>
<td>SD</td>
<td>9.77</td>
<td>9.45</td>
</tr>
<tr>
<td>Avoid Positive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>41.00</td>
<td>43.39</td>
</tr>
<tr>
<td>SD</td>
<td>11.08</td>
<td>10.59</td>
</tr>
</tbody>
</table>

Next, to determine whether, in the absence of attentional change, mere exposure to the two attentional training conditions served to differentially modify positive emotional reactivity, the Positive Emotional Disposition Index Scores were computed, as described in the Method section, and these are shown in Table 4. If positive emotional reactivity was differentially modified, despite no attentional change, then this would be revealed by a two-way interaction of Training Condition x Anagram Test Phase. The positive emotional disposition index scores were subjected to a mixed-design 2 x 2 ANOVA that considered the between-group factor Training Condition (attend positive training vs. avoid positive training), and the within-group factor Anagram Test Phase (pre-training assessment vs. post-training assessment). The analysis did not reveal any significant main effects (all $p > .05$),
Table 4. Mean and standard deviation of positive emotional disposition index scores under each experimental condition.

<table>
<thead>
<tr>
<th>Attentional Training Condition</th>
<th>Attentional Assessment Point</th>
<th>Pre-Training Assessment</th>
<th>Post-Training Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attend Positive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2.59</td>
<td>4.41</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>7.33</td>
<td>6.30</td>
<td></td>
</tr>
<tr>
<td>Avoid Positive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2.39</td>
<td>6.33</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>8.42</td>
<td>9.60</td>
<td></td>
</tr>
</tbody>
</table>

and of most importance to the issue under consideration, there was no evidence of a significant two-way interaction of Training Condition x Anagram Test Phase ($F < 1$), as would be the case if mere exposure to the two training contingencies was enough to differentially modify positive emotional reactivity.

**Discussion**

To rigorously test the hypothesis that variation in one dimension causally contributes to variation in a second dimension, it is necessary to experimentally manipulate the first dimension, to test the prediction that the scores on the second dimension will subsequently change. Hence, it follows that to test the hypothesis that an attentional bias to positive information makes a causal contribution to positive emotional disposition, it is necessary to first manipulate attentional response to positive information, and assess whether this changes
subsequent positive emotional disposition. In the present study, the pattern of probe
discrimination latencies obtained on the attentional assessment trials delivered before and
after the training procedure did not reveal any evidence that this attentional manipulation was
effective in differentially modifying attentional response to positive information. As a
consequence, analysis of the mood scale data obtained from the anagram success task could
not serve to illuminate the validity of the hypothesis that an attentional bias to positive
information makes a causal contribution to positive emotional disposition.

Before turning to discuss this failure to differentially modify attentional response to
positive information, it is again worth noting two results that emerged from the analysis of
the mood scale data obtained from the anagram success task. First, in general, the positive
mood scores observed immediately after the anagram task were significantly higher than
those observed immediately before the anagram task. Hence, this suggests that the anagram
success task is capable of inducing elevations in positive mood as intended, and confirms that
its use in subsequent studies is justified. Second, given the attentional training task did not
differentially modify attentional response to positive information, and the two training groups
did not differ in the degree to which the anagram success task served to elevate positive
mood, this suggests that mere exposure to the attentional training conditions is not sufficient
to alter positive emotional disposition. This finding is of particular importance, if it can be
shown that future delivery of such attentional training does serve to differentially modify
attentional response to positive information. Specifically, if such attentional modification is
found to subsequently impact positive emotional reactivity, then the current findings suggest
this effect would be carried by change in attentional bias, rather than from mere exposure to
the alternative training contingencies. Of course, it remains to be seen whether attentional
bias to positive information actually can be altered, and so candidate explanations for the present failure to alter such attentional selectivity will now be considered.

One straightforward possibility is that attentional responses to positive information are more robust than attentional responses to negative information, and so a greater number of training sessions may be required to modify such positive attentional selectivity. In a recent meta-analysis, Hakamata et al. (2010) found that the number of attentional training sessions delivered to participants significantly moderated the degree to which such attentional training impacted on attentional response to negative information, suggesting that greater exposure to such training tasks may produce a larger attentional effect. In the present study, participants were only exposed to a single attentional training session. Hence, it may be the case that by exposing participants to a greater number of attentional training sessions of the present type, this will result in the successful modification of positive attentional bias. Such extended delivery of attentional training could be achieved, for example, by having participants complete the same attentional training procedure over multiple days either within the laboratory or at home via the Internet.

An alternative reason for the failure to modify positive attentional selectivity concerns the possibility that such attentional training may require participants to experience high levels of positive mood before it can be effective. Some investigators have suggested that the benefits of cognitive behavioural therapy (CBT), in terms of altering negative emotional disposition, may be maximised when individuals are encouraged to experience the types of negative thought content, and heightened levels of negative emotion, that they would otherwise experience in their daily life, during the delivery of the CBT treatment (Riggs, Cahill, & Foa, 2006). Drawing on this principle, Kuckertz et al. (2013) exposed socially
anxious patients to an attentional training procedure designed to reduce attentional bias to negative information. But, of relevance, some of these participants were instructed to expose themselves to social situations that provoked negative emotional responses immediately before completing the attentional training, such as, making a difficult phone call, or walking into a crowded room. The other participants did not receive such instruction. It was found that the attentional training procedure was effective for the former participants, but not for the latter participants, in terms of modifying attentional response to negative information. Thus, the present attentional training may have failed to modify positive attentional selectivity because participants were not exposed to a positive event prior to completing the training procedure, which elicited a level of positive emotion of sufficient intensity, to make the modification of positive attentional selectivity possible. Of course, in the present study, participants were exposed to the anagram success task, which was designed to elevate positive mood, just before receiving the attentional training. However, the anagram success task is a contrived laboratory procedure, and it may be the case that the type of positive event that could render the attentional training effective in modifying positive attentional selectivity must be more naturalistic, and perhaps more intense. So, for example, it may be possible to obtain the required attentional training effect by having participants watch their favourite TV show, or listen to their favourite music, just before completing the training.

A third possibility that may explain the present failure to modify positive attention concerns whether the capacity of participants to exploit the training contingency. For an attentional training procedure to be effective in modifying attentional response to emotional information, it is plausible that participants must encode the differential emotional valence of word pair members, in order to apprehend, and exploit, the training contingency between the
position of the emotional word stimuli and the position of probes. In contrast to previous studies, the word pairs used in the current attentional training task comprised one positive member and one neutral member, rather than one negative member and one neutral member (e.g. MacLeod, et al., 2002; Amir, Beard, Burns, & Bomyea, 2009; See, MacLeod, & Bridle, 2009). Hence, it is possible that the current failure to modify attentional response to positive information reflects the fact that the discrepancy between the emotional tone of the positive members of the word pair, and the neutral members of the word pair, was not especially noticeable. Indeed, while there is evidence to suggest that negative emotional information is prioritised by the cognitive system, and is readily detected and processed, it appears that positive emotional information may not enjoy this same status (Smith, Cacioppo, Larsen, & Chartrandm 2003). Thus, the capacity of participants to effectively apprehend, and exploit, the alternative training contingencies in the present study may have been critically hampered, giving rise to the failure to alter positive attentional selectivity. Thus, if participants could be encouraged to encode the emotional valence of the word pair members used in the attentional training, then this may make it possible to successfully manipulate attentional response to positive information.

The candidate accounts put forward to explain the present failure of the attentional training task to alter attentional response to positive information each could be pursued in the current research program, in an effort to achieve the differential modification of such attentional selectivity. Indeed, it is of critical importance that attentional response to positive information be modified, if the hypothesis that an attentional bias to positive information makes a functional contribution to positive emotional disposition is to be addressed. In the forthcoming study, it was decided that the latter candidate explanation for the failure to
modify positive attentional selectivity, which concerned the possibility that the discrepancy between the positive and neutral members of the word pair was not particularly salient, would be the initial focus of the further attempts to modify positive attentional selectivity. Of course, if the attentional training is still not effective in modify attentional response to positive information, then the other avenues described to potentially render the training effective in modifying such attentional selectivity could be pursued.
Chapter 6

Study 3

The following chapter reflects a manuscript that was published in the European Journal of Personality. The full article is provided in Appendix A.

Introduction

Like Study 2, the aim of the present study was to determine whether an attentional bias to positive information makes a causal contribution to positive emotional disposition. As noted, the attentional training task did not, in the previous study, serve to differentially modify attentional response to positive information. A plausible explanation for this failure to modify such attentional selectivity was that the discrepancy between the emotional tone of the positive members, and the neutral members, of the word pairs might not have been readily apparent to participants. If participants do not encode this emotional discrepancy, then they would not be able to apprehend and exploit the training contingency, and so the training task would not be capable of modifying attentional selectivity. But if participants could be encouraged to encode the emotional tone of the stimuli presented during the attentional training trials, then this could render the training effective in differentially altering attentional response to positive information, as required.

One way in which participants could be encouraged to encode the emotional discrepancy between the word pair members would be to have participants complete a task prior to the attentional training, in which they were required on each trial to make judgements concerning the emotional tone of word pair stimuli (e.g. whether two word pair members were or were not matched in terms of their emotional tone). However, if this approach were
taken, then participants may consider this task as quite separate from the attentional training, which plausibly may compromise its impact on the encoding of the emotional tone of word pair members presented during the attentional probe task. So, rather than requiring participants to make emotional judgements about word pair members in a quite separate task, it would be instead be possible to include such trials within the training itself. Given these emotional judgement trials would be presented at the same time as the attentional training trials, this would likely ensure that their impact, in terms of encoding the differential emotional tone word pair members, would transfer to the attentional training trials. Hence, this was the approach adopted in the present research. In developing these emotional judgement trials it was necessary to take into consideration two methodological issues. In the following, the nature of these two issues, and the manner in which they were addressed, is described.

The first methodological issue taken into consideration was that the impact of the emotional judgement trials, in terms of emotional encoding during the attentional training trials, might be compromised if the structure of the former trials was noticeably different from the latter trials. Thus, it was decided that the physical and temporal characteristics of the emotional judgement trials should be kept as close as possible to the attentional training trials. Further, given that the members of the emotional word pairs used in the attentional training trials were matched in terms of word length, it was considered important that the members of the emotional judgement word pairs also should be (closely) matched in word length.

The second methodological issue considered arose following the recognition that, if the word pairs presented on the emotional judgement trials comprised one member that was
positive in emotional valence, and one member that was neutral in emotional valence, then participants could only be asked to make emotional judgements about these stimuli in two ways: i) they could be asked to determine whether the word pair members were, or were not, matched in their emotional valence; or ii) they could be asked whether one of the word pair members was positive, or neutral, in emotional valence. But if either of these approaches were employed, then it would raise the possibility that participants may come to adopt a pattern of attentional scanning during the attentional probe task. Such attentional scanning would not be desirable, as it may compromise the impact of the training manipulation and/or the assessment of attentional selectivity. Hence, in order to ensure the emotional judgement trials did not result in participants adopting a pattern of attentional scanning, each emotional judgement word pair comprised two members that were of the same emotional valence (positive or neutral). Participants were required to indicate whether the word pair member they attended to during the trial was either positive or neutral in emotional tone. Thus, in order to make a response on the emotional judgement trials, it was not necessary for participants to encode the valence of both members of a word pair, and so participants were able to successfully complete the task without the need to attend to engage in attentional scanning.

Method

Participants

A new sample of 36 introductory psychology students at the University of Western Australia accepted an invitation to participate in the study. They were selected in exactly the same manner as in Study 2, and again were assigned at random to the same two attentional
training conditions. None of the participants had prior knowledge of the research topic, or had taken part in the previous study. In the attend positive group, the mean PAS score was 33.22 (SD = 1.85) and the mean age was 19.00 yrs (SD = 2.38). In the avoid positive group, the mean PAS score was 33.06 (SD = 1.70) and the mean age was 18.06 yrs (SD = 0.94). The two groups did not differ in terms of trait PAS scores, \( t(34) = 1.57, \text{ns} \), or age, \( t(34) = .27, \text{ns} \).

**Materials**

**Experimental Stimuli**

*Emotional Word Pairs.* The same two emotional word pair subsets employed in Study 2 were used in the present study.

*Emotional Judgement Word Pairs.* As noted, the emotional judgement trials were interspersed in the attentional training trials of the probe task, to encourage participants to encode the emotional tone of the stimuli presented. For this purpose, two sets of 48 emotional judgement word pairs were needed. It was required that each emotional judgement word pair comprised two members of the same emotional valence, which were approximately matched in word length. The two emotional word pair subsets were used to generate the emotional judgement word sets. Specifically, for each emotional word pair subset, the two positive (or neutral) words with the longest word lengths were paired, before the two positive (or neutral) words with the next longest word length were paired, and so on. This procedure resulted in two subsets of 48 emotional judgement word pairs. Each subset comprised 24 word pairs in which both members were positive in emotional valence, and 24 word pairs in which both members were neutral in emotional valence. Thus, the members of
each emotional judgement word pair had the same emotional tone, and were closely matched in terms of word length, as required.

**Anagram Task Letter Strings.** The anagram letter stings employed in the success task were identical to those used in Study 2.

**Emotional Assessment Instruments**

*Positive and Negative Affectivity Schedule.* Consistent with previous studies, the Positive Affectivity Schedule (PAS) of the Positive and Negative Affectivity Schedule (PANAS; Watson, et al, 1988) was employed to assess positive emotional disposition.

*Visual Analogue Mood Scale.* The same analogue mood scale employed in Study 2 was used to measure positive mood state before and after the delivery of the anagram success task.

**Experimental Hardware**

The hardware employed in this study was the same as the two previous studies, with the exception of Sennheiser HD201 stereo headphones, which were used to present the audio files for the emotional judgement trials.

**Experimental Tasks**

*Attentional Probe Task.* The temporal and physical characteristics of each trial of the attentional probe task were identical to those described in Study 2. The structure of the emotional judgement trials differed slightly, though, as described below.
Attentional training trials. The attentional training trials were the same as described in Study 2, however, 96 emotional judgement trials were interspersed throughout these training trials in the current study.

Emotional judgement trials. The temporal and physical characteristics of the emotional judgement trials were almost identical to the attentional training trials. Specifically, the emotional judgement trials commenced with the 500 ms presentation of the indicator “Next Trial” in the centre of the screen, which served as a fixation cue. Immediately upon termination of this display, an emotional judgement word pair was presented for 500 ms, with one word member appearing 1.5 cm above, and the other member appearing 1.5 cm below, the fixation cue. Following the offset of this lexical display, the screen was cleared, and rather than a probe stimulus being presented, a single-word question was instead presented via the headphones. On half of the trials the single-word was the word “Positive”, and on the remaining trials it was the word “Neutral”. In both cases the single-word was intonated as a question. With equal probability, the emotional tone of the word pair members did or did not match the valence of this single-word question. Using the mouse, participants were required to indicate whether the emotional tone of the word pair member they had attended to either did, or did not, match the valence of the single-word question, by clicking the right or left mouse button, respectively. As soon as the participant’s response was detected and recorded, the next trial commenced after a 500 ms inter-trial interval.

The 96 emotional judgement trials were interspersed within the attentional training trials, such that for every 7 trials presented, 6 were an attentional training trial, and 1 was an emotional judgement trial. The order of presentation of the attentional training trials, and the emotional judgement trials, within these 7 trials was randomised. For each participant, the
emotional judgement word pair set used corresponded to the same word pair subset used in 
the attentional training trials. This ensured that the participant was not exposed to new 
stimuli during this training block. Each of the 48 emotional judgement word pairs was 
presented twice, in random order, with the constraint that each of these word pairs was 
exposed once before any was presented again.

Attentional assessment trials. The attentional assessment trials were identical to those 
described in the previous study. On the attentional assessment trials, a low accuracy score 
would indicate that the participant had not complied with the task instructions, and so an 85% 
criterion level of overall probe discrimination accuracy was again set for participant 
exclusion.

Anagram Success Task. The anagram success task employed in the present study was 
identical to that used in Study 2. Again, the analogue mood scale was delivered immediately 
before, and immediately after, each delivery of the anagram task. From these scores an index 
of positive emotional disposition was calculated. This index reflects the heightened tendency 
to respond to a positive event with greater elevation of positive mood state, and was 
computed using the following equation:

Positive Emotional Disposition Index = post-anagram positive mood score - pre-anagram 
positive mood score.

Procedure

The procedure was the same as described in Study 2, but the instructions for the 
attentional probe task differed. Specifically, participants were informed that a word pair 
would be presented in the centre of the computer screen. They were told that, on some trials,
one or both of the words in the word pair would either be distinctively positive, or
distinctively neutral, in emotional tone. Next, they were informed that, on the majority of
trials, a small probe would appear in the locus of the screen where one of the words had just
been displayed, and instructions for responding to the probe were given, with the need to
respond as quickly as possible, while minimising errors, being emphasised. Participants were
then informed that, interspersed between these probe trials, would be others in which they
were instead required to determine the emotional tone of the word pair members. It was
stressed to the participant that, on every occasion they were required to do this, both
members of the word pair would have the same emotional tone. Hence, whichever member
of the word pair they happened to attend to, would provide sufficient information to answer
the question. The participant was then told that a single-word question, either ‘Positive’ or
‘Neutral’, would be presented via the headphones, and instructions on how to respond were
given.

Results

Two issues were sequentially addressed in the analysis of the data. First, attentional
probe discrimination latencies were analysed to determine whether the attentional training
procedure was effective in differentially modifying attentional responding to positive
information, as intended. Second, the analogue mood scale data was analysed to determine
whether the differential modification of positive attentional bias resulted in differential
positive emotional disposition, as revealed by the intensity of positive emotional reactions to
the post-training anagram success experience. Analyses pertinent to each of these two issues
will be reported in turn.
Impact of Attentional Training Manipulation on Attentional Response to Positive Information

Two participants were found to display probe discrimination accuracy below the 85% criterion level, and one participant reported being unable to complete the task proficiently due to ill health. These three participants were removed from further analysis. The remaining participants displayed reassuringly high levels of accuracy, averaging less than 7% errors across attentional assessment trials, suggesting good compliance with the task instructions. Accuracy rates did not differ for participants in the two attentional training conditions ($F < 1$).

In order to determine the efficacy of the attentional training procedure in modifying attentional response to positive information, the probe discrimination latencies obtained from the pre- and post-attentional assessment trials were examined. Mean probe discrimination latencies for accurate responses were first computed under each experimental condition, after removing latencies less than 200ms and greater than 2000ms, and outliers using a 95% confidence interval. This led to the exclusion of 6.7% of latencies. The mean probe discrimination latencies observed in each condition are shown in Table 1. Attentional bias to positive information index scores were then computed by subtracting the mean discrimination latency for probes in the locus of positive words from the mean discrimination latency for probes in the locus of neutral words. A higher score on this attentional bias index reflects a greater attentional bias towards positive, relative to neutral, information.
Table 1. Mean and standard deviation of probe discrimination latencies, in milliseconds, under each experimental condition.

<table>
<thead>
<tr>
<th>Attentional Assessment Point</th>
<th>Pre-Training Assessment</th>
<th>Post-Training Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive Word Position</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attent Training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive Word Upper</td>
<td>746.84</td>
<td>654.03</td>
</tr>
<tr>
<td>Positive Word Lower</td>
<td>742.47</td>
<td>704.83</td>
</tr>
<tr>
<td>Positive Word Upper</td>
<td>745.60</td>
<td>673.84</td>
</tr>
<tr>
<td>Positive Word Lower</td>
<td>762.16</td>
<td>686.84</td>
</tr>
<tr>
<td>Probe Position</td>
<td>655.06</td>
<td>609.66</td>
</tr>
<tr>
<td>Probe Lower</td>
<td>677.56</td>
<td>636.06</td>
</tr>
<tr>
<td>Probe Upper</td>
<td>657.41</td>
<td>603.89</td>
</tr>
<tr>
<td>Probe Lower</td>
<td>676.68</td>
<td>655.02</td>
</tr>
<tr>
<td>SD</td>
<td>111.63</td>
<td>68.04</td>
</tr>
<tr>
<td>SD</td>
<td>83.30</td>
<td>98.32</td>
</tr>
<tr>
<td>SD</td>
<td>95.73</td>
<td>89.37</td>
</tr>
<tr>
<td>SD</td>
<td>92.96</td>
<td>78.99</td>
</tr>
<tr>
<td>SD</td>
<td>70.30</td>
<td>74.26</td>
</tr>
<tr>
<td>SD</td>
<td>95.23</td>
<td>64.44</td>
</tr>
<tr>
<td>SD</td>
<td>65.75</td>
<td>76.08</td>
</tr>
<tr>
<td>SD</td>
<td>82.04</td>
<td>85.55</td>
</tr>
</tbody>
</table>
These attentional bias index scores were subjected to a mixed-design 2 x 2 ANOVA that considered the between-group factor Training Condition (attend positive vs. avoid positive), and the within-group factors Attentional Assessment Point (pre-training assessment vs. post-training assessment). As described in Study 2, if the training is effective in differentially modifying attentional response to positive information, then this will give rise to a two-way interaction of Training Condition x Attentional Assessment Point. The analysis revealed no significant main effect of either Training Condition, $F(1, 31) = 1.20, ns$, $\eta^2 = 0.04$, or Attentional Assessment Point, $F(1, 31) = 1.23, ns$, $\eta^2 = 0.04$. Rather, as predicted, there was a significant two-way interaction of Training Condition x Attentional Assessment Point, $F(1, 31) = 6.26, p < .05, \eta^2 = 0.17$. Analysis of its component effects revealed that the nature of this interaction was consistent with expectation. Specifically, participants in the avoid positive training condition came to display reduced scores on the index of attentional bias to positive information at the post-training assessment ($M = -24.73, SD = 60.49$), relative to the pre-training assessment ($M = 37.79, SD = 64.37$), and this change was statistically significant, $F(1, 16) = 4.83, p < .05, \eta^2 = 0.23$. In contrast, participants in the attend positive training condition tended to show the opposite pattern of change in their attentional bias index scores, coming to display higher scores on the index of attentional bias towards positive information at the post-training assessment ($M = 3.23, SD = 49.43$), relative to the pre-training assessment ($M = -20.93, SD = 78.51$), though this change fell short of statistical significance, $F(1, 15) = 1.62, ns$, $\eta^2 = 0.10$. Thus, the interaction confirms that the two attentional training conditions exerted a differential impact on attentional response to positive information, and the direction of the observed effects were consistent with expectation.
It was thought prudent to conduct post-hoc analyses to examine whether there was a between group effect of Training Condition on the index of attentional bias to positive information at the pre- and post-training assessments. This post-hoc analysis revealed an unexpected significant simple main effect of Training Condition at the pre-training assessment, $F (1, 31) = 5.55, p < .05, \eta^2 = 0.15$, reflecting higher initial positive attentional bias index scores in the participants assigned to the avoid positive training condition. Given the random allocation of participants to training condition, and the fact that this group difference was observed before training had commenced, the effect must represent a Type I error. Following exposure to attentional training, participants in the attend positive training condition increased their positive attentional bias index scores, while those exposed to the avoid positive training condition decreased their positive attentional bias index scores, such that post training the former participants ($M = 3.23, SD = 49.43$) had nominally higher attentional bias index scores than did the latter ($M = -24.73, SD = 60.49$). This simple main effect of Training Condition did not, however, reach statistical significance at the post-training assessment $F (1, 31) = 2.10, \text{ns}, \eta^2 = 0.04$. Nevertheless, as noted above, the interaction confirms that the two attentional training conditions exerted a differential impact on attentional response to positive information and, despite the unexpected group difference in attentional bias prior to the delivery of attentional training, the direction of the observed attentional training effects were as intended.

**Impact of Attentional Training on Positive Emotional Disposition**

The positive mood scores obtained from the analogue mood scale for each of the participant groups are shown in Table 2. It was thought prudent to determine, as in Study 2, whether the anagram success task was generally effective in elevating positive mood state.
Table 2. Mean and standard deviation of positive mood scores under each experimental condition.

<table>
<thead>
<tr>
<th></th>
<th>Anagram Test Phase</th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Pre-attentional training</td>
<td>Post-attentional training</td>
</tr>
<tr>
<td>Training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>Pre-anagram</td>
<td>Post-anagram</td>
<td>Pre-anagram</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-anagram</td>
</tr>
<tr>
<td>Attend Positive</td>
<td>Mean</td>
<td>40.38</td>
<td>41.38</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>13.32</td>
<td>13.29</td>
</tr>
<tr>
<td>Avoid Positive</td>
<td>Mean</td>
<td>40.53</td>
<td>42.82</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>8.78</td>
<td>7.55</td>
</tr>
</tbody>
</table>

Hence, consistent with the previous study, average positive mood scores were computed for each participant, when such positive mood state was assessed before and after the anagram success task. These average positive mood scores were subjected to repeated measure ANOVA that considered the within-group factor Mood Assessment Point (pre-anagram vs. post-anagram). The analysis revealed a significant main effect of Mood Assessment Point, $F(1, 32) = 12.78, p < .01, \eta^2 = 0.29$, reflecting the fact that positive scores obtained at the post-anagram success assessment were higher ($M = 42.56, SD = 9.76$) than those at the pre-anagram success assessment ($M= 39.76, SD = 9.47$). This again confirms that the anagram success task was generally effective in elevating positive mood, as intended.
Having shown that the anagram success task served to increase positive mood state, it was possible to examine whether the observed differential modification of positive attentional bias resulted in differential positive emotional reactivity to the anagram success task. The Positive Emotional Disposition Index scores were computed, for each participant, by subtracting positive mood scores immediately prior to delivery of the anagram task, from those obtained immediately after delivery of the anagram task. The resulting positive emotional disposition index scores are shown in Table 3. Higher scores on this index of positive emotional disposition reflect the heightened tendency to respond to the success task with greater elevation of positive mood state. The hypothesis that attentional bias to positive information causally contributes to positive emotional disposition predicts a two-way interaction of Training Condition x Anagram Test Phase, whereby the nature of this two-way interaction reflects a significant simple main effect of Training Condition on this positive emotional disposition index after, but not before, exposure to the attentional training manipulation.
Table 3. Mean and standard deviation of positive emotional disposition index scores under each experimental condition.

<table>
<thead>
<tr>
<th>Attentional Training Condition</th>
<th>Anagram Test Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Training Assessment</td>
</tr>
<tr>
<td>Attend Positive</td>
<td>Mean</td>
</tr>
<tr>
<td></td>
<td>SD</td>
</tr>
<tr>
<td>Avoid Positive</td>
<td>Mean</td>
</tr>
<tr>
<td></td>
<td>SD</td>
</tr>
</tbody>
</table>

The positive emotional disposition scores were subjected to a mixed-design 2 x 2 ANOVA that considered the between group factor Training Condition (attend positive training vs. avoid positive training), and the within-group factor Anagram Test Phase (pre-training assessment vs. post-training assessment). Of most theoretical importance, the only effect to emerge from this analysis was a significant two-way interaction of Training Condition x Anagram Test Phase, $F(1, 31) = 4.90, p < .05, \eta^2 = 0.14$. The pattern of results was fully consistent with expectation. Specifically, while the simple main effect of Training Condition on the positive emotional disposition index score did not approach significance pre-attentional training $F(1, 31) = 0.29, ns$, this same simple main effect was statistically significant post-attentional training, $F(1, 31) = 8.03, p < .01, \eta^2 = 0.21$, and reflected the fact participants who had just received the attend positive training displayed higher positive
emotional disposition index scores compared to participants who had just received the avoid positive training.

**Discussion**

The reported study demonstrates that an attentional training manipulation, that differentially modified attentional response to positive information, differentially modified the degree to which a subsequent positive event then elevated positive mood state. This finding suggests that variability in selective attentional response to positive information can make a causal contribution to variability in positive emotional reactivity to a positive event. Thus, it supports the hypothesis that individual differences in attentional bias towards positive information can causally contribute to positive emotional disposition.

It is recognised that the degree to which people experience feelings of subjective well-being will also be influenced by situational variables. In the present study, positive mood state was elevated by exposure to a success event, and there is much evidence that heightened subjective well-being is related to demographic factors that plausibly are associated with increased access to success experiences (Diener & Lucas, 1999). However, investigators such as Diener, Suh, Lucas, and Smith (1999) have noted that situational factors of this type account for only a modest proportion of the variance in subjective well-being, which also depend crucially on individual differences in disposition. This observation has led them to call for increased research into the cognitive factors that underpin positive emotional disposition. The current work responds to this call, and provides evidence that the preferential allocation of attention to positive information may represent one of the cognitive mechanisms that causally underpins the disposition to experience positive emotion. This is
consistent with the claims of emotional regulation theorists who posit that people shape their emotional experience through selective attentional deployment (John & Gross, 2004). In particular, the findings support Wadlinger & Isaacowitz’s (2010) recent proposal that an attentional bias favouring positive information plays a crucial role in determining the likely intensity of positive mood experienced in response to positive events, with an attentional bias to positive information leading to stronger positive emotional responses to such events.

In addition to advancing theoretical understanding of positive emotional disposition, by lending empirical weight to the hypothesis that positive attentional selectivity causally contributes to this disposition, the findings also suggest possible applied benefits of an attentional bias modification approach, capable of inducing increased attention to positive information. The present study revealed that such attentional change influenced the degree to which positive mood was elevated by a positive event within the laboratory setting. However, it is recognised that individual differences in positive mood response to one particular success event, within a contrived laboratory context, may not provide an optimal index of positive emotional disposition. Thus, it is suggested that future researchers should seek to determine whether inducing an attentional preference for positive information more generally increases the intensity of positive mood states evoked by a wider array of naturalistic situations, as will be the case if such attentional selectivity contributes to trait positive emotion.

The current attentional training study sought only to transiently modify attentional response to positive information. It remains to be seen whether extended delivery of this training procedure across multiple sessions can bring about an enduring increase in selective attention to positive information and, if so, whether this serves to elevate scores on
conventional positive emotional disposition questionnaires assessing real-world emotional experience, such as the PANAS positive affectivity subscale (Watson et al., 1988). There are good grounds for optimism that this may prove possible, given the findings of recent studies in which extended versions of this training task, designed to instead modify selective attentional response to negative information, have been employed. Such extended delivery has been shown to exert a lasting influence on attentional response to negative information, and to influence real-world negative emotion, months beyond the cessation of training (See, MacLeod, Bridle, 2009; Amir, Beard, Burns, & Bomyea, 2009; Schmidt, Richey, Buckner, & Timpano, 2009). For example, when clinically anxious participants were exposed over three weeks to six sessions of this training, designed to reduce attentional bias to negative information, Amir et al. (2009), and Schmidt et al. (2009) observed a resulting reduction in their anxiety symptoms, that remained evident at follow up three months later.

It is suggested that future researchers should now seek to establish whether a similarly extended program of attentional training, designed instead to increase attentional bias towards positive information, can serve to induce a stable elevation in positive emotional disposition. Not only would such a finding further support the hypothesis that biased attentional response to positive information causally contributes to this disposition, but it could also have important real-world applications. The benefits of elevated positive emotional disposition are well documented, and there is clear evidence that this emotional disposition is associated with enhanced functioning in many settings (c.f. Lyubomirsky, King, & Diener, 2005). For example, elevated positive emotional disposition is associated with superior job performance and productivity (Wright & Cropanzano, 2000), and with reduced levels of absenteeism, job turnover, and burnout (George, 1989; Shaw, 1999;
Thoresen, Kaplan, Barsky, Warren, & De Chermont, 2003). One of the key objectives that motivated the development of positive psychology was to identify ways of enabling more people to achieve the benefits that accompany positive emotional experience (Seligman, Steen, Park, & Peterson, 2005). While it is recognised that the use of attentional bias modification methodologies to induce high levels of positive emotional disposition may raise some ethical issues, it is nevertheless the case that there may be appropriate applications.

In particular, it is suggested that such an approach could be warranted when individuals suffer the adverse symptoms associated with unusually low levels of positive emotional disposition. It is now well-recognised that deficient positive emotion is a hallmark of clinical depression. Clinical anxiety and depression are both characterised by elevated levels of negative emotion, but clinical depression alone also is marked by the distinctive lack of positive emotion (Lee et al., 1994). In their recent meta-analysis, Hallion & Ruscio (in press) found good evidence that anxiety is therapeutically responsive to attentional bias modification procedures that reduce the selective attentional processing of negative information, but conclude that this is not reliably the case for depression. Plausibly, this may reflect the fact that effective therapeutic alleviation of depression requires not only the attenuation of negative emotion, but also the amplification of positive emotion. Given the present evidence that attentional bias to positive information contributes to positive emotional disposition, this suggests that attentional bias modification approaches to the remediation of depression may require the inclusion of a training component that serves to increase selective attention to positive information, before this attentional training will be fully effective in attenuating depressive symptomatology.
Although the present findings support the hypothesis that individual differences in positive attentional bias can causally contribute to positive emotional disposition, this does not exclude the possibility that there may be a bidirectional causal relationship between these two variables, whereby positive emotional disposition also causally influences attentional preference for positive information. While there is some evidence to suggest that the induction of positive mood state can influence the breadth of attentional focus (Gable & Harmon-Jones, 2010; Rowe, Hirsh, & Anderson, 2006), no research has sought to determine whether the induction of positive mood serves to increase selective attention to positive information. Further, no work has investigated whether an increase in the disposition to experience positive mood states can elevate such positive attentional bias. Research addressing this issue could make a valuable future contribution to the literature. However, whether or not such a bidirectional causal relationship exists, the present findings indicate that attentional bias to positive information makes a causal contribution to positive emotional disposition.

There are, of course, limitations associated with the present study. For one thing, although the alternative training conditions differentially influenced attentional response to positive information in the intended directions, an unexpected difference in attentional preference for positive information was observed between the two training groups prior to attentional training. Thus, in principle, it could be proposed that the discrepant effects of the differing attentional training conditions might be accounted for by regression to mean. However, if this were the case, then there would be no basis for anticipating that these training manipulations also would differentially influence positive emotional reactivity to the anagram success task. In light of the differing elevation in positive mood state observed
between participants in the two training conditions, the most parsimonious account is that there was a genuine training induced change in attentional response to positive information, which served to influence positive emotional reactions to the success experience. Of course, confidence in this conclusion will be further increased by replication of these findings in participants who do not initially differ in terms of attentional bias.

Another limitation concerns the restricted measurement focus adopted in the present study. One example of this restricted focus is that, while it is possible to conclude the training procedure did appear to influence attentional response to positive information, the possibility that it might also have modified attentional response to negative information cannot be excluded. Specifically, it is not impossible that the training conditions respectively designed to reduce, and to increase selective attentional bias to positive information, may also have respectively increased and reduced selective attentional bias to negative information. If this were the case, then it could be the change in attentional response to negative information that impacted on positive emotional disposition. Thus, it will be important in future studies to include both positive and negative emotional stimulus materials when assessing the attentional impact of this training manipulation. Such an approach would permit determination of whether the present training procedure modifies only attentional bias to positive information, as it has been assumed that positive and negative attention biases are independently related.

A second example of the restricted measurement focus concerns the present mood rating scale. This was intended to assess the impact of the success experience on positive mood state. However, because this scale ranged from a positive terminal (happy) to a negative terminal (sad), what has been interpreted here as increases in positive mood state
following the success experience, could alternatively be construed to reflect decreases in negative mood state following the anagram success task. To fully dissociate the impact of the success task on positive and negative mood, two mood rating scales would need to be employed. One could assess positive mood alone, using terminal labels that describe high and low levels of positive mood (for example, *elated* and *sluggish*). The other could assess negative mood alone, using terminal labels that describe high and low levels of negative mood (for example, *distressed* and *placid*).

A third example of the restricted measurement focus concerns the fact that participants were only exposed to a positive event. While the results show that positive attentional selectivity makes a causal contribution to positive emotional disposition, they do not exclude the possibility that positive attentional selectivity may also make a contribution to negative emotional disposition (as revealed by negative emotional responses to a negative event). Indeed, it is not implausible that attention to positive aspects of a negative situation may attenuate the degree to which it induces negative emotion (Segerstrom, 2001), and there is some preliminary evidence that variability in attentional bias towards positive information may be inversely related to variability in negative emotional reactivity to a negative event (Taylor, Bomyea, & Amir, 2011). Hence, it is suggested that research should seek to determine whether training procedures that discretely manipulate attentional response to positive information serve to impact not only positive emotional responses to positive events, but also negative emotional responses to negative events. The results of such work will determine whether biased attentional responding to positive information causally contributes specifically to positive emotional disposition, or also to negative emotional disposition.
While it will require further research to address these various limitations, for the moment the results are fully consistent with the hypothesis that selective attentional responding to positive information makes a causal contribution to positive emotional disposition. The findings show that it is possible to differentially modify attentional response to positive information using an attentional probe training procedure, and that this serves to influence the intensity of positive emotional reactivity to a positive event. It is hoped this work may stimulate further interest into the attentional basis of positive emotional disposition, and that other researchers also will find the attentional bias modification task developed in the present study useful in investigating the functional relationship between attentional selectivity and emotional disposition.
Chapter 7

Study 4

Introduction

The findings obtained in Study 3 show that a training manipulation, which successfully modified attentional response to positive information, served to differentially modify positive emotional reactivity to a positive event. Hence, the results support the conclusion that an attentional bias to positive information makes a causal contribution to positive emotional disposition. While these findings are promising, and indeed quite exciting, replication evidence is often considered the gold standard by which scientific claims are evaluated (Bonett, 2012). That is, if a particular pattern of effects can be replicated, then this provides greater confidence that the observed effects are real (Francis, 2012). Hence, in the present study, the first key purpose was to determine whether the patterns of effects obtained in Study 3 are replicable. But a second key purpose of the present study was to extend the findings obtained in Study 3. As will expanded upon, the study was designed to more rigorously test of the conclusion that it is specifically attentional bias to positive information, that makes a causal contribution specifically to positive mood reactivity, to positive events specifically.

In Study 3, the hypothesis under test was that an attentional bias to positive information makes a causal contribution to positive emotional reactivity to a positive event. It is possible to parse this hypothesis into three components. The first component concerns the type of attentional selectivity (positive attentional bias or negative attentional bias) that hypothetically exerts a causal impact on emotional reactivity. The second component
concerns the type of emotional reactivity (positive mood state or negative mood) that hypothetically is causally influenced by attentional selectivity. The third component concerns the type of emotional event (positive event or negative event) under which attentional selectivity hypothetically exerts a causal impact on emotional reactivity. In Study 3, the findings obtained were fully consistent with this hypothesis that an attentional bias to positive information causally contributes to positive emotional reactivity to a positive event. But the capacity of the findings to strongly support this hypothesis depends upon the validity of the assumed specificity of the findings. As noted in the previous chapter, the measurement of the three components of the hypothesis (i.e. positive attentional selectivity, positive emotional reactivity, and positive events) was restricted in focus, making it possible to generate alternative accounts that could equally well accommodate the observed pattern of effects. In the following, the manner in which the findings and conclusions drawn in Study 3 bear upon each of the three components of the hypothesis will be outlined. The assumptions underlying the conclusions, and the alternative possibilities that would be invited if these assumptions were incorrect, will then be distinguished. Finally, the ways in which these assumptions will be tested in the present study, to empirically discriminate the validity of the alternative possibilities identified, will then be discussed.

The first component of the Study 3 hypothesis concerns the type of attentional selectivity that exerts a causal impact on emotional reactivity. It was found in Study 3 that the participants exposed to the training contingency designed to encourage attentional vigilance for positive information came to display higher attentional bias to positive information scores from pre- to post-training, whereas the participants exposed to the training contingency designed to encourage attentional avoidance of positive information showed the
reverse pattern of effects, coming to display lower attentional bias to positive information scores from pre- to post-training. Hence, it was concluded that the attentional training procedure served to differentially modify attentional response to positive information. But this conclusion is based on the assumption that the change in attentional selectivity observed was specific to attentional response to positive information. The validity of this assumption is negated by the possibility that the training procedure may also have modified attentional response to negative information. If the training procedure did modify both types of attentional selectivity, then the observed impact of the attentional training on positive emotional reactivity could have been driven by change in negative attention, rather than by change in positive attention. That is, if the training procedure did change attentional response to negative information, then this would give rise to the alternative possibility that an attentional bias to negative information causally contributes to positive emotional reactivity to a positive event, rather than an attentional bias to positive information causally contributes to positive emotional reactivity to a positive event. To determine whether the attentional training modified only selective attentional response to positive information, or whether it also modified selective attentional response to negative information, would require assessing the impact of the attentional training task on both types of attentional selectivity. Hence, word pairs comprising one positive and one neutral member, and word pairs comprising one negative and one neutral member, were presented in the attentional assessment trials of the present probe task. This enabled the two alternative possibilities, concerning whether the attentional training modifies only positive attentional selectivity or also modifies negative attentional selectivity, to be evaluated.
The second component of the Study 3 hypothesis concerns the type of emotional reactivity that is causally influenced by positive attentional selectivity. In the previous study, it was claimed that the attentional training manipulation served to differentially modify degree to which positive emotional reactivity was influenced by the anagram success task. Hence, it was concluded that an attentional bias to positive information makes a causal contribution to positive emotional reactivity to a positive event. But this conclusion is based on the assumption that the change in emotional reactivity observed was specific to positive mood state. The validity of this assumption is negated by the recognition that the rating scale employed to assess positive mood state used terminal labels ranging from happy to sad. That is, the observed change in scores on this scale in response to the anagram success task may have reflected an increase in positive mood, but also may have reflected a decrease in negative mood, or a change in both types of mood. Consequently, there are three possibilities that would be consistent with the observed findings. The first is that positive attentional selectivity causally influences only elevations in positive mood state to a positive event. The second is that positive attentional selectivity causally influences only reductions in negative mood state to a positive event. The third is that positive attentional selectivity makes a causal contribution to both elevations in positive mood state, and reductions in negative mood state, to a positive event. To distinguish these alternative possibilities, it is important that increases in the presence of positive mood, can be readily distinguished from reductions in the presence of negative mood. Thus, a novel analogue mood rating procedure was developed in the present study to enable the dissociation of changes in positive and negative mood, and so the validity of the three alternative possibilities concerning the impact of positive attentional selectivity on mood state could be discriminated.
The third component of the Study 3 hypothesis concerns the type of emotional event under which positive attentional selectivity exerts a causal impact on positive emotional reactivity. The findings of Study 3 showed that a training manipulation that successfully modified attentional response to positive information served to elevate positive emotional reactivity to a positive event. Hence, it was concluded that an attentional bias to positive information makes a causal contribution to positive emotional reactivity to a positive event. But this conclusion is based on the assumption that the causal impact of the attentional training manipulation of positive emotional reactivity was specific to positive events. The validity of this assumption is negated by the possibility that the training procedure may also have causally influenced negative emotional reactivity to a negative event. Hence, two alternative possibilities can be distinguished. The first is that positive attentional selectivity only makes a causal contribution to positive emotional reactivity to positive events. The second is that positive attentional selectivity makes a causal contribution to positive emotional reactivity to positive events, and also makes a causal contribution to negative emotional reactivity to negative events. To distinguish these two possibilities would require exposing some participants to a positive event, and other participants to a negative event. This was the approach adopted in the present study, whereby some participants were exposed to the anagram success task employed in the previous study, and other participants were instead exposed to a modified variant of this anagram task, designed to provide participants with a failure experience. Thus, this enabled the validity of these two alternative possibilities, concerning whether positive attentional selectivity makes a functional contribution to positive emotional reactivity to only a positive event, or also to negative emotional reactivity to a negative event, to be empirically distinguished.
So, in summary, it was claimed in Study 3 that the findings were consistent with the possibility that an attentional bias to positive information makes a causal contribution to positive emotional reactivity to a positive event. Hence, it was concluded that positive attentional selectivity can make a causal contribution to positive emotional disposition. But, given the restricted measurement focus of this previous study, the observed pattern of effects are consistent with a number of alternative possibilities. By employing both positive and negative stimulus information in the attentional assessments trials of the probe task, a visual mood scale that can dissociate positive and negative mood, and by exposing participants to either a positive event or a negative event, however, the validity of these alternative possibilities can be evaluated, and so the present study will be able to confirm whether it is indeed the case that positive attentional selectivity functionally contributes to positive emotional disposition.

Method

Participants

128 introductory psychology students from the University of Western Australia took part in the study. The participants were selected in the same manner as the previous two studies, and were randomly assigned to the same two attentional training conditions. Again, none of the participants had prior knowledge of the research topic, or had taken part in any previous studies of this research program. Participants exposed to the avoid positive training (19 males) had a mean trait PAS score of 32.25 (SD = 2.37), and a mean age of 18.22 years (SD = 1.44). Participants exposed to the attend positive training (16 males) had a mean trait PAS score of 32.17 (SD = 2.62), and a mean age of 18.06 years (SD = 1.26). Those assigned
to the two training conditions did not differ in terms of trait PAS scores, $F (1, 126) = .03$, age, $F (1, 126) = .48$, or gender ratio, $\chi^2 (1, n = 128) = .35$.

**Experimental Stimuli**

**Emotional Word Pairs.** To determine whether the attentional training task only modified attentional response to positive information, or whether it also modified attentional response to negative information, it was necessary to include word pairs comprising one positive member and one neutral member (termed positive/neutral word pairs), as well as word pairs comprising one negative member and one neutral member (termed negative/neutral word pairs), in the attentional assessment trials of the probe task. In the following, the manner in which these two types of emotional word pair were generated is first described, before the generation of two emotional word pair subsets (comprising the two types of emotional word pairs) that were to be used in the attentional assessment trials is described.

**Positive/Neutral Word Pairs.** The positive/neutral word pairs employed in the present study were identical to those used in the previous studies of this research phase.

**Negative/Neutral Word Pairs.** As described in Study 1 of this research program, a large pool of 200 candidate word pairs was generated. Half of the words pairs in this pool were thought to be positive/neutral word pairs, whereas the remaining word pairs were thought to be negative/neutral word pairs. Thus, from this pool it was possible to generate a set of 96 word pairs, in which one member had a negative emotional valence and the other member had a neutral valence. In the final set of 96 negative/neutral word pairs, the mean emotional rating of the negative word member was -2.10 ($SD = .53$), and the mean emotional rating of the neutral word member was 0.10 ($SD = .21$). A $t$-test confirmed that, across this final set of
word pairs, the valence of the two word pair members significantly differed in terms of emotionality, \( t(95) = 37.49, p < .001 \), as required. This set of 96 negative/neutral word pairs was then divided into two word pair subsets, each containing 48 word pairs. The two subsets of negative/neutral word pairs did not differ significantly in terms of their emotional characteristics, word lengths, or word frequencies (all \( p \)’s > .05).

**Emotional Word Pair Subsets.** Two emotional word pair subsets, each containing 96 word pairs, were then generated by pairing one subset of 48 positive/neutral word pairs with one subset of 48 negative/neutral word pairs. Within each of the two emotional word pair subsets, the positive/neutral word pairs, and the negative/neutral word pairs, did not significantly differ in terms of their emotional intensity, word lengths, or word frequencies (all \( p \)’s > .05).

**Emotional Judgement Word Pairs.** The emotional judgement word pairs used in the present study were identical to those employed in Study 3.

**Anagram Task Letter Strings.**

**Anagram Success Task.** The anagram letter stings employed in the anagram success task were identical to those used in the studies previously reported in this research phase.

**Anagram Failure Task.** A set of 60 letter strings were generated for use in the anagram failure task. Two thirds of these letter strings were soluble anagrams, in that the letters could be rearranged to form a legitimate English word. To ensure that the anagram were mostly difficult to solve, half of the letter strings were four to six letters in length, while the remaining letter strings were seven to nine letters in length. All of their solutions were common English words. The other one third of these letter strings could not be rearranged to form any legitimate English word, and so were considered insoluble anagrams.
**Emotional Assessment Instruments**

*Positive and Negative Affectivity Schedule.* As in the previous studies, the Positive Affectivity Schedule (PAS) of the Positive and Negative Affectivity Schedule (PANAS; Watson, et al, 1988) was used to assess positive emotional disposition.

*Visual Analogue Positive and Negative Mood Grid.* To independently assess variation in positive mood, and variation in negative mood, following the anagram success (and failure) task, a novel analogue mood grid was developed. Specifically, this grid employed a rectangular coordinate system, where the $x$ and $y$ axis each were 24 cm in length, and divided into 60 equal partitions. The terminal labels used were based upon those suggested by Watson and Tellegen (1985) to measure positive and negative mood. The positive mood dimension was represented on the $x$-axis, with the labels reflecting strong positive mood (e.g. *elated*) at the rightmost terminal, and labels reflecting the absence of strong positive mood at the leftmost terminal (e.g. *sluggish*). The negative mood dimension was represented on the $y$-axis, with the labels reflecting strong negative mood (e.g. *distressed*) at the uppermost terminal, and labels reflecting the absence of strong negative mood at the lowermost terminal (e.g. *placid*). Two 27.5cm dotted lines also ran diagonally through the origin, one sloping upwards $45^\circ$ to the right and the other sloping upwards $45^\circ$ to the left, with terminal labels that described intermediate mood states, in order to help guide participants in making their response. Using the mouse, participants moved the cursor to any point within the grid that corresponded with their current level of positive mood and negative mood. This resulted in a score between 1 and 60 on each scale, with a higher score indicating a greater level of positive mood state, and negative mood state, respectively.
Experimental Tasks

Attentional Probe Task. The physical and temporal characteristics of the each trial of the attentional probe task were identical to those described in the probe task used in Study 3. The attentional training trials, attentional assessment trials, and the emotional judgement trials, of this probe task are described in turn below.

Attentional training trials. The attentional training trials were identical to the training trials described in the previous study. Again, only the positive/neutral word pairs were presented during these training trials.

Attentional assessment trials. As in the previous two studies, 96 attentional assessment trials were delivered before, and after, the attentional training procedure. But in this study, on half of the attentional assessment trials a positive/neutral was presented, whereas on the remaining assessment trials a negative/neutral word pair was presented. For all participants, probes appeared in the locus of the previously displayed emotional word, and in the locus of the previously displayed neutral word, with equal frequency. To ensure the attentional assessment trials did not employ word pairs previously encountered during the attentional probe task, the post-training attentional assessment always used the emotional word pair subset not employed in the pre-training attentional assessment. Across the pre- and post-training attentional assessment trials, each of the 96 word pairs of the emotional word pair subset employed were presented once, in random order. The probe discrimination latency data obtained from the attentional assessment trials were used to calculate two indices of attentional bias to emotional information. Specifically, the probe discrimination latency data obtained from the attentional assessment trials on which the positive word pairs
were presented were used to calculate an index of attentional bias to positive information. A higher score on this index reflects a greater attentional preference for positive information, and was computed using the following equation:

\[
\text{Attentional Bias to Positive Information Index} = \text{RT for probes opposite positive word locus} - \text{RT for probes in positive word locus}.
\]

The probe discrimination latency data obtained from the attentional assessment trials on which the negative word pairs were presented was used to calculate an index of attentional bias to negative information. A higher score in this index reflects a greater attentional preference for negative information, and was computed using the following equation:

\[
\text{Attentional Bias to Negative Information Index} = \text{RT for probes opposite negative word locus} - \text{RT for probes in negative word locus}.
\]

As in the previous studies, on the attentional assessment trials, a low accuracy score would indicate that the participant had not closely complied with the task instructions. Thus, an 85% criterion level of overall probe discrimination accuracy was again set for participant exclusion.

*Emotional judgement trials.* The emotional judgement trials were identical to the judgement trials described in the previous study.

*Anagram Tasks*

Participants completed either one of two anagram tasks in the present study. One anagram task was designed to provide participants with a success experience to induce an
elevation in positive emotional reactivity, whereas the other anagram task was designed to provide participants with a failure experience to induce an elevation in negative emotional reactivity. These two anagram tasks are described below.

**Anagram Success Task.** The anagram success task employed in the present study was identical to that used in the previous studies of this second research phase. The analogue mood grid was delivered immediately before, and immediately after, the anagram task. From the positive and negative mood scores obtained before and after the anagram success task, it was possible to calculate two indices of Valenced-Event Congruent Mood Change. In each case, the index reflects a heightened tendency to respond to the anagram success task with greater elevation in mood state congruent with this positive event. The two indices of congruent mood change were computed, using the following equations:

Elevation in Positive Mood State to a Positive Event = post-anagram positive mood score - pre-anagram positive mood score; and

Reduction in Negative Mood State to a Positive Event = pre-anagram negative mood score - post-anagram negative mood score.

**Anagram Failure Task.** The anagram success task was modified to create an anagram task which instead delivered a failure experience in order to elicit a negative emotional response. This anagram failure task was the same as the anagram success task, however, to render the task capable of eliciting a negative emotional response, the anagrams were now very difficult to solve, and the false feedback provided to participants indicated that the participant performed much worse, rather than much better, than average. To deliver this feedback, a graph was presented in the bottom, left-hand corner of the screen. Participants were told that
the red bar on the graph corresponded to their rate of solution of anagrams, while the yellow bar on the graph corresponded to the average rate of solution of anagrams at that point in time, based on the results of other students who had previously completed the task. A percentile rank, indicating the participant’s supposed rank among these previous students, was also displayed above the graph. Performance feedback was such that each participant began the task with both bars at zero, and with a percentile rank that read ‘Average.’ As the participant progressed, their performance bar elevated each time they made a correct response. The program ensured that the bar supposedly displaying the average performance of previous participants initially fell behind the bar showing the participant’s own performance. However, the average performance bar progressively drew closer, and then eventually overtook, the bar showing the participant’s own performance. As the discrepancy between both bars widened, the percentile label changed accordingly, indicating a progressively lower percentile rank for the participant. All participants finished with a percentile rank that read ‘Lower 10%’. The anagram letter strings were presented in random order.

The participants’ mood state was assessed on the analogue mood grid immediately before and after the delivery of the anagram task. From the positive and negative mood scores obtained before and after the anagram, it was again possible to calculate two indices of Valenced-Event Congruent Mood Change. In each case, the index reflects a heightened tendency to respond to the anagram failure task with greater elevation in mood state congruent with this negative event. The two indices of congruent mood change were computed, using the following equations:
Reduction in Positive Mood State to a Negative Event = pre-anagram positive mood score - post-anagram positive mood score; and

Elevation in Negative Mood State to a Negative Event = post-anagram negative mood score - pre-anagram negative mood score.

**Procedure**

Each participant was tested individually. The test session commenced with the participant being seated approximately 60cm from the computer screen, and provided with instructions the attentional probe task. The instructions emphasised the need for the participant to respond as quickly as possible, without compromising accuracy. Following completion of the attentional probe task, the participant was briefed about the requirements of the analogue mood grid and the anagram task. Half of the participants were exposed to the anagram success task, whereas the other the participants were exposed to the anagram failure task. The participant then completed the analogue mood grid, followed by the anagram task, and then the second administration of the analogue mood grid. At the end of the session, the participant was debriefed as to the purpose of the study, and thanked for their participation.

**Results**

Two sequential issues were addressed in the analysis of the data. First, to determine whether the attentional training procedure was effective in differentially modifying attentional response to positive information, and potentially also attentional response to negative information, the probe discrimination latency data obtained from the attentional probe task was analysed. Second, if the training manipulation is shown to be effective, then the analogue mood data can be analysed to determine the impact of this attentional
modification on positive emotional reactivity, and negative emotional reactivity, to both the positive and negative event.

**Impact of Attentional Training Manipulation on Attentional Response to Emotional Information**

Two participants from the attend positive group, and two participants from the avoid positive group, displayed probe discrimination accuracy that fell below the criterion level, and so were removed from further analysis. The remaining participants displayed high levels of accuracy across the attentional assessment trials, averaging less than 4% errors, suggesting good compliance with the task instructions. Accuracy rate did not differ between the two attentional training conditions, $F(1, 124) = 2.43$, ns.

In order to determine the efficacy of the attentional training procedure in modifying attentional selectivity, the probe discrimination latencies obtained from the attentional assessment trials were examined. Mean probe discrimination latencies for accurate responses under each experimental condition, which are shown in Table 1, were computed after removing latencies less than 200ms and greater than 3000ms, and outliers using a 99% confidence interval. This led to the exclusion of 5.7% of latencies. From these raw probe discrimination latencies, the Attentional Bias to Positive Information Index scores, and the Attentional Bias to Negative Information Index scores, were computed for each participant, as described in the Method section. These attentional bias index scores, which respectively indexed the degree to which such attentional selectivity was evident when the task assessed attentional response to positive information, and when it assessed attentional response to
Table 1. Mean and standard deviation of probe discrimination latencies, in milliseconds, under each experimental condition.

<table>
<thead>
<tr>
<th>Attentional Assessment Point</th>
<th>Pre-training assessment</th>
<th>Post-training assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional Word Valence</td>
<td>Positive Word</td>
<td>Negative Word</td>
</tr>
<tr>
<td>Emotional Word Upper</td>
<td>723.31</td>
<td>707.82</td>
</tr>
<tr>
<td>Emotional Word Lower</td>
<td>136.44</td>
<td>120.82</td>
</tr>
<tr>
<td>Attentional Training Condition</td>
<td>Probe</td>
<td>Probe</td>
</tr>
<tr>
<td>Attend Positive</td>
<td>Mean</td>
<td>723.31</td>
</tr>
<tr>
<td>SD</td>
<td>136.44</td>
<td>120.82</td>
</tr>
<tr>
<td>Avoid Positive</td>
<td>Mean</td>
<td>702.89</td>
</tr>
<tr>
<td>SD</td>
<td>160.72</td>
<td>154.64</td>
</tr>
</tbody>
</table>
negative information, are shown in Table 2. In each case, a higher score reflects higher attentional preference for the emotional information.

Table 2. Mean and standard deviation of attentional bias to positive information, and attentional bias to negative information, index scores under each experimental condition.

<table>
<thead>
<tr>
<th>Attentional Assessment Point</th>
<th>Pre-training assessment</th>
<th>Post-training assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Attentional Bias index Score</td>
<td></td>
</tr>
<tr>
<td>Training Condition</td>
<td>Positive Bias</td>
<td>Negative Bias</td>
</tr>
<tr>
<td>Attend Positive</td>
<td>Index</td>
<td>Index</td>
</tr>
<tr>
<td>Mean</td>
<td>-35.74</td>
<td>27.78</td>
</tr>
<tr>
<td>SD</td>
<td>151.40</td>
<td>158.89</td>
</tr>
<tr>
<td>Avoid Positive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>16.49</td>
<td>-19.17</td>
</tr>
<tr>
<td>SD</td>
<td>118.59</td>
<td>124.39</td>
</tr>
</tbody>
</table>

These attentional bias index scores were subjected to a mixed-design 2 x 2 x 2 ANOVA that considered the between-group factor Training Condition (attend positive training vs. avoid positive training), and the within-group factors Attentional Assessment Point (pre-training assessment vs. post-training assessment), and Attentional Bias Type (positive bias index vs. negative bias index). As noted, the present study enabled the assessment of whether the attentional training task modified only attentional response to
positive information, or whether it also modified attentional response to negative information, in order to exclude the possibility that the observed impact of the attentional training on positive emotional reactivity in Study 3 was due to change in the latter bias, rather than the former bias.

If the attentional training modified only attentional response to positive information, then this would be revealed by a three-way interaction involving Training Condition x Attentional Assessment Point x Attentional Bias Valence. If, however, the attentional training modified attentional response to both positive and negative information, then this also would be revealed by the same three-way interaction. Hence, this three-way interaction must be obtained in order to make the claim that the attentional training differentially modified attentional selectivity. But its presence alone cannot reveal whether the attentional training modified only attentional response to positive information, or whether it also modified attentional response to negative information. In order to address this issue, it is necessary to examine the component two-way interactions that contribute to this higher-order interaction. Specifically, if the attentional training procedure only modified attentional response to positive information, then a simple two-way interaction of Training Condition x Attentional Assessment Point would be evident on the positive bias index scores, but not the negative bias index scores. If, however, the attentional training procedure modified attentional response to positive information, and also attentional response to negative information, then this would be revealed by a three-way interaction involving Training Condition x Attentional Assessment Point x Attentional Bias Valence.

1 This is because the same direction of attentional change in these two types of attentional bias (i.e. a more positive change or a more negative change) would result from the bias scores moving in the numerically opposite direction. Thus, for example, a more positive change on both the positive bias index, and the negative bias index, would be revealed by an increase in scores on the former bias index, but a decrease in scores on the latter bias index, which would give rise to the three-way interaction described.
information, then a simple two-way interaction of Training Condition x Attentional would be evident on both the positive and negative bias index scores.

The ANOVA analysis revealed a significant three-way interaction involving Training Condition x Attentional Assessment Point x Attentional Bias Valence, $F(1, 120) = 5.60, p < .05, \eta^2 = 0.04$. No other significant effects emerged from the ANOVA. Hence, this indicates that the attentional training procedure did differentially modify attentional selectivity. But, as just described, to determine whether it modified only attentional response to positive information, or whether it also modified attentional response to negative information, it is necessary break down this higher-order interaction, to examine the simple two-way interactions obtained on each index of attentional bias. Hence, the three-way interaction was broken down by separately examining the effects obtained on each index of attentional bias. This revealed that the three-way interaction was due to the fact that no simple two-way interaction of Training Condition x Attentional Assessment Point emerged on the negative bias index scores, $F(1, 120) = 2.94, p = .09, \eta^2 = 0.02$, but a strong trend towards a two-way interaction of Training Condition x Attentional Assessment Point emerged on the positive bias index scores, $F(1, 120) = 3.76, p = .05, \eta^2 = 0.03$. Thus, this pattern of results suggests that the attentional training procedure serves only to modify attentional response to positive information, and not also attentional response to negative information. Consequently, any subsequent impact of the attentional training on emotional reactivity would be consistent only with the hypothesis that an attentional bias to positive information makes a causal contribution to such emotional reactivity, and not the hypothesis that an attentional bias to negative information makes a causal contribution to emotional reactivity (as the latter would have required change in attentional response to negative information).
Consistent with the studies reported in this research phase, the nature of this simple two-way interaction, evident only on the positive attentional bias scores, should reflect the fact that participants trained to avoid positive information should come to display a relative decrease in attentional bias to positive information from pre- to post-training, whereas participants trained to attend to positive information should come to display the reverse pattern of change, reflecting a relative increase in attentional bias to positive information from pre- to post-training. The pattern of the simple two-way interaction was consistent with such expectation, and replicated the pattern of significance of the attentional training effects obtained in Study 3. Specifically, participants in the avoid positive training condition displayed reduced scores on the index of attentional bias to positive information at post-training assessment (M = 16.49, SD = 118.59), relative to pre-training assessment (M = -35.91, SD = 110.42), and this change was statistically significant, $F(1, 60) = 5.87, p < .05, \eta^2 = .09$. In contrast, participants in the attend positive training condition tended to display increased scores on the index of attentional bias to positive information at post-training assessment (M = -25.96, SD = 105.29), relative to pre-training assessment (M = -35.74, SD = 151.40), though this change fell short of statistical significance, $F(1, 60) = .17, p = .68, \eta^2 = .003$. Thus, the presence of this simple two-way interaction confirms that the two attentional training conditions exerted a differential impact on attentional response to positive information, and the direction of the observed effects were consistent with expectation.

**Impact of Attentional Training on Emotional Reactivity to the Anagram Tasks**

It will be recalled that, in Study 3, it was not possible to determine whether the impact of positive attentional selectivity on positive emotional reactivity reflected an elevation in positive mood state, a reduction in negative mood state, or both. Further, it also was not
possible to determine whether the causal impact of such positive attentional bias on emotional reactivity was restricted to only to positive events, or may also have been found in response to negative events. Hence, in the present study, variation in positive mood and variation in negative mood were independently assessed, and participants were exposed either to a positive event or a negative event, thus enabling these different possibilities to be addressed. In the following, the mood data obtained from participants who were exposed to the anagram success task will first be analysed, before the mood data obtained from participants who were exposed to the anagram failure task is then analysed.

**Impact of Attentional Training on Emotional Reactivity to Anagram Success Task.**

The positive and negative mood scores, obtained from the visual analogue mood grid for each of the participant groups exposed to the anagram success task, are shown in Table 3. As in the previous studies, it was thought prudent to determine whether the anagram success task was effective in inducing an elevation in positive-event congruent mood change. In the present study, such efficacy would be revealed by a significant two-way interaction of Mood Scale Type x Mood Assessment Point, and the nature of this interaction would reflect a relative increase in positive mood state, and a relative decrease in negative mood state, pre to post the anagram task.
Table 3. Mean and standard deviation of positive mood scores, and negative mood scores, to anagram success task.

<table>
<thead>
<tr>
<th>Attentional Training Condition</th>
<th>Mood Assessment Point</th>
<th>Mood Score Valence</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-anagram</td>
<td>Post-anagram</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mood Score</strong></td>
<td><strong>Positive Mood</strong></td>
<td><strong>Negative Mood</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Score</strong></td>
<td><strong>Score</strong></td>
<td><strong>Score</strong></td>
<td><strong>Score</strong></td>
<td><strong>Score</strong></td>
</tr>
<tr>
<td>Attend Positive</td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
</tr>
<tr>
<td></td>
<td>28.09</td>
<td>14.61</td>
<td>28.97</td>
<td>11.63</td>
</tr>
<tr>
<td></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
</tr>
<tr>
<td></td>
<td>27.83</td>
<td>14.03</td>
<td>22.03</td>
<td>12.84</td>
</tr>
<tr>
<td></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
</tr>
<tr>
<td></td>
<td>28.97</td>
<td>11.63</td>
<td>42.71</td>
<td>12.85</td>
</tr>
<tr>
<td></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
</tr>
<tr>
<td></td>
<td>42.71</td>
<td>12.85</td>
<td>21.12</td>
<td>9.90</td>
</tr>
<tr>
<td></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
</tr>
<tr>
<td></td>
<td>17.32</td>
<td>11.16</td>
<td>38.52</td>
<td>12.03</td>
</tr>
<tr>
<td></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
</tr>
<tr>
<td></td>
<td>21.12</td>
<td>9.90</td>
<td>38.52</td>
<td>12.03</td>
</tr>
<tr>
<td></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
</tr>
<tr>
<td></td>
<td>21.12</td>
<td>9.90</td>
<td>38.52</td>
<td>12.03</td>
</tr>
<tr>
<td></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
</tr>
<tr>
<td></td>
<td>21.12</td>
<td>9.90</td>
<td>38.52</td>
<td>12.03</td>
</tr>
<tr>
<td></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
</tr>
<tr>
<td></td>
<td>21.12</td>
<td>9.90</td>
<td>38.52</td>
<td>12.03</td>
</tr>
<tr>
<td></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
</tr>
<tr>
<td></td>
<td>21.12</td>
<td>9.90</td>
<td>38.52</td>
<td>12.03</td>
</tr>
<tr>
<td></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
</tr>
<tr>
<td></td>
<td>21.12</td>
<td>9.90</td>
<td>38.52</td>
<td>12.03</td>
</tr>
<tr>
<td></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
<td><em>Mean</em></td>
<td><em>SD</em></td>
</tr>
<tr>
<td></td>
<td>21.12</td>
<td>9.90</td>
<td>38.52</td>
<td>12.03</td>
</tr>
</tbody>
</table>

The positive and negative mood scores obtained before and after the anagram success task were subjected to a 2 x 2 repeated measures ANOVA that considered the within-group factors Mood Scale Type (positive mood scale vs. negative mood scale), and Mood Assessment Point (pre-anagram assessment vs. post-anagram assessment). The analysis revealed a significant main effect of Mood Scale Type, $F(1, 60) = 29.45, p < .001, \eta^2 = 0.33$, reflecting the fact that participants reported significantly higher levels of positive mood ($M = 34.29, SD = 12.54$) compared to negative mood ($M = 22.36, SD = 10.66$). The analysis also revealed a significant main effect of Mood Assessment Point, $F(1, 60) = 16.47, p < .001, \eta^2$
= 0.33, reflecting the fact that participants reported significantly higher mood scores immediately after (M = 29.92, SD = 7.33) compared to immediately before (M = 26.73, SD = 9.30) the anagram success task. Of more importance, however, these main effects were subsumed within a two-way interaction of Mood Scale Type x Mood Assessment Point, $F(1, 60) = 107.10, p < .001, \eta^2 = 0.64$, and the nature of this two-way interaction was consistent with expectation. Specifically, the positive mood scores tended to be higher when assessed immediately after (M = 40.61, SD = 12.52) compared to immediately before (M = 27.97, SD = 14.21) the anagram success task. In contrast, the negative mood scores tended to be lower when assessed immediately after (M = 17.32, SD = 11.16) compared to immediately before (M = 25.50, SD = 12.64) the anagram task. Thus, this pattern of results suggests that the anagram success task induced a relative increase in positive mood, and a relative decrease in negative mood, as intended.

To test the alternative possibilities concerning the causal impact of positive attentional selectivity on emotional reactivity to a positive event, the two Valenced-Event Congruent Mood Change scores were computed for each participant, as described in the Method section. The resulting congruent mood change scores are shown in Table 4. Higher scores on these mood indices reflect the heightened tendency to respond to the anagram success task with greater elevation of positive-event congruent mood change. If positive attentional selectivity makes a causal contribution to only positive mood state, or to only negative mood state, to a positive event, then this would be revealed by a two-way interaction involving Mood Scale Type x Training Condition. But, if positive attentional selectivity makes a causal contribution to both types of mood state to a positive event, then this would be revealed by the presence only of a main effect of Training Condition.
Table 4. Mean and standard deviation of positive-event congruent mood change scores to anagram success task.

<table>
<thead>
<tr>
<th>Attentional Training Condition</th>
<th>Mood Assessment Point</th>
<th>Elevation in Positive Mood</th>
<th>Reduction in Negative Mood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attend Positive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>14.61</td>
<td>7.84</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>9.94</td>
<td>9.47</td>
<td></td>
</tr>
<tr>
<td>Avoid Positive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>10.68</td>
<td>4.71</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>8.53</td>
<td>9.58</td>
<td></td>
</tr>
</tbody>
</table>

The positive-event congruent mood change scores were subjected to a mixed design 2 x 2 ANOVA which considered the between-group factor Training Condition (attend positive training vs. avoid positive training), and the within-group factor Mood Scale Type (positive mood scale vs. negative mood scale). The analysis revealed a significant main effect of Mood Scale Type, $F(1, 60) = 16.22, p < .001, \eta^2 = 0.21$, reflecting the fact that mood change on the positive mood scores ($M = 12.64, SD = 9.40$) was higher than mood change on the negative mood scores ($M = 6.27, SD = 9.58$). Of more importance, however, the analysis revealed a very strong trend towards a significant main effect of Training Condition, $F(1, 60) = 3.91, p = .05, \eta^2 = 0.06$, which reflected the fact that participants in the attend positive training condition displayed higher positive-event congruent mood change scores ($M = 11.22, SD = 7.65$) compared to participants in the avoid positive training condition $M = 7.69, SD = 6.36$).
Of relevance to the issue under present scrutiny, there was no evidence whatsoever that this main effect was further modified by Mood Scale Type, $F (1, 60) = .06, p = .80, \eta^2 = 0.001$.

Hence, the present findings lend support to the possibility that positive attentional selectivity makes a causal contribution to both types of mood state, as participants who had been exposed to the training contingency designed to increase attentional bias to positive information, relative to participants who had been exposed to the training condition designed to decrease attentional bias to positive information, subsequently displayed disproportionately greater elevations in positive mood state, and disproportionately greater reductions in negative mood state, following exposure to the anagram success task.

So far, the analysis has shown that an attentional training procedure that modified only attentional response to positive information impacted on positive emotional reactivity to a positive event. This finding is consistent with the hypothesis that positive attentional selectivity makes a causal contribution to positive emotional disposition. Like Study 3, however, this finding is also consistent with the possibility that attentional selectivity makes a causal contribution to negative emotional reactivity to a negative event. If the former possibility is true, then the attentional training procedure should serve to impact emotional reactivity to the positive event, but not to the negative event. If the latter possibility is true, then the attentional training procedure should serve to impact emotional reactivity to both types of valenced event. Hence, in order to determine the validity of these two alternative possibilities, the mood data obtained from participants exposed to the anagram failure task was analysed.

**Impact of Attentional Training on Emotional Reactivity to Anagram Failure Task.** The positive mood and negative mood scores, obtained from the visual analogue mood grid for
each of the participant groups exposed to the anagram failure task, are shown in Table 5. These scores were analysed to determine whether the anagram failure task was effective in inducing an elevation in negative-event congruent mood change. If so, then this would be revealed by a two-way interaction of Mood Scale Type x Mood Assessment Point, the nature of which would reflect a relative decrease in positive mood, and a relative increase in negative mood, pre to post the anagram task.

Table 5. Mean and standard deviation of positive mood scores, and negative mood scores, to anagram failure task.

<table>
<thead>
<tr>
<th>Attentional Training Condition</th>
<th>Mood Assessment Point</th>
<th>Mood Score Valence</th>
<th>Pre-anagram</th>
<th>Post-anagram</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Positive Mood Score</td>
<td>Negative Mood Score</td>
<td>Positive Mood Score</td>
</tr>
<tr>
<td>Attend Positive</td>
<td>Mean</td>
<td>26.41</td>
<td>28.00</td>
<td>23.52</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>15.99</td>
<td>10.34</td>
<td>12.95</td>
</tr>
<tr>
<td>Avoid Positive</td>
<td>Mean</td>
<td>28.94</td>
<td>22.55</td>
<td>26.87</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>14.37</td>
<td>12.80</td>
<td>11.77</td>
</tr>
</tbody>
</table>

The positive and negative mood scores obtained before and after the anagram failure task were subjected to a repeated measures 2 x 2 ANOVA that considered the within-group
factors Mood Scale Type (positive mood scale vs. negative mood scale), and Mood Assessment Point (pre-anagram assessment vs. post-anagram assessment). The analysis revealed a significant main effect of Mood Assessment Point, $F(1, 60) = 10.46, p < .01, \eta^2 = 0.15$, reflecting the fact that participants reported significantly higher mood scores immediately after (M = 30.10, SD = 8.12) compared to immediately before (M = 26.48, SD = 9.84) the anagram failure task. More importantly, however, this main effect of Mood Assessment Point was further modified by Mood Scale Type, $F(1, 60) = 30.25, p < .001, \eta^2 = 0.34$, which was the only other significant effect to emerge from the analysis. The nature of this two-way interaction was consistent with expectation, and reflected the fact that the positive mood scores tended to be lower when assessed immediately after (M = 25.19, SD = 12.39) compared to immediately before (M = 27.68, SD = 15.13) the anagram failure task. In contrast, the negative mood scores tended to be higher when assessed immediately after (M = 35.02, SD = 12.43) compared to immediately before (M = 25.27, SD = 11.86) the anagram task. This pattern of results suggests the anagram failure task tended to induce a reduction in positive mood state, and an increase in negative mood state, as required.

In order to determine whether the differential modification of attentional response to positive information, also served to differentially modify negative emotional reactivity to a negative event, the two Valenced-Event Congruent Mood Change scores were computed for each participant, as described in the Method section. The resulting congruent mood change scores are shown in Table 6. Higher scores on these mood indices reflect the heightened tendency to respond to the failure event with greater elevation of negative-event congruent mood change. If positive attentional selectivity makes a causal contribution only to positive mood state, or to negative mood state, to a negative event, then this would be revealed by a
two-way interaction involving Mood Scale Type x Training Condition. But, if positive attentional selectivity makes a causal contribution to both types of mood state to a negative event, then this would be revealed by the presence of only a main effect of Training Condition.

Table 6. Mean and standard deviation of negative-event congruent mood change scores to anagram failure task.

<table>
<thead>
<tr>
<th>Attentional Training Condition</th>
<th>Mood Assessment Point</th>
<th>Reduction in Positive Mood</th>
<th>Elevation in Negative Mood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attend Positive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2.90</td>
<td>10.52</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>12.20</td>
<td>11.63</td>
<td></td>
</tr>
<tr>
<td>Avoid Positive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2.06</td>
<td>8.97</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>11.43</td>
<td>14.28</td>
<td></td>
</tr>
</tbody>
</table>

The negative-event congruent mood change scores were subjected to a mixed design 2 x 2 ANOVA which considered the between-group factor Training Condition (attend positive training vs. avoid positive training), and the within-group factor Mood Scale Type (positive mood scale vs. negative mood scale). The analysis revealed a significant main effect of Mood Scale Type, $F(1, 60) = 10.46, p < .01$, $\eta^2 = 0.15$ reflecting the fact that the negative mood change scores ($M = 9.74$, $SD = 12.94$) were higher than the positive mood change scores ($M = 2.48$, $SD = 11.73$). But, in contrast to the pattern of results obtained for
participants exposed to the anagram success task, there was no evidence whatsoever of a main effect of Training Condition, $F(1, 60) = .29, p = .59, \eta^2 = 0.005$, or a two-way interaction of Mood Scale Type x Training Condition, $F(1, 60) = .03, p = .88, \eta^2 = 0$. Hence, the present findings provide support for the possibility that positive attentional selectivity makes a causal contribution only to negative emotional reactivity to positive events, as there was no evidence to show that the attentional training procedure impacted on negative emotional reactivity to the anagram failure task.

**Discussion**

In the previous study, it was claimed the observed findings were consistent with the hypothesis that an attentional bias to positive information makes a causal contribution to positive emotional disposition. But the capacity of the findings to strongly support this hypothesis was compromised by the study’s restricted focus in the measurement of attentional selectivity, emotional reactivity, and the valence of event to which participants were exposed to. As a consequence of this restricted focus, it was recognised that a number of alternative possibilities, which could equally well accommodate the observed effects, could not be excluded. Therefore, the results obtained in the previous may not, in principle, have supported the hypothesis that an attentional bias to positive information functionally contributes to positive emotional disposition. Thus, the purpose of the present study was to confirm whether it really is the case that positive attentional selectivity causally underpins positive emotional disposition. The current findings suggest that the attentional training task modified only selective attentional response to positive information, and that this subsequently influenced only emotional reactivity to positive events, and not to negative events. Thus, this pattern of effects confirm the conclusion drawn in Study 3 that an
attentional bias to positive information makes a causal contribution to positive emotional disposition, but also enables refinement of our understanding concerning the specific facets of mood influenced by positive attentional selectivity.

The first and most important issue addressed in the current study concerned whether the attentional training manipulation exerted an impact only on attentional response to positive information, or also attentional response to negative information. That is, one of the issues that motivated the current study was the possibility that the impact of the training manipulation on positive emotional disposition in Study 3 may have been driven by change in negative, rather than positive, attentional selectivity. As noted, the current evidence suggests that the attentional training task did modify attentional response to positive information, but did not modify attentional response to negative information. Thus, it is possible to conclude that the impact of the training manipulation on attentional selectivity is specific to positive information. It follows then that the impact of the attentional training on positive emotional disposition could not have been driven by change in negative attentional selectivity, and is instead consistent with the possibility that such impact of attentional training impact on positive emotional disposition was driven by change in positive attentional selectivity.

While not directly relevant to the present research program, it is interesting to note that the finding that the attentional training task modified only attentional response to positive information, and not also attentional response to negative information, is consistent with the idea that these two types of selectivity are functionally independent of one another. Of course, this does not mean that they are necessarily statistically uncorrelated in the real-world, but if they are, the present results suggest this is because different mechanisms
contribute to them. It is interesting to speculate what these different mechanisms might be. One possibility is that the mechanisms which contribute to these two types of bias differ in terms of the relative involvement of automatic vs. strategic processing (Shiffrin & Schneider, 1977). For example, it may be the case that negative attentional selectivity is influenced more by automatic attentional processes, whereas positive attentional selectivity is influenced more by strategic attentional processes. There is good evidence to suggest that former type of attentional selectivity does operate quite automatically (Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003), but little work has sought to investigate the involvement of automatic vs. strategic processing in the latter type of attentional selectivity. Such work will be of great value, though, if future studies can confirm the current finding that these two types of selective attention are functionally independent of one another.

A second important issue addressed in the present study concerned whether positive attentional selectivity influences only positive emotional reactivity to positive events (i.e. positive emotional disposition), or whether it also influences negative emotional reactivity to negative events (i.e. negative emotional disposition). Specifically, it was shown in Study 3 that positive attentional selectivity causally influenced positive emotional reactivity to a positive event, but the possibility that such attentional selectivity may also causally influence negative emotional reactivity to a negative event could not be excluded. Hence, in the present study, some participants were exposed to a positive event, and others were exposed to a negative event, making it possible to distinguish between the two possibilities. The current findings show that the attentional training manipulation served to influence positive emotional responses to positive events, but did not serve to influence negative emotional responses to negative events. Thus, consistent with the conclusion drawn in Study 3, it
appears that positive attentional selectivity makes a causal contribution to positive emotional disposition, but it does not appear that positive attentional selectivity makes a causal contribution to negative emotional disposition. But it should be noted that the present study also has extended our understanding of the causal impact of positive attentional selectivity on positive emotional reactivity to a positive event. Specifically, it was recognised in Study 3 that, as a result of the particular mood rating scale used, the reported effects could have reflected an increase in positive mood state, a decrease in negative mood state, or both. In the present study, a novel analogue mood grid was developed to enable the ready dissociation of increases in positive mood, from decreases in negative mood. The current evidence shows that the differential modification of attentional response to positive information served to differentially modify the degree to which a subsequent positive event then elevated positive mood state, and also attenuated negative mood state. Hence, while the present evidence supports the conclusion that an attentional bias to positive information makes a causal contribution to positive emotional reactivity to a positive event, it is possible to refine this conclusion, in that the current results show that positive attentional selectivity exerts a causal influence on both positive mood and negative mood, to a positive event.

It is interesting to consider the finding that positive attentional selectivity did not causally influence negative emotional disposition, in the light of research focused on the causal contribution of negative attentional selectivity to negative emotional disposition. It is almost always the case that stimulus pairs employed in such research comprise one negative member and one neutral member (e.g. MacLeod, Rutherford, Campbell, Holker, & Ebsworthy, 2002; Amir, Weber, Beard, Bomyea, & Taylor, 2008; Heeren, Lievens, & Philippot, 2011; Heeren, Reese, McNally, & Philippot, 2012). While it has been shown that
the training procedures employed in these studies can modify attentional bias to negative information, it is of course possible they may also have modified attentional response positive information. Thus, similar to the issues addressed in the present research, if this were the case, then change in the latter type of attentional selectivity, rather than change in former type of attentional selectivity, may drive the impact of such attentional training manipulations on negative emotional disposition. The current findings, however, show that positive attentional bias does not appear to impact on negative emotional responses to negative events. Thus, the previously reported impacts of attentional training manipulations on negative emotional disposition are likely a result of change in attentional bias to negative information, as assumed.

It is also worthy to consider why positive attentional selectivity did not serve to differentially modify negative emotional responses to a negative event, as this finding is inconsistent with the theoretical claims of some investigators, who have suggested that such patterns of attentional selectivity can serve to buffer against the impact of negative life events (e.g. Segerstrom, 2001). A candidate possibility for this null finding concerns the possibility that there may have been relatively little scope for positive attentional selectivity to exert a causal impact on negative emotional reactivity during the failure event. Specifically, in the anagram failure task, no positive information was provided to participants, and so in the absence of any positive information, it is perhaps not surprising that variation in attentional response to positive information did not impact on negative emotional reactivity. If this was indeed the reason for the null effects, then it may be possible to reconcile the current findings with the claims of previous researchers by considering the possibility that, while positive attentional selectivity may not influence the degree to which an initial negative emotional
reaction is elicited by a negative event, it may instead influence the degree to which that negative emotional response persists subsequent to that event.

This distinction between the initial negative emotional response to negative events, and the subsequent perseveration of such negative response, is consistent with one made recently in the anxiety literature, where it has been demonstrated that trait anxiety, a construct that reflects individual differences in the disposition to event elevated state anxiety, can be parsed into dissociable dimensions of anxiety vulnerability (Rudaizky, Page, & MacLeod, 2012; Rudaizky & MacLeod, 2013). These two dimensions have been termed anxiety reactivity, reflecting the elevated probability of an anxious reaction being elicited in response to a stressful situation, and anxiety perseveration, reflecting the increased tendency to experience prolonged anxious reactions to stressors. To dissociate these two dimensions of anxiety vulnerability, Rudaizky et al. asked participants three questions about each of the anxiety symptoms that comprise the Spielberger State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), a widely used instrument employed to measure trait anxiety (Grös, Antony, Simms, & McCabe, 2007). Participants were first asked the original STAI-T question, concerning the extent to which each symptom described them. They were then asked two additional questions about each symptom. One question assessed anxiety reactivity, and required participants to indicate the probability that they would event each symptom when exposed to a moderate stressor. The other question assessed anxiety perseveration, and required the respondent to indicate how long each symptom would persist, once it had been elicited. Using multiple regression analysis, the results demonstrated that anxiety reactivity and anxiety perseveration scores each accounted for independent variance in conventional trait anxiety scores, confirming that they represent
dissociable dimensions of anxiety vulnerability. Importantly, this finding has since been replicated using in-vivo measures of anxiety reactivity and anxiety perseveration (Rudaizky & MacLeod, in press), and, in supplementary studies conducted during the course of the author’s PhD candidature, has also been extended to include depressive reactivity and depressive perseveration (Grafton, Rudaizky, & MacLeod, in preparation), and ruminative reactivity and ruminative persistence (Grafton & MacLeod, 2013).

Given this distinction between the initial negative emotional response to a negative event, and the subsequent perseveration of such negative emotional response, a plausible hypothesis worthy of future investigation is that an attentional bias to positive information does not make a causal contribution to initial negative emotional reactions to negative events, but it does make a causal contribution to subsequent perseveration of the negative emotional reactions to negative events. The anagram failure task used in the present research is only capable of indexing individual differences in the initial negative emotional response to a negative event, and not individual differences in the perseveration of the negative emotional response induced by that event. But it would be possible to test the validity of the hypothesis that positive attentional selectivity causally contributes to the perseveration of negative mood state following a negative event, by modifying the anagram failure task in a manner that renders it capable of measuring both facets of the negative emotional response. For example, this could be achieved by introducing two phases into the present task. The first phase would be used to assess initial negative emotional response (i.e. the change in mood state pre to post the anagram task), and would not require any change to the present procedure. The second phase would instead be used to assess the perseveration of the negative emotional response, and could be achieved by informing participants about the contrived nature of the task, but
then requiring them to complete another simple task for 5 minutes (e.g. identifying whether a short string of characters contains a number), while also rating their mood during this period. In this second phase, the degree to which the negative emotional response elicited by the anagram failure task is sustained across the 5 minute period could be used to index individual differences in the perseveration of negative mood. If attentional bias to positive information makes a causal contribution to negative emotional perseveration, then the degree to which the negative mood response persists, when participants are informed that performance on the task was contrived, would be attenuated in participants exposed to the attend positive training compared to in participants exposed to the avoid positive training.

It remains to be seen whether attentional bias to positive information makes a differential functional contribution to these two dimensions of negative emotional response to a negative event. Of course, it would also be possible to distinguish between initial positive emotional responses, and the subsequent perseveration of those responses, to positive events. Indeed, the more general hypothetical distinction that researchers have drawn between anxiety reactivity and perseveration (Rudaizky et al., 2012), could readily be extended to the disposition to experience positive emotion. It would be possible to investigate this issue in future research by employing in-vivo assessment approaches of initial positive mood responses, and the perseveration of such positive emotional response (e.g. using modified variants of the anagram success task), or by employing questionnaire based approaches, such as those developed by Rudaizky et al., and Grafton et al. (in preparation).

For the moment, however, the results show that an attentional bias modification procedure, which targets attentional response to positive information, differentially modifies only attentional bias to positive information, and that this served to differentially modified
positive emotional responses to a positive event, but not a negative event. Thus, the present evidence supports the hypothesis that an attentional bias to positive information can make a causal contribution to positive emotional disposition.
Chapter 8

Research Phase 3 – Abstract

The results obtained in phase one of the present research program demonstrated that participants high in positive emotional disposition exhibited higher attentional bias to positive information scores compared to participants low in positive emotional disposition, consistent with the hypothesis that such attentional selectivity is characteristic of high positive emotional disposition. The results obtained in phase two showed that an attentional bias to positive information can make a casual contribution positive emotional disposition. Given that a causal relationship between variation in positive attentional bias and variation in such dispositional positive emotion appears to exist, it becomes particularly important to now seek to obtain a deeper understanding of such positive attentional selectivity, especially given the potential applied benefits, in terms of improving levels of positive emotional disposition, that may come from the delivery of attentional training procedure designed to modify selective attentional response to positive information.

As described in Study 1, there are a number of potential research avenues that could potentially be pursued. For example, one line of research could involve determining whether the patterns of attentional bias to positive information that characterise high positive emotional disposition are automatic or strategic in nature. Another line of research could involve investigating the influence of state and trait positive emotion in the expression of this pattern of attentional selectivity. These examples only represent a few of the many other that would be worthy of consideration, and pursuing these issues would likely be the focus of an entire program of research. But, in the present thesis, it was decided that the third and final
research phase would focus on delineating the attentional mechanisms that underpin this positive emotional disposition-linked preference for positive information. Specifically, the study reported in this research phase represents a first step towards determining whether high positive emotional disposition is characterised by facilitated attentional engagement with, or impaired attentional disengagement from, positive information.

A second aim of the study, however, was to determine whether the patterns of attentional selectivity that characterise variation in positive emotional disposition, are the same as, or are different to, those that characterise variation in negative emotional disposition. It is important to address this issue, because it is known that variation in these types of emotional disposition can contribute to more complex emotions, such as, anxiety and depression. Thus, by better understanding the ways in which the attentional substrate of variation in positive emotional disposition, and variation in negative emotional disposition, is the same or different, it may be possible to gain a better understanding of the attentional basis of the types of complex emotions that are of critical importance to clinical psychology.

The findings obtained in the reported study show that individual differences in positive emotional disposition, and individual differences negative disposition, do differ in terms of their characteristic patterns of attentional selectivity. However, the present results do not serve to adequately resolve the issue of whether the attentional bias to positive information that was found to characterise high positive emotional disposition in the earlier phases of the research program, reflects facilitated attentional engagement with, or impaired attentional disengagement from, positive information. Hence, suggestions for future research that may shed light on this issue are discussed.
Introduction to Research Phase 3

As noted, one of the key aims of the study reported in this final phase of the research program was to shed light on whether the attentional bias to positive information, shown to be characteristic of high positive emotional disposition in the first research phase, reflects increased attentional engagement with, or reduced attentional disengagement from, positive information. Investigating the more precise facets of attentional selectivity that characterise individual differences in positive emotional disposition is important from both a theoretical perspective, and an applied perspective. Indeed, given that it appears positive attentional selectivity makes a causal contribution to positive emotional disposition, it is likely that the applied potential of attentional training tasks, designed to modify such positive attentional selectivity, will be maximised if these tasks can be refined in manner that targets the specific facets of attention that underpin such selectivity.

But in the second research phase, it was shown that, while positive attentional selectivity causally influences positive emotional disposition, there was no evidence to suggest that such attentional selectivity causally influences negative emotional disposition. This raises the possibility that the patterns of attentional selectivity that characterise these two emotional dispositions may not be the same. Hence, it was thought prudent in the present study to further explore this issue, and so another key aim was to investigate whether the patterns of attentional selectivity that characterise individual differences in positive emotional disposition are the same as, or are different from, the patterns of attentional selectivity that characterise individual differences in negative emotional disposition. Such research is of particular importance given that it has been established these two emotional
disposition contribute to anxiety and depression, two complex emotions that have been of crucial interest in clinical psychology.

As expanded upon in the reported manuscript, it is widely recognised that high negative emotional disposition is a shared characteristic of anxiety and depression, whereas low positive emotional disposition is a distinctive characteristic of depression (Lee, Watson, & Mineka, 1994). Consequently, it seems plausible that some similarities between anxiety and depression may reflect the characteristics of their shared negative emotional disposition, while some differences between anxiety and depression may reflect the characteristics of attenuated positive emotional disposition, which is specific to the latter emotion. Of particular interest to investigators have been the similarities and differences between the patterns of attentional selectivity that characterise anxiety and depression. While both types of emotion are associated with an attentional bias to negative information, it does not appear that attentional preference for negative information is equally characteristic of heightened vulnerability to anxiety, and heightened vulnerability to depression. A plausible hypothesis that may explain the attentional similarities and differences between anxiety and depression is that the former reflect the attentional characteristics of their shared negative emotional disposition, whereas the latter reflect the attentional characteristics of the attenuated positive emotional disposition that is particular to depression. Thus, by investigating the ways in which the patterns of attentional selectivity that characterise individual differences in positive emotional disposition, and the patterns of attentional selectivity that characterise individual differences negative emotional disposition, are the same or different, it may be possible to shed light on the attentional substrates of anxiety and depression.
Of course, it is important to consider potential candidate distinctions that may serve to illuminate the ways in which the patterns of attentional selectivity that characterise variation in positive emotional disposition, and that characterise variation in negative emotional disposition, are the same or different. As noted, one way in which the attentional characteristics of these emotional dispositions may be the same or different, may be in terms of the facets of attentional selectivity that are associated with them. But a different category of possibilities concern the type of emotional information that such attentional selectivity favours. One possibility is that it may be the valence of emotional information (e.g. negative vs. positive) which is of crucial importance to consider. For example, variation in positive emotional disposition, and variation in negative emotional disposition, may be the same in that both types of variation reflect the operation of selective attentional engagement and selective attentional disengagement. But they may differ in that variation in the former emotional disposition may be characterised by selective attention only to positive information, and variation in the latter emotional disposition may be characterised by selective attention only to negative information.

A different possibility is that it may not be the valence of emotional information that is important to consider, but it is instead the emotional domain the information relates to that is most crucial. For example, variation in positive emotional disposition, and variation in negative emotional disposition, may be the same in that both types of variation reflect the operation of selective attentional engagement and selective attentional disengagement, to both positive and negative information. But they may differ in that variation in the former emotional disposition may be characterised by selective attention only to emotional information related to happy/depressed material (perhaps as a result of its association with
depression), whereas variation in the latter emotional disposition may be characterised by selective attention only to negative information relaxed/anxious material (perhaps as a result of its association with anxiety).

The study reported in the final research phase was designed to shed light on these different possibilities, and so reveal whether the patterns of attentional selectivity that characterise these two emotional dispositions are the same or different. Thus, unlike the previous studies reported in the thesis, in the present study, participants who were high and low in positive emotional disposition, and participants who were high and low in negative emotional disposition were invited to participate (the recruitment of these latter participants was based on scores obtained from the negative affectivity scale (NAS) of the Positive and Negative Affectivity Schedule (PANAS)). It was thought prudent to ensure that participants in the high and low groups were closely matched in terms of the emotional disposition they had not been selected to differ in. Hence, in the present study, it was required that participants discrepant in positive emotional disposition did not differ in terms of their negative emotional disposition (i.e. they all fell in the middle third of the negative emotional disposition score distribution), and that participants who were discrepant in negative emotional disposition did not differ in terms of their positive emotional disposition (i.e. they all fell in the middle third of the positive emotional disposition score distribution).

These participants were exposed to an attentional assessment task that employed both positive and negative word stimuli. These stimuli were drawn from the same pool as described in Study 1. But, in contrast to the previously reported studies, the stimulus pairs used in the attentional assessment task were now required to differ in terms of their relationship to anxiety and depression. That is, by employing both positive and negative
words, and distinguishing the particular emotional domain these words belonged to, it was possible to evaluate whether the patterns of attentional selectivity that characterise individual differences in positive emotional disposition, and individual differences negative emotional disposition, are the same or different with respect to these two types of stimulus characteristic.

But, as has previously been mentioned, attentional assessment tasks, such as the conventional attentional probe task, are not capable of separately measuring engagement and disengagement bias. Hence, it was necessary to develop a task that was capable of discretely assessing these two facets of attentional selectivity in the present study. As in the previous research phases, the experimental methodologies that have been developed to assess engagement and disengagement in individual who differ in terms of negative emotional disposition, can readily be drawn upon to help in this regard. Thus, in the following section, the experimental tasks that have been employed to assess engagement and disengagement bias in high negative emotional disposition will be critically reviewed, in order to identify a candidate approach that can enable the assessment of these two facets of attentional selectivity in the present study.

**Distinguishing Between Selective Attentional Engagement and Selective Attentional Disengagement in Negative Emotional Disposition**

Researchers working in the field of visual attention more generally have long recognised that the attentional system is not unitary, but instead comprises a number of different facets. These facets are thought to include the selective engagement of attention, the shifting of attentional focus, and the selective disengagement of attention (Posner, 1980). A
great deal of research has been focused, in particular, on the assessment of attentional engagement and attentional disengagement. An approach often employed to measure these two facets of selective attention is the exogenous cuing task (Posner, Inhof, Friedrich, & Cohen, 1987). In this task, the participant is instructed to attend to a visual cue (e.g. a flashing light) that appears either to the left, or the right, of a central fixation. This cue is intended to secure the attentional focus of participants in one of the two critical screen loci. Immediately after offset of the cue, a target probe is presented, and the participant is required to execute a discriminatory response to this probe. On 80% of the trials, the target probe is presented in the same locus as the previously presented cue (valid trial), and on the other 20% of trials, the target is presented in the locus opposite to the previously presented cue (invalid trial). It has commonly been found that participants are speeded to respond on valid trials, relative to invalid trials, which is interpreted as a difficulty disengaging attention from the cued location, and subsequently engaging attention with the target in the opposite locus (Posner & Peterson, 1990).

Drawing on the work of Posner and colleagues (Posner, 1980; Posner & Peterson, 1990), a number of investigators have in recent years suggested that the patterns of attentional bias displayed by individuals high in negative emotional disposition may result from increased attentional engagement with negative information, reflecting a disproportionate tendency for attention to become more readily focused on initially distal negative information, or from impaired attentional disengagement from negative information, reflecting a tendency for attentional focus to remain more firmly focused on initially proximal negative information (Grafton & MacLeod, in press). For example, some researchers have suggested that high negative emotional disposition is characterised only by
increased attentional engagement with negative information (Mogg & Bradley, 1998; Massar, Mol, Kenemans, & Baas, 2011). Others have instead argued that such negative disposition is characterised only by reduced attentional disengagement from negative information (Fox, et al., 2002; Amir, et al., 2003). But a few investigators have raised the intriguing possibility that these two facets of attentional selectivity are both characteristic of high negative emotional disposition (e.g. Eysenck, Derakhshan, Santos, and Calvo, 2007).

It is widely acknowledged that experimental tasks commonly used to assess attentional bias, such as, the emotional Stroop task and the attentional probe task, are not capable of discretely assessing engagement and disengagement bias (Clarke, MacLeod & Guastella, 2012). Consider, for example, the results obtained using the former task, whereby individuals who are high in negative emotional disposition are slowed to colour name negative words. This pattern of results could be a consequence of such individuals initially assigning disproportionate attentional resources to the negative word content (i.e. an engagement bias), or else all participants may initially attend equally to the semantic content of the negative and neutral words, with the more negative emotional individuals then having an impaired ability to shift attention away from semantic information, to instead process colour information, when such word content is negative (i.e. a disengagement bias).

Likewise, consider the attentional probe task finding that participants high in negative emotional disposition are relatively speeded to process probes presented in the locus of negative information. This could reflect either an elevated tendency to initially move attention towards the locus of distal negative stimuli (i.e. an engagement bias), or a reduced ability to then move attention away from the locus of negative stimuli, as is required in order to process probes in the opposite screen location (i.e. a disengagement bias). Hence,
researchers have developed novel attentional assessment tasks in an effort to separately assess engagement and disengagement bias, which will now be discussed.

**Experimental Tasks Employed to Assess Attentional Engagement and Disengagement Bias in Negative Emotional Disposition**

In this section, the experimental approaches that have previously been employed to assess engagement bias, and disengagement bias, in individuals who differ in terms of their negative emotional disposition, will be discussed. It will be argued that the approach most often employed for this purpose, the emotional spatial cuing task (Fox, Russo, Bowles, & Dutton, 2001), is not capable of discretely assessing these two facets of attentional selectivity. However, a more recently developed experimental approach, the attentional response to distal and proximal emotional information (ARDPEI) task (Grafton & MacLeod, in press) can provide such measures, and so represents a candidate approach that could be amended to enable the discrete assessment of these two facets of attentional selectivity in the present research.

*The Assessment of Attentional Engagement and Disengagement Bias in Negative Emotional Disposition Using the Emotional Spatial Cuing Task*

The approach most often used in previous attempts to separately assess engagement and disengagement bias is based on the the exogenous cuing paradigm developed by Posner et al. (1987), and is commonly termed the emotional spatial cuing task (e.g. Fox, et al., 2001; Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006). In this approach, participants are instructed to initially focus their attention on a central fixation cue, before a single negative or neutral stimulus is briefly displayed, usually for 500 ms, to either the left
or right of this initial attentional focus. Upon termination of this single stimulus, a target probe is displayed in either the same or opposite screen location to where this stimulus was just presented, and the participant is required to quickly execute a discriminatory response to this probe. In this approach, however, the relative probe discrimination latencies in each of the two lateral screen loci are not used to reveal the distribution of attention between these loci. Instead, it is assumed that variation in latencies to discriminate probes that appear in the same locus as the differentially emotional stimuli will reflect only variation in selective attentional engagement with this information, whereas variation in latencies to discriminate probes that appear in the locus opposite to these differentially emotional stimuli will reflect only variation in selective attentional disengagement from such information.

Using the emotional spatial cuing task, a number of investigators have found that high negative emotional disposition participants are slowed to identify probes in the opposite location to initial negative stimuli, relative to neutral stimuli. Hence, it has been claimed that such high negative emotional disposition is characterised only by impaired attentional disengagement from negative information (e.g. Amir, Elias, Klumpp, & Przeworski, 2003; Fox, Russo, & Dutton, 2002; Yiend & Mathews, 2001). Unfortunately, this approach has been the focus of much recent criticism concerning its capacity to adequately dissociate these two types of attentional selectivity (e.g. Clarke, MacLeod & Guastella, 2012; Mogg, Holmes, Garner, & Bradley, 2008; Yiend, 2010). As will be seen, such criticism is justified, which consequently raises serious doubts concerning the veracity of conclusions drawn from studies that have used this common approach.

The first problem with the emotional spatial cuing task is that the differential emotional information is always presented in a screen location distal to the intended initial
attentional focus (i.e. the central fixation cue) of participants. Hence, on every trial, the first attentional response made by participants would vary depending upon the degree to which attention is captured by initially distal negative, relative to neutral, information. Thus, this task cannot yield a measure of disengagement bias that is uncontaminated by engagement bias, as the latter would exert its influence on every trial.

The second problem with this task is that the distribution of attention between the two key screen locations where the probes can subsequently appear is not assessed. Rather, it is assumed that the pattern of response latencies obtained when the probe appears in the same locus as the differentially valenced stimulus can be used to infer selective attentional engagement with this information, whereas the pattern of response latencies obtained when the probe appears in the locus opposite to these differentially emotional stimuli can be used to infer selective attentional disengagement from such information. It has, however, been shown that high negative emotional individuals display a general response slowing in the presence of negative information, independent from their attentional response to such stimuli (e.g. Mogg, et al., 2008), thus negating the validity of this assumption. As a consequence, the finding that such negative emotional participants are slowed to identify probes in the opposite location to initial negative stimuli, relative to neutral stimuli, may simply reflect their general response slowing in the presence of negative information, and not impaired disengagement from such stimuli. Conversely, the finding that negative emotional participants do not show a speeding to identify probes in the same location as initially negative stimuli, relative to neutral stimuli, does not exclude the possibility that they exhibit biased attentional engagement with such negative stimuli. For example, their general response slowing in the presence of negative information would be overlaid upon, and hence
may obscure, the detection of any such speeding that otherwise would result from this engagement bias. Therefore, to sensitively assess engagement and disengagement bias, it must be the case that indices of each type of bias can be computed in a manner that prevents the possibility that any negative emotional-linked general slowing in the presence of negative information contaminates these indices.

**Methodological Framework for the Assessment of Attentional Engagement and Disengagement Bias in Negative Emotional Disposition**

In order to overcome the methodological problems of the emotional spatial cuing task, in a supplementary study conducted during the course of the author’s PhD candidature, Grafton and MacLeod (in press) have suggested that tasks designed to independently assess engagement and disengagement bias must satisfy three key methodological criteria. First, on each trial, the participant’s initial attentional focus must be effectively anchored in a predetermined location. Second, differentially valenced information must then be presented either proximal, or distal, to this initial attentional focus. Third, the deployment of attention between these two loci, proximal and distal to the initial attentional focus, must then be assessed. Using this approach, the tendency for attention to become focused on initially distal emotional information (i.e. engagement bias) would be revealed by assessing the pattern of subsequent attentional distribution on trials where the differentially valenced information was presented distally to the initial focus of attention. In contrast, the tendency for attention to remain focused on initially proximal emotional information (i.e. disengagement bias) would be revealed by assessing the pattern of subsequent attentional distribution on trials where the differentially valenced information was presented proximally to the initial focus of attention.
Based on this framework, Grafton & MacLeod (in press) developed a novel variant of the attentional probe task that meets all three criteria, termed the Attentional Response to Distal vs. Proximal Emotional Information (ARDPEI) task. In this approach, participants are required to first attend either to a left or right screen location. An anchor probe is then briefly exposed in this initial location, and the participant is required to apprehend its identity, thus ensuring that the participant’s attentional focus is initially secured in this predetermined location. A stimulus pair is then presented, with one member of the pair appearing in each of the two screen loci. The stimulus pairs comprise one member that has meaningful content (in this case a representational image), which is either negative or neutral in emotional tone. The other member of the stimulus pair has meaningless content (in this case an abstract image). Hence, the participant can begin a trial with their attention initially being focused either distally from, or proximal to, differentially valenced information. Following the offset of the stimulus display, a target probe is presented with equal frequency in either of these two screen loci. The participant is required to rapidly process the target probe in order to determine whether its identity matches that of the anchor probe. The relative speed with which participants can accurately make the required discriminative response to target probes presented each of the two critical screen regions are used to reveal the distribution of selective attentional between these loci. Thus, by initially securing the focus of attention in a predetermined location, before presenting differentially valenced information either distal to, or proximal from, this initial attentional focus, then assessing the distribution of selective attention between these two screen loci, the ARDPEI task satisfies the key methodological criteria that are required to enable the discrete assessment of engagement and disengagement bias.
In contrast to previous studies that have employed the emotional spatial cuing task, which have supposedly revealed evidence only of an anxiety-linked attentional disengagement bias, the pattern of results obtained when in studies using the ARDPEI task have shown that, by employing an experimental procedure that enables the independent assessment of these two types of attentional selectivity, this can reveal high negative emotional disposition to be characterised both by facilitated attentional engagement with, and impaired attentional disengagement from, negative information (Grafton & MacLeod, in press; Rudaizky, Basanovic, & MacLeod, 2013).

**Summary and Proposed Approach for Assessing Engagement and Disengagement Bias in Positive Emotional Disposition**

While the emotional spatial cuing task has been the most commonly used procedure to investigate engagement and disengagement bias, it does not satisfy the three methodological criteria that enable the discrete assessment of these two facets of attentional selectivity. Hence, in the present research program, a variant of the ARDPEI task will be employed, as this approach does meet the key criteria, and so represents a more rigorous approach for assessing selective attentional engagement and selective attentional disengagement in the present research.

**Reporting Approach**

The study reported in this phase of the research program was accepted for publication in a Special Issue of the Journal of Cognitive Psychology. Space constraints in the Special Issue precluded a manuscript of sufficient length to handle all of the issues the study was designed to address. Consequently, the reported manuscript simplified the expression of the
attentional bias indices so that they reflected attentional preference for negative compared to positive information. Doing so did not compromise the capacity of the study to fully address the issues under consideration in the manuscript, however, in terms of the issues under consideration in the present research, it is of critical importance that attentional selectivity to positive information can be distinguished from attentional selectivity to negative information. Hence, a Supplementary Reporting and Discussion Section is provided following the discussion of the published manuscript. In this supplementary section, the attentional bias indices were re-computed in manner that enabled the dissociation of selective attention to positive and negative information, thus making it possible to fully address all of the issues relevant to the thesis.
Chapter 9

Study 5

The Ups and Downs of Cognitive Bias: Dissociating the Attentional Characteristics of Positive and Negative Affectivity.

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Abstract

Despite considerable past interest in distinguishing the patterns of attentional bias that characterize vulnerability to anxiety and to depression, little research has yet sought to delineate the attentional correlates of two affective dimensions that differentially contribute to these alternative forms of emotional vulnerability - negative and positive affectivity. In the present study, we employ a novel variant of the attentional probe task to examine selective attentional engagement with, and disengagement from, negative words, in participants whose heightened emotional vulnerability reflects either elevated negative affectivity, or attenuated positive affectivity. Elevated negative affectivity was found to be associated with both increased attentional engagement with, and impaired attentional disengagement from, negative information, especially when this was anxiety-relevant. In contrast, attenuated positive affectivity instead was associated with facilitated attentional disengagement from negative information, especially when this was depression-relevant. We discuss how this new insight into the attentional characteristics of negative and positive affectivity may serve to illuminate the basis of previously observed discrepancies between the patterns of attentional selectivity observed in anxious and in depressed participants.
Introduction

Although anxiety and depression are different emotions, there is much evidence that they share a close relationship. Measures of anxiety and depression typically correlate strongly (Watson et al., 2007), individual differences in the disposition to experience anxiety and depression are predicted by the same personality constructs (Watson & Naragon-Gainey, 2009), and clinical depression often is co-morbid with clinical anxiety (Kessler, Gruber, Hettema, Hwang, & Sampson, 2010). Therefore, efforts to better understand individual differences in anxiety and depression must focus on illuminating both the similarities, and the differences, between these emotions. Particularly helpful in this regard has been the distinction drawn, by Watson and Tellegen (1985), between individual differences in negative and in positive affectivity. It now is widely accepted that elevated negative affectivity, reflecting the heightened tendency to experience negative emotion, is a shared characteristic of dispositional anxiety and depression, while attenuated positive affectivity, reflecting the reduced tendency to experience positive emotion, is a distinctive characteristic of depressive disposition (Lee, Watson, & Mineka, 1994). Consequently, it seems plausible that some similarities between anxiety and depression may reflect the characteristics of their shared negative affectivity, while some difference between anxiety and depression may reflect the characteristics of the attenuated positive affectivity that is peculiar to the latter emotion.

There has been a steady growth of interest in the patterns of selective information processing that underpin vulnerability to anxiety and depression, largely inspired by the work of M. W. Eysenck, whose profound influence on the cognitive study of emotion has been sustained throughout a long and distinguished career (e.g., Eysenck, 1979; 1985; 1997; 2010;
Eysenck, Derakhshan, Santos, & Calvo, 2007; Eysenck & Derakhshan, in press). Cognitive psychologists investigating the patterns of attentional selectivity associated with emotional vulnerability have been interested in both the similarities, and the differences, between the selectivity associated with vulnerability to anxiety and with vulnerability to depression. Individuals who report heightened levels of emotional vulnerability, or who suffer from emotional dysfunction, commonly demonstrate an attentional bias towards emotionally negative information (cf. Mathews & MacLeod, 2005; Cisler, Bacon & Williams, 2009). Many theorists contend that this attentional bias causally contributes to emotional vulnerability, and so plays a functional role in the aetiology and maintenance of emotional pathology (Beck & Clark, 1997; Williams, Watts, Mathews, & MacLeod, 1988; 1997; Mathews & Mackintosh, 1998). However, it does not appear that attentional preference for negative information is equally characteristic of heightened vulnerability to depression, and heightened vulnerability to anxiety. Individuals who score high on measures of trait anxiety, or who suffer from anxiety pathology, reliably demonstrate an attentional bias towards negative information (cf. Cisler & Koster, 2010; MacLeod & Rutherford, 2004). This bias often has been demonstrated using the dot probe task which, in its original form, involves exposing participants to word pairs for 500 ms on a computer screen, and requiring them to discriminate small probe stimuli that appear in the locus of either word. High trait anxious participants, and people suffering from anxiety disorders, display speeded processing of probes that appear in the locus of more negative words, indicating that they selectively shift their attention towards such negative stimuli (MacLeod, Mathews, & Tata, 1986; Mogg, Bradley, & Williams, 1995; Frewen, Dozois, Joanisse, & Neufeld, 2008). Indeed, this finding has been so robust that, in a recent meta-analysis of the experimental literature on anxiety-
linked attentional bias, Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, and van Ijzendoorn (2007) noted that it would require consistently null results across a series of 11,339 further studies of this type, before the effect would be reduced to non-significance.

In contrast, evidence has been more mixed concerning the possibility that vulnerability to depression also may be characterized by an attentional preference for negative information (cf. Gotlib & Joormann, 2010). Some studies employing the original version of the probe task, which exposes word pairs for 500 ms, have produced evidence for such an effect (Mathews, Ridgeway, & Williamson, 1996). However, also using this stimulus exposure duration, other studies have revealed no evidence of attention bias in depressed participants (MacLeod et al., 1986). Several researchers, motivated by the idea that reliable evidence of depression-linked attentional bias may require longer stimulus presentations, have modified the probe approach by exposing the stimuli for 1000 ms before the probe appears. In studies employing this 1000 ms exposure condition, there has better evidence of a depression-linked attentional preference for negative information (Gotlib, Krasnoperova, Yue, & Joormann, 2004; Joormann & Gotlib, 2007; Donaldson, Lam, & Mathews, 2007), though again there have been failures to find such an effect (Bradley, Mogg, & Lee, 1997). Another suggestion has been that depression-linked attentional bias may be observed only when negative stimuli are specifically related to depressogenic concerns (Mathews & MacLeod, 1994; Taghavi, Neshat-Doost, Moradi, Yule, & Dalgleish, 1999). Again, while some studies reporting evidence of depression-linked attentional bias have employed negative stimuli with particular relevance to depression (Bradley et al., 1997; Joormann & Gotlib, 2007), other studies using similar stimuli have found no such effects (Mogg, Bradley, Williams, & Mathews, 1993; Neshat-Doost, Moradi, Taghavi, Yule, & Dalgleish, 2000).
Thus, individuals with high vulnerability to anxiety, and those with high vulnerability to depression, are similar in that both sometimes display heightened attentional preference for negative information. However, they differ in that this attentional bias is reliably demonstrated by the former individuals, but is a more fragile and inconsistent effect in the latter (cf. Mogg & Bradley, 2005; Wilson, MacLeod, & Campbell, 2006).

It seems possible that the attentional similarities and differences between anxious and depressed participants may be amenable to hypothetical explanation in terms of the potentially discrepant patterns of attentional selectivity that characterize heightened negative affectivity and attenuated positive affectivity. If heightened negative affectivity is associated with a robust and pervasive attentional preference for negative information, while attenuated positive affectivity instead is associated with attentional avoidance of negative information under certain circumstances, then the observed pattern of findings would be anticipated. Given that it involves elevated negative affectivity, but not attenuated positive affectivity, heightened anxiety would be characterized by a reliable attentional preference for negative information. However, because it combines elevated negative affectivity with attenuated positive affectivity, heightened depression would less consistently be characterized by this pattern of attentional selectivity. Specifically, to the extent that an attentional assessment task taps the attentional avoidance of negative information associated with their attenuated positive affectivity, so depressed participants would be unlikely to display the attentional preference for negative information associated with their elevated negative affectivity.

This idea, that the specific dimension of emotional vulnerability which differentiates depression from anxiety may be characterized by attentional avoidance of negative information, also can explain Bradley, Mogg, Millar, & White (1995) findings concerning
the patterns of attentional selectivity shown by participants whose generalized anxiety disorder (GAD) either was, or was not, co-morbid with major depression. While participants suffering from GAD alone demonstrated an attentional preference for negative words on the dot probe task, those whose GAD was accompanied by major depression did not. As noted by Bradley and colleagues, this suggests that the emotional attributes which distinguish dysfunctional depression from anxiety must be associated with a pattern of attentional selectivity that negates the attentional preference for negative information characteristic of anxiety alone. Bradley et al.’s position is compatible with our proposal that attenuated positive affectivity may, under certain circumstances, be associated with attentional avoidance of negative information, whereas heightened negative affectivity instead is associated with a robust attentional preference for negative information.

Clearly, if attenuated positive affectivity were always characterized by attentional avoidance of negative information, then depressed participants would never display the attentional preference for negative information that they sometimes do. Therefore, it is necessary to suppose that this pattern of attentional avoidance, hypothesized to characterize attenuated positive affectivity, sometimes does not occur, perhaps depending upon the precise facet of attentional selectivity tapped by any given implementation of the dot probe task. A recent conceptual distinction that has appeared in the literature, between biases in attentional engagement with negative information and biases in attentional disengagement from negative information, provides a framework that could potentially accommodate this inconsistency. An attentional preference for negative information may reflect enhanced attentional engagement with such information. Operationally, such an attentional engagement bias can be defined as greater attentional capture by negative stimuli, relative to non-negative
stimuli, when such stimuli appear distally from initial attentional focus. Alternatively, an attentional preference for negative information may reflect impaired attentional disengagement from negative information. Operationally, such an attentional disengagement bias can be defined as greater continued attention to negative stimuli, relative to non-negative stimuli, when these stimuli have initially been attended to.

Early research into emotionally-linked attentional bias was motivated by models predicting that, in emotionally vulnerable individuals, attention would selectively favour the processing of negative information presented outside initial attentional focus (Beck, Emery, & Greenberg, 1985; Bower, 1981; Williams et al., 1988). Thus, the consistent theoretical view was that such vulnerability would be characterized by enhanced attentional engagement with negative information. In contrast, more recent interest in the patterns of attentional selectivity that operate subsequent to initial attentional focus on emotional information has been marked by theoretical conflict. One influential position, put forward by Mogg and Bradley (1998), is that initial attention to negative information is followed by subsequent avoidance of this information in emotionally vulnerable individuals. According to this “approach-avoidance” account, heightened emotional vulnerability should be characterized by facilitated attentional disengagement from negative information. An alternative but equally influential position, put forward by Fox, Russo, Bolwes and Dutton (2001) and by Yiend and Mathews (2001), instead maintains that heightened emotional vulnerability should be characterized by impaired attentional disengagement from negative information. Empirical evidence has failed to convincingly resolve this issue, because experimental support has been claimed both for the former position (Carlson & Reinke, 2008) and the latter position (Amir, Elias, Klumpp, & Prezworski, 2003; Salemink, van den Hout, & Kindt, 2007). Such mixed
findings invite speculation that some aspects of emotional vulnerability may be characterized by enhanced attentional disengagement from negative information, while other aspects of emotional vulnerability instead may be characterized by impaired attentional disengagement from negative information.

We suggest that increased attentional engagement with negative information may be a ubiquitous feature of heightened emotional vulnerability, representing a characteristic of both elevated negative affectivity and attenuated positive affectivity, but that these two types of emotional vulnerability may differ in terms of their characteristic patterns of selective attentional disengagement from negative information. Specifically, we suggest that heightened negative affectivity may be associated with impaired attentional disengagement from negative information, while attenuated positive affectivity may instead be associated with facilitated attentional disengagement from such information. If this were the case then high levels of anxiety vulnerability, being characterized primarily by elevated negative affectivity, would be associated with a robust and pervasive attentional preference for negative information, regardless of whether an assessment procedure tapped selective engagement with or disengagement from such information. In contrast, because heightened vulnerability to depression involves both elevated negative affectivity, and attenuated positive affectivity, observed patterns of selectivity would be more variable. To the extent that an assessment procedure specifically tapped selective attentional engagement, so the more depressed individuals should show attentional preference for negative information. However, if an assessment procedure were simultaneously influenced both by patterns of selective attentional engagement and disengagement, then there should be less consistent findings with depressed participants. In some cases, the increased attentional engagement
with negative information associated with their heightened negative affectivity may dominate, leading to an overall attentional preference for negative information. However, it might be expected that this attentional preference effect would be attenuated, and perhaps often eliminated, by the facilitated attentional disengagement from negative information associated with their attenuated positive affectivity. It is generally accepted that the attentional bias measures yielded by the conventional form of the dot probe task will reflect the combined influence of any bias in attentional engagement and in attentional disengagement (Cisler & Koster, 2010). Therefore, our hypothesis explains why an anxiety-linked attentional preference for negative information has been more reliably observed, on this task, than has a depression-linked attentional preference for negative information.

The objective of the present study was to directly test this hypothesis, by examining the patterns of selective attentional engagement with, and disengagement from, negative information, demonstrated by participants whose elevated emotional vulnerability reflected either heightened negative affectivity or attenuated positive affectivity. This required an attentional probe procedure capable of cleanly dissociating these two forms of attentional selectivity. In recent years, some investigators have attempted to do this using a single stimulus variant of the original probe task. This variant first requires participants to fixate a central screen location, then delivers only a single negative or non-negative stimulus in either of two adjacent screen locations for a brief duration, followed by a probe stimulus in either of these two loci (Fox et al., 2001; Koster, Leyman, de Raedt, & Crombez, 2006). The pattern of latencies to discriminate probes in the locus of the initial stimuli is used to infer differential attentional engagement with these stimuli, whereas the pattern of latencies to discriminate probes in the opposite screen location is used to infer differential attentional
disengagement from them. On this type of task, it has been found that emotionally vulnerable participants are not speeded to process probes in the locus of the single negative stimuli, compared to those in the locus of single neutral stimuli, which has led researchers to claim that they do not display facilitated attentional engagement with negative information. Rather, emotionally vulnerable participants are slowed to process probes in the opposite location from the single negative stimuli, compared to those in the opposite location from single neutral stimuli, which has led researchers to claim that they display impaired attentional disengagement from negative information. However, the single stimulus probe task has two significant limitations, which seriously compromise its capacity to differentiate selective attentional engagement with, and disengagement from, emotional stimuli (Mogg, Holmes, Garner, & Bradley, 2008; Yiend, 2010; Clarke, MacLeod & Guestella, under review). We will comment on each limitation in turn, and also will indicate the steps needed to overcome each problem.

The first limitation is that, before the patterns of discrimination latencies observed on probes distal to initial emotional stimuli can be used to infer differential attentional disengagement from these stimuli, it is necessary that attention must always have been initially focused on these emotional stimuli, to an equivalent degree regardless of their valence or the participant group. Otherwise, relative slowing to discriminate probes presented distally to one type of initial stimulus may not reflect impaired attentional disengagement from this initial stimulus, but rather may result from a greater degree of prior attentional engagement with this type of initial stimulus. In previous versions of the single stimulus probe task, differential attentional engagement with the single stimulus has been permitted. Hence, the measure of individual difference in attentional disengagement from
any given type of emotional stimuli will be systematically contaminated by individual differences in attentional engagement with this type of emotional stimuli. To prevent this confound, an experimental approach is required that reliably secures initial attention in a predetermined locus, either proximal to or distal from differentially valenced stimuli, then assesses subsequent attention, to independently index individual differences in attentional engagement with the initially distal emotional information, and individual differences in attentional disengagement from the initially proximal emotional information.

The second limitation of the single stimulus probe task employed by previous researchers, such as Fox et al. (2001) and Koster et al. (2006), is that it fails to take account of the possibility that emotionally vulnerable individuals may display generic slowing of response latencies in the presence of negative information. As Yiend (2010) points out, if emotionally vulnerable participants display such an effect, then this could explain their slowing to probes appearing opposite negative stimuli, without the need to suppose impaired attentional disengagement from these stimuli. This general slowing also would be overlaid upon, and hence may obscure, the relative speeding to probes in the locus of negative stimuli that otherwise would result from facilitated attentional engagement with them. The severity of this potential methodological limitation depends upon whether emotionally vulnerable individuals do demonstrate generic slowing in the presence of negative information, independent of their attentional response to this information. Mogg et al. (2008) directly addressed this issue, when recently carrying out a single stimulus probe task. They found that their emotionally vulnerable participants did indeed display general response slowing when negative rather than neutral stimuli were presented, under conditions that precluded differential attention to these two categories of stimuli. When attentional selectivity was
assessed in a manner that controlled for this general slowing effect, these participants showed
evidence of selective attentional engagement with negative information, which otherwise
would have gone undetected. Therefore, in order to sensitively assess selective attentional
engagement with, and disengagement from, emotional information, it is necessary to
appropriately control for possible individual differences in general response slowing incurred
by the presence of negative information.

Consequently, we developed a novel attentional probe variant to differentiate these
two facets of attentional selectivity, in a manner that circumvents both of these previous
methodological limitations. On each trial, the participant first is informed, by a central arrow
display, whether to initially attend to an upper or lower screen location. A cue stimulus then
flashes up briefly at this location, before a pair of letter strings appear, one string at each of
the two screen loci. One of these strings is a word, related either to anxiety or depression,
which can be either negative or positive in emotional valence, while the other string is a
meaningless non-word. Thus, the participant begins each trial either with attention already
focussed on an emotional word, or with attention focussed distally to an emotional word (i.e.
focussed on the non-word). After either a 500 ms or 1000 ms exposure, the letter strings then
disappear, and a final probe stimulus appears in either screen location, which either does or
does not match the identity of the cue stimulus. Participants must quickly decide whether the
cue and probe match in identity. Accurate responding on this task is possible only if the
participant starts the trial with attention on the briefly exposed cue, and finishes with
attention on the probe. Thus, the task fulfils the need for attention to initially be secured in a
predetermined locus, either proximal to or distal from differentially valenced stimuli (by the
need to process the cue), before attention is then subsequently assessed 500 or 1000 ms later,
by contrasting the speed to process probes in each locus. The resulting pattern of response latencies will independently index individual differences in selective attentional engagement with emotional information distal from initial attentional focus, and individual differences in selective attentional disengagement from emotional information proximal to initial attentional focus. Furthermore, because the measures used to infer attentional selectivity in this task reflect relative speed to process probes in differing screen loci, when a given valence of information is present, they control for possible individual differences in general response slowing in the presence of negative information. Thus, variation in degree of response slowing elicited by the mere presence of negative information would not compromise the assessment of selective attentional engagement with, and disengagement from, such information.

Given previous research interest in contrasting the patterns of attentional selectivity observed on emotional information specifically related to anxiety, or specifically related to depression, we included both types of stimulus materials in the task. Using this task we compared attentional preference for negative information, revealed by the engagement bias measure and the disengagement bias measure, in student participants reporting high and low levels of emotional vulnerability, subdivided into two types. For half of these participants, high and low emotional vulnerability reflected elevated and attenuated levels of negative affectivity, respectively, and these participants did not differ in terms of positive affectivity. For the remaining participants, high and low emotional vulnerability reflected attenuated or elevated positive affectivity, respectively, and these participants did not differ in terms of negative affectivity.
Our hypothesis predicts that the high emotional vulnerability participants selected on the basis of elevated negative affectivity will show greater attentional preference for negative words than their low emotional vulnerability counterparts, on both the attentional engagement and disengagement measures. In contrast, the hypothesis predicts that the high emotional vulnerability participants selected on the basis of attenuated positive affectivity will display discrepant patterns of selectivity on the engagement and disengagement bias measure. On the disengagement bias measure alone, they will show reduced attentional preference for negative words, relative to their low emotional vulnerability counterparts.

Method

Participants

Approximately 800 first year students at the University of Western Australia were screened on the trait version of the Positive and Negative Affect Schedule (PANAS; Watson, Clark & Tellegen, 1988), which yields separate scores representing the disposition to experience positive and negative affect. Forty participants were selected on the basis of differing in emotional vulnerability in terms of negative affectivity, but not positive affectivity. Twenty of these participants scored in the top third of the negative affectivity distribution, and so were considered high in emotional vulnerability, while twenty scored in the bottom third of this distribution, and so were considered low in emotional vulnerability, and all forty scored in the middle third of the positive affectivity distribution. A further forty participants were selected on the basis of differing in emotional vulnerability in terms of positive affectivity, but not negative affectivity. Twenty of these participants scored in the bottom third of the positive affectivity distribution, and so were considered high in emotional
vulnerability, while twenty scored in the top third of this distribution, and so were considered low in emotional vulnerability, and all forty scored in the middle third of the negative affectivity distribution.

These four subgroups of participants gave rise to two nested between-group factors, Emotional Vulnerability Level (High Emotional Vulnerability vs. Low Emotional Vulnerability), and Vulnerability Subtype (Discrepant Negative Affectivity vs. Discrepant Positive Affectivity). Participant characteristics are shown in Table 1. Separate 2 x 2 ANOVAs carried out on age, and on gender ratio, revealed no significant effects of either Emotional Vulnerability Level, Vulnerability Subtype, or their interaction, confirming that the groups did not differ on these dimensions. However, when such an ANOVA was carried out on negative affectivity scores, it revealed a significant main effect of Emotional Vulnerability Level, \( F(1, 76) = 108.67, p < 0.001, \eta^2 = 0.59 \), modified as expected by Vulnerability Type, \( F(1, 76) = 105.38, p < 0.001, \eta^2 = 0.58 \). As required, this two-way interaction resulted from the fact that the simple main effect of Emotional Vulnerability Level was significant for participants selected on the basis of Discrepant Negative Affectivity, \( F(1, 38) = 125.65, p < 0.001, \eta^2 = 0.77 \), but not for participants selected on the basis of Discrepant Positive Affectivity, \( F < 1 \). An equivalent ANOVA carried out on positive affectivity scores also revealed a significant main effect of Emotional Vulnerability Level, \( F(1, 76) = 121.13, p < 0.05, \eta^2 = 0.61 \), and once more confirmed that this was modified by Vulnerability Type, \( F(1, 76) = 100.11, p < 0.001, \eta^2 = 0.57 \). Again as required, this two-way interaction now resulted from the fact that the simple main effect of Emotional Vulnerability level was significant for participants selected on the basis of Discrepant
Positive Affectivity, $F(1, 38) = 122.76, p < 0.001, \eta^2 = 0.76$, but not for participants selected on the basis of Discrepant Negative Affectivity, $F(1, 38) = 2.48, ns, \eta^2 = 0.06$.

[Insert Table 1 about here]

**Positive and Negative Affect Schedule**

The Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) comprises two 10 item mood scales, one assessing positive affect and the other negative affect. Depending upon the manner of its delivery, it can be employed as either a state measure (to assess current affect), or as a trait measure (to assess dispositional affectivity). In the state version of the questionnaire, participants are directed to rate “to what extent you feel this way right now; that is, at the present moment”. In the trait version, participants are instead instructed to rate “to what extent you generally feel this way; that is, how you feel on average”. The PANAS has been found to have good reliability and validity (Crawford & Henry, 2004).

**Apparatus**

A Hewlett-Packard Compaq dc7800 with a 22-inch colour monitor, and a standard two button mouse, were used to present stimuli and to record participant responses.

**Stimuli**

Experimental stimuli comprised 64 emotional words, each paired with a length matched non-word. The words were selected on the basis of an initial rating procedure, which involved six clinical psychologists rating 400 candidate words on two dimensions. One rating concerned the emotional valence of the word, which was judged on a 7 point scale
ranging from -3 (extremely negative) to +3 (extremely positive), where the mid-point of zero was identified as emotionally neutral. Half of the experimental words (32 words) were chosen on the basis of receiving highly negative ratings, while half were chosen because, although their ratings deviated from zero by an equivalent amount, these words had received highly positive ratings. This gave rise to a Stimulus Valence factor (Negative Words vs. Positive Words).

The raters also assessed the degree to which the candidate words were related either to the emotional dimension associated with variations in anxiety (ranging from anxious to relaxed experiences), or to the emotional dimension associated with variations in depression (ranging from sad to happy experiences). Half of the negative words and half of the positive words in the final stimulus set were selected because they had been rated more closely related to the former emotional dimension, and half were selected because they had been rated more closely related to the latter emotional dimension. This gave rise to a Stimulus Domain factor (Anxious/Relaxed Words vs. Sad/Happy Words), nested within the Stimulus Valence factor.

The full set of experimental words is provided in Table 2. A two way ANOVA carried out on the valence ratings confirmed a significant main effect of Stimulus Valence, $F(1, 60) = 3357.61, p < 0.05, \eta^2 = 0.98$, while providing reassurance that neither the main effect of Stimulus Domain, $F(1, 60) = 1.88, ns, \eta^2 = 0.03$, nor the interaction between the two factors, $F(1, 60) = 1.60, ns, \eta^2 = 0.03$, was significant. Thus, stimulus emotionality differed as required, and was not confounded with the domain distinction. Additional ANOVAs carried out on word frequency (according to Kucera & Francis, 1967) and on word
length (expressed in terms of letters) revealed no significant effects, indicating that the stimulus distinctions were not confounded with either word length or frequency.

[Insert Table 2 about here]

**Attentional Assessment Task**

Each trial commenced with the appearance of an upper and lower string of asterisks, centralized horizontally on the computer screen and separated vertically by a distance of 3 cm. These asterisk strings demarcated the two critical screen regions, and between them was an arrow display pointing either towards the upper or the lower region, with equal frequency. Participants were required to direct their attention to the screen region indicated by the arrow display. One second later, the screen was cleared, and a cue stimulus was briefly exposed (150 ms) in this attended region. The cue stimulus was a small (2 mm) red line, sloping upwards 45 degrees to either the left or to the right, with equal frequency. Immediately thereafter, a word/non-word stimulus pair was presented, one member appearing in each of the two critical screen regions. Thus, the word either appeared where the participant was already attending, or else it appeared in the distal screen region, with equal frequency. This lexical display was exposed for either 500 ms, or 1000 ms, with equal frequency, representing the same two stimulus exposure durations employed in the previous dot probe variants reviewed within the introduction. A probe stimulus then appeared in either of the two critical screen regions, with equal frequency. Again this was a small (2 mm) red line, sloping upwards 45 degrees to either the left or to the right. Participants were required to quickly indicate whether the slope direction of the probe stimulus matched that of the cue stimulus, which was the case on 50% of trials. They registered their response by pressing either the
right or left mouse button, to respectively indicate either that the slopes did or did not match. Response latency to make this probe discrimination decision was recorded, as was its accuracy.

Using these probe discrimination latencies, selective attention to the word members, relative to the non-word members, of the stimulus pairs will be revealed by relative speeding to discriminate probes in the loci of the words relative to probes in the opposing loci, where the non-words appeared. Therefore, attentional preference for negative words, relative to positive words, can be indexed by the degree to which this speeding to probes in the loci of words (relative to probes in their opposing loci) is greater when these words are negative, compared to when they are positive. Greater attention preference for the negative words relative to the positive words will be revealed higher scores on this Attentional Preference for Negativity index, which can be expressed as follows:

Attentional Preference for Negativity index = (RT for probes opposite negative word loci – RT for probes in negative word loci) – (RT for probes opposite positive word loci – RT for probes in positive word loci)

Importantly, this task enabled us to compute attentional preference for negativity under two conditions, to discriminate selective attentional engagement with, and disengagement from, the negative words. It can be computed to index attentional response to emotional words presented distally to initial attentional focus, by using the RT data from those trials on which the initial cue appeared in the non-word locus. This provided our Attentional Preference for Negativity: Engagement Bias Index (APN:EBI). A high score of this index will reflect facilitated attentional engagement from negative words, relative to
positive words. Attentional preference for negativity also can be computed to index attentional response to emotional words presented within the initial focus of attention, by using the RT data from those trials on which the initial cue appeared in the word locus. This provided our Attentional Preference for Negativity: Disengagement Bias Index (APN:DBI). A high score of this index will reflect impaired attentional disengagement from negative words, relative to positive words.

Across the attentional assessment task, each of the 64 lexical string pairs was presented a total of 4 times, twice with the word in the locus of initial attention and twice with the word distal to the focus of initial attention, and in each case with the probe appearing once in the locus of initial attention and once in the opposing screen location. Order of presentation was randomized.

**Procedure**

Participants were tested individually. The test session commenced with completion of the state version of the PANAS. The participant then was seated approximately 60 cm from the computer screen, and the requirements of the cue-probe matching task were described. Instructions emphasized the need for accuracy, but stressed that the response should be made as quickly as possible without compromising accuracy. A short practice was then given, comprising 20 trials that employed only neutral stimuli. Following this, the participants completed the attentional assessment task, before being thanked and debriefed.
Results

Participant Characteristics at Test Time

To confirm that required between group differences in negative and positive affect remained evident at test time, state negative and positive affect scores collected during the experimental test session were examined. These scores are shown in Table 3. They were subjected to two-way between-group ANOVAs, which considered the factors of Emotional Vulnerability Level (High Emotional Vulnerability vs. Low Emotional Vulnerability), and Vulnerability Type (Discrepant Negative Affectivity vs. Discrepant Positive Affectivity).

[Insert Table 3 about here]

The ANOVA carried out on state negative affect scores revealed a significant main effect of Emotional Vulnerability Level, $F(1, 76) = 12.07, p < 0.001, \eta^2 = 0.14$, modified as anticipated by Vulnerability Type, $F(1, 76) = 6.65, p < 0.05, \eta^2 = 0.08$. As expected, this two-way interaction arose because a significant simple main effect of Emotional Vulnerability Level was observed on the negative affect scores for participants selected on the basis of Discrepant Negative Affectivity, $F(1, 38) = 12.78, p < 0.01, \eta^2 = 0.25$, but not for those selected on the basis of Discrepant Positive Affectivity, $F < 1$.

Analysis of state positive affect scores also revealed a significant main effect of Emotional Vulnerability Level, $F(1, 76) = 9.15, p < 0.01, \eta^2 = 0.11$, again modified by Vulnerability Type, $F(1, 76) = 4.45, p < 0.05, \eta^2 = 0.06$. Also as expected, the two-way interaction now was due to the fact that a significant simple main effect of Emotional Vulnerability Level was observed on the positive affect scores for participants selected on the
basis of Discrepant Positive Affectivity, $F(1, 38) = 12.04, p < 0.01, \eta^2 = 0.24$, but not for those selected on the basis of Discrepant Negative Affectivity, $F < 1$.

**Probe Task Measures of Attentional Selectivity**

Participants displayed a high level of accuracy on the cue-probe matching task, averaging less than 9% errors. Such accuracy indicates that they complied with the requirement to initially attend to the locus of the cue, and subsequently attend to the locus of the probe. For each participant, mean latencies for accurate responses were computed under each experimental condition, after eliminating RT outliers using a 95% confidence interval\(^1\). Using the full set of participants, SPSS (v19) was employed to run a boxplot analysis, as recommended by Howell (2002), to determine if any participants were extreme outliers in terms of overall mean RT, and so should be excluded.\(^2\) No participants prove to be extreme outliers in terms of mean RT. The mean probe discrimination latencies obtained in every experimental condition, by each group of participants, are shown in Table 4. There was no significant difference between the mean probe discrimination latencies shown by High Emotional Vulnerability participants and Low Emotional Vulnerability participants, either overall (1080.35 ms vs. 1047.73 ms; $F < 1$), or for the subsets of participants whose discrepant emotional vulnerability reflected either differential positive affectivity (1103.33 ms vs. 1075.07 ms; $F < 1$), or differential negative affectivity (1085.64 ms vs. 992.13 ms; $F(1, 38) = 1.45, ns, \eta^2 = 0.04$).

[Insert Table 4 about here]

From these raw response latencies, two attentional bias scores were calculated for each participant as described in the Method section; the Attentional Preference for
Negativity: Engagement Bias Index (APN:EBI), and the Attentional Preference for Negativity: Disengagement Bias Index (APN:DBI). A boxplot analysis again was carried out on the full participant set, using SPSS (v19), this time to determine if any participants were extreme outliers in terms of their attentional preference for negativity scores. This revealed one participant, from the high positive affectivity group, to be an extreme outlier in terms of attentional preference for negativity scores. Consequently, this participant was excluded from further analysis. The attentional preference for negativity scores for the remaining participants, respectively indexing the degree to such attentional preference was evident when the task assessed attentional engagement with initially distal negative words, and when it assessed attentional disengagement from initially proximal negative words, are shown in Table 5. In all cases, higher scores reflect greater attentional preference for negative words.

These attentional preference for negativity scores were subjected to a mixed-design ANOVA, that considered two between-group factors and three within-group factors. The between-group factors were Emotional Vulnerability Level (High Emotional Vulnerability vs. Low Emotional Vulnerability) and Vulnerability Type (Discrepant Negative Affectivity vs. Discrepant Positive Affectivity). The within-group factors were Attentional Bias Type (Engagement Bias Index vs. Disengagement Bias Index), Stimulus Domain (Anxious/Relaxed Words vs. Sad/Happy Words), and Exposure Duration (500 ms Exposure vs. 1000 ms Exposure). The hypothesis under test predicts a three-way interaction involving Emotional Vulnerability Level x Vulnerability Type x Attentional Bias Type. If the pattern of effects predicted by the hypothesis is restricted to either the short or long exposure duration,
or is evidenced more for one particular domain of emotional words, then such a three-way interaction would be modified by either or both of the other within-group factors.

The ANOVA revealed a significant two-way interaction between Emotional Vulnerability Level x Stimulus Domain, $F(1, 75) = 7.98, p < 0.01, \eta^2 = 0.10$ and a significant three-way interaction between Attentional Bias Type x Stimulus Domain x Exposure Duration, $F(1, 75) = 4.31, p < 0.05, \eta^2 = 0.05$. Of more direct relevance to the particular issue under present scrutiny, these effects were subsumed within an overall five-way interaction involving Emotional Vulnerability Level x Vulnerability Type x Attentional Bias Type x Stimulus Domain x Exposure Duration, $F(1, 75) = 5.19, p < 0.05, \eta^2 = 0.07$. Therefore, in order to understand the differing patterns of attentional engagement and disengagement exhibited by participants whose emotional vulnerability reflected either heightened negative affectivity or attenuated positive affectivity, we must decompose this complex higher order interaction to its component effect.

The contribution of Exposure Duration to the five-way interaction was straightforward. Neither the simple four-way interaction of the other factors, $F(1, 75) = 1.03, ns, \eta^2 = 0.01$, nor any other effects were evident under the 1000 ms exposure condition. However, this simple four-way interaction was significant under the 500 ms exposure condition, $F(1, 75) = 5.47, p < 0.05, \eta^2 = 0.07$. Thus, the differing patterns of attentional selectivity that distinguished the alternative types of emotional vulnerability were evident only when attention was assessed 500 ms after word onset.

We went on to explore the nature of the simple four-way interaction involving Emotional Vulnerability Level x Vulnerability Type x Attentional Bias Type x Stimulus
Domain, observed using 500 ms word exposures. This involved breaking down the interaction to reveal the component effects shown by participants chosen on the basis of differing in alternative facets of emotional vulnerability. First, consider the pattern of attentional selectivity shown, at this 500 ms exposure duration, by those participants selected because of their discrepant levels of negative affectivity. Our hypothesis was that individuals whose heightened emotional vulnerability reflects elevated negative affectivity would show a similar attentional preference for negative information on both types of attentional bias measure. Hence we expected no impact of the Attentional Bias Type factor for participants who differed in negative affectivity. Consistent with this expectation, the Attentional Bias Type factor was not involved in any significant effects for this subgroup of participants.

There was a significant effect of Emotional Vulnerability Level for these participants, subsumed within an interaction that also involved Stimulus Domain, $F (1, 38) = 5.91, p < 0.05, \eta^2 = 0.14$. This two-way interaction, which was not further modified by Attentional Bias Type, $F (1, 38) = 2.01, ns, \eta^2 = 0.05$, is shown in Figure 1.

[Insert Figure 1 about here]

As can be seen, the interaction reflected the fact that these High Emotional Vulnerability participants, characterized by heightened levels of negative affectivity, obtained higher attentional preference for negative information scores than did their Low Emotional Vulnerability counterparts, but only when stimulus words fell within the Anxious/Relaxed domain ($M = 115.19, SD = 475.65$ vs. $M = 101.08, SD = 254.31; F (1, 38) = 5.26, p < 0.05, \eta^2 = 0.12$). There was no significant difference in the attentional preference for negative information scores shown by these High and Low Emotional Vulnerability participants when stimulus words fell within the Sad/Happy domain, $F (1, 38) = 1.14, ns, \eta^2$
= 0.03. This pattern of results confirms that participants whose heightened emotional vulnerability reflected elevated negative affectivity showed greater attentional preference for negative information bias than did participants with lower levels of negative affectivity, and supports the prediction this attentional preference for negativity would be equally evident on measures of biased attentional engagement and disengagement. But it further demonstrates that the difference in attentional bias associated with discrepant levels of negative affectivity is especially evident on emotional information of particular relevance to anxiety.

Next, consider the pattern of attentional selectivity shown, at this 500 ms exposure duration, by those participants selected because of their discrepant levels of positive affectivity. Our hypothesis predicts that individuals high in emotional vulnerability because of attenuated positive affectivity, will show greater attentional preference for negative information than their low emotional vulnerability counterparts only on the engagement bias measure. In contrast, on the disengagement bias measures they instead should demonstrate reduced attentional preference for negativity, relative to their low emotional vulnerability counterparts. This should give rise to a significant interaction between Emotional Vulnerability Level and Attentional Bias Type, for these participants. This two way interaction did indeed prove to be significant, $F (1, 37) = 4.81, p < 0.05, \eta^2 = 0.11$. This interaction effect was more evident for stimulus words falling in the Sad/Happy domain, rather than the Anxious/Relaxed domain, as evidenced by a three-way interaction also involving Stimulus Domain, $F (1, 37) = 4.20, p < 0.05, \eta^2 = 0.10$. This interaction is shown in Figure 2.

[Insert Figure 2 about here]
The simple two-way interaction of Emotional Vulnerability Level x Attentional Bias Type demonstrated on Anxious/Relaxed stimulus words, which is illustrated within the left panel of Figure 2, did not approach significance, $F < 1$. However, the simple interaction demonstrated on Sad/Happy stimulus words, which is illustrated within the right panel of Figure 2, was statistically reliable, $F (1, 37) = 8.72, p < 0.01, \eta^2 = 0.19$. The pattern of this simple two-way interaction, observed on emotional stimuli from the Sad/Happy domain, was generally consistent with predictions. On the engagement bias measure, the attentional preference for negativity score was nominally higher for the High Emotional Vulnerability participants than for the Low Emotional Vulnerability participants ($M = 84.47; SD = 278.67$ vs. $M = 24.51; SD = 306.71$), though this effect fell short of statistical significance, $F < 1$. In direct contrast, on the disengagement bias measure these High Emotional Vulnerability participants instead demonstrated lower attentional preference for negativity scores than did the Low Emotional Vulnerability group ($M = -163.99$ SD = 324.47 vs. $M = 171.49$, SD = 357.88; $F (1, 38) = 9.42, p = 0.01, \eta^2 = 0.20$).

These findings are consistent with the hypothesis that participants whose heightened emotional vulnerability reflects attenuated positive affectivity display greater attentional avoidance of negative information than do participants with higher levels of positive affectivity, but only as a result of facilitated attentional disengagement from such negative information. The results also indicate that the facilitated attentional disengagement from negative information, demonstrated by participants with attenuated levels of positive affectivity, is especially evident on emotional information that is of particular relevance to sadness.
Discussion

The purpose of the present study was to test a novel hypothesis concerning the patterns of selective attentional engagement with, and disengagement from, negative emotional information, characteristic of emotional vulnerability that reflects either elevated negative affectivity or attenuated positive affectivity. In order to explain the previously observed robustness of the attentional preference for negative information in anxious participants, we proposed that heightened negative affectivity may be associated with a pervasive attentional preference for negativity, expressed both as relatively facilitated attentional engagement with, and impaired attentional disengagement from, negative information. In contrast, to explain the relative fragility of the attentional preference for negative information less commonly observed in depressed participants, we proposed that attenuated positive affectivity instead may be associated with reduced attention preference for negativity that specifically reflects facilitated attentional disengagement from such information. In addition to potentially illuminating the similarities and differences between the attentional characteristics of anxiety and depression, this hypothesis also may help to resolve the contradiction between conflicting theoretical accounts, which propose either that initial attention to negative information is followed by active avoidance of such information in emotionally vulnerable participants (Mogg & Bradley, 1998), or that negative information disproportionately holds attention in such individuals (Fox et al., 2001; Yiend, 2010). According to the present hypothesis, both accounts are valid, but each pattern of selective attentional disengagement is associated with a different underlying dimension of emotional vulnerability.
Using a new variant of the attentional probe task, designed to cleanly differentiate selective attentional engagement and disengagement, we found support for the hypothesis, though only when attention was assessed following 500 ms word exposures, as employed in the original version of the conventional dot probe task (MacLeod et al., 1986). Before discussing the pattern of attentional effects observed 500 ms after stimulus word onset, and their implications, it is appropriate to briefly reflect on the possible reasons why no group differences presently were evident when attention instead was assessed 1000 ms after stimulus word onset. As noted in the introduction, variants of the conventional probe task, using 1000 ms stimulus exposure durations, have sometimes found that emotionally vulnerable participants show evidence of attentional preference for negative information (e.g. Leyman, de Raedt, Schacht, & Koster, 2006; Donaldson et al., 2007). We can suggest two possible reasons why such previously observed effects may not have been evident in the present study. First, these previous studies have tested clinical participants diagnosed with emotional pathology. It is possible that the prolonged continuation of an attentional preference for threat stimuli, which remains evident 1000 ms after their onset, may be a characteristic of clinical pathology, not evidenced by non-clinical participants reporting elevated negative affectivity or attenuated positive affectivity. Second, these previous studies have employed pictorial stimuli, rather than words. While the visual processing of word stimuli required to fully access their meanings can be completed very rapidly, the visual processing of pictorial stimuli extends across a longer time span. Given that the visual processing required to fully extract meaning plausibly may extend beyond 1000 ms with pictorial images, but not with words, it may be that biased visual attention to emotionally-charged pictorial images is more likely to remain evident at a 1000 ms SOA than will be the
case for emotionally-charged words. Future research could investigate the veracity of these alternative explanations, by systematically comparing the patterns of attentional selectivity observed 1000 ms after stimulus onset, when clinical and non-clinical participants are tested, and when verbal and pictorial stimuli are employed.

At the 500 ms exposure duration employed in the present study, there was clear evidence of group differences in selective attentional response to negative information, and the nature of the observed effects was consistent with our hypothesis. Elevated negative affectivity was associated with a pattern of response latencies suggesting attentional preference for negative words, on measures of both attentional engagement and disengagement. However, the pattern of response latencies associated with attenuated positive affectivity suggested attentional avoidance of negative words, restricted to the measure of disengagement bias, and reflecting enhanced attentional disengagement from negative words. It is also noteworthy that the attentional preference for negativity associated with elevated negative affectivity was evident primarily for emotional stimuli related to the dimension of anxiety. In contrast, the attentional avoidance of negativity associated with attenuated positive affectivity, displayed on the measure of selective attentional disengagement, was evident primarily for emotional stimuli related to the dimension of depression. We believe these findings can shed new light on the nature of attentional selectivity likely to characterize heightened vulnerability to anxiety, and to depression, respectively, and we will consider each emotion in turn.

Since heightened vulnerability to anxiety principally involves elevated negative affectivity, without attenuated positive affectivity, anxious individuals would be expected to reliably demonstrate the patterns of attentional selectivity we have found to characterize such
negative affectivity. As we have noted, there is ample evidence that both high trait anxiety, and anxiety dysfunction, are associated with a robust attentional preference for negative words presented for durations of 500 ms (cf. Bar-Haim et al., 2007; Frewen et al., 2008). There is also evidence that anxious participants display this attentional selectivity primarily on emotional stimuli linked to their anxiety-related concerns (Becker, Rinck, Margraf, & Roth, 2001), consistent with the current observation that the attentional selectivity associated with heightened negative affectivity is most evident on anxiety-relevant stimuli. However, the question of whether anxiety-linked attentional selectivity reflects increased attentional engagement with negative stimuli, or impaired attentional disengagement from such stimuli, has not hitherto been resolved.

Some researchers previously have claimed that anxiety vulnerability is characterized only by enhanced attentional engagement with negative information (Massar, Mohl, Kenemans, & Baas, 2010; Matsumoto, 2010), while others instead have argued that it is characterized only by impaired attentional disengagement from negative information (Fox, Russo & Dutton, 2002; Koster, Crombez, Verschuere, & de Houwer, 2004). The present methodology provides an especially powerful means of independently assessing both forms of attentional selectivity, by differentiating the attentional response to emotional stimuli that appear distally from initial attentional focus, and the attentional response to emotional stimuli that appear proximally to initial attentional focus. The findings invite the conclusion that elevated anxiety vulnerability, being marked principally by heightened negative affectivity, is likely to be simultaneously associated with both types of attentional selectivity. This accords with the theoretical position recently put forward by Ouimet, Gawronski and Dozois (2009), who propose an integrative model of cognitive vulnerability to anxiety vulnerability, within
which facilitated attentional engagement with, and impaired attentional disengagement from, negative information, both operate.

While it may be the case that both forms of attentional preference for negative information are equally associated with the heightened negative affectivity characteristic of anxiety vulnerability, this need not mean that biased attentional engagement and disengagement make an equivalent causal contribution to anxious symptomatology. In recent years, researchers have sought to determine the causal contributions of attentional bias by exposing participants to probe task variants designed to systematically modify selective attentional response to negative information, then examining the impact of such attentional change on anxiety symptoms (cf. Mathews & MacLeod, 2002; Hakamata et al., 2010). Although it usually has been unclear whether these bias modification procedures influence attentional engagement or disengagement, it repeatedly has been shown that reducing attentional preference for negative information serves to attenuate anxiety symptoms, suggesting that attentional selectivity causally contributes to anxiety (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002; See, MacLeod, & Bridle, 2009; Schmidt, Richey, Buckner, & Timpano, 2009). In a recent variant of this approach, Hirsch, MacLeod, Mathews, Sandher, Siyani, & Hayes (2010) compared the impact of alternative bias modification variants, designed either to reduce attentional engagement with, or to increase attentional disengagement from, negative information, in a sample of self-selected worriers. Both procedures were equally effective in eliciting attentional change, but only the former procedure served to reduce the intensity of subsequently reported worry. Two possible accounts of these findings can be distinguished. One possibility is that only facilitated engagement with negative information causally contributes to anxiety, while impaired
disengagement from negative information arises only as a consequence of this elevated anxiety. An alternative possibility is that facilitated attentional engagement with, and impaired disengagement from, negative information, may each make a causal contribution to differing dimensions of anxiety. For example, we have suggested elsewhere that the engagement bias may impact on the intensity of the anxiety response, while the disengagement bias may impact on its longevity (Rudaizky, MacLeod, & Page, under review). Whatever their relative contribution to anxious symptomatology, it appears that heightened anxiety vulnerability is likely to be marked by attentional preference for negative information, on adequately sensitive measures of both selective attentional engagement and disengagement.

Let us turn now to consider how the present findings may shed light on the patterns of attentional selectivity that previous investigators have observed to characterize depressed participants. The results of the present study suggest that two dissimilar profiles of attentional selectivity will be combined in these participants; the profile associated with elevated negative affectivity, as just described, and the profile associated with attenuated positive affectivity. When an assessment task principally measures selective attentional engagement with negative information, then there will be no conflict between these two profiles of selectivity, and so depression should be characterized by facilitated attentional engagement with negative information. When an assessment task instead principally measures selective attentional disengagement, then the contradictory profiles of selectivity associated with elevated negative affectivity and attenuated positive affectivity will compete with each other, and their mutual negation may undermine the expression of depression-linked bias. Moreover, the present findings suggest that depressed participants’ elevated negative
affectivity should be associated with impaired disengagement from negative stimuli related to anxiety, while their attenuated positive affectivity should be associated with enhanced attentional disengagement from negative stimuli relatedness to sadness. This leads to the counter-intuitive expectation that a depression-linked preference for negative information on attentional disengagement tasks will be most likely when this negative information is related to anxiety rather than to sadness.

We already have noted that, when attentional bias is assessed using tasks that do not distinguish selective engagement from disengagement, depression-linked effects are fragile and unreliable (Mathews & MacLeod, 2005; Gotlib & Joorman, 2010). However, in the past few years, a number of researchers have sought to specifically assess the patterns of selective attentional disengagement evidenced by depressed participants. Although their methodologies may always have not been optimal, there has indeed been evidence that depressed participants may display impaired attentional disengagement from negative information that is anxiety-related. For example, when Leyman and colleagues (Leyman, de Raedt, Schacht, & Koster, 2006; Leyman, de Raedt, & Koster, 2009) employed hostile faces as negative stimuli, they concluded that their depressed participants showed impaired attentional disengagement from these images. Similar conclusions were drawn by Rinck & Becker (2005), who employed anxiety-related verbal stimuli, and by Caseras, Gardner, Bradley, & Mogg (2007), whose negative stimuli included images of injured people, and individuals facing life threatening circumstances. In contrast, Kaporava, Kiesting, & Suslow (2005) employed negative stimuli related to sadness (sad faces), and concluded that the ability to disengage attention from such negative stimuli is not impaired in depression.
While we have found evidence that attenuated positive affectivity is associated with enhanced attentional disengagement from sadness-related information, the causal basis of this relationship presently remains indeterminate. It is possible that this attentional effect may causally contribute to the maintenance of low positive affect, because it reduces the effective emotional processing of sadness-related information. Teasdale (1999) argues that when effective emotional processing of negative information is prevented, the consequence is sustained rumination, which serves to perpetuate depression. Alternatively, however, it also is possible that increased attentional disengagement from sadness-related information may be a consequence of low positive affect, perhaps adopted for the purpose of mood repair. Emotion regulation researchers contend that undesirable emotional states can trigger patterns of selective information processing that favour more desirable emotional states (cf. Gross, 2008). Speeded attentional disengagement from sadness-related information may thus represent an emotion regulation response, elicited by attenuated levels of positive affect, and serving to facilitate the elevation of positive affect. The validity of these alternative accounts could be empirically discriminated by future research delivering appropriate variants of the attentional bias modification procedure previously employed by Hirsch et al. (2010), to selectively manipulate this pattern of selective attentional disengagement. If it causally contributes to low positive affectivity then reducing the bias should lead to increased levels of positive affectivity. In contrast, if the bias is a consequence of low positive affectivity, then reducing it will not elevate positive affectivity. Indeed, if this attentional bias serves a mood repair function, then reducing it would instead lead to further attenuation of positive affect.
Another important avenue for future research will be to delineate the precise attentional mechanisms that underpin the presently observed individual differences in attentional engagement with, and disengagement from, negative information. Our paradigm permits us to conclude that participants with elevated negative affectivity demonstrate enhanced attentional engagement with negative information, in the sense that they exhibit an attentional preference for such information when it appears outside initial attentional focus. However, it is not yet possible to determine whether this reflects their elevated probability of moving attention to the locus of such distal negative information before the probe appears (thereby inflating their likelihood of attending here at the point of probe onset), or instead reflects their capacity to move attention with greater speed to the locus of the negative information, when the position of the probe indicates this to be required. Similarly, our paradigm permits conclusions concerning impaired (and enhanced) attentional disengagement from negative information, in the sense that such information is more (or less) likely to continue receiving attention 500 ms after having initially been the focus of attention. Once again, such differential disengagement could result from a variety of mechanisms. It may reflect the probability of participants moving attention away from negative information prior to probe onset, or might instead reflect the speed with which attention could be moved from the locus of the negative information when a distal probe appeared. It also is possible that individual differences in inhibition of return (IOR; cf. Klein, 2000) might contribute to the observed individual differences in attentional disengagement from negative information. For example, perhaps participants high in negative affectivity show continuing attention to negative information, 500 ms after they initially have attended to it, because they exhibit reduced inhibition of return effects for initially attended negative information (Perez-Duenas,
Acosta, & Lupianez, 2009). By compromising their capacity to effectively sustain attentional disengagement from such negative information, such attenuated IOR would inflate the prospect of their subsequently displaying continued attention to it. Research employing eye-movement measures, to provide a more continuous record of attentional distribution during performance of this task, could shed valuable light on the contributions made by these various candidate mechanisms to the observed pattern of attentional effects (Buckner, Maner, & Schmidt, 2010).

Future research also could overcome a limitation of the current work, that prevents us from determining whether the presently observed attentional effects result from the selective processing of positive information, negative information, or both. Many previous attentional studies have contrasted only emotionally negative and neutral information, which has attracted the criticism that stimulus negativity has been confounded with stimulus emotionality (Rutherford, MacLeod, & Campbell, 2004). As noted by these critics, specific conclusions concerning selective attentional response to stimulus negativity requires contrasting equally emotional stimuli that differ only in terms of negativity. Our own design adopted this approach, thereby enabling us to draw conclusions concerning biased patterns of attention to negative information, relative to equally emotional positive information. However, such biases could, in principle, reflect selective attentional responding to positive material, rather than to negative material. Thus, for example, the relatively enhanced attentional engagement with negative words related to anxiety, which we observed in participants with elevated negative affectivity, could equally well be construed as relatively impaired attentional engagement with positive words related to relaxation. Similarly, the relatively enhanced attentional disengagement from negative words drawn from the sad-
happy domain, which we observed in participants with attenuated positive affectivity, could also be described as relatively impaired attentional disengagement from positive words drawn from this domain. Studies that directly contrast attentional responses to negative, positive & neutral stimuli, could address this issue. Such designs also would permit researchers to examine how stimulus emotionality, as well as stimulus negativity, impacts on the patterns of attentional selectivity associated with individual differences in these two dimensions of affectivity.

Future investigations of this type seem certain to further advance understanding of the variations in attentional selectivity associated with individual differences in both negative and positive affectivity. For the moment, however, we can conclude that heightened emotional vulnerability involving elevated negative affectivity has a quite different attentional signature from heightened emotional vulnerability involving attenuated positive affectivity. Elevated negative affectivity is marked by an increase in attentional preference for negative relative to positive information, especially when it is anxiety-related, and this bias reflects facilitated attentional engagement with, and impaired attentional disengagement from, such information. Attenuated positive affectivity instead is marked by reduced attentional preference for negative information relative to positive information, especially when it is depression-related, and this bias reflects only enhanced attentional disengagement from such information. Given the differing contributions made by negative and positive affectivity to anxiety and depression, anxious participants would be expected to consistently display the former pattern of attentional selectivity, while depressed participants would be expected to display a combination of both patterns of selectivity. The specific nature of this combination will depend upon the degree to which a given task assesses selective attentional
engagement or disengagement, and the degree to which emotional stimuli are related to anxiety or to depression. We suggest that this may help explain why the patterns of attentional selectivity associated with elevated depression have proven to be less consistent than has the pattern associated with elevated anxiety.
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Table 1. Participant characteristics (SDs in parentheses)

<table>
<thead>
<tr>
<th>Group</th>
<th>Measure</th>
<th>Emotional Vulnerability</th>
<th>Vulnerability Subtype</th>
<th>Trait Positive Affectivity Score</th>
<th>Trait Negative Affectivity Score</th>
<th>Age</th>
<th>Gender (% of Females)</th>
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<td>Trait Negative</td>
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<td>Emotional</td>
<td>Affectivity</td>
<td>(2.86)</td>
<td>(1.47)</td>
<td>(1.38)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vulnerability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discrepant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Emotional</td>
<td>Positive</td>
<td>39.00</td>
<td>19.1</td>
<td>18.35</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotional</td>
<td>Affectivity</td>
<td>(3.68)</td>
<td>(1.59)</td>
<td>(1.84)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vulnerability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discrepant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td></td>
<td>33.10</td>
<td>26.85</td>
<td>17.85</td>
<td>90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affectivity</td>
<td></td>
<td>(1.02)</td>
<td>(4.23)</td>
<td>(1.09)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Experimental stimulus words

<table>
<thead>
<tr>
<th>Anxious/Relaxed</th>
<th>Sad/Happy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative Word</td>
<td>Positive Word</td>
</tr>
<tr>
<td>intimidated</td>
<td>Brave</td>
</tr>
<tr>
<td>fretting</td>
<td>Ease</td>
</tr>
<tr>
<td>fearful</td>
<td>Relaxed</td>
</tr>
<tr>
<td>tense</td>
<td>composed</td>
</tr>
<tr>
<td>dangerous</td>
<td>Heroic</td>
</tr>
<tr>
<td>worried</td>
<td>confident</td>
</tr>
<tr>
<td>neurotic</td>
<td>Serene</td>
</tr>
<tr>
<td>agitation</td>
<td>Calm</td>
</tr>
<tr>
<td>frightened</td>
<td>Restful</td>
</tr>
<tr>
<td>nervous</td>
<td>Tranquil</td>
</tr>
<tr>
<td>suffocating</td>
<td>Assertive</td>
</tr>
<tr>
<td>attack</td>
<td>courageous</td>
</tr>
<tr>
<td>panicky</td>
<td>Peaceful</td>
</tr>
<tr>
<td>uneasy</td>
<td>Secure</td>
</tr>
<tr>
<td>restless</td>
<td>Safe</td>
</tr>
<tr>
<td>alarmed</td>
<td>Fearless</td>
</tr>
</tbody>
</table>
Table 3. PANAS state affect scores at test time (SDs in parentheses)

<table>
<thead>
<tr>
<th>Group</th>
<th>Measure</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional</td>
<td>Vulnerability</td>
<td>State Positive</td>
</tr>
<tr>
<td>Vulnerability</td>
<td>Subtype</td>
<td>Affect</td>
</tr>
<tr>
<td>Level</td>
<td>Score</td>
<td>Score</td>
</tr>
<tr>
<td></td>
<td>Discrepant</td>
<td>23.44</td>
</tr>
<tr>
<td>High</td>
<td>Positive</td>
<td>(5.15)</td>
</tr>
<tr>
<td>Emotional</td>
<td>Affectivity</td>
<td></td>
</tr>
<tr>
<td>Vulnerability</td>
<td>Discrepant</td>
<td>27.20</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>(6.86)</td>
</tr>
<tr>
<td>Low</td>
<td>Positive</td>
<td>(7.88)</td>
</tr>
<tr>
<td>Emotional</td>
<td>Affectivity</td>
<td></td>
</tr>
<tr>
<td>Vulnerability</td>
<td>Discrepant</td>
<td>30.85</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>(5.10)</td>
</tr>
<tr>
<td></td>
<td>Affectivity</td>
<td></td>
</tr>
</tbody>
</table>
Table 5. Attentional preference for negativity index under each experimental condition (SDs in parentheses)

<table>
<thead>
<tr>
<th>Emotional Vulnerability Level</th>
<th>Stimulus Domain</th>
<th>Attentional Bias Type</th>
<th>500 ms Exposure Duration</th>
<th>1000 ms Exposure Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Engagement Bias Index</td>
<td>Disengagement Bias Index</td>
</tr>
<tr>
<td>Anxious/Relaxed</td>
<td>Sad/Happy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discrepant Positive Affectivity</td>
<td></td>
<td></td>
<td>-58.10 (347.85)</td>
<td>-25.91 (315.05)</td>
</tr>
<tr>
<td>Discrepant Negative Affectivity</td>
<td></td>
<td></td>
<td>126.04 (503.33)</td>
<td>104.34 (459.13)</td>
</tr>
<tr>
<td>Discrepant Positive Affectivity</td>
<td></td>
<td></td>
<td>-103.51 (195.82)</td>
<td>-13.59 (401.74)</td>
</tr>
<tr>
<td>Discrepant Negative Affectivity</td>
<td></td>
<td></td>
<td>-129.87 (262.96)</td>
<td>-72.29 (248.72)</td>
</tr>
</tbody>
</table>

| Discrepant Positive Affectivity | 126.44 (230.24) | -62.28 (275.71) | -23.90 (213.59) | 11.88 (474.04) |
| Discrepant Negative Affectivity | 56.88 (380.14)  | -74.30 (248.70) | -92.49 (265.03) | -186.56 (699.07) |
| Discrepant Positive Affectivity | 33.48 (240.90)  | 3.80 (376.69)    | 17.23 (321.62)  | 74.26 (335.80)    |
| Discrepant Negative Affectivity | 100.46 (429.76) | -72.12 (252.28) | 78.71 (487.53)  | 193.33 (508.76)   |
Figure 1. Interaction between emotional vulnerability level x stimulus domain at 500 ms exposure duration for participants discrepant in negative affectivity.
Figure 2. Interaction between emotional vulnerability level x attentional bias type x stimulus domain at 500 ms exposure duration for participants discrepant in positive affectivity.
Footnote

1 Specifically, for each participant and in each condition, any RT falling more than 1.96 SD from that participant’s mean RT for that condition was classified as an outlier and excluded. This resulted in exclusion of 4.6% of latencies.

2 In this approach, SPSS defines as an extreme outlier any score that falls more than three times the magnitude of the interquartile range above, or below, the 75th and 25th percentile of the score distribution, respectively (Weinberg & Abramowitz, 2008).

3 We could instead have run two independent ANOVAs that separately contrasted participants high and low in each type of emotional vulnerability. However, this would have prevented us from statistically determining whether the patterns of attentional selectivity associated with the two types of emotional vulnerability differed significantly. Given that our hypothesis predicts differences between the attentional concomitants of these two types of emotional vulnerability, it can best be tested using the chosen ANOVA design, which statistically tests for these predicted differences.
**Supplementary Reporting and Discussion Section**

As noted, the dependent variable analysed in the published manuscript (attentional preference for negativity scores) did not distinguish selective attentional processing of positive information, from selective attentional processing of negative information. Doing so was not of relevance to the issues under consideration in the manuscript. But in terms of the issues addresses in the present thesis, it is of critical importance that these two types of attentional selectivity can be separated. As described in the Reporting Approach section that preceded the published manuscript, it is possible to compute indices of biased attentional engagement and attentional disengagement in a manner that distinguishes selectivity to positive information, from selectivity to negative information. This was the approach taken in this supplementary section. Specifically, rather than computing the dependent variable in a manner that expressed selective attention to negative information compared to selective attention positive information, the dependent variable was expressed in a manner that enabled the dissociation of these two types of selective attention (i.e. by computing the indices so they reflect emotional compared to neutral information). Computing the attentional bias scores this way give rise to a within-group factor of Attentional Bias Valence (negative attentional selectivity vs. positive attentional selectivity), and so enabled examination of whether the effects obtained in the present study were a consequence of selective attentional processing of positive information, negative information, or both.

The analysis below was performed to determine whether the effects reported in the manuscript for participants who differed in terms of their negative emotional disposal (i.e. differential attentional engagement and attentional disengagement), and for participants who differed in terms of their positive emotional disposal (differential attentional
disengagement), was a function of biased attentional responding to positive information, negative information, or both. Of course, the patterns of results obtained in the published manuscript would not be altered by the inclusion of this Attentional Bias Valence factor in the ANOVA analysis. That is, given the attentional bias indices reported in the manuscript represent the difference score that would be obtained by subtracting the attentional bias index scores computed separately for negative words, and for positive words, it follows that every effect obtained in the analysis would simply emerge as a high-order interaction involving Attentional Bias Valence. Thus, the overall 5-way interaction that was obtained in the original analysis now emerges as a 6-way interaction, reflecting the fact that this 5-way interaction was further modified by Attentional Bias Valence, $F(1, 75) = 5.19, p < 0.05, \eta^2 = 0.07$. But of most importance, by performing the analysis in this manner, it is possible to break down the component effects of this higher-order interaction to reveal whether the patterns of attentional selectivity found to characterise negative emotional disposition, and positive emotional disposition, were due to the selective attentional processing of positive information, negative information, or both. This higher-order interaction was broken down in the same manner as that reported in the published manuscript.

So, when this 6-way interaction was broken down by Exposure Duration, then the previous simple four-way interaction, significant under the 500 ms exposure condition, now emerged as a simple five-way interaction involving Attentional Bias Valence, $F(1, 75) = 5.47, p < 0.05, \eta^2 = 0.07$. Again, there was no significant simple four-way interaction under the 1000 ms exposure condition, $F(1, 75) = 1.03, ns, \eta^2 = 0.01$. In keeping with the published manuscript, the patterns of attentional selectivity, shown at this 500 ms exposure duration by participants selected because of their discrepant levels of negative emotional
disposition, was next considered. The previous simple two-way interaction of Stimulus Domain x Emotional Vulnerability Level for this subgroup of participants was further modified by Attentional Bias Valence, $F(1, 38) = 5.91, p < 0.05, \eta^2 = 0.14$. Breaking this three-way interaction by Stimulus Domain revealed a significant simple two-way interaction of Attentional Bias Valence x Emotional Vulnerability Level when the stimulus words fell within the Anxious/Relaxed domain, $F(1, 38) = 5.26, p < 0.05, \eta^2 = 0.12$, but not when the stimulus words fell within the Sad/Happy domain, $F(1, 38) = 1.14, ns, \eta^2 = 0.03$. The nature of this two-way interaction, observed on the anxious/relaxed materials alone, reflected the fact that, on the attentional bias to negative information scores, these High Emotional Vulnerability participants, characterised by high levels of negative emotional disposition, tended to show higher attentional preference for negative information ($M = 85.99, SD = 358.89$) than did their Low Emotional Vulnerability counterparts ($M = -52.25, SD = 164.53$). In contrast, on the attentional preference for positive information scores, these High Emotional Vulnerability participants showed the reverse pattern of effects, tending to show lower attentional preference for positive information ($M = -29.20, SD = 154.99$) than their Low Emotional Vulnerability counterparts ($M = 66.28, SD = 161.36$). In both cases, however, the simple main effect of Emotional Vulnerability Level fell short of statistical significance ($p = 0.10$ vs. $p = 0.13$).

Turning now to consider the pattern of attentional selectivity, shown at this 500 ms exposure duration by those participants selected because of their discrepant levels of positive emotional disposition. Of course, the previously reported simple three-way interaction of Attentional Bias Type x Stimulus Domain x Emotional Vulnerability Level now emerged as a four-way interaction involving Stimulus Domain, $F(1, 37) = 4.20, p < 0.05, \eta^2 = 0.10$. 
When broken down by Stimulus Domain, a simple three-way interaction of Attentional Bias Type x Attentional Bias Valence x Emotional Vulnerability Level was evident on Sad/Happy stimulus words, $F (1, 37) = 8.72, p < 0.01, \eta^2 = 0.19$, but not on Anxious/Relaxed stimulus words, $F < 1$. As with the analysis reported in the manuscript, on the engagement bias measure, the simple two-way interaction of the Attentional Bias Valence x Emotional Vulnerability Level did not reach significance, $F (1, 37) = 1.25, p = 0.27, \eta^2 = 0.03$. But, in direct contrast, on the disengagement bias measure there was a very strong trend towards a simple two-way interaction of Attentional Bias Valence x Emotional Vulnerability Level, $F (1, 37) = 4.04, p = 0.05, \eta^2 = 0.10$. This interaction reflected the fact that these High Emotional Vulnerability participants, characterised by low levels of positive emotional disposition, showed nominally lower attentional disengagement from negative information scores ($M = -38.28, SD = 249.25$) compared to their Low Emotional Vulnerability counterparts ($M = -17.04, SD = 362.06$), though this effect fell short of significance, $F (1, 37) = 1.69, p = 0.18, \eta^2 = 0.03$. In contrast, these same High Emotional Vulnerability participants showed higher attentional disengagement from positive information scores ($M = 125.71, SD = 342.57$) compared to their Low Emotional Vulnerability counterparts ($M = -114.07, SD = 330.16$), and this latter simple main effect of Emotional Vulnerability Level was statistically reliable, $F (1, 37) = 4.72, p < 0.05, \eta^2 = 0.19$.

The results obtained in this supplementary reporting section provide greater insight into the patterns of attentional selectivity that characterise variation in positive emotional disposition, and variation in negative emotional disposition, than was revealed by the analysis reported in the published manuscript. Specifically, the present analysis shows that the engagement bias and disengagement bias effects found to characterise high negative
emotional disposition reflect, to an equal degree, increased attentional selectivity for negative information, and decreased attentional selectivity for positive information. In contrast, the findings show that the disengagement bias effect found to characterise low positive emotional disposition reflected increased attentional selectivity only for positive information.

**General Discussion**

One of the aims of the present study was to determine whether the patterns of attentional selectivity that characterise positive emotional disposition, and negative emotional disposition, are the same or different. Indeed, by doing so, it was possible to shed light on the attentional substrates of anxiety and depression. These issues were addressed in detail in the published manuscript, but it will again be emphasised that the current findings suggest that the patterns of attentional selectivity that characterise these two types of emotional disposition are indeed quite different. Specifically, the former emotional disposition appears only to be characterised by biased attentional disengagement from positive information, and this effect is carried by positive stimuli related to the happy/depressed domain. In contrast, the latter emotional disposition appears to be characterised by both biased attentional engagement and attentional disengagement, and this effect is equally carried both by negative and positive information that is related to the relaxed/anxious domain.

The pattern of attentional selectivity displayed by participants who were discrepant in terms of their negative emotional disposition replicates and extends the findings previously reported by Grafton and MacLeod (in press), and Rudaizky et al. (2013), in two ways. First, like these previous studies, the current results show that variability in negative emotional disposition is characterised by selective attentional processing of negative information, but
unlike these studies, it shows that variability in such negative disposition appears also to be characterised by selective attentional processing of positive information. Given this pattern of results, it is suggested that future researchers investigating engagement bias, and disengagement bias, in individuals who differ in terms of their negative emotional disposition, would profit from the inclusion of both types of emotional information in the assessment of such attentional selectivity. It is worth pausing, however, to reflect on this pattern of effects, in particular, the finding that high negative emotional disposition appears to be characterised by selective attentional processing of positive information. In Study 4, it was found that the modification of positive attentional selectivity did not impact on negative emotional reactivity to a negative event. Hence, it was concluded that such positive attentional selectivity does causally contribute to negative emotional disposition. So, when this Study 4 finding is considered in terms of the current results, it suggests that the nature of the observed association between high negative emotional disposition, and attentional avoidance of positive information, is not causal (at least in the sense that the latter does not causally influence the former). But it will still be important for future researchers to directly test this issue in order to confirm whether this is indeed the case.

The second way in which the present results extends those obtained in previous studies investigating the association between engagement and disengagement bias and variation in negative emotional disposition, is that they show that this pattern of attentional selectivity is restricted to information related to anxiety. Researchers investigating the patterns of attentional selectivity that characterise emotional vulnerability do not often take into account whether the stimulus material used is related more or less to anxiety, depression, or indeed any other type of negative emotion. But, given the present findings, by making this
distinction in future research it may be the case that investigators can increase their capacity
to detect the patterns of attentional selectivity of interest, while also refining theoretical
understanding of the patterns of attentional bias that characterise negative emotion.

The present findings do not, however, serve to fully resolve the main aim this study
was designed to address. Specifically, this aim was to determine whether the attentional bias
to positive information shown to characterise variation in positive emotional disposition in
the earlier research phases, reflects increased attentional engagement with, or reduced
attentional disengagement from, positive information. The current evidence shows that the
high positive emotional disposition participants displayed relatively facilitated attentional
disengagement from positive information (i.e. attentional avoidance of positive information).
This of course is inconsistent with the results of the earlier studies whereby it was found that
high levels of positive emotional disposition were characterised by an attentional preference
for positive information. Thus, it may be tempting to conclude that the pattern of attentional
selectivity observed in these earlier studies must reflect increased attentional engagement
with positive information (i.e. attentional preference for positive information). Post-hoc
inspection of the engagement bias with positive information index scores showed that the
high positive emotional disposition participants displayed nominally higher selective
attentional engagement with positive information scores (M = -36.43, SD = 104.10)
compared to the low positive emotional disposition participants (M = -40.23, SD = 306.04).
But this effect did not reach statistical significance (F < 1). Hence, it will be important for
future researchers to confirm whether high positive emotional disposition really is
characterised by increased attentional engagement with positive information, for example, by
employing attentional assessment tasks of the type used in the present study, but which have
greater power to detect the attentional effects of interest. Indeed, a number of additional experimental manipulations were introduced into the current attentional assessment task, which may have reduced its capacity to statistically reveal the patterns of engagement and disengagement bias that are characteristic of positive emotional disposition. Thus, given that evidence for discrepant patterns of engagement and disengagement bias, in participants who differed in terms of their positive emotional disposition, appears to be restricted to 500 ms exposure durations, and stimulus material that is depression relevant, future assessment tasks may benefit from the use of more refined experimental designs that employ only this short exposure duration, and only depressogenic stimuli.

It is important to consider why the current high positive emotional disposition participants showed attentional avoidance of positive information (on the disengagement measure), as this pattern of attentional selectivity was not observed when high and low positive emotional disposition participants were assessed on the conventional attentional probe task. A candidate explanation is that the conventional probe task is differentially sensitive to the assessment of engagement and disengagement bias. Specifically, when the conventional probe task is considered in terms of the key methodological criteria that must be met to assess these two facets of attentional selectivity, it could be argued that it may plausibly be more sensitive to the detection of selective attentional engagement with a particular type of emotional information. On each trial of the conventional probe task, the participant is required to initially focus their attention on a central fixation cue. If the participant follows this instruction, then they would always begin a trial with their attention in a location that is initially distal to emotional information (which is what is required to assess engagement bias). Hence, the patterns of attentional selectivity revealed by this
approach may reflect biased attentional engagement, more than biased attentional disengagement. Thus, if the conventional probe task really were more sensitive to the assessment of engagement bias, then it would not be expected that the attentional avoidance of positive information, currently displayed by the high positive emotional disposition participants on the measure of attentional disengagement, would be obtained. It would be possible for future researchers to determine whether the conventional probe task is differentially sensitive to the assessment of attentional engagement with, and attentional disengagement from, a particular type of emotional information, by exposing participants to the conventional probe task, and to the current attentional assessment task. It would then be possible to assess whether the index of attentional bias obtained in the former task correlates more strongly with the index of attentional engagement, or the index of attentional disengagement, obtained in the latter task.

In the present study, the finding that positive emotional disposition-linked attentional selectivity was only evident on stimulus material related to depression, whereas the negative emotional disposition-linked attentional was only evident on stimulus material related to anxiety, raises an interesting possibility concerning the pattern of results obtained in Study 4. While this distinction between anxious/depressed material was not made in Study 4 (nor in any other of the earlier studies), it may be the case that the impact of the attentional training manipulation on positive mood state was carried by a change in attentional response to positive information related to depressive material, whereas the impact of the attentional training manipulation on negative mood state was carried by a change in attentional response to positive information related to anxious material. If this were the case, then the conclusion drawn in this study, that an attentional bias to positive information makes a causal
contribution to positive mood state, and negative mood state, to a positive event, would need
to be refined to instead reflect attentional responses to more specific types of positive
stimulus material. It would be possible to test whether attentional responses to different types
of positive material exert a differential impact of positive and negative mood state by
employing an attentional training procedure that either uses only the former type of positive
material, or only the latter type of positive material, within the attentional training trials, in
order to determine the subsequent impact of such attentional manipulation on positive and
negative mood reactivity to a positive experience. Of course, if such attentional procedures
were to be employed in real-world settings, then it may be best just to include both types of
positive material in the training procedure, to maximise its impact of positive emotional
disposition.

It is perhaps worth pausing to reflect on the manner in which positive emotional
disposition was assessed in studies reported in the second research phase, and in the present
study. In the former studies, positive emotional disposition was indexed by assessing positive
emotional reactivity to a positive event. It was shown, however, that such emotional
reactivity reflected an increase in positive mood state, and a decrease in negative mood state,
to a positive event. This is contrast to present study, whereby positive emotional disposition
was indexed using the Positive Affectivity Scale (PAS) of the Positive and Negative
Affectivity Schedule (PANAS). In this latter case, the PAS is considered to reflect individual
differences in the tendency for positive events to elevate (specifically) positive mood state.
Thus, it may not necessarily be the case that positive emotional disposition is being assessed
in the same manner across these studies. It would be possible to investigate this issue in
future research, for example, by exposing a large group of participants to the same anagram
success task employed in Study 4, using the same analogue mood grid to assess positive and negative mood state, and then basing recruitment of high and low positive emotional disposition participants on the mood data obtained from this exercise. These participants could then complete the same attentional assessment task as the present study, to determine whether the patterns of findings were the same or different from those reported when participant recruitment was based on the PAS. If the results were the same, then this would provide support for the idea that positive emotional disposition is indeed being assessed in the same manner across the studies reported in this thesis.

For the moment, however, the present results suggest that the patterns of attentional selectivity that characterise variation in positive emotional disposition, and variation in negative emotional disposition, are quite different. Variation in the former emotional disposition is characterised by biased attentional disengagement from positive information, but only for stimuli related to the happy/depressed domain. In contrast, variation in the latter emotional disposition is characterised by both biased attentional engagement and attentional disengagement, and this effect appears to be equally carried by negative information and positive information, which is specifically related to the relaxed/anxious domain. The pattern of effects revealed for participants discrepant in terms of their positive emotional disposition suggest that the positive emotional disposition-linked attentional bias observed in previous studies most likely reflects increased attentional engagement with positive information, however, such a claim must be made with caution, and it will be important for researchers to confirm this pattern of findings in future studies. Nevertheless, this study represents an important first step towards addressing this issue, and it is hoped that the attentional
assessment procedure developed in the present research will be useful for investigators examining such issues in years to come.
Chapter 10

Conclusions and Future Directions

In this final chapter of the thesis, the conclusions drawn in each phase of the research program will first be described, before potential avenues for future research are considered. This chapter will then end with a brief discussion of other lines of investigation that, while not directly related to the issues addressed in the present research, could nevertheless serve to further understanding of individual differences in positive emotional disposition.

Research Phase 1 – Conclusions and Future Directions

The hypothesis under test in the first phase of the research program was that an attentional bias to positive information is characteristic of high levels of positive emotional disposition. Using a conventional attentional probe task, the findings obtained in Study 1 demonstrated that participants who reported high levels of positive emotional disposition displayed higher attentional bias to positive information scores compared to participants who reported low levels of such positive emotional disposition. Hence, this pattern of effects is consistent with the hypothesis that high positive emotional disposition is characterised by an inflated tendency to preferentially allocate attention to positive information. Of course, this study was not without its limitations. Hence, in the following section, two categories of future research direction will be considered in turn. The first concerns the potential value in seeking to obtain converging support for the present findings by using a wider array of attentional assessment techniques. The second concerns the importance of future research to address the limitations of the reported study, in order to more fully delineate the nature of observed positive emotional disposition-linked attentional bias to positive information.
Obtaining Converging Evidence for a Positive Emotional Disposition-Linked Attentional Bias to Positive Information

A common feature of the experimental tasks employed to assess attentional selectivity in the present research, and indeed in many of the experimental tasks used more generally in research investigating the association between attentional selectivity and emotional disposition, is that the measure of such selectivity is based on reaction time (RT) data. As clearly shown by the findings reported in the current research program, reaction time based paradigms clearly can be usefully employed to distinguish the patterns of selective attention that characterise individuals who differ in terms of their positive emotional disposition. Of course, all assessment measures (and RT measures of attention are no exception) will have some strengths and limitations concerning their capacity to index the cognitive process of interest. However, by employing a wide range of different assessment techniques, it may be possible for researchers to obtain converging support for a particular conclusion, in manner that enables greater confidence in that conclusion. Thus, two candidate approaches that could serve to provide such converging support for the findings obtained in the first research phase will now be discussed.

An often cited limitation of RT based measures of attention is that they provide only a snap-shot of attentional focus at a specific point in time (c.f. Armstrong & Olatunji, 2012). One approach that can overcome this limitation involves the use of eye-movement technology (Buckner, Maner, & Schmidt, 2010). Eye-movement procedures involve the tracking, and recording, of a participant’s eye-gaze direction while they are viewing a visual display (c.f. Findlay & Gilchrist, 2003). It has been shown that the direction of eye-gaze is reliably associated with the focus of attention (c.f. Rayner, 1998), but it is important to note
that there is evidence to demonstrate that attentional shifts can occur in the absence of eye-movements, and that eye movements can occur while the focus of attention remains constant (c.f. Klein, 2004). Hence, like any measure, there are limitations of eye-movement procedures that must also be taken into consideration when interpreting the results of studies using these measures. Nevertheless, eye-movement procedures may represent a potentially valuable approach for assessing the patterns of attentional selectivity that characterise individual differences in positive emotional disposition, which could usefully serve to augment the more commonly used RT based attentional assessment tasks. Indeed, a particular advantage of eye-movement procedures is their capacity to provide a very high temporal resolution, which enables the moment by moment assessment of shifts in a participant’s eye-gaze (Henderson, 2003). A number of potentially valuable indices of attentional processing can be computed, including indices based on initial orienting responses to stimuli following their onset, shifts in eye-gaze during the window in which stimulus material is displayed on the screen, and proportion of each trial that a participant’s eye-gaze is focused on one category of stimuli compared to another (Rayner, 1998).

Eye-movement procedures are becoming more widely used in the assessment of attentional bias in negative emotional disposition, and have provided converging support for the hypothesis that such negative disposition is characterised by an attentional bias to negative information (Cisler & Koster, 2010). For example, Armstrong, Olatunji, Sarawgi, Simmons (2010) exposed participants who were high and low in contamination fear to stimulus pairs that comprised one emotional face image (disgust, fearful) and one neutral face image, during a free viewing procedure. It was found that the high contamination fearful participants, relative to the low contamination fearful participants, fixated their eyes for
longer periods on the fearful and disgust expressions compared to the neutral expressions, consistent with the hypothesis that such negative emotion is characterised by an attentional bias to negative information. Similar patterns of results have also been obtained in other types of anxiety, including social anxiety (e.g. Chen, Clarke, MacLeod, & Guastella, 2012), post-traumatic stress disorder (Felmingham, Rennie, Manor, & Bryant, 2011), and have also been found in depression (Siegle, Granholm, Ingram, & Matt, 2001). Hence, these results suggest that eye-movement procedures can indeed be employed to augment the more commonly used RT based measures of attentional bias, and highlight their potential value in the assessment of attentional selectivity in positive emotional disposition. So, for example, future researchers could employ a free viewing procedure similar to that used by Armstrong et al. but use stimulus pairs that comprise one positive emotional face image (e.g. happy) and one neutral face image. It would then be possible to determine whether high positive emotional disposition participants, relative to their low positive emotional disposition counterparts, show relatively longer eye-gaze fixations on the positive emotional faces. Such evidence would provide converging support for the conclusion that high positive emotional disposition is characterised by an attentional preference of positive information.

A rather different experimental technique that could serve to provide converging support for the conclusion that high positive emotional disposition is characterised by an attentional bias to positive information, relies on electroencephalography (EEG) recordings. In the 1960s, it was found that a visual stimulus that is repeatedly presented at a fixed rate of 5 – 6 Hz or greater (e.g. a flickering light), elicits a response in electro-cortical activity at the same fundamental frequency as the modulated stimulus (Regan, 1966), a phenomenon that has since become known as a steady-state visual evoked potential (ssVEP). Of importance, a
number of studies have shown that the amplitude of the ssVEP is significantly increased when attentional focus is directed towards the flickering stimulus (e.g. Muller, Picton, Valdes-Sosa, Riera, Teder-Salejarvi, & Hillyard, 1998; Muller & Hubner, 2002). Such findings suggest that ssVEPs could be used to assess the deployment of selective attention to emotional information.

Wieser, McTeague, and Keil (2011) recruited participants who were high or low in social anxiety, and exposed them to a procedure similar to the attentional probe task, which was designed to enable the assessment of ssVEPs. On each trial, a fixation cue was presented in the centre of the screen, along with a pair of differentially valenced stimuli, for 3000 ms. One member of the stimulus pair flickered at frequency of 14 Hz, while the other member flickered at a frequency of 17.5 Hz. Participants were instructed to maintain their eye-gaze on the central fixation for the duration of the trial, and to avoid any eye-movements. Using a technique called frequency tagging, the investigators were able to obtain a measure of attentional bias to negative information. In frequency tagging, the electro-cortical signature of the two stimuli, which flicker at different rates, are statistically separated. Hence, if one member of the stimulus pair is preferentially attended to (i.e. the negative stimulus), then the magnitude of the associated ssVEP will be greater compared to the unattended stimulus (i.e. the neutral stimulus). In their high socially anxious participants, Weiser et al. found that the magnitude of the ssVEP evoked by negative information was greater than that evoked by neutral information. In contrast, the low socially anxious participants did not show any evidence of this effect. Thus, the findings are consistent with the hypothesis that the former participants are characterised by an attentional bias to negative information.
The results of Weiser et al. suggest that ssVEPs should also be sensitive to the detection of attentional bias to positive information, in participants who differ in terms of their positive emotional disposition. So, for example, using the same word pairs as in Study 1, future researchers could present the two members of the each word pair at a different hertz rate. Converging support for the finding that elevated positive emotional disposition is characterised by an attentional preference for positive information would be revealed by disproportionately large ssVEPs for positive words compared to neutral words, in high positive emotional disposition individuals, but not in low positive emotional disposition individuals.

Of course, whether the two types of approaches just described prove capable of distinguishing attentional selectivity in participants high and low in positive emotional disposition, awaits the results of future investigation. But it is likely that such research will be of much interest to investigators, especially in terms of its capacity to provide converging support for the conclusion that positive emotional disposition is characterised by an attentional bias to positive information, and also may provide further important insights into the attentional basis of positive emotional disposition.

**Distinguishing Automatic vs. Strategic Selective Attentional Processing in Positive Emotional Disposition**

In Study 1 it was shown that high positive emotional disposition is characterised by an attentional bias to positive information. A limitation of this study, however, was that it was not possible to determine whether this bias was automatic or strategic in nature. It would be of particular importance to address this issue, not only because it would serve to advance
theoretical understanding of the patterns of attentional selectivity that characterise positive emotional disposition, but because it may have significant applied implications. If, for example, the attentional selectivity that characterises high positive emotional disposition is strategic rather than automatic in nature, then the types of attentional training manipulations that may be most effective in changing such selectivity may need to involve the use of explicit instruction and practice.

The distinction between automatic vs. strategic processing (Shiffrin & Schneider, 1977) has been of considerable interest to researchers investigating the attentional basis of negative emotional disposition. A number of studies have now demonstrated that this bias operates quite rapidly, prior to participants becoming consciously aware of the emotional content of stimuli (c.f. McNally, 1995). In order to examine automatic vs. strategic attentional processing in negative emotional disposition, researchers often have employed backward pattern masking procedures to prevent the awareness of stimulus content (c.f. Turvey, 1973). It is assumed that, if the attentional bias that characterises high negative emotional disposition is automatic in nature, then restriction of the awareness of stimulus content should not eliminate the expression of this bias. Backward pattern masking procedures can involve, for example, the presentation of word pair stimuli for very brief durations (30 ms or less), before these stimuli are replaced with random letter strings. It has been shown that, while such masking procedures can prevent the content of stimuli from reaching conscious awareness, processing of the masked stimuli can still occur (c.f. Van den Bussche, Van den Noortgate, Reynvoet, 2009). Using such backward masking procedures, many studies have demonstrated that participants who report high levels of negative emotional disposition display attentional bias to negative information, even when conscious
awareness of stimulus content is eliminated (e.g. MacLeod & Rutherford, 1992; Mogg, Bradley, Williams, & Mathews, 1993). These findings are fully consistent with the possibility that such attentional selectivity is automatic, rather than strategic, in nature.

As noted, the results of the present research cannot shed light on the issue of whether the attentional bias to positive information that is characteristic of elevated positive emotional disposition is automatic or strategic in nature. But by drawing on the experimental approaches, such as, backward masking, it would be possible to determine whether the attentional bias that characterises high positive emotional disposition, like negative emotional disposition, involves more automatic processes, or whether it involves more strategic processes. So, for example, it would be possible to expose participants high and low in positive emotional disposition to the same attentional probe task as used in Study 1. On some trials, the word pair stimuli could be presented for 500 ms, but on other trials the members of the word pair could be replaced by random letter strings 30 ms after stimulus onset. If the attentional bias that characterises high positive emotional disposition is automatic in nature, then it would be expected that the high positive emotional disposition participants would show a relatively greater attentional preference for positive information on the trials on which the word pairs were presented for the full 500 ms exposure duration, and also on the trials on which the word pairs were presented for only 30 ms of the 500 ms trial duration. Work of this type would serve to further illuminate the nature of the attentional substrate of positive emotional disposition, and as already mentioned, would carry both significant theoretical and applied implications.
Distinguishing Whether Attentional Bias to Positive Information is a Direct Characteristic of State vs. Trait Positive Emotion

Study 1 was designed to investigate whether an attentional bias to positive information is a characteristic of the disposition to experience high levels of positive emotional, and the findings of this study were consistent with this hypothesis. Some investigators have suggested, however, that this same pattern of attentional selectivity is a direct characteristic of state, rather than trait, positive emotion (e.g. Goetz, Goetz, & Robinson, 2007). In Study 1, it can reasonably be expected that participants high in positive emotional disposition would have differed from participants low in positive emotional disposition, in terms of the degree to which they experienced high positive mood state within the experimental session. Hence, it is possible that the attentional bias to positive information exhibited by the former participants may have reflected the influence of high levels of state, rather than trait, positive emotion. Thus, it will be important for future researchers to determine whether this bias reflects the direct influence of high positive emotional disposition (as claimed in the present research), or whether it reflects the influence of high levels of state positive emotion. In doing so, such work will serve to distinguish the alternative hypothetical accounts proposed by researchers, for example, Goetz et al., who claim that such selectivity is a direct characteristic of high state positive emotion, and others, for example, Wadlinger and Isaacowitz (2010), who claim that such selectivity is a direct characteristic of high trait positive emotion.

This same issue has previously been the focus of considerable interest in research examining the patterns of attentional selectivity that characterise high negative emotional disposition. It has been pointed out that, when comparing participants who differ in terms of
their negative emotional disposition, it can be expected that these participants will also exhibit related differences in terms of their state negative emotion (Mathews & MacLeod, 2005). Thus, to determine whether the patterns of attentional bias that characterise high negative emotional disposition reflect the direct influence of state negative emotion, or trait negative emotion, MacLeod & Mathews (1988) recruited high and low trait anxious undergraduate psychology students, and measured their attentional bias to negative information 12 weeks before a major exam (when state anxiety was relatively low), and again one week before this exam (when state anxiety was relatively high). It was found that the high trait anxious participants displayed a relatively greater attentional bias to negative information on both assessment occasions, suggesting that this pattern of attentional selectivity is a direct characteristic of trait negative emotion, and is not a direct characteristic of state negative emotion.

The approach adopted by MacLeod and Mathews could be exploited to determine whether the attentional preference for positive information, shown to characterise participants high in positive emotional disposition in Study 1, reflects the direct influence of trait positive emotion, or whether it reflects the direct influence of state positive emotion. So, for example, attentional bias to positive information could be measured a number of weeks before students are to attend their university graduation ceremony, and then again in the week before this ceremony. If the pattern of attention selectivity observed in Study 1 really is a direct characteristic of positive emotional disposition, then it would be expected that participants who report high levels of positive emotional disposition would display higher attentional bias scores on both assessment occasions compared to their low positive emotional disposition counterparts.
As noted, the study reported in the first research phase was limited, in that a number of interesting issues, each of which would be worthy of investigation, could not be addressed. But, importantly, this first study was able to establish that high positive emotional disposition is characterised by an attentional bias to positive information, and so it sets the scene for future researchers to more fully examine this positive emotional disposition-linked attentional bias.

**Research Phase 2 – Conclusions and Future Directions**

The hypothesis under test in the second phase of the research program was that an attentional bias to positive information makes a causal contribution to positive emotional disposition. In order to test this hypothesis, an attentional training task, designed to systematically manipulate attentional response to positive information, was used to determine whether the transient modification of positive attentional selectivity served to differentially alter positive mood reactivity to a positive experience. In Study 2, however, it was found that the attentional training task did not serve to differentially modify attentional response to positive information. It was reasoned that this may have been because the discrepancy between the emotional tones of the word pair members was not sufficiently apparent to participants, and so they were unable to apprehend and exploit the training contingency. In Study 3, emotional judgement trials were introduced into the attentional training procedure, in an effort to encourage participants to encode the differential emotional tone of the word pair members. The findings of this study showed that the training task was successful in modifying attentional response to positive information, and importantly, that such modification served to differentially modify the degree to which a subsequent positive experience then elevated positive mood, consistent with the hypothesis that such attentional
selectivity causally contributes to positive emotional disposition. But the capacity of the reported findings to strongly support this hypothesis was compromised by the study’s restricted focus in the measurement of attentional selectivity, mood change, and the valence of event participants were exposed to. As a consequence of this restricted focus, it was recognised that it was not possible to exclude a number of alternative accounts that could equally well have accommodated the observed effects. Indeed, the nature of these possibilities meant that the results obtained, in principle, may not support the hypothesis that an attentional bias to positive information functionally contributes to positive emotional disposition. Thus, the purpose of Study 4 was to confirm whether positive attentional selectivity really does causally underpin positive emotional disposition. The findings of Study 4 showed that the attentional training task modified only selective attentional response to positive information, and that this subsequently influenced only positive emotional reactions to positive events, and not negative emotional reactions to negative events. Thus, the observed effects confirm the conclusion drawn in Study 3, that an attentional bias to positive information makes a causal contribution to positive emotional disposition. In the following section, a number of limitations of the present work will be discussed. These include the strength of conclusions drawn, the capacity of the reported studies to shed light on the mechanisms underpinning attentional change, and the potential applied benefits of such attentional training. The types of future research that could serve to overcome these limitations will be considered in turn.
More Rigorously Testing the Conclusion That an Attentional Bias to Positive Information Causally Contributes to Positive Emotional Disposition

In their review of the research that has investigated whether an attentional bias to negative information makes a causal contribution to negative emotional disposition, MacLeod, Koster, and Fox (2009) noted it is possible that an attentional training procedure may serve to independently influence change in attentional selectivity, and change in emotional reactivity. Hence, the hypothesis that an attentional bias to positive information functionally contributes to individual differences in positive emotional disposition could be more rigorously tested by determining whether the change in attentional bias produced by the training manipulation mediates the change in positive emotional disposition, as the hypothesis under test would predict that change in positive emotional disposition should be mediated by change in attentional selectivity to positive information.

There are two ingredients necessary to conduct this type of mediation analysis. First, it is necessary to employ an experimental design in which attentional selectivity, and positive emotional reactivity, are both assessed before and after completion of the training manipulation, as only this design enables computation of change scores in attentional selectivity, and in positive emotional reactivity, required to execute the analysis. Second, it is necessary to recruit a sample of sufficient size, if the analysis is to have adequate power to reveal evidence of mediation. As noted by MacLeod et al. (2009), a formal requirement when conducting mediation analyses is that the mediator variable must be assessed with almost no measurement error. Unfortunately, measures of attentional selectivity have not undergone the types of psychometric refinement required to ensure that measurement error is minimised. Consequently, if the power to detect the mediator effect were to be held at the conventional
.8, then given that measurement error is present, the sample sizes required to appropriately run mediation analyses in attentional bias modification studies would range from 400 - 20000, depending on the assumed effect size of the mediator (Fritz & Mackinnon, 2010).

In Study 3, the experimental design does enable the computation of the necessary change scores in attentional selectivity and positive emotional reactivity, but given the relatively small sample size, it was not viable to conduct a formal mediation analysis to investigate whether the impact of the training manipulation on positive emotional disposition was mediated by its impact on attentional response to positive information. While a larger sample was recruited in Study 4, the experimental design did not enable computation of change scores in positive emotional reactivity, as the impact of the attentional training task on such reactivity was revealed only by an assessment conducted after training. Hence, it was simply not possible to perform a formal mediation analysis. Thus, it is suggested that future researchers employ both larger samples, and experimental designs that enable the computation of both types of change scores, to determine whether the emotional impact of attentional training procedures is mediated by its attentional impact, as doing so will enable them to more rigorously address the hypothesis that positive attentional bias causally contributes to positive emotional disposition.

Some researchers have suggested that attentional modification procedures may result in general improvements in the ability to exert volitional control over attentional deployment (e.g. Klumpp and Amir, 2010). If this is correct, then it would carry the implication that the influence of the attentional manipulation on positive emotional disposition may have resulted from improvements in attentional control, rather than from changes in attentional bias, hence potentially undermining the present conclusion that an attentional bias to positive
information causally contributes to positive emotional disposition. Thus, future research could seek to more rigorously test the hypothesis that an attentional bias to positive information causally underpins positive emotional disposition, by measuring other candidate cognitive process that may be influenced by attentional training tasks, and so might themselves be responsible for the observed emotional impacts of attentional training.

In the attention training tasks employed in the present research, participants were exposed to a training contingency designed either to increase, or to reduce, attentional preference for positive information. The results obtained showed that these attentional training procedures differentially influenced attentional response to positive information, and that such change in attentional selectivity was accompanied by differential positive emotional reactivity to a positive event. Therefore, the conclusion that the influence of the attentional training manipulation on positive emotional reactivity reflected general improvements in attentional control, rather than attentional selectivity, would require the assumption the two training conditions exerted a differential impact on such attentional control. Hence, the most parsimonious account, at present, is that the influence of training procedure on positive emotional disposition was indeed due to changes in attentional bias. But it will nevertheless be useful for researchers to directly assess attentional control following completion of attentional training, as this will enable them to more rigorously test the hypothesis that an attentional bias to positive information causally contributes to positive emotional disposition. Specifically, by examining whether attentional training can modify attentional control, it would be possible to determine whether change in such attentional control mediates the impact of the attentional manipulation on positive emotional disposition. If attentional control does not mediate the change in positive emotional disposition, then this would lend
further support to the hypothesis that an attentional preference for positive information functionally contributes to positive emotional disposition.

**Illuminating the Mechanisms That Underpin Change in Attentional Bias to Positive Information**

It will also be important for future researchers to investigate the mechanisms that bring about change in attentional selectivity. Such work would have valuable theoretical implications, and also potentially important applied benefits. For example, it may be the case that greater attentional change produces a greater change in positive emotional disposition. Thus, by understanding the mechanisms that produce such attentional change, it may be possible to refine attentional training procedures in ways that can enable researchers to maximise their potential applied benefits. One way in which researchers have attempted to illuminate the mechanisms that may underpin change in attentional selectivity has been to investigate whether attentional training procedures modify selective attention through implicit or explicit learning processes (MacLeod & Mathews, 2012). A number of investigators in the anxiety field have found that participants are often unable to report the training contingency, consistent with the notion that implicit learning drives the impact of the training manipulation on attentional selectivity. However, on some occasions, researchers have found the influence of attentional modification has been strongest in participants who have identified, and so can accurately report, the training contingency (e.g. Field et al, 2007), consistent with the idea that explicit learning processes underpin the influence of the attentional manipulation on attentional bias.
One way of directly testing whether attentional training procedures modify attention through implicit or explicit learning would involve informing participants of the attentional training contingency, and instructing them to adopt the pattern of attentional processing it is designed to encourage. Across two supplementary studies conducted during the course of the author’s PhD candidature, Grafton, Mackintosh, Vujic, and MacLeod (2013) did just this. In the first study, Grafton et al. exposed participants to an attentional training contingency designed either to encourage attentional avoidance of negative information, or to encourage attentional vigilance for negative information. Participants received conventional instructions for the training procedure, which did not involve altering them to the presence of the training contingency, nor any instruction to actively practice the pattern of attentional selectivity this contingency was designed to foster. Consistent with the results of previous research, Grafton et al. found the training manipulation served to differentially alter attentional response to negative information, and that such attentional modification exerted a differential impact on negative emotional reactivity to a subsequent negative event.

In the second study, Grafton et al. exposed participants to exactly the same attentional training procedure as used in their first study, but now delivered different instructions to participants. Specifically, participants were explicitly informed of the training contingency, and directed to practice the pattern of attentional selectivity this training contingency was designed to induce. The results showed that the attentional manipulation was still effective in modifying attentional response to negative information. In fact, the magnitude of the attentional bias effect size obtained in this latter study was more than twice as great as the attentional bias effect size obtained in the former study. But despite the attentional training having exerted a more robust impact on attentional selectivity, the change in such selectivity
was, however, no longer accompanied by any corresponding change in negative emotional reactivity to a subsequent negative event. Taken together, these findings suggest that the impact of the attentional training procedure on emotional disposition is carried by implicit processes, rather than explicit processes. The findings also demonstrate that procedures which may bring about greater attentional change will not always be accompanied by greater symptom change, and so it will be important for future researchers to clearly delineate the circumstances under which greater attentional change can exert a more powerful impact on emotion.

Of course, it remains to be seen whether explicitly informing participants of the current attentional training contingency, and directing them to practice the pattern of attentional selectivity it is designed to encourage, has a similar impact on attentional response to positive information, and on positive emotional reactivity to a positive event. But it will be important for future investigators to carry out such work, as this would likely further understanding of the positive emotional disposition-linked attentional bias, and may help to improve the capacity of attentional bias modification procedures to deliver real-world benefits.

**Investigating the Potential Applied Benefits of Attentional Bias Modification Procedures**

**Targeting Attentional Bias to Positive Information**

As has just been highlighted, the results obtained in the second phase of the research program suggest that it is now time to investigate whether attentional training tasks, designed to modify attentional bias to positive information, are capable of delivering real-world benefits. Of course, it was not possible to draw any conclusions concerning the potential real-
world benefits of the attentional training procedures employed in the present research program, as these were all delivered to participants in the laboratory setting. Nevertheless, there are two ways in which such research could proceed. First, the types of attentional training developed in the current thesis could be delivered to emotionally healthy individuals, in an effort to determine whether such adaptive emotional functioning can be further bolstered. As noted, there are a great number of beneficial outcomes are associated with high levels of positive emotional disposition including financial independence, occupational attainment, work autonomy, improved physical health and longevity, and better quality relationships (c.f. Lyubomirsky, Kind, & Diener, 2005). Hence, by delivering the types of attentional training procedures used in the present research, it may be possible for more people to achieve the types of benefits that accompany positive emotional experience. Indeed, there appears to be much interest in this type of intervention, but at present there are relatively few empirically validated techniques for improving positive emotional disposition (Wood & Tarrier, 2010). One concern has been that interventions designed to promote positive functioning may not be economically viable, but given that attentional bias modification procedures could likely be delivered to a large number of people, at a relatively low cost (e.g. over the Internet), they may represent a particularly powerful approach for further enhancing positive emotion in emotionally healthy individuals.

A second way in which researchers could seek to determine the applied benefits of attentional training tasks, designed to modify positive attentional selectivity, would be to deliver them to patients suffering with clinical levels of emotional dysfunction. Indeed, such training procedures may be particularly helpful in the treatment of depression, social anxiety, and schizophrenia, as these disorders are known to be characterised by a pronounced deficit
in positive emotion (Watson and Naragon-Gainey, 2009). Over the last 5 years or so, there has been a rapid growth in the number of studies investigating the potential clinical benefits of attentional training procedures, designed to modify attentional bias to negative information, and the results of such work has shown that these procedures can significantly attenuate the symptoms of clinical psychopathology (MacLeod & Mathews, 2012). For example, Amir, Beard, Taylor, Klumpp, Elias, Burns and Chen (2009) delivered a probe-based attentional training procedure to patients diagnosed with social anxiety disorder. Participants were either exposed to a training condition designed to reduce attention preference for negative information, or to a control condition containing no attentional training contingency, twice weekly for a period of one month. Only those patients who received the avoid negative training displayed a significant reduction in anxiety symptoms across this period, and clinical improvement was fully maintained after four months. A similar pattern of findings was reported by Schmidt, Richey, Buckner, and Timpano (2009). They delivered the same attentional training procedure as Amir et al. to a sample of patients diagnosed with social anxiety disorder. Again, only those patients who received the avoid negative training showed a significant decrease in emotional symptoms, which was maintained at four month follow-up. Similar findings have been reported in other studies involving patients diagnosed with social anxiety disorder (e.g. Beard, Wiseberg, & Amir, 2011; Li, Tan, Qian, Liu, 2008), and also generalised anxiety disorder (e.g. Amir, Beard, Burns, and Bomyea, 2009; Hazen, Vasey, and Schmidt, 2009).

These findings show that attentional bias modification procedures, which target selective attention to negative information, can attenuate the severity of clinical levels of negative emotion. Hence, there are good grounds for optimism that attentional bias
modification procedures which instead target attentional bias to positive information may also prove useful in the remediation of emotional dysfunction, in particular, in those disorders characterised by low levels of positive emotion. Whether such future attentional training tasks are delivered to enhance positive emotion in emotionally healthy individuals, or whether they are delivered with the aim of remediating the symptoms of clinical psychopathology, future researchers will likely be faced with the same types of issues that researchers investigating the clinical benefits of attentional training task are now beginning to wrestle with. In the following, three such issues will be outlined, and potential research avenues to overcome them will be discussed.

**Potential Future Issues Concerning the Capacity of Attentional Bias Modification Techniques to Enhance Positive Emotional Disposition**

As mentioned, the finding that an attentional bias to positive information can make a causal contribution to positive emotional disposition raises the exciting possibility that attentional training approaches, which serve to modify such attentional selectivity, may be employed to further enhance emotional functioning in healthy individuals, or a clinical tool to remediate the symptoms of emotional psychopathology. But to fully exploit the potential applied benefits of attentional training procedures that target attentional response to positive information, it will be important for future researchers to illuminate the ways in which existing training procedures, such as the type used in the present research, can be delivered to maximise their potential real-world benefits. While such research would have obvious applied relevance, it also would further enhance theoretical understanding of such attentional bias.
In a recent meta-analysis, Hakamata et al. (2010) reported a strong correlation \( (r = 0.75) \) between the magnitude of induced change in attentional response to negative information, and the subsequent change in negative emotional disposition. Of course, it remains to be seen whether this same relationship is evident when considering change in attentional response to positive information, and change in positive emotional disposition. But if such a relationship exists, then it suggests that the capacity of future attentional training procedures to influence positive emotional disposition will be maximised by the development of training procedures that can induce the largest possible change in attentional selectivity. One way in which future research could try to bring about greater attentional change would be to determine the optimal balance between the number of trials per training session, and the overall number of such sessions delivered. It has been demonstrated that the retention of learned material can be enhanced when the learning episodes are distributed across time (c.f. Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006). Hence, it may be the case that bigger attentional training effects can be achieved if training sessions are widely distributed across time, rather than grouped in close temporal proximity (e.g. Hertel & Mathews, 2011). To date, no formal test of this proposal has been undertaken, either when using attentional training procedures that target attentional bias to negative information, or (or course) attentional bias to positive information. But it is likely that work of this type will serve to inform the manner in which such future attentional training can best be delivered to enhance positive emotional disposition.

But even if future attentional training procedures can bring about greater changes in attention, it would seem reasonable that such change is unlikely to effectively influence real-world positive emotional disposition unless it both generalises beyond the training task, and
also endures over time. Hence, it will be important for future researchers to not only enhance the power of attentional training procedures to increase the size of the attentional effects they induce, but also to ensure both the generalisation and stability of this attentional change. In the present research, it was found that the attentional impact of the training procedures transferred to new positive stimulus material not encountered during the training task, which researchers often refer to as ‘near’ transfer (Hertel & Mathews, 2011). Such transfer is perhaps unsurprising, however, as the same attentional processes clearly operate on both the training and assessment tasks. Thus, it will be important for researchers to focus more on ‘far’ transfer effects, if attentional training procedures are to produce better generalisation and stability of attentional change. Within the anxiety literature, some studies have demonstrated such ‘far’ transfer, showing that attentional training effects can be detected across different types assessment tasks, influencing other measures of attentional selectivity (e.g., Dandeneau & Baldwin, 2004), and even measures of interpretive selectivity (e.g., White et al., 2011). It will be important for future investigators to also determine whether the attentional change produced by training procedures, which target attentional selectivity to positive information, show evidence of ‘far’ transfer, for example, by delivering a visual search task after the training procedure to assess attentional selectivity.

An issue of concern in both laboratory and real-world settings is whether participants will remain engaged in the completion of attentional training procedures if, for example, these are delivered on multiple occasions, and across an extended period of time (as is often the case when these procedures have been used in real-world settings). For example, Beard, Weisberg, Perry, Schofield, & Amir (2010) found that anxiety patients who received multi-session attentional training reported that the attentional probe task was ‘boring’ and
‘repetitive’, which prevented them from more actively engaging in the intended therapeutic process. Hence, it will likely be important for future researchers to try and develop attentional training tasks that participants find more engaging. In a supplementary study conducted during the course of the author’s PhD candidature, Grafton, Notebaert, Rudaizky, Clarke, and MacLeod (under review) developed a novel attentional bias modification task, termed the Emotion in Motion (EiM) task, in which dynamic stimulus displays, and a game-like scoring system, were introduced into the training procedure in an effort to make it more engaging. In the EiM task, 4 blocks of training trials were delivered. At the beginning of each block, the facial images of 8 individuals each were presented in one of 8 different stimulus display rectangles. Seven of these faces served as distractors, and all displayed the same emotional expression. The remaining face displayed an emotional expression that was different from the distractors, and so served as a target. On each trial, which lasted for 7 – 10 sec, the participant was required to track the trajectory of the target face using the mouse. The next trial began when the target face switched to occupy a new stimulus display rectangle. At the end of each training block, the participant received a score that was based on the amount of time spent tracking the target face, and the speed to switch to identify the new target face. Grafton et al. were able to show that their novel training procedure was capable of modify attentional bias to negative information, and that such modification served to alter negative emotional responses to a subsequent negative event. Hence, the researchers were able to demonstrate that the EiM task could, in principle, be used for attentional bias modification in clinical populations.

Of course, it remains to be seen whether training approaches such as the EiM task can improve patient acceptability of attentional modification procedures. But if researchers are to
deliver attentional training procedures, which target attentional response to positive information, to patients who are characterised by deficits on positive emotional disposition, or healthy individuals seeking to enhance positive emotion, then tasks such as the EiM could, if appropriately amended, represent quite a useful approach for changing such attentional selectivity. Indeed, it is likely that the development of attentional training techniques which do not rely on the probe based procedures will have a significant impact on the attentional bias modification field in the years to come.

Research Phase 3 – Conclusions and Future Directions

The study reported in this third and final research phase reflected a first step towards addressing two issues, not previously considered within the thesis. The first was whether the attentional bias to positive information that was found to characterise high positive emotional disposition in the preceding research phases reflected increased attentional engagement with, or reduced attentional disengagement from, positive information. The second was whether the patterns of engagement and disengagement bias that characterise positive emotional disposition are the same as, or are different from, those that characterise negative emotional disposition. While the findings obtained in Study 5 provided clear evidence to show that the patterns of attentional selectivity that characterise positive and negative emotional disposition are different from one another, the results of this study did not conclusively resolve the issue of whether the patterns of attentional selectivity observed in the earlier phases of the research program reflected increased attentional engagement with, or reduced attentional disengagement from, positive information. Hence, ways in which future researchers may seek to further investigate this issue will now be discussed, as well as the present research’s limited capacity to draw conclusions concerning the potential causal influence of these two
facets of attentional selectivity, and the types of experimental approaches that could be employed to overcome such limitations.

**Refining the Assessment of Selective Attentional Engagement with, and Selective Attentional Disengagement From, Positive Information**

It was noted that the attentional assessment task employed in Study 5 involved a number of experimental manipulations, which potentially compromised its capacity to reveal the patterns of attentional selectivity characteristic of high positive emotional disposition. Indeed, for each new manipulation introduced, the number of trials under each experimental condition was halved, thus resulting in potentially less power to detect the effects of interest. Of course, the downsides of such experimental manipulations were offset by their capacity to reveal a more fine-grained understanding of the patterns of attentional selectivity that characterise variation in positive emotional disposition. Nevertheless, future researchers could benefit from the use of more refined tasks when assessing engagement and disengagement bias in individuals who differ in terms of their positive emotional disposition. Specifically, given that evidence of positive emotional disposition-linked attentional biases were evident only at 500 ms exposure durations, and only for material that fell within the happy/depressed stimulus domain, then the capacity of future attentional assessment tasks to reveal the patterns of engagement and disengagement bias that characterise positive emotional disposition could maximised by using only 500 ms exposure durations and only stimulus material related to the happy/depressed domain, and depending upon the particular issue under scrutiny, perhaps only positive emotional information or only negative emotional information.
But researchers would not necessarily have to rely on RT based measures to index engagement and disengagement bias. Indeed, eye-movement procedure may represent a particularly useful approach for distinguishing these two facets of attentional selectivity in individuals who differ in terms of their positive emotional disposition, and so could help to resolve the issue of whether high positive emotion is characterised, in particular, by increased attentional engagement with positive emotion. For example, it would be possible to employ precisely the same task as used in Study 5, but instead assess participants’ patterns of eye-movement subsequent to the initial anchoring of attention. It would be possible to index positive emotional disposition-linked biases in attentional engagement with positive information by examining the velocity of eye-gaze orientation towards initially distal negative information, or by the probability of the first eye fixation being on positive information. Such tasks would also be capable of assessing disengagement bias, for example, by assessing dwell times for positive information presented in a locus proximal to initial attentional focus.

Whether such refined probe-based attentional assessment tasks, or eye-movement task, prove capable of better revealing the patterns of attentional engagement and disengagement bias that characterise individual differences in positive emotional disposition remains to be seen. But work of this type will help to refine understanding of the attentional substrate of such positive emotion, and may potentially have important applied benefits. For example, by helping to guide researchers to more precisely target, and modify, the patterns of attentional selectivity that characterise variation in positive emotional disposition.
Investigating the Potential Causal Contribution of Engagement Bias and Disengagement Bias to Positive Emotional Disposition

Whatever future studies happen to reveal when investigating the patterns of engagement and disengagement bias that directly characterise positive emotional disposition, an important next step will inevitably be to determine whether any positive emotional disposition-linked biases in these facets of attention make a causal contribution to such positive emotion. It would be possible to develop attentional training variants of the current attentional probe task by introducing the training contingency only into those trials which present the representational images distally from initial attentional focus (to discretely modify selective engagement with negative information), or only into those trials which present the representational images proximally to initial attentional focus (to discretely modify selective attentional disengagement from negative information). In a supplementary study conducted during the course of the author’s PhD candidature, Grafton, Liebregts, and MacLeod (in preparation) developed a training variant of the attentional assessment task employed in Study 5, to determine the causal contribution of biased attentional engagement with positive information, and biased attentional disengagement from such information, to positive emotional disposition.

In the task developed by Grafton et al., word pairs comprising one word (which was either positive or neutral in emotional tone), and one non-word, were employed. For some participants, the attentional training contingency was designed to discretely modify selective engagement with positive information, and so during the training phase, these participants always began the trial with their attention initially distal to the word (i.e. in the locus of the non-word). Participants either received a training contingency that was designed to increase,
or to reduce, attentional engagement with positive information. In the former case, the training contingency involved the presentation of target probes always in the locus of the word when it was positive in emotional tone, and always in the opposite locus of the word when it was neutral in emotional tone (i.e. in the locus of the non-word). In the latter case, the training contingency involved the presentation of target probes always in the opposite locus of the word when it was positive in emotional tone (i.e. in the locus of the non-word), and always in the same locus of the word when it was neutral in emotional tone.

For other participants, the attentional training contingency was designed to discretely modify selective disengagement from positive information. Hence, during the training phase, these participants always began the trial with their attention initially proximal to the word (i.e. in the locus of the word). Participants either received a training contingency that was designed to increase, or to reduce, attentional disengagement from positive information. In the former case, the training contingency involved the presentation of target probes always in the opposite locus of the word when it was positive in emotional tone (i.e. in the locus of the non-word), and always in the same locus of the word when it was neutral in emotional tone. In the latter case, the training contingency involved the presentation of target probes always in the same locus of the word when it was positive in emotional tone, and always in the opposite locus of the word when it was neutral in emotional tone (i.e. in the locus of the non-word).

In order to determine whether a training induced change in each type of attentional bias impacted on positive emotional reactivity to a positive event, participants were exposed to the same anagram success task used in the present research upon completion of the attentional training. Unfortunately, the pattern of probe discrimination latencies obtained
from attentional assessment trials delivered before and after the training phase, in which the training contingencies were removed, did not reveal any evidence that the attentional training procedure was successful in modifying either engagement bias or disengagement bias. Hence, it was not possible in this study to evaluate the causal contribution of either bias to individual differences in positive emotional disposition.

Given the training procedure was not effective in modifying these two facets of attentional selectivity, it was possible, however, to examine the relationship between the index of engagement bias, and the index of disengagement bias (which were both computed across the pre and post attentional assessment trials), and positive emotional disposition. Of significance to the present research, this analysis revealed that higher attentional engagement with positive information bias scores were associated with higher levels of positive emotional disposition. Hence, this pattern of findings is important in the context of the present research, as they suggest that high levels of positive emotional disposition are characterised by biased attentional engagement with positive information, and that the nominal engagement bias effect obtained in Study 5 may indeed have been due to reduced experimental power to detect the effect.

Although the attentional training procedure employed by Grafton et al. did not modify attentional selectivity, as intended, this study represents a valuable first step in determining the causal contribution of engagement bias, and disengagement bias, to positive emotional disposition. It will be important for future researchers to build on the attentional training approach developed by these investigators, however, as such work could not only deliver important theoretical insights, but could also lead to the development of attentional training procedures that can more precisely target the attentional mechanisms that
characterise positive emotional disposition, which could in turn yield greater applied benefits.

**Broadening the Scope: Investigating Other Types of Cognitive Bias That May Contribute to Positive Emotional Disposition**

The focus of the present research has been on determining the attentional basis of positive emotional disposition. But a number of other types of cognitive biases, such as, selective memory and selective interpretation, have been implicated in theoretical accounts of emotional disposition, and these too could be of interest to researchers investigating individual differences in positive emotional disposition. Indeed, there is now considerable evidence to suggest that negative emotional disposition is characterised by relatively enhanced memory for negative information, by an increased tendency to impose negative interpretations on ambiguous information, and by a difficulty in (Mathews & MacLeod, 2005). Future researchers could greatly extend our understanding of the types of cognitive biases that characterise, and potentially also make a causal contribution to, individual differences in positive emotional disposition, by drawing on and appropriately amending the techniques used to assess such biases in participants who differ in terms of their negative emotional disposition.

A number of studies have established that vulnerability to depression, more so than vulnerability to anxiety, is characterised by relatively increased ability to recall negative information (e.g. Gilboa-Schechtman, Erhard-Weiss, & Jeczemien, 2002; Ridout, Astell, Reid, Glen, & O’Carroll, 2003). Indeed, such depression-linked memory bias is considered one of the most robust findings in the depression literature (Gotlib & Joormann, 2010). For
example, Gilboa-Schechtman et al. (2002) exposed depressed and non-depression participants during an incidental learning phase, to facial images displaying negative or positive emotional expressions. The participants were asked to indicate whether they would be interested in meeting the individual displayed in the image. In a subsequent recognition phase, the participants were exposed to the same faces they had seen in the learning phase. It was found that the depressed participants showed enhanced recognition for faces displaying negative emotional expressions, relative to positive emotional expressions. The non-depressed participants did not show evidence of this same effect, consistent with the hypothesis that negative emotional disposition is characterised by enhanced memory for negative information. By drawing upon the types of experimental approaches employed in research investigating memory bias in depressed individuals, future investigators could seek to determine whether individual differences in positive emotional disposition are associated with biased memory for positive information (and perhaps also negative information). While there is some evidence to suggest that variation in state positive mood is associated with improved memory for positive information (e.g. Isen, Shalker, Clark, & Karp, 1978; Teasdale & Russell, 1983), no research has yet focussed on whether variation in dispositional positive emotion is also associated with a memory bias for positive information.

There is also considerable evidence that negative emotional disposition is characterised by an inflated tendency to interpret ambiguous information in a negative manner (Wilson & MacLeod, 2007). For example, Richards and French (1992) exposed participants high and low in anxiety to homograph primes (e.g. ‘stroke’) that permitted either a negative or a neutral interpretation. A target word was then presented 750 ms later, and the participants were required to make a rapid decisions concerning whether the target was a
word or non-word. In a primed-condition, the target was related to a meaning of the ambiguous prime, whereas in an unprimed condition, the target and prime were unrelated. It was reasoned that, to the extent participants imposed a negative interpretation on the homograph prime, in the primed compared to the unprimed condition, they would be disproportionately speeded to determine the lexical status of target words related to the negative meaning compared to the neutral meaning. It was found that the high anxious participants displayed greater priming effects for targets related to negative interpretations of the homographs compared to neutral interpretations of the homographs. The low anxious participants did not show this same effect. Hence, the results are consistent with the hypothesis that negative emotional disposition is characterised by an interpretive bias that favours negative resolutions of ambiguous information. But like selective memory, no study has sought to determine whether individual differences in positive emotional disposition are characterised by biased patterns of interpretation, which in this case would be expected to favour positive resolutions of ambiguous information.

Hence, it is suggested that future research seeks to broaden their cognitive horizons, and seek to investigate not only the patterns of selective attention that characterise positive emotional disposition, but also other candidate information processing bias, such as the type discussed here. There has been a paucity of research designed to illuminate the cognitive basis of positive emotional disposition, but given the well-documented benefits of high levels of positive emotion, it perhaps time for this field of inquiry to begin to blossom.
Concluding Remarks

A number of researchers have recently called for research designed to improve our understanding of the psychological factors that underpin positive emotional disposition. The present research program responds to this call, and represents an important first step in delineating the attentional basis of this emotional disposition. In the present research, it has been shown that selective attentional responding to positive information is not just a characteristic of, but also makes a causal contribution to, individual differences in positive emotional disposition. This dimension of emotion has largely been neglected by psychological investigators, and so it is hoped that the present work will help to stimulate further research not only into the patterns of selective attention, but the patterns of selective information processing more generally, that may contribute to variation in positive emotional disposition.
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Appendix

Always Look on the Bright Side of Life: The Attentional Basis of Positive Affectivity.

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Abstract

There is now reliable evidence that heightened positive affectivity is associated with a distinctive pattern of attentional selectivity, favouring emotionally positive information. While this has invited speculation that differential attentional responding to positive information may directly contribute to the determination of this emotional temperament, the causal basis of their association as yet remains unknown. We addressed this issue by experimentally manipulating selective attentional response to positive information, using a cognitive bias modification variant of the attentional probe task, and examining the impact of this attentional manipulation on positive emotional reactivity to a subsequent success experience. The findings support the hypothesis that individual differences in selective attentional response to positive information can make a causal contribution to variation in positive affectivity.

Keywords: cognitive bias modification, attentional training, positive affectivity, attentional bias
It is now widely accepted that two personality dimensions, negative affectivity and positive affectivity, represent distinct aspects of emotional temperament (Watson, Weise, Vaidya, & Tellegen, 1999). Negative affectivity (NA) reflects the disposition to experience negative emotion, while positive affectivity (PA) instead reflects the disposition to experience positive emotion (Watson & Naragon-Gainey, 2009; Watson & Tellegen, 1985). Factor analysis has shown that these two facets of emotional disposition are orthogonal dimensions of personality (Watson & Tellegen, 1999; Watson, Clark, & Tellegen, 1988), consistent with biological evidence indicating that they are associated with differing neurological substrates (Davidson, Jackson, & Kalin, 2000; Shankman & Klein, 2003).

Considerable research effort has sought to determine the attentional basis of individual differences in these two dimensions of emotional disposition. The early focus of this work was squarely placed on revealing the attentional underpinnings of variation in negative affectivity, but more recently this focus has been broadened, reflecting developing interest in also determining the attentional substrate of variation in positive affectivity. Both lines of research have been motivated by the hypothesis that heightened attentional bias towards a particular emotional valence of information causally contributes to an elevated disposition to experience a corresponding emotional state (Wadlinger & Isaacowitz, 2010). Thus, according to this theoretical position, it should not only be the case that heightened attentional bias towards emotionally negative information, relative to neutral information, causally contributes to elevated negative affectivity (Beck, Emery & Greenberg, 1985; Williams, Watts, Mathews, & MacLeod, 1988; 1997), but also that heightened attentional bias towards emotionally positive information, relative to neutral information, causally contributes to elevated positive affectivity (Tamir & Robinson, 2007). While the former
position, concerning the contribution of attentional selectivity to individual differences in negative affectivity, has received strong empirical support, the latter position, concerning the contribution of attentional selectivity to individual differences in positive affectivity, has not yet been adequately tested. This was the purpose of the present study.

There is robust evidence that an attentional bias operating to favour the processing of negative information is a reliable characteristic of elevated negative affectivity (c.f., Cisler, Bacon & Williams, 2009; Mathews & MacLeod, 2005; Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van-Ijzendoorn, 2007). Elevated negative affectivity can be inferred from heightened levels of anxiety vulnerability (Lee, Watson, & Mineka, 1994). The two most common experimental paradigms employed to determine the pattern of attentional selectivity that characterises elevated negative affectivity have been the emotional Stroop task (Cisler & Koster, 2010; Williams, Mathews, & MacLeod, 1996) and the attentional probe task (MacLeod, Mathews, & Tata, 1986; MacLeod, Soong, Rutherford, & Campbell, 2004). In the emotional Stroop task, participants are presented with emotionally toned words, displayed in different colours, and are required to rapidly name the colour of words while not attending to their semantic content. The repeated finding that participants high in negative affectivity reliably display disproportionate slowing to colour name emotionally negative, relative to neutral words, provides evidence that such individuals have particular difficulty inhibiting attention to negative semantic content (Rutherford, MacLeod, & Campbell, 2004; Amir, Freshman, & Foa, 2002). In the attentional probe task, participants are briefly exposed to word pairs that each contain an emotionally negative and an emotionally neutral item. They then must quickly discriminate the identity of a small visual probe, which subsequently appears in the locus where either of these words was just displayed. The consistent finding
that participants high in negative affectivity are disproportionately speeded to discriminate probes presented to the locus of the emotionally negative words indicates that they preferentially assign attention towards negative information (e.g. Frewen, Dozois, Joanisse, & Neufled, 2008; MacLeod et al., 1986; Mathews, Ridgeway & Williamson, 1996).

While these studies confirm that there is an association between elevated negative affectivity and an attentional bias towards negative information (Bar-Haim et al., 2007), the demonstration of this association cannot suffice to verify the hypothesis that this negative attentional bias causally contributes to negative affectivity. In order to test this causal hypothesis, it is necessary to determine whether directly modifying attentional response to negative information serves to alter negative affectivity. MacLeod, Rutherford, Campbell, Ebworthy and Holker (2002) introduced a methodology for inducing transient change in attentional response to negative stimuli, in order to reveal whether this temporarily alters negative emotional reactivity to an unpleasant event. They developed a training variant of the attentional probe task, in which a systematic contingency between the position of the negative words and the position of probes was designed to modify attentional response to such stimuli. For some participants, this training contingency was that probes always appeared in the same locus as the negative words, to induce an attentional bias towards negative information (“attend negative” training). For other participants, the training contingency was that probes always appeared in the opposite locus to the negative words, to induce an attentional bias away from negative information (“avoid negative” training). The observed change in the pattern of probe discrimination latencies confirmed that these alternative training conditions differentially altered attentional response to the negative information, as required. Specifically, exposure to the “avoid negative” training condition
served to reduce attentional bias towards the negative stimuli, whereas exposure to the “attend negative” training condition produced the opposite change in attentional selectivity, tending instead to increase attentional bias towards the negative stimuli.

Having succeeded in differentially altering attentional response to negative information using this training procedure, MacLeod et al. examined the degree to which participants then displayed negative emotional reactions to an aversive event. For this purpose, they exposed participants to an anagram task, contrived in a manner that ensured they would perform poorly, and assessed the emotional impact of this failure experience by recording negative mood state immediately before and after the anagram task using an analogue scale. Consistent with the causal hypothesis, participants initially exposed to the “attend negative” training condition came to show disproportionately large elevations of negative mood state in response to this later failure experience, compared to participants initially exposed to the “avoid negative” training condition. Subsequent research has replicated the finding that manipulation of negative attention bias using this attentional probe training approach impacts on negative affectivity, as revealed by the intensity of the elevation in negative mood state induced by a laboratory stressor (c.f. Hakamata et al., 2010). This represents clear evidence that variability in attentional bias towards negative information does make a causal contribution to variability in negative affectivity.

As yet, however, it remains unknown whether biased attentional responding to positive information causally contributes to positive affectivity. It is perhaps surprising that this issue has not yet been empirically addressed, given the burgeoning interest in the psychological mechanisms underpinning positive affectivity that has accompanied the rise of positive psychology in recent years (c.f. Linley, Joseph, Harrington, & Wood, 2006;
Seligman & Csikzentmihalyi, 2000). Determining the cognitive basis of positive affectivity is of more than purely theoretical interest, as there is evidence that elevated positive affectivity is associated with many beneficial outcomes, including improved mental and physical health, and better social functioning (c.f. Lyubomirsky, King, & Diener, 2005). In keeping with the methodological approaches used to investigate the attentional characteristics of negative affectivity, Tamir and Robinson (2007) employed an attentional probe task in which the members of word pairs were emotionally positive (rather than negative) and neutral, to examine the attentional concomitants of variation in positive affectivity. Consistent with the hypothesis that positive affectivity is characterised by a positive attentional bias, the results showed that elevations in reported experience of daily positive affect were associated with heightened attentional preference for positive information. Using the Emotional Stroop paradigm, the studies of Mauer and Borkenau (2007), and Segerstrom (2001) provided converging support for this conclusion. Across these two studies, attentional preference for positive information was found to be associated with increased approach temperament, a personality factor on which positive affectivity loads heavily, and with heightened optimism, respectively. Thus, there does appear to be a reliable association between positive attentional bias and elevated positive affectivity.

However, while these studies demonstrate the existence of this association, they do not permit conclusions concerning the causal contribution of such attentional selectivity to variation in positive affective disposition. Addressing this issue would require a methodological framework paralleling that employed to investigate the functional contribution of negative attentional bias to negative affectivity (Eldar, Ricon, & Bar-Haim, 2008; MacLeod et al., 2002). This was the approach we adopted in the present study.
Participants reporting mid-range positive affectivity performed an attentional training task, designed to differentially modify attentional response to positive emotional information. The efficacy of this training procedure was determined by examining probe discrimination latencies obtained from attentional assessment trials presented before and after the attentional training, in which the training contingencies were eliminated. In keeping with previous research, evidence that the training procedure was effective in differentially modifying positive attentional bias will be revealed by an interaction between training condition and attentional assessment point. Specifically, participants trained to avoid positive information should display a relative reduction in attentional preference for positive information, while participants trained to attend to positive information should display the reverse pattern of change, reflecting a relative increase in attentional preference for positive information.

Following this attentional training procedure, participants were exposed to an anagram success task, designed to elicit positive emotional reactivity. In this task, participants were provided with false feedback indicating that they performed particularly well. Assuming that the attentional training task is capable of modifying attentional response to positive information, the mood data obtained from the success task can be examined to determine the validity of the hypothesis that positive attentional bias causally contributes to variation in positive affectivity. If this hypothesis is correct, then following exposure to the attentional training procedure, but not before, participants trained to attend towards positive information will display significantly greater positive affective responses to the success task than will participants trained to avoid positive information.
Method

Participants

Thirty-six introductory psychology students at the University of Western Australia accepted an invitation to participate in the study. We sought participants who were mid-range with respect to dispositional positive affectivity. Thus, recruitment was guided by a mass screening of approximately 800 introductory psychology students on the trait version of the Positive Affectivity Schedule (PAS; Watson, Clark, & Tellegen, 1988). Only students who scored within the middle fifty percent of trait PAS scores (i.e. between 30 - 36) were invited to participate in the study.

Participants were randomly allocated to one of two groups, with the constraint that an equivalent gender ratio (10 female and 8 male) was maintained across both groups. One group of participants was exposed to the training contingency designed to induce a relative increase in attention to positive information, and was designated the “attend positive” group. The remaining participants were instead exposed to the training contingency designed to induce a relative decrease in attention to positive information, and were designated the “avoid positive” group. This gave rise to a between-group factor of Training Condition (attend positive training vs. avoid positive training). Participant characteristics are shown in Table 1. The two groups did not differ in terms of trait PAS scores, t (34) = 1.57, ns, or age, t (34) = .27, ns.

[Insert Table 1 about here]
Materials

Experimental Stimuli

**Emotional Word Pairs.** We required word pairs in which one member of each pair had a positive emotional valence, while the other member instead had a neutral valence. A final set of 96 word pairs was selected from a larger initial pool of 200 candidate word pairs, on the basis of emotional valence ratings provided by 6 clinical psychologist judges. Each of these candidate 200 word pairs comprised members that were thought to differ in emotional valence, but that were matched in terms of both word length (in terms of letters,) and word frequency (according to Kucera & Francis, 1967). All 400 candidate words were presented in random order to the judges, who were asked to rate the emotional valence of each word using a 7-point scale, ranging from -3 (extremely negative) to +3 (extremely positive). In the final set of 96 word pairs selected for use in the study, the mean emotional rating of the positive word member was 1.98 (SD = 0.60), and the mean emotional rating of the neutral word member was 0.07 (SD = 0.20). A t-test confirmed that across this final set of word pairs, the valence of the two word pair members significantly differed in terms of emotionality, t (95) = 29.96, p < .001, as required. This set of 96 word pairs was then divided into two word pair subsets, each containing 48 word pairs. The two subsets of word pairs did not differ significantly in terms of their emotional characteristics, word lengths or frequencies. The full set of experimental word pairs is provided in the Appendix.

**Anagram Task Letter Strings.** The anagram success task was delivered twice, once prior to and once following completion of the attentional training task. A set of 120 letter strings were generated for use in this anagram success task. Each letter string was a soluble
anagram, in that the letters could be rearranged to form a legitimate English word. To ensure that participants were able to solve these anagrams with a high degree of ease, the letter strings were only three or four letters in length, and their solutions all were common words. This set of 120 letter strings was divided into two subsets, each containing 60 letter strings. Each subset comprised 35 three-letter strings, and 25 four-letter strings.

**Emotional Assessment Instruments**

**Positive Affectivity Schedule.** The Positive Affectivity Schedule (PAS) of the PANAS (Watson, Clark, & Tellegen, 1988) is a 10-item mood scale, designed to assess positive affectivity. The study employed the trait version of the scale, in which participants are instructed to rate “to what extent you generally feel this way; that is, how you feel on average.” This instrument has been found to have both good reliability and validity (Crawford & Henry, 2004).

**Visual Analogue Positive Mood Scale.** To measure positive mood state before and after completion of the anagram success task, an analogue mood scale assessing happiness was programmed for computer delivery. This scale consisted of a 15cm horizontal line, divided into 60 equal partitions, with the terminal labels happy and sad. Using the mouse, participants moved a cursor along the line to a point that corresponded with their current level of happiness, and pressed the left mouse button to register their response. This resulted in a score between 1 and 60, with a higher score indicating a greater level of happiness. Using the mood score data obtained from these scales, we were able to compute an index of positive affectivity, which expressed the degree to which exposure to the success experience served to elevate positive mood, using the following equation:
Index of Positive Affectivity = post-anagram positive mood score – pre-anagram positive mood score.

**Experimental Hardware**

A Hewlett-Packard Compaq dc7800 with a 22-inch colour monitor, and a standard two button mouse, was used to present the both the attentional probe task, and the anagram success task.

**Experimental Tasks**

**Attentional Probe Task.** The attentional probe task used to assess and manipulate attentional responding to positive information was closely based on the task previously employed by MacLeod et al. (2002) to manipulate attentional responding to negative information. Each trial commenced with the presentation of the signal “Next Trial” in the centre of the screen for 500ms, which served as a fixation cue. The screen was then cleared and a word pair was presented for 500ms, with one member appearing just above and the other member appearing just below the fixation cue. The position of the positive word was random, such that it appeared with equal frequency in the upper or lower screen location. Immediately upon termination of the word pair display, a small probe stimulus appeared in the position previously occupied by one of the word pair members. With equal probability, this probe stimulus was either a single red dot, or a pair of adjacent red dots. Participants were required to indicate the identity of the probe as quickly as possible, using the left or right mouse button to indicate that the probe was either a single dot or a double dot, respectively. The probe remained on the screen until the participant’s response was detected, and probe discrimination latency was recorded. The screen was then cleared, and the next
trial commenced after a 500ms inter-trial interval. In total, 864 trials were presented across the attentional probe task. The first 96 and final 96 were attentional assessment trials, while the intervening 672 were attentional training trials, and the distinction between these blocks of trials was as follows:

**Attentional Training Trials.** In the attentional training trials, the screen position in which the probes appeared depended upon training group assignment. For participants in the attend positive group, every probe appeared in the locus of the previously presented positive word, while for participants in the avoid positive group, every probe appeared in the locus of the previously presented neutral word. For each participant, only one of the two word pair subsets was employed in the attentional training trials, though across participants each word pair subset was used an equal number of times in the attentional training trials. During the attentional training trials each of these 48 word pairs was exposed a total of 12 times. Presentation order was random, with the constraint that each of these 48 word pairs was exposed once before any were presented for a second time, and was only exposed for a third time, after all had presented twice, and so forth. We adopted Koster, Baert, Bockstaele and De Raedt’s (2010) procedure to encourage affective processing of the stimulus words. Specifically, for this purpose, we included 96 trials on which no probe appeared, but instead participants were told to judge the emotional tone of the stimuli in a word pair. These trials always contained either two positive words or two neutral words, and they were distributed evenly across the attentional training block.

**Attentional Assessment Trials.** In the attentional assessment trials, probes appeared in locus of a previously presented positive word, and in the locus of a previously presented neutral word, with equal frequency, for all participants. To ensure that the attentional assessment
trials only used words not previously encountered in the attentional training trials, the post-training attentional assessment always used the word subset not employed in the attentional training trials. The pre-training attentional assessment used the other word pair subset, as subsequently employed in attentional training. Across each block of attentional assessment trials, each of the 48 word pairs was presented twice, in random order, with the constraint that each of these 48 word pairs was exposed once before any was presented for a second time. For each word pair, the probe appeared once in the screen locus previously occupied by the positive word, and once in the screen locus previously occupied by the neutral word. Using the probe discrimination latency data obtained from these attentional assessment trials, we calculated an index reflecting attentional bias for positive information. This index expressed the speeding for probes in the locus of positive words relative to probes in the locus of neutral words, and was computed using the following equation:

Attentional Bias to Positive Information Index = RT for probes opposite positive word locus – RT for probes in positive word locus.

**Anagram Success Task.** We modified the anagram stress task developed by MacLeod et al. (2002), originally designed to provide a failure experience in order to elevate negative mood state, to instead create an anagram task that ensured a success experience in order to elevate positive mood state. Participants were informed that the task was part of ongoing research investigating the association between academic achievement and performance on cognitive tasks, and that it was designed to measure individual differences in the capacity to solve anagrams. They were advised that individual anagrams would appear in the centre of the computer screen, and were told that they had 3 minutes to complete as many as possible. On presentation of each anagram, the participant responded by first pressing the spacebar,
enabling them to input the correct answer. The participant then pressed the enter key to
register their response, and proceed to the next anagram. If the participant was unable to
solve an anagram, they were instructed to press the mouse button to skip to the next anagram.

To render the task capable of elevating positive mood state, not only were the
anagrams easy to solve, but also false feedback was provided online to the participant,
indicating that they were performing much better than average. To achieve this, a graph was
presented in the bottom, left-hand corner of the screen during the task. Participants were
informed that the red bar on this graph corresponded to their own performance at that point in
time, while the yellow bar on the graph corresponded to the average performance at that
point in time of the other participants who had previously completed the task. A percentile
rank, indicating the participant’s supposed rank among these previous participants was also
displayed on the graph. Performance feedback was such that each participant began the task
with both bars at zero, and with a percentile rank reading ‘Average.’ As the participant
progressed, their performance bar elevated each time they made a correct response. The
program ensured that the bar supposedly displaying the average performance of previous
participants did not keep up with the bar showing the participant’s own performance. As the
discrepancy between both bars widened, the percentile label changed accordingly, indicating
a progressively higher percentile rank for the participant. All participants finished with a
percentile rank that read “Upper 10%”. The anagram success task was administered both
before, and after the attentional training task, with mood state being assessed on the analogue
scale immediately before and immediately after each delivery of the anagram task. A
different anagram letter string subset was used on each occasion the success task was
delivered, with these letter strings being presented in random order.
Procedure

Each participant was tested individually. The test session commenced with the participant being seated approximately 60cm from the computer screen, and provided with instructions concerning completion of analogue mood scale and the anagram task. The participant then completed the analogue mood scale, followed by the anagram success task, and then a second administration of the analogue mood scale. Next, the participant was briefed about the requirements of the attentional probe. They were instructed to discriminate probe identity as quickly as possible, while minimising errors, and no mention was made of any contingency that predicted the position of the probes. Following completion of the attentional probe task, the session continued with delivery of the analogue mood scale, the anagram success task, and the repeated administration of the analogue mood scale. At the end of the session, the participant was debriefed about the purpose of the study, and thanked for taking part.

Results

Two issues were sequentially addressed in the analysis of the data. First, attentional probe discrimination latencies were analysed to determine whether the attentional training procedure was effective in differentially modifying attentional responding to positive information, as intended. Second, analogue mood scale data were analysed to establish whether the differential modification of positive attentional bias resulted in differential positive affectivity following the attentional training procedure, as revealed by the intensity of positive emotional reaction to the post-training anagram success experience. Analyses pertinent to each of these two issues will be reported in turn.

Impact of Attentional Training on Attentional Response to Positive Information
One participant reported being unable to complete the task proficiently due to ill health, while two further participants were found to be outliers in terms of their low probe discrimination accuracy, which fell more than two standard deviations below the mean. These three participants were removed from further analysis. The remaining participants displayed reassuringly high levels of accuracy, averaging less than 7% errors across attentional assessment trials. Accuracy rates did not differ for participants in the two attentional training conditions (F < 1).

To determine the efficacy of the attentional training procedure, we examined the probe discrimination latencies from the two attentional assessment blocks. Consistent with previous research using the attentional probe task, latencies less than 200ms and greater than 2000ms first were eliminated, as were those that fell further than 1.96 SD from the participant’s mean probe discrimination latency, obtained under each of the 8 unique experimental conditions that arose from the nested combination of the 3 two-level experimental factors (Koster, Crombez, Verschuere, & De Houwer, 2004). This led to the exclusion of 6.7% of latencies. The mean probe discrimination latencies observed in each condition next were calculated, and are shown in Table 2.

[Insert Table 2 about here]

These data were subjected to a mixed-design 2 x 2 x 2 x 2 ANOVA that considered the between-group factor Training Condition (attend positive vs. avoid positive), and the within-group factors Attentional Assessment Point (pre-training assessment vs. post-training assessment), Positive Word Position (positive word upper vs. positive word lower) and Probe Position (probe upper vs. probe lower). The analysis revealed a significant main effect of
Training Condition, F (1, 31) = 5.31, p < .05, η² = 0.15, reflecting the fact that participants in the avoid positive training condition displayed faster probe discrimination latencies (M = 653.02, SD = 84.82) than did participants in the attend positive condition (M = 707.97, SD = 95.70). Also emerging from the analysis was a significant main effect of Attentional Assessment Point, F (1, 31) = 31.92, p < .001, η² = 0.51, reflecting generally shorter probe discrimination latencies in the post-training, relative to pre-training, attentional assessment (M = 645.80, SD = 79.62 vs. 713.53, SD = 95.72), and a significant main effect of Probe Position, F (1, 31) = 10.17, p < .01, η² = 0.25, reflecting faster discrimination latencies to probes appearing in the upper screen location (M = 667.29, SD = 94.82), rather than the lower screen location (M = 692.04, SD = 92.26). Of more importance, these main effects all were subsumed within the predicted four-way interaction of Training Condition x Attentional Assessment Point x Positive Word Position x Probe Position, F (1, 31) = 6.26, p < .05, η² = 0.17, which was the only other significant effect to emerge from the analysis.

In order to communicate the nature of this effect, we computed attentional bias to positive information index scores, expressing the degree to which probes presented in the locus of positive words were discriminated more rapidly than probes presented in the locus of neutral words (by subtracting the mean discrimination latency for the former probes from the latter). A higher score on this index reflects a greater attentional bias towards positive, relative to neutral, stimuli. Examination of the attentional bias index scores revealed that participants in the avoid positive training condition came to display reduced scores on the index of attentional bias to positive information at the post-training assessment (M = -24.73, SD = 60.49), relative to the pre-training assessment (M = 37.79, SD = 64.37), and this change was statistically significant, F (1, 16) = 4.83, p < .05, η² = 0.23. In contrast,
participants in the attend positive training condition tended to show the opposite pattern of change in their attentional bias index scores, coming to display higher scores on the index of attentional bias towards positive information at the post-training assessment (M = 3.23, SD = 49.43), relative to the pre-training assessment (M = -20.93, SD = 78.51), though this change fell short of statistical significance, F (1, 15) = 1.62, ns, η² = 0.10. We conducted post-hoc analyses to determine whether there was a between group effect of Training Condition on the index of attentional bias to positive information, at the pre- and post-training assessments. This post-hoc analysis revealed an unexpected significant simple main effect of Training Condition at the pre-training assessment, F (1, 31) = 5.55, p < .05, η² = 0.15, reflecting higher initial positive attentional bias index scores in the participants assigned to the avoid positive training condition. Given, the random allocation of participants to training condition, and the fact that this group difference was observed before training had commenced, the effect must represent a Type I error. Following exposure to attentional training, participants in the attend positive training condition increased their positive attentional bias index scores, while those exposed to the avoid positive training condition decreased their positive attentional bias index scores, such that post training the former participants (M = 3.23, SD = 49.43) had nominally higher attentional bias index scores than did the latter (M = -24.73, SD = 60.49). This simple main effect of Training Condition did not reach statistical significance at the post-training assessment F (1, 31) = 2.10, ns, η² = 0.04. Nevertheless the interaction confirms that the two attentional training conditions exerted a differential impact on attentional response to positive information and, despite the unexpected group difference in attentional bias prior to the delivery of attentional training, the direction of the observed attentional training effects were consistent with our expectations.
Impact of Attentional Training on Positive Affectivity

The positive mood scores obtained from the analogue mood scale for each of the participant groups are shown in Table 3. These data were subjected to a mixed-design ANOVA that considered the between-group factor Training Condition (attend positive training vs. avoid positive), and the within-group factors Anagram Test Phase (pre-training anagram success vs. post-training anagram success), and Mood Assessment Point (pre-anagram assessment vs. post-anagram assessment). This analysis revealed a significant main effect of Mood Assessment Point, F (1, 31) = 13.13, p < .01, η² = 0.30, reflecting the fact that the level of positive mood indicated by analogue mood scale rating scores at the post-anagram success assessment were significantly higher than the level of positive mood indicated by the analogue mood scale scores at the pre-anagram success assessment (M = 42.56, SD = 10.44 vs. M = 39.76, SD = 10.14). This confirms that the anagram success experience did serve to elevate positive mood state, as intended. Of greater theoretical importance, this main effect was subsumed within a higher order interaction of Training Condition x Anagram Test Phase x Mood Assessment Point, F (1, 31) = 4.90, p < .05, η² = 0.14, which was the only other significant effect to emerge from the analysis.

[Insert Table 3 about here]

This three-way interaction, which is displayed in Figure 1, resulted from the emergence of a simple two-way interaction of Training Condition x Mood Assessment Point post-training, F (1, 31) = 8.03, p < .01, η² = 0.21, which did not approach significance pre-attentional training, F (1, 31) = 0.29, ns. As can be seen from panel b of Figure 1, following attentional training, but before the subsequent anagram success experience, participants who
had completed the alternative attentional training conditions did not differ in their levels of positive mood, $F(1, 31) = 0.02$, ns. However, in response to the anagram success experience, those participants who had undergone the attend positive attentional training displayed a significantly greater elevation of positive mood state than did the participants who had experienced the avoid positive attentional training condition. For the former participants, the anagram success experience significantly elevated positive mood state, $F(1, 15) = 21.72$, $p < .001$, $\eta^2 = 0.59$, whereas this was not the case for the latter participants, $F(1, 16) = 2.37$, ns, $\eta^2 = 0.13$. Thus, those participants who had been exposed to the training contingency designed to increase attentional bias to positive information subsequently came to display disproportionately pronounced elevations of positive mood state in response to the anagram success experience, relative to participants who had been exposed to the training condition designed to decrease attentional bias to positive information.

We computed an index of positive affectivity as foreshadowed in the method section, by subtracting positive mood scores immediately prior to delivery of the anagram task (pre-anagram), from those obtained immediately after delivery of the anagram task (post-anagram), and the resulting positive affectivity scores are shown in Figure 2. Higher scores on this positive affectivity index reflect the heightened tendency to respond to the success experience with greater elevation of positive mood state. The hypothesis that attentional bias to positive information causally contributes to positive affectivity predicts a significant simple main effect of Training Condition on this positive affectivity index after, but not before, exposure to the attentional training manipulation. The pattern of results displayed in Figure 2 is fully consistent with this expectation. While the simple main effect of Training
Condition on positive affectivity index score did not approach significance pre-attentional training F (1, 31) = 0.29, ns, this same simple main effect was statistically significant post-attentional training, F (1, 31) = 8.03, p < .01, η² = 0.21.

[Insert Figure 2 about here]

Discussion

The reported study demonstrates that an attentional training manipulation, that differentially modified attentional response to positive information, differentially modified the degree to which a subsequent pleasant experience then elevated positive mood state. This finding suggests that variability in selective attentional response to positive information can make a causal contribution to variability in positive affectivity. Thus, it supports the hypothesis that individual differences in attentional bias towards positive information can causally contribute to positive affectivity.

We recognise that the degree to which people experience feelings of subjective well-being will also be influenced by situational variables. In the present study, positive mood state was elevated by exposure to a success experience, and there is much evidence that heightened subjective well-being is related to demographic factors that plausibly are associated with increased access to success experiences (Diener & Lucas, 1999). However, investigators such as Diener, Suh, Lucas, and Smith (1999) have noted that situational factors of this type account for only a modest proportion of the variance in subjective well-being, which also depend crucially on individual differences in temperament. This observation has led them to call for increased research into the cognitive factors that underpin positive affective disposition. The current work responds to this call, and provides evidence that the
preferential allocation of attention to positive information may represent one of the cognitive mechanisms that causally underpins the disposition to experience positive affect. This is consistent with the claims of emotional regulation theorists who posit that people shape their emotional experience through selective attentional deployment (John & Gross, 2004). In particular, our findings support Wadlinger & Isaacowitz’s (2010) recent proposal that an attentional bias favouring positive information plays a crucial role in determining the likely intensity of positive affect experienced in response to emotional situations, with an attentional bias to positive information leading to stronger positive affective responses to such situations.

In addition to advancing theoretical understanding of positive affectivity, by lending empirical weight to the hypothesis that attentional selectivity causally contributes to this disposition, our findings also suggest possible applied benefits of a cognitive bias modification approach, capable of inducing increased attention to positive information. Our study revealed that such attentional change influenced the degree to which positive mood was elevated by a positive experience within the laboratory setting. However, we recognise that individual differences in affective response to one particular success experience, within a contrived laboratory context, may not provide an optimal index of positive affectivity as a personality dimension. Thus, we suggest that future researchers should seek to determine whether inducing an attentional preference for positive information more generally increases the intensity of positive mood states evoked by a wider array of naturalistic situations, as will be the case if such attentional selectivity contributes to trait positive affectivity.

Our own attentional training study sought only to transiently modify attentional response to positive information. It remains to be seen whether extended delivery of this
training procedure across multiple sessions can bring about an enduring increase in selective attention to positive information and, if so, whether this serves to elevate scores on conventional positive affectivity questionnaires assessing real-world emotional experience, such as the PANAS positive affectivity subscale (Watson et al., 1988). There are good grounds for optimism that this may prove possible, given the findings of recent studies in which extended versions of this training task, designed to modify selective attentional response to negative information, have been employed. Such extended delivery has been shown to exert a lasting influence on attentional response to negative information, and to influence real-world negative affect, months beyond the cessation of training (See, MacLeod, Bridle, 2009; Amir, Beard, Burns, & Bomyea, 2009; Schmidt, Richey, Buckner, & Timpano, 2009). For example, when clinically anxious participants were exposed over three weeks to six sessions of this training, designed to reduce attentional bias to negative information, Amir et al. (2009), and Schmidt et al. (2009) observed a resulting reduction in their anxiety symptoms, that remained evident at follow up three months later.

We suggest that future researchers should now seek to establish whether a similarly extended program of attentional training, designed instead to increase attentional bias towards positive information, can serve to induce a stable elevation in positive affectivity. Not only would such a finding further support the hypothesis that biased attentional response to positive information causally contributes to this personality dimension, but it could also have important real-world applications. The benefits of elevated positive affectivity are well documented, and there is clear evidence that this emotional disposition is associated with enhanced functioning in many settings (c.f. Lyubomirsky, King, & Diener, 2005). For example, elevated positive affectivity is associated with superior job performance and
productivity (Wright & Cropanzano, 2000), and with reduced levels of absenteeism, job turnover, and burnout (George, 1989; Shaw, 1999; Thoresen, Kaplan, Barsky, Warren, & De Chermont, 2003). One of the key objectives that motivated the development of positive psychology was to identify ways of enabling more people to achieve the benefits that accompany positive emotional experience (Seligman, Steen, Park, & Peterson, 2005). While we recognise that the use of cognitive bias modification methodologies to induce heightened levels of positive affectivity may raise some ethical issues, we nevertheless believe that there may be appropriate applications.

In particular, we would suggest that such an approach could be warranted when individuals suffer the adverse symptoms associated with unusually low levels of positive affectivity. It is now well-recognised that deficient positive affectivity is a hallmark of clinical depression. Clinical anxiety and depression are both characterised by elevated levels of negative affectivity, but clinical depression alone also is marked by the distinctive lack of positive affectivity (Lee et al., 1994). In their recent meta-analysis, Hallion & Ruscio (in press) found good evidence that anxiety is therapeutically responsive to cognitive bias modification procedures that reduce the selective processing of negative information, but conclude that this is not reliably the case for depression. Plausibly, this may reflect the fact that effective therapeutic alleviation of depression requires not only the attenuation of negative affectivity, but also the amplification of positive affectivity. Given our present evidence that attentional bias to positive information contributes to positive affectivity, this suggests that attentional bias modification approaches to the remediation of depression may require the inclusion of a training component that serves to increase selective attention to
positive information, before this attentional training will be fully effective in attenuating depressive symptomatology.

In the current study, we employed the same approach that MacLeod et al. (2002) used to address the hypothesis that attentional bias to negative information causally influences negative affectivity (as assessed by negative emotional reactivity to an unpleasant event), and amended it to instead address the hypothesis that attentional bias to positive information causally influences positive affectivity (as assessed by positive emotional reactivity to a pleasant event). While the results support our hypothesis, they do not exclude the possibility that biased attentional response to positive information might also make a contribution to negative affectivity. It is not implausible that attention to positive aspects of a negative situation may attenuate the degree to which it induces negative affect (Segerstrom, 2001), and there is some preliminary evidence that variability in attentional bias towards positive information may be inversely related to variability in negative emotional reactivity to a stressor (Taylor, Bomyea, & Amir, 2011). It also is possible that attentional bias towards negative information may contribute to positive affectivity, serving to attenuate the intensity of positive emotional reactions to pleasant events. Hence, we suggest that future investigators should contrast the impact of training procedures that discretely manipulate attentional response to either positive or negative information, on both positive and negative emotional reactivity to pleasant and unpleasant events. The results of such future work will determine whether biased attentional responding to negative and to positive information each uniquely contribute to positive and negative affectivity respectively, or whether both forms of attentional selectivity contribute in combination to each emotional disposition.
Although we have found support for the hypothesis that individual differences in positive attentional bias can causally contribute to positive affectivity, this does not exclude the possibility that there may be a bidirectional causal relationship between these two variables, whereby positive affectivity also causally influences attentional preference for positive information. While there is some evidence to suggest that the induction of positive mood state can influence the breadth of attentional focus (Gable & Harmon-Jones, 2010; Rowe, Hirsh, & Anderson, 2006), we are not aware of any research that has sought to determine whether the induction of positive mood serves to increase selective attention to positive information. Nor are we aware of work investigating whether an increase in the disposition to experience positive mood states can elevate such positive attentional bias. Research addressing this issue could make a valuable future contribution to the literature. However, whether or not such a bidirectional causal relationship exists, the present findings indicate that attentional bias to positive information makes a causal contribution to positive affectivity.

There are, of course, limitations associated with the present study. For one thing, although the alternative training conditions differentially influenced attentional response to positive information in the intended directions, an unexpected difference in attentional preference for positive information was observed between the two training groups prior to attentional training. Thus, in principle, one could propose that the discrepant effects of the differing attentional training conditions might be accounted for by regression to mean. However, if this were the case, then there would be no basis for anticipating that these training manipulations also would differentially influence positive affective responses to the anagram success task. In light of the differing elevation in positive mood state observed
between participants in the two training conditions, the most parsimonious account is that there was a genuine training induced change in attentional response to positive information, which served to influence positive emotional reactions to the success experience. Of course, confidence in this conclusion will be further increased by replication of these findings in participants who do not initially differ in terms of attentional bias.

Another limitation is that, while we are able to conclude that the training procedure did appear to influence selective attentional responding to positive information, we cannot exclude the possibility that it might have modified selective attentional responding to negative information too. Specifically, it is not impossible that the training conditions respectively designed to reduce, and to increase selective attentional bias to positive information, may also have respectively increased and reduced selective attentional bias to negative information. If this were the case, then it could be the change in attentional response to negative information that impacted on positive affectivity. Thus, we suggest that future researchers should include both positive, and negative emotional stimulus materials when assessing the attentional impact of this training manipulation. Such an approach would permit determination of whether the present training procedure modifies only attentional bias to positive information, as we have assumed positive and negative attention biases are independently related.

The third limitation reflects the fact that, because we assigned participants only to active training conditions, we cannot conclusively determine whether each of the two training contingencies served to exert a significant impact on positive attention bias. Inspection of the data invites speculation that the training condition designed to reduce attentional preference for positive information may have served to attenuate positive
attentional bias more than the training condition designed to increase attentional preference for positive information served to elevate this bias. However, such a conclusion cannot confidently be drawn in the absence of a control condition that exposed participants to the same probe task but without including a training contingency. In order to determine the relative contribution of the two training contingencies to changes in positive attentional bias, we suggest that future studies should seek to include such a no contingency control condition.

A further limitation concerns our mood rating scale. This was intended to assess the impact of the success experience on positive mood state. However, because this scale ranged from a positive terminal (happy) to a negative terminal (sad), what we interpret here as increases in positive mood state following the success experience, could alternatively be construed to reflect decreases in negative mood state following the success experience. To fully dissociate the impact of the success experience on positive and negative mood we recommend that future researchers should employ two mood rating scales. One could assess positive affect alone, using terminal labels that describe high and low levels of positive affect (for example, elated and dull). The other could assess negative affect alone, using terminal labels that describe high and low levels of negative affect (for example, distressed and calm).

Finally, because of the relatively small sample size, we are unable to conduct a formal mediation analysis to confirm that impact of the training manipulation on positive affectivity was mediated by its impact on attentional response to positive information. As noted by MacLeod, Koster, and Fox (2009), it is possible that an attentional training procedure may independently influence selective attentional bias and affective reactivity. Thus, the change in positive affectivity reactivity we currently observed to accompany the training induced
modification of attentional preference for positive information may not have been mediated by this attentional change. To directly address this issue, future researchers should employ larger samples, to allow for formal mediation analysis to be performed, thereby enabling them to more rigorously address the hypothesis that positive attentional bias causally contributes to positive affectivity.

While it will require further research to address these various limitations, for the moment our results are fully consistent with this hypothesis that biased attentional responding to positive information makes a causal contribution to positive affectivity. Our findings show that it is possible to differentially modify attentional response to positive information using an attentional probe training procedure, and that this serves to influence the intensity of positive emotional reactivity to a pleasant experience. We hope this work may stimulate further interest into the attentional basis of positive affectivity, and we are optimistic that the attentional bias modification approach could prove useful to other personality researchers investigating the functional relationship between attentional selectivity and emotional temperament.
References


Table 1. Characteristics of participants.

<table>
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<tr>
<th>Characteristic</th>
<th>Attend Positive Condition</th>
<th>Avoid Positive Condition</th>
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<tr>
<td>PAS</td>
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<tr>
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*Note. PAS = Trait version of Positive Affectivity Schedule*
Table 2.
Mean and standard deviation of probe discrimination latencies, in milliseconds, under each experimental condition

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<thead>
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<th>Post-Training Assessment</th>
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<tr>
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<td>Positive Word Lower</td>
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<tr>
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<td>Probe Upper</td>
<td>Probe Upper</td>
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<tr>
<td>SD</td>
<td>68.04</td>
<td>98.32</td>
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</table>
Table 3.
Mean and standard deviation of analogue mood scores obtained from anagram success task delivered pre- and post-attentional training

<table>
<thead>
<tr>
<th>Attentional Training Condition</th>
<th>Pre-Attentional Training</th>
<th>Post-Attentional Training</th>
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<td>Mood Assessment Point</td>
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<tr>
<td></td>
<td>Pre-Anagram</td>
<td>Post-Anagram</td>
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<td>SD</td>
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Figure 1. Impact of anagram success task on positive mood, before and after attentional training.
Figure 2. Mean and standard error of positive affectivity index scores obtained from anagram success task delivered pre- and post-attentional training.