Exploring the Neurocognitive Basis of Age-related Differences in an Anxiety-linked Bias in Negative Expectancy

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Anxiety-linked Bias in Negative Expectancy
Abstract

Anxiety vulnerability refers to one’s tendency to experience anxiety. There is evidence that people with high anxiety vulnerability show disproportionately high expectancy for negative relative to positive future events. However, the mechanisms that give rise to this ‘anxiety-linked’ bias in expectancy remain unclear. There is also a strong basis for anticipating that advanced age instead may be associated with disproportionately high expectancy for positive relative to negative future events. This ‘age-linked’ bias in expectancy is yet to be empirically established and it also remains uncertain as to whether such may be associated with additive or interactive effects with the established anxiety-linked bias in expectancy. Further, the contributions from age-related neuropsychological influences on observed patterns of emotional expectancy have not been previously explored.

The current research was designed to address these issues, and had four main aims: (1) to develop and deploy an experimental task capable of sensitively assessing relative expectancy for negative and positive future events, in a manner that can distinguish the mechanisms that underpin anxiety-linked and age-linked differences in such relative expectancies, (2) to determine the existence of an age-linked bias in expectancy and, if in doing so, subsequently reveal the mechanisms that give rise to such an age-linked effect, (3) to establish whether an anxiety-linked bias and age-linked bias in expectancy represent independent effects, or whether age moderates the expression of an anxiety-linked bias in expectancy, and (4) to reveal the neurocognitive basis of any observed age-related differences in emotional expectancy.

Four experiments are reported. Experiment 1 illuminates the basis of an anxiety-linked bias in expectancy using a newly developed experimental task designed to measure relative expectancy for negative and positive future events. Specifically, this task aimed to reveal the specific mechanisms underpinning observed group differences
in such relative expectancy. Results revealed that, as anticipated, participants with higher trait anxiety showed inflated relative expectancy for negative compared to positive future events. The nature of the mechanisms underpinning this anxiety-linked difference was also identified.

Experiment 2 aimed to replicate the findings obtained in Experiment 1. In addition, this study contrasted older and younger adults to determine: (i) whether an age-linked bias in expectancy exists, and if so (ii) whether this age-linked bias and the anxiety-linked bias represent additive or interactive effects, and (iii) to illuminate the underpinning mechanisms. An anxiety-linked bias in expectancy and an age-linked bias in expectancy were confirmed. Older adults showed a greater tendency than the younger adults to demonstrate heightened expectancy for positive relative to negative future events. The study also revealed that these two effects were interactive in nature, such that age moderated the expression of the anxiety-linked bias in expectancy. Experiment 2 also identified the mechanisms that gave rise to this age-linked bias in expectancy.

Consideration was given to the possibility that, the observed impact of age on an anxiety-linked bias in expectancy within Experiment 2 may have been carried by an unintended age group difference in state anxiety, due to the older adults being less familiar with the testing environment than the younger adults. Experiment 3 was conducted to test the viability of this alternative account, by determining whether the experimental induction of elevated state anxiety would lead younger adults to display the pattern of findings previously exhibited by the older adults in Experiment 2. This was not the case, rendering implausible the state anxiety account of the age-related difference in an anxiety-linked bias in expectancy.

Experiment 4 was designed to discriminate the validity of two competing neuropsychological accounts of this age-related difference in emotional expectancy, one implicating age-related decline in neurocognitive capacity, and the other implicating
age-related enhancement of wisdom and experience. The results provided support for the former account, by revealing that anxiety-linked differences in emotional expectancy were most evident in older participants who displayed the least evidence of cognitive deficits.

In the final chapter, the findings pertaining to each of the four main issues this thesis was designed to address are discussed and their implications considered, as are the limitations of the experimental design, and potentially valuable directions for future research.
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Statement of Original Contribution

The author played a significant role in all aspects of the studies reported within this thesis. This included experimental design and task development, participant recruitment and testing, data entry, data analysis and interpretation. A Psychology Honours student, Lenny Chan, who was co-supervised by the author/PhD candidate, collected a portion of the data in Experiment 1 and 2 (reported in Chapter 2 and 3, respectively). However, the PhD candidate collected additional data and conducted novel analyses, the results of which are reported in these Chapters. Thus all the analyses reported in this thesis represent the independent work of the author/PhD candidate.

Recruitment and testing of older adults were done in collaboration with a fellow PhD student, Melissa Burgess, the latter for experiments reported in Chapter 3 and 5. Older adults were jointly recruited and tested in these studies due to the difficulty in recruiting adequate numbers of community dwelling older adults who met selection criteria and were able to attend the university to partake in such research. Preparation and revision of a published manuscript reported in Chapter 2 was done in collaboration with both of the author/PhD candidate’s supervisors, Professor Colin MacLeod and Associate Professor Romola S. Bucks, and a fellow postgraduate student (and co-first author on the manuscript), Shari Steinman, from the University of Virginia, USA. The PhD candidate and the co-first author on this manuscript contributed equally to this work, given that two studies (one by each of these authors) were reported in this publication.
Publications

**Peer reviewed publications (See Appendix 1)**

(The data reported in this publication was reanalysed and rewritten for thematic consistency within this PhD thesis)


**Components of this thesis presented at conferences**


**Research impact**

(Evidenced by publications reporting the use of the experimental task/paradigm which was developed as part of the current research)

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<th>Abbreviation</th>
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<td>ANOVA</td>
<td>Analysis of Variance</td>
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<td>BFI</td>
<td>Big Five Inventory</td>
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<td>CBM</td>
<td>Cognitive Bias Modification</td>
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<td>DSM-IV</td>
<td>Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition</td>
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<td>EEH</td>
<td>Emotional Extrapolation Hypothesis</td>
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<td>EQ-I:S</td>
<td>Emotional Quotient Inventory: Short</td>
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<td>MMSE</td>
<td>Mini-Mental State Examination</td>
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<td>NART-R</td>
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<td>STAI-T</td>
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<tr>
<td>TEA</td>
<td>Test of Everyday Attention</td>
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<td>WAIS-IV</td>
<td>Wechsler Adult Intelligence Scale – Fourth Edition</td>
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CHAPTER 1: INTRODUCTION

There is research evidence that high anxiety vulnerability in younger adults is associated with greater expectancy for negative relative to positive future events when compared to individuals with low anxiety vulnerability. This effect is referred to as an ‘anxiety-linked bias in negative expectancy’. It is important to note that this effect refers to anxiety-linked variation in relative expectancy for negative compared to positive future events, and does not represent a greater expectancy for negative than positive future events in an absolute sense. While there is evidence for such a bias, the mechanisms that give rise to it remain unclear. The first facet of the present research program concerns the relationship between anxiety and expectancy (i.e., an anxiety-linked bias in negative expectancy) and identifying the mechanisms that give rise to this bias. Widely accepted theory strongly predicts that advancing age is instead associated with greater expectancy for positive relative to negative future events compared to younger adults. However this has not yet been investigated. This potential age difference in expectancy is referred to as an ‘age-linked bias in negative expectancy’. A second important facet of this research concerns establishing the presence of an association between age and expectancy and, if evident, identifying the mechanisms that give rise to this age-linked bias in negative expectancy. Additionally, whether an anxiety-linked bias and an age-linked bias, in negative expectancy represent two independent effects, or whether age moderates the expression of an anxiety-linked bias in negative expectancy is investigated. A third facet of the present research program concerns testing the neuropsychological basis of observed age-linked differences in expectancy by contrasting two competing neuropsychological accounts - one implicating age-related decline in neurocognitive capacity, and the other implicating age-related enhancement of wisdom and experience.
This introductory chapter lays the foundation for the current research by initially providing a review of the literature that relates to the importance of an anxiety-linked bias in negative expectancy. This involves discussing anxiety vulnerability and empirical evidence for patterns of selective processing that have been found to contribute to high anxiety vulnerability. Existing evidence of an anxiety-linked bias in negative expectancy in younger adults is discussed as well as alternative mechanisms that are proposed to potentially underpin this bias. Next, an age-linked bias in negative expectancy is considered in line with the second main focus of this research. This involves reviewing age differences in anxiety vulnerability, followed by age differences in patterns of selective processing. A possible age-linked bias in negative expectancy is also discussed, and two possibilities regarding the nature of such an age-linked bias (should it exist) are presented. Thereafter, the third main focus of this research is to distinguish between potential neuropsychological mechanisms that may underlie an age-linked bias in negative expectancy. This involves discussing the plausibility of how an age-related decline in neurocognitive capacity may be associated with an age-linked bias in negative expectancy. This is termed the ‘Age-related Decline in Neurocognitive Capacity Account’, and is compared to the alternative possibility that an age-related enhancement of wisdom and experience may be associated with an age-linked bias in negative expectancy – termed the ‘Age-related Enhancement of Wisdom and Experience Account’. The chapter ends with the main objectives of the current research program being highlighted as well as a summary of the four experiments conducted to address these key objectives.

**Anxiety Vulnerability**

Individuals differ in terms of their susceptibility (or heightened tendency) to experience anxiety, or anxiety vulnerability. The terms ‘dispositional anxiety’ and ‘trait anxiety’ have often been used interchangeably with the term ‘anxiety vulnerability’.
Throughout this thesis the term ‘anxiety vulnerability’ is preferentially used. While people generally experience state anxiety at one time or another (i.e., a transient state of anxiety), some individuals experience state anxiety more frequently than others. Those who are high in anxiety vulnerability (e.g., high in trait anxiety) have long been observed to be at greater risk of experiencing higher levels of state anxiety under conditions of failure or stress compared to those with low anxiety vulnerability (e.g., Hanton, Mellalieu, & Hall, 2002; Hodges, & Spielberger, 1969; Martens, Vealey, & Burton, 1990). Those who more frequently respond with anxiety when presented with situations they perceive as threatening are considered to have ‘dispositional anxiety’ (Spielberger, Gorusch Lushene, Vagg, & Jacobs, 1983). In some cases, this vulnerability to anxiety is observed through manifestations of pathological anxiety conditions (e.g., Generalised Anxiety Disorder, Social Phobia, Specific Phobias, and Panic Disorder), in others, this is observed through elevated scores on questionnaires that provide a measure of how frequently people experience anxiety (i.e., measures of trait anxiety). When the term ‘trait anxiety’ is used within this thesis, it refers specifically to scores (and variability in scores) on a questionnaire measure of trait anxiety (i.e., that State Trait Anxiety Inventory – Trait form; Spielberger, 1983).

Excessive anxiety vulnerability is a widespread problem that affects a large proportion of the world’s population. The global prevalence of anxiety disorders is 7.3% (Baxter, Scott, Vos, & Whiteford, 2013). In 2010, anxiety represented a high proportion of disease burden and was the sixth leading cause of disability across low-, middle- and high-income countries (Baxter, Vos, Scott, Ferrari, & Whiteford, 2014). Furthermore, the 12-month prevalence of anxiety disorders (which indicate high anxiety vulnerability) in the general Australian population aged 16 to 85 years of age in 2007 was 14% (Australian Bureau of Statistics, 2007). It is important to gain an
understanding of what contributes to making some individuals more vulnerable to
anxiety than others, due to the high prevalence and disabling nature of this condition.

**Patterns of Selective Processing Contributing to High Anxiety Vulnerability**

There is a large body of research evidence that younger adults with high anxiety
vulnerability demonstrate patterns of selective processing which are typically
characterised by a preference for negative information (see Ouimet, Gawronski, &
Dozois, 2009, for a review). These established patterns of selective processing in high
anxiety vulnerability have been observed in attention, memory and interpretation.
Individuals tend to demonstrate a preference for selectively attending to, and recalling
negative information, as well as selectively interpreting ambiguous information in a
negative manner. Moreover, many of these patterns of selective processing (particularly
in attention and interpretation) have been found to causally contribute to elevated levels
of anxiety vulnerability (see MacLeod & Mathews, 2012, for a review).

One pattern of selective processing associated with high anxiety vulnerability
that has been under-investigated is that observed in terms of expectancy of future events
(i.e., an anxiety-linked bias in expectancy). According to previous research this is
characterised by those high in anxiety vulnerability demonstrating greater expectancy
for negative relative to positive future events when compared to individuals with low
anxiety vulnerability (MacLeod, Tata, Kentish, & Jacobsen, 1997; Miranda & Mennin,
2007). It is not unreasonable to consider that how one feels is likely to be impacted on
by how one views the future and what one expects it to involve. Expecting the future to
be negative or threatening in some way may likely lead to increased feelings of anxiety,
while anticipating that the future will be positive would likely be associated with less
anxiety. Furthermore, it is well documented that anxiety pertains to future-oriented
concerns (e.g., Barlow, 2002; Brown, Moras, Zinbarg, & Barlow, 1993; Kendall &
Watson, 1989). While this next review of the literature will consider studies that have
examined anxiety-linked selective processing biases in attention, memory and interpretation, special emphasis will be placed on an anxiety-linked bias in expectancy, as this is the focus of the current research.

**Anxiety-linked attentional, memory and interpretive bias.**

Individuals with high anxiety vulnerability have been found to exhibit selective attention towards negative information (see Cisler & Koster, 2010; Van Bockstaele et al., 2014; Yiend, 2010). This is referred to as an anxiety-linked attentional bias (see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van Ijzendoorn, 2007). According to a meta-analytic review by Bar-Haim et al. (2007), this effect has been robustly found across experimental paradigms and manifestations of elevated anxiety vulnerability (i.e., high trait anxiety and clinical anxiety), and is not observed in those with low anxiety vulnerability. This anxiety-linked attentional bias has been found to further involve both facilitated attentional engagement with negative information (i.e., attention is more likely to be directed towards distal negative stimuli) and impaired attentional disengagement from negative information (i.e., attention is less likely to be moved away from negative proximal stimuli; see Grafton, & MacLeod, 2014).

There is also evidence for an anxiety-linked memory bias, with those high in anxiety vulnerability displaying a tendency to selectively recall negative information (Eysenck & Byrne, 1994; Ghassemzadeh, Lzadikah, & Baraheni, 2003; Richards & French, 1991). This anxiety-linked memory bias has been demonstrated across both implicit and explicit memory tasks. Implicit memory tasks typically involve either word-stem completion or lexical decision/stimulus identification tasks (see Mitte, 2008, for a review), and contrast explicit memory measures which require the participant to directly state what they recall of the previously presented information (Mitte, 2008).

Those high in anxiety vulnerability also show a tendency to selectively interpret ambiguous information in a negative rather than non-negative manner, compared to
those who are low in anxiety vulnerability (e.g., Hirsch & Mathews, 1997). This is termed an anxiety-linked interpretive bias (see Richards, 2004; Ouimet et al., 2009, for a review). This effect has also been demonstrated across various experimental paradigms (e.g., Butler & Mathews, 1983; Richards & French, 1992) and has not been observed in those low in anxiety vulnerability (see Wilson, MacLeod, Mathews, & Rutherford, 2006).

**Anxiety-linked bias in negative expectancy.**

Not only are there anxiety-linked differences in the interpretation of current situations, there is also evidence for anxiety-linked differences in the expectancy of future events. Importantly, as mentioned earlier, anxiety is characterised by predominantly, future-oriented concerns (e.g., Barlow, 2002; Brown et al., 1993; Kendall & Watson, 1989). Thus, expectations of the future would appear to be an important area of investigation in anxiety research. It is evident that, not only do individuals high in anxiety vulnerability show a tendency towards the specific aforementioned processing biases, they have similarly been found to show greater expectancy for negative relative to positive future events when compared to those low in anxiety vulnerability (MacLeod et al., 1997; Miranda & Mennin, 2007).

Miranda and Mennin (2007) employed a Future Events Task which was made up of a questionnaire containing a list of 34 future events (half positive and half negative). Participants were required to read each item and to answer the question “is this likely to happen to you at some time in the future” by circling yes or no. There was also a 5-point Likert-scale for participants to rate how certain they were of each response (with 1 indicating “not at all certain” and 5 indicating “as certain as one can be”). Generalised Anxiety Disorder scores were found to be significantly associated with an elevated tendency to predict the occurrence of negative future events, and not
Anxiety-linked Bias in Negative Expectancy

significantly associated with an elevated tendency to predict that positive future events would not occur.

MacLeod et al. (1997) used a Personal-future Task to examine expectancy of negative and positive future experiences in those with depression and high anxiety vulnerability compared to controls. In this task, participants were required to think of future experiences occurring over the next week (including today), the next year and the next 5 to 10 years. One condition required participants to think of positive future experiences and in another condition participants were asked to think of negative future experiences. Participants were given 1 minute to describe future experiences in each of the two conditions. The total number of experiences reported was recorded. Those with anxiety disorders (and thus high anxiety vulnerability) reported a greater number of expected negative future experiences, though no fewer positive future experiences, when compared to controls.

Stöber (2000) gave participants a list, which contained 20 negative future events and 10 positive future events. Participants were then asked to imagine experiencing each of the potential future events and to rate their capacity to imagine these candidate future events using visual analogue scales. High trait anxiety was associated with an enhanced capacity to imagine negative future events, though not with a reduced capacity to imagine positive future events.

Despite the empirical evidence for an anxiety-linked bias in negative expectancy, the mechanisms that give rise to such a bias have not yet been investigated. Previous studies have employed experimental paradigms, which have not been able to distinguish the potential mechanisms giving rise to an anxiety-linked bias in expectancy. More specifically, these previous studies have not involved experimental manipulation of the emotional tone of current information prior to assessing expectancy for (negative and positive) future events. Thus, it is not possible to assess how any
variations in the emotional tone of current information would impact on expectancy for negative and positive future events based on these studies. Developing a task that involves such a manipulation in order to identify these mechanisms is one important focus of the current research. Proposed alternative mechanisms that could in principle give rise to an anxiety-linked bias in negative expectancy, together with the manner in which these mechanisms might be empirically discriminated, will now be considered.

**Alternative Mechanisms Possibly Giving Rise to an Anxiety-linked Bias in Negative Expectancy**

Determining the exact nature of an anxiety-linked bias in negative expectancy by empirically discriminating between alternative mechanisms which may give rise to this bias is important for increasing knowledge regarding the cognitive processes involved in anxiety and, in turn, identifying patterns of thinking which need to be focused on or addressed in psychological treatment/therapies. Given previous research, three anxiety-linked mechanisms are delineated in the current research that each could potentially give rise to anxiety-linked bias in negative expectancy.

As mentioned earlier, those with high anxiety vulnerability have been found to show greater expectancy for negative relative to positive future events when compared to those low in anxiety vulnerability (e.g., MacLeod et al., 1997; Miranda & Mennin, 2007). Although this previous research did not investigate the possible impact of current negative or positive events on future expectancy, in terms of the present research, it may be that participants with high anxiety vulnerability consistently show greater expectancy for negative than positive future events regardless of whether the present event is negative or positive in emotional tone. Thus, in terms of the first proposed candidate mechanism, when computing the probability of future events, the cognitive system of those with high anxiety vulnerability (compared to that of those with low anxiety vulnerability) may add a constant to the probability of experiencing negative future
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events when considering possible outcomes. This results in negative outcomes being considered as more likely to occur than positive outcomes. This is termed the Pervasive Negative Expectancy Hypothesis (PNEH). This hypothesis generates the prediction that those high in anxiety vulnerability will consistently display an inflated expectancy for negative compared to positive future events, relative to those low in anxiety vulnerability, regardless of whether present events are negative or positive in emotional tone.

Alternatively, it is possible that the emotional tone of current events may contribute to the occurrence of an anxiety-linked bias in negative expectancy. Therefore, the second proposed candidate mechanism (termed the Emotional Extrapolation Hypothesis; EEH), assumes that people will generally extrapolate from the emotional tone of current events such that their expectancy for future events that are consistent with the emotional tone of current events will be heightened. Put another way, how an individual construes the present will determine their expectations of the future. According to this hypothesis, those high in anxiety vulnerability will show this general tendency to a greater extent than those low in anxiety vulnerability, such that the former group of individuals will show greater extrapolation from current experiences to inform their future expectations. Of course, a tendency to show greater extrapolation would not itself lead to negatively biased expectations of the future in those with high compared to low anxiety vulnerability, unless the current experience of those with high anxiety vulnerability is predominantly negative. Thus, anxiety-linked increases in general extrapolation would lead to an anxiety-linked bias in negative expectancy only if people with high anxiety vulnerability tend to have more negative than positive current experiences. Similarly, those with high anxiety vulnerability will also show heightened expectations for positive future events to a greater extent than those low in anxiety vulnerability when having more positive than negative current
experiences. Thus, it is predicted that those with high anxiety vulnerability will show
greater emotional extrapolation from current events, whether these are negative or
positive (with this being equally evident across negative and positive situations).
However, this heightened emotional extrapolation in these individuals would not give
rise to an anxiety-linked difference in expectancy for negative or positive future events
when the current experience is neither negative nor positive.

Other research focusing on depression has found that depressed individuals tend
to have disproportionately negative expectations of the future, and tend to rely more on
negative emotion as information and less on positive emotion when compared to
healthy controls (Marroquín & Nolen-Hoeksema, 2015). Moreover, according to
Willner-Reid, Smith, Jones, and MacLeod (2012), it is well documented that negative
events can have a greater effect on behaviour than positive events. The ‘impact bias’
referred to in the affective forecasting literature refers to individuals overestimating the
intensity of their emotional reactions to negative outcome in the future. This bias is
considered an ‘affective forecasting error’ (Willner-Reid et al., 2012). Together this
literature suggests that individuals with high anxiety vulnerability may have more
negative than positive expectations of the future, particularly when present events are
negative rather than positive, when compared to those with low anxiety vulnerability.
In other words, the former (like those who are depressed) may rely on more negative
than positive current information when forming expectations of the future. Thus, the
third candidate mechanism for an anxiety-linked bias in negative expectancy (termed
the Negative Extrapolation Hypothesis; NEH) also assumes that emotional extrapolation
will occur. However, an anxiety-linked bias in negative expectancy is attributed to a
disproportionate tendency to exhibit such emotional extrapolation from current negative
events as opposed to current positive events in those with high anxiety vulnerability.
Therefore this mechanism involves those with high anxiety vulnerability differentially
engaging in extrapolation concerning the likelihood of future experiences, based on the emotional valence of the present experience. More specifically, this hypothesis predicts that when the current experience is negative, those high in anxiety vulnerability (compared to those low in anxiety vulnerability) will be disproportionately inclined to have greater expectancy for negative than positive future events. Importantly, this will be greater than their elevated expectancy for positive than negative future events when the current experience is positive.

The idea that an anxiety-linked bias in negative expectancy may involve the use of ongoing, current information in the computation of such a bias may seem challenged by the finding that such an anxiety-linked bias is commonly observed when assessed without manipulating the emotional valence of ongoing, current information (e.g., as found by Miranda and Mennin, 2007). However, every participant will have had real world experiences up until the point of forming expectations of the future. Therefore, it is theoretically plausible that they could be utilising information pertaining to the emotional tone of their current experiences when forming their expectations of the future. According to the PNEH, pervasive negative expectancy in those high (compared to those low) in anxiety vulnerability is defined as an inflated expectancy for negative compared to positive future events, regardless of whether present events are negative or positive in emotional tone. This means that this mechanism is incompatible with the other two mechanisms (hypothesised by the EEH and NEH) as these latter two hypotheses concern an anxiety-linked bias in negative expectancy being modified by the emotional tone of present (recent) events. Therefore it is important that those with high anxiety vulnerability consistently showing a bias in negative expectancy compared to those low in anxiety vulnerability not be mistaken as a bias in pervasive expectancy, as the term ‘pervasive’ in this research refers to such a bias being unaffected by current events, and not to a bias that is consistently observed.
Experimental Approach to Discriminate the Validity ofAlternative Mechanisms Underlying an Anxiety-linked Bias in Negative Expectancy

In life, people typically anticipate future events, and in forming such expectations of the future they may consider how events have been proceeding to date. Thus, in order to empirically discriminate between these alternative mechanisms which may give rise to an anxiety-linked bias in negative expectancy, it would be important to not only ask participants what they think might happen in the future, but to do so in the context of events that have happened to date which may themselves be emotional in tone. Therefore, there is a recent or ongoing context that in principle may bear upon future expectations. In light of this, it is required that groups of individuals who are high and low in anxiety vulnerability complete a task which: 1) assesses their relative expectancy for future negative and positive events, and 2) provides the opportunity to manipulate the emotional tone of current information prior to assessing their expectancy for (negative and positive) future events that will likely occur next. Such a manipulation would enable the emotional tone of current scenarios to be either predominantly negative, predominantly positive, or emotionally balanced (that is, neither predominantly negative nor positive). This would allow the degree to which the introduction of predominantly, negative versus positive, current emotional tone impacts on the relative expectancies for negative and positive future events to be assessed.

The PNEH predicts that no matter whether current scenarios presented in this experimental task are predominantly negative, predominantly positive, or emotionally balanced, those with high anxiety vulnerability will show greater expectancy for negative than positive future events, relative to those with low anxiety vulnerability. Alternatively, the EEH predicts that those with high anxiety vulnerability will show greater expectancy for negative than positive future events in predominantly negative scenarios, and greater expectancy for positive than negative future events in
predominantly positive scenarios than those with low anxiety vulnerability, with this
effect being equally evident across predominantly negative and predominantly positive
scenarios. Furthermore, this hypothesis generates the prediction that there would be no
anxiety-linked difference in expectancy for negative or positive future events in
emotionally balanced scenarios. As another alternative, the NEH predicts that those
with high anxiety vulnerability (relative to those with low anxiety vulnerability) will
show inflated expectancy for negative compared to positive future events in
predominantly negative scenarios to a greater degree than their inflated expectancy for
positive compared to negative future events in predominantly positive scenarios.

Despite its seeming importance and relevance to anxiety, anxiety-linked patterns
of selective processing in the area of expectancy have been largely under-investigated.
Whilst there is evidence for an anxiety-linked bias in negative expectancy, the
mechanisms that may give rise to such a bias remain unknown as this has not been
explored in previous research. As mentioned earlier, previous experimental tasks
generally presented participants with future events without providing participants with
information regarding the current situation, which may plausibly lead to such future
events. The absence of such information means that the emotional valence of the current
situation could not be manipulated in order to differentiate between the possible
mechanisms giving rise to an anxiety-linked bias in negative expectancy. Determining
the exact nature of an anxiety-linked bias in negative expectancy in younger adults has
implications for understanding contributing factors to differences in anxiety
vulnerability between younger and older adults. This will be explored in further detail
below.

**Ageing and Anxiety Vulnerability**

While individuals differ along a continuum of anxiety vulnerability, some
cohorts are more resistant to experiencing high levels of anxiety vulnerability. For
example, males have generally lower prevalence rates of anxiety symptoms and anxiety disorders than females (see Craske, 2003, for a review, see McLean & Anderson, 2009). People who are married report lower levels of anxiety symptoms than those who have never been married (Casey, 2013). Moreover, employed individuals have also been noted to suffer from lower levels of anxiety symptoms compared to those who are unemployed (Casey, 2013; see Goldman-Mellor, Saxton, & Catalano, 2010, for review; Julkunen, & Carle, 1998).

Of greatest relevance to the present research program, older adults appear to show decreased vulnerability to anxiety, compared to younger adults (Wolitzky-Taylor, Castriotta, Lenze, Stanley & Craske, 2010), including experiencing lower levels of anxiety symptoms and anxiety disorders (Kryla-Lighthall, & Mather, 2009). This is surprising given that older age is typically accompanied by a number of losses that might be expected to compromise resilience, such as retirement, loss of friends and loved ones, and a decline in physical health (e.g., Garrett, 1987). In Australia, older adults have reported higher levels of wellbeing and significantly lower levels of anxiety symptoms than has been the case for younger adults in the Stress and Wellbeing Survey conducted each year over three years (see Casey, 2013). Some researchers point out the need for caution in interpreting this age-related decline in anxiety vulnerability (see Kogan, Edelstein, & McKee, 2000), due to a number of factors. One of these factors mentioned by Kogan et al. (2000) includes the tendency of prevalence studies to only include community dwelling older adults and not those who live in institutions. Another factor is the possibility that older adults may still experience anxiety that affects their functioning despite not meeting the Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition (DSM-IV; American Psychiatric Association, 2000) criteria for anxiety disorders which is used in many epidemiological studies. However, later studies, designed to overcome a number of methodological problems, including some
that have controlled for factors contributing to possible cohort effects such as income, education, and marriage, have demonstrated that well-being appears to be U-shaped across the lifespan. Well-being decreases with age, reaching its minimum during middle age, and then increases again into older adulthood (e.g., Blanchflower, 2008; Uppal, 2006). These studies suggest that anxiety vulnerability (at least in terms of self-report symptoms) follows an inverted U-shape across the lifespan since it increases with age and then decreases into older adulthood (see Jorm, 2000, for a review).

Gaining more knowledge regarding lower anxiety vulnerability in older populations may have particular importance in addressing higher levels of anxiety vulnerability in younger adults (as well as understanding such vulnerability when it does occur in older adults). This knowledge would also be important given increasing stressors in the current era (e.g., Bourbonnais, Comeau, Vezina, & Dion, 1998; Weber & Jaekel-Reinhard, 2000), and since stress is highly associated with anxiety (Cohen, 2000; Lovibond & Lovibond, 1995).

**Age-related Differences in Patterns of Selective Processing**

Contrary to research regarding young adults with high anxiety vulnerability, there is evidence that advancing age (i.e., older adulthood) is associated with patterns of selective processing which are instead characterised by a preference for positive information (e.g., Mather & Carstensen, 2005; Reed, Chan & Mikels, 2014). These patterns of selective processing in older adults have also been observed in the areas of attention, memory and interpretation, whereby there is a selective preference to focus on and recall positive information, as well as a tendency to selectively interpret ambiguous information in a positive manner. While patterns of selective processing in expectancy for future events have been established in younger adults with high anxiety vulnerability, this has not yet been investigated in older adults (i.e., a potential age-linked bias in negative expectancy). This information provides a potential source for
understanding why increasing age is associated with less anxiety vulnerability. It would not be unwarranted to anticipate that how people feel would likely be impacted on by what they expect the future to involve, and that this perception of the future may change with advancing age. In fact, there is evidence that older adults tend to be less future-oriented when compared to younger adults (e.g., Lennings, 2000). Given that older adults have been shown to demonstrate lower levels of anxiety vulnerability than younger adults, it may be that when thinking about the future, they demonstrate greater expectancy for positive relative to negative future events when compared to younger adults (i.e., an age-linked bias in negative expectancy\(^1\)). Other factors that may contribute to an age-related decrease in anxiety vulnerability include age-related changes to activation patterns across different areas of the brain in response to positive stimuli. For example, according to Mather et al. (2004), there is an age-related increase in amygdala activation in response to positive stimuli, though no change in amygdala activation in response to negative stimuli.

In light of the focus of the current research, what follows is an examination of age-linked selective processing biases in attention, memory and interpretation. Special emphasis will be placed on a potential age-linked bias in negative expectancy, and the possibility that age-linked differences in anxiety vulnerability might be associated with an age-linked bias in negative expectancy. This is an important focus of the current research.

**Age-linked attentional, memory and interpretive bias.**

Age-related differences in selective attentional processing have been observed, with older adults showing a processing advantage for positive information compared to

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\(^1\) Although previous literature refers to a ‘positivity effect’ or ‘positivity bias’ in older adults, the term ‘age-linked bias in negative expectancy’ is used in the current research when referring to a (negative relative to positive) bias in expectancy across age groups. This was done for the sake of consistency in the terminology used across age groups. Thus an ‘age-linked bias in negative expectancy’ refers to the anticipation that increasing age will be associated with reduced expectancy for negative relative to positive future events.
younger adults. This is referred to as an age-linked attentional bias. According to Mather and Carstensen (2005), older adults (who perceive that they are approaching the end of life) tend to use more of their time processing positive than negative emotional information compared to younger adults. Other studies (e.g., Isaacowitz, Toner, Goren & Wilson, 2008; Isaacowitz, Wadlinger, Goren, & Wilson, 2006; Leclerc & Kensinger, 2008) have also found that older adults tend to focus on/pay more attention to positive than negative information.

Not only are older adults more likely to attend to positive than negative information, older adults also appear to recall more positive than negative information compared to younger adults (Kennedy, Mather, & Carstensen, 2004). This preference for recalling more positive than negative information (i.e., age-linked memory bias) extends to pictures, emotional experiences, and options related to a recent decision (e.g., Charles, Mather, & Carstensen, 2003; Fung & Carstensen, 2003; Levine & Bluck, 1997; Mather, 2006; Mather & Johnson, 2000).

Despite the scarcity of research, there is some evidence of age-related differences in selective interpretation, with older adults again showing a processing advantage for positive information compared to younger adults (termed an age-linked interpretation bias). For example, older adults show a tendency to interpret ambiguous social information more positively than negatively (e.g., Werntz, Green, & Teachman, 2011).

**Age-related differences in negative expectancy.**

While age group differences in expectancy have not yet been investigated or empirically established, this previous research regarding the ‘positivity effect’ in older adulthood strongly suggests that older adults may show a decreased tendency to expect negative relative to positive future events and/or will be more likely to overestimate the probability of positive relative to negative future events, compared to younger adults.
Conversely, the fact that younger adults display a ‘negativity effect’ when compared to older adults suggests that they would be more likely to overestimate the probability of negative relative to positive future events and/or show a reduced tendency to expect positive relative to negative future events. In other words, it is anticipated that expectancy would differ between younger and older adults, with the pattern of expectancy observed in younger adults likely being attenuated in older adults. Investigating these potential age differences in negative expectancy is of research relevance as they may be associated with age-related differences in anxiety vulnerability and with why older adults show less anxiety vulnerability compared to younger adults. Furthermore, evidence for these anticipated age differences in expectancy cannot be obtained from previous research studies that have instead examined how attention, memory or interpretation differ with age. The nature of any age differences in expectancy may be contrary to those anticipated since expectancy involves considering the future, which can involve change and uncertainty. Should an age-linked bias in negative expectancy exist, this could potentially be explained by quite different patterns of selective processing in expectancy. There are two major possibilities regarding how patterns of selective processing in expectancy may differ with age in ways that could lead to an age-related reduction in anxiety vulnerability.

Specifically, it may be that future expectancy changes more generally as a function of age. In other words, it may be that there is an age group difference in the expected probability of negative relative to positive future events. Thus, it may be that older adults show reduced expectancy for negative relative to positive future events when compared to younger adults and that would lead to older adults not being as high in anxiety vulnerability.

Another more complex possibility is that the relationship between anxiety vulnerability and expectancy differs with age, such that there is an age-linked difference
in the degree to which there is an anxiety-linked bias in negative expectancy. Older adults may show a reduced association between expectancy and anxiety vulnerability in that an anxiety-linked bias in negative expectancy is attenuated in older than younger adults. Thus, older adults may not differ from younger adults in terms of their general tendency to expect negative relative to positive future events. However this same tendency to expect more negative than positive future events may be less anxiogenic such that it would not serve to produce elevated anxiety vulnerability in older adults as it does in younger adults.

Alternative Mechanisms Possibly Giving Rise to an Age-linked Bias in Negative Expectancy

Given that an age-linked bias in negative expectancy has not previously been investigated, the mechanisms that may give rise to such a bias (should it exist) are also unknown. Any of the three proposed candidate mechanisms that may give rise to an anxiety-linked bias in negative expectancy as discussed earlier (i.e., according to the PNEH, EEH and NEH) may also be found to give rise to either of these possibilities regarding how patterns of selective processing in expectancy may differ with age. Older adults may show a tendency to expect things to go well in the future and do not consider how the current situation is proceeding (i.e., whether it is going well or badly at present). This would be consistent with the PNEH, in that the cognitive system of older adults (compared to that of younger adults) may add a constant to the probability of positive future events when considering possible future outcomes. This results in positive outcomes being considered as more likely to occur than negative outcomes, in older than younger adults. This hypothesis generates the prediction that with regards to age, older adults will consistently display an inflated expectancy for positive compared to negative future events (and thus less inflated expectancy for negative compared to
positive future events), relative to younger adults, regardless of whether the current experience is negative or positive in emotional tone.

Or it may be that the emotional tone of the current experience contributes to the occurrence of an age-linked bias in negative expectancy. Older adults may show less of a general tendency to extrapolate from the emotional tone of the current experience such that their expectancy for future events that are consistent with the emotional tone of the current experience will be reduced to a greater extent than younger adults, such that older adults will show less extrapolation from current experiences to inform their future expectations. The EEH thus predicts that older adults will show reduced emotional extrapolation from the current experience, whether these are negative or positive (with this being equally evident across negative and positive experiences) when compared to younger adults.

Alternatively, it could be that while the emotional tone of the current experience contributes to the occurrence of an age-linked bias in negative expectancy, older adults only focus on positive current experiences and thus expect more positive than negative future events. Therefore, according to the NEH, older adults may differentially engage in extrapolation concerning the likelihood of future experiences, based on the emotional valence of the current experience. More specifically, according to this hypothesis, when the present experience is positive, older adults will be disproportionately more inclined to have greater expectancy for positive than negative future events to a greater degree than they will have greater expectancy for negative than positive future events when the present experience is negative.

**Experimental Approach to Discriminate Between Two Possibilities Regarding How Expectancy may differ with Age as well as Alternative Mechanisms.**

In order to distinguish between the two possibilities regarding how patterns of selective processing in expectancy may differ with age, it would be necessary to assess
expectancy in older and younger adults who are high and low in anxiety vulnerability. Furthermore, to investigate the proposed alternative mechanisms that may give rise to an age-linked bias in negative expectancy, an experimental task that distinguishes between these three mechanisms is required (as discussed earlier when referring to an anxiety-linked bias in negative expectancy). Such a task would need to assesses relative expectancy for future negative and positive events, and provide opportunity to manipulate the emotional tone of current information prior to assessing expectancy for negative and positive future events that will likely occur next. Should an age-linked bias in negative expectancy be observed (and whether this is characterised by age independently ameliorating negative expectancy or age attenuating an anxiety-linked bias in negative expectancy), the next important research question concerns the neuropsychological aspects of ageing that may contribute to this age-linked bias.

**Alternative Neuropsychological Accounts of Age-related Differences in Negative Expectancy**

Two classes of explanations have been put forward in the literature for why anxiety vulnerability may be less common with increasing age. First, there is the decline-based account (termed in this thesis the ‘Age-related Decline in Neurocognitive Capacity Account’). This proposes that a decline in the neurocognitive capacity of older adults results in less sensitivity to emotional information and thus reduced emotional responding during normal ageing. Second, there is the enhancement-based account (referred to here as the ‘Age-related Enhancement of Wisdom and Experience Account’). This account posits that the motivated prioritisation of emotional goals that accompanies increasing age, leads to better/more adaptive emotion regulation in older adults. Few research studies (to the author’s knowledge) have aimed to directly and empirically distinguish between these alternative neuropsychological accounts of age-linked differences in anxiety vulnerability, and there is certainly no research
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Distinguishing between these accounts in terms of an age-linked bias in negative expectancy. While these accounts are not the entire (or at least initial) focus of the present research, steps will be taken towards the end of the current series of experiments to determine the validity of these alternative accounts through more direct investigation. Previous literature has highlighted the urgent need for such research, investigating cognitive aspects of anxiety, ageing and their neural/neurocognitive basis, in order to develop assessment tools and interventions that are better suited to older adults (e.g., Mohlman, Beaudreau, & Price, 2015).

Age-related Decline in Neurocognitive Capacity Account

There is a long history of research on the neuropsychological deterioration that occurs during the normal ageing process, in the absence of disease, due to various gradual changes to the brain and brain functions (Harada, Love, & Triebel, 2013). The type, rate and extent of such changes tend to vary between individuals (O’Sullivan et al., 2001). These brain changes include morphological, inflammatory, oxidative, metabolic and neuromodulatory alterations.

Morphological changes encompass structural alterations to areas of the brain, and specifically, decline in size, weight and volume (Kemper, 1994; Scabill et al., 2003). There is extensive evidence that the brain shrinks with age (e.g., Good et al., 2002), and that this atrophy is accompanied by increases in cerebrospinal fluid (see Courchesne et al., 2000). Other structural changes include deterioration in white matter integrity or volume (Guttmann, et al., 1998).

The inflammatory changes that occur during healthy ageing involve the brain becoming more vulnerable to the effects of inflammation associated with infection and injury (Deleidi, Jäggle, & Rubino, 2015). Oxidative stress occurs when there is a build up of highly reactive molecules in cells due to an imbalance between the amount of reactive oxygen (free radicals) being produced and antioxidant defences (Betteridge,
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2000). This leads to structural changes to the brain and the way in which cells function, and has been observed during ageing (Pizza, Agresta, Iorio, & Capasso, 2013). Metabolic processes can also influence the brain and cognition during normal ageing. For example, there are various insulin receptors found in various areas of the brain (such as the hippocampus, entorhinal cortex and frontal cortex), typically involved in episodic memory and executive functioning (Craft et al., 2012). It has been suggested that irregularities in the way that the brain regulates and uses insulin contributes to age-related neurocognitive decline (Craft et al.). Neuromodulatory changes during normal ageing involve alterations to neurotransmitter systems in the brain (including cholinergic, dopaminergic, serotonergic and noradrenergic systems) and are thought to likely be associated with neurocognitive changes during the ageing process (Blandina, Efoudebe, Cenni, Mannaioni, Passani, 2004).

The neurological and neurocognitive changes associated with healthy ageing is a complex area of research comprising many avenues of research as highlighted above (e.g., morphological, inflammatory, oxidative, metabolic and neuromodulatory alterations with age). A detailed review of all these changes is beyond the scope of the current research program. For detailed reviews on such changes, please see Craft et al. (2012), Fjell and Walhovd (2010) and Li, Lindenberger, and Sikström (2001).

For the purpose of the current research, it is worth noting that there are a number of theories that propose one particular set of cognitive functions as undergoing the most decline (see Hedden & Gabrieli, 2004, for a review). These theories refer primarily to morphological brain changes with advancing age. Two of these theories are focused on in the current research given that the age-related neurological and neuropsychological changes they refer to (i.e., in the frontal and temporal lobes, and thus executive functions and episodic memory, respectively) are deemed to be the most
fundamental neurocognitive changes that occur with advancing age which have the greatest impact on daily functioning and quality of life.

**Prefrontal-executive theory of age-related neurocognitive decline.**

The Prefrontal-Executive Theory of age-related neurocognitive decline (West, 1996) refers to the frontal lobes being particularly vulnerable to decline during healthy ageing. Specifically, the prefrontal cortex (PFC) has been found to show greater rates of atrophy than other cortical regions in older adults (Driscoll et al., 2009; see Raz et al., 2005). There are also decreases in dopamine (Volkow et al., 2000), and greater white matter atrophy (Kennedy & Raz, 2009) and white matter lesions (Guttman et al., 1998) in the PFC with increasing age. One explanation for the normal ageing process having this predilection for frontal lobe deterioration is that cortical regions which are older from a phylogenetic perspective are the most resistant to decline during healthy ageing, while those cortical regions which emerged more recently are most vulnerable to decline (Kalpouzos et al., 2009). These age-related changes to the PFC are associated with poorer inhibition, attentional switching and planning abilities (Phillips & Henry, 2008; Salthouse, Atkinson, & Berish, 2003), as well as reductions in other executive abilities such as divided attention/dual task processing (e.g., see Sarter & Turchi, 2001, for a review).

Executive functions are defined as a collection of correlated but separable control processes that regulate lower level cognitive processes to shape complex performance (see Friedman et al., 2007). The term ‘executive function’ is typically used as a broad term for a number of abilities that guide actions or behaviours, such as: planning, working memory, initiation, monitoring of action and response inhibition (Knight & Stuss, 2002). Response inhibition is defined as the suppression of reflex-like, inappropriate, premature, or incorrect responses (Aron, Robbins, & Poldrack, 2004; Burle, Vidal, Tandonnet, & Hasbroucq, 2004). Attentional switching is described as the
ability to smoothly alter the focus of attention between stimuli or tasks when required (Bayless & Stevenson, 2007; Mirsky, Anthony, Duncan, Ahearn & Kellam, 1991). And importantly for the current research, divided attention (which is also often referred to as dual task processing), concerns the capacity to simultaneously focus attention on two or more tasks or stimuli (Loose, Kaufmann, Auer, & Lange, 2003).

Although caution is advised when proposing absolute functional-structural links between cognitive functions and specific or discrete neuroanatomical areas, the frontal lobes are involved in executive abilities (see Stuss, 2011, for a review). Importantly, some researchers have found that these age-related changes in executive functioning mediate age-related changes in other cognitive domains (Phillips & Henry, 2008; Salthouse et al., 2003). For example, these age-related changes in executive functioning are associated with, and can account for age-related changes (i.e., decline) in memory (Clarys, Bugaiska, Tapia, & Baudouin, 2009). This provides support for the idea that age-related changes in the frontal lobes and executive functions appear to be a fundamental aspect of the neurocognitive presentation associated with healthy ageing.

**Temporal lobe-memory theory of age-related neurocognitive decline.**

The Temporal Lobe-Memory Theory of age-related neurocognitive decline highlights the temporal lobes as also being vulnerable to deterioration during normal ageing. This involves subtle alterations (including structural changes and reduced activity) in the hippocampus and other medial temporal lobe structures (such as the entorhinal cortex and parahippocampal gyrus) during healthy ageing (Daselaar, Veltman, Rombouts, Raaijmakers, & Jonker, 2003; Raz et al., 2005). These age-related changes to the temporal lobes are associated with greater deficits in episodic memory and learning (Erickson & Barnes, 2003). Memory difficulties are commonly observed in community dwelling ‘healthy’ older adults (e.g., see Drag & Bieliauskas, 2010; Hoyer & Verhaeghen, 2006; Nyberg, Lövdén, Riklund, Lindenberger, & Bäckman, 2012). For
example, older adults show poorer episodic memory than younger adults, and
demonstrate reduced ability to learn and recall lists of words (see Craik & Bosman,
1992) and poorer recall for pictures and spatial locations (Craik, 1994). This, together
with the high prevalence rate of subjective memory impairment in community dwelling
older adults (which ranges from 27% to 43%; Reid & McLullich, 2006) and the
significant impact of memory impairment on quality of life in older adults (see Mol et
al., 2007, for a review), suggests that age-related changes in the temporal lobes and
memory functions are another important aspect of the neurocognitive variations
associated with healthy ageing.

**Global-processing speed theory of age-related neurocognitive decline.**

While not relevant to the current research, there is a Global-Processing Speed
Theory of age-related neurocognitive decline which describes demyelination of white
brain matter during normal ageing (Birren & Fisher, 1995; Lu et al., 2011). This has
been found to result in more global cognitive changes (particularly a general slowing of
processing speed) with increasing age (Finkel, Reynolds, McArdle, Hamagami, &
Pedersen, 2009; Salthouse, 1996, 2010).

**Relationship between age-related decline in neurocognitive capacity and an
age-related reduction in anxiety vulnerability.**

The neurocognitive changes that are consistently observed during normal
ageing, and which have a particularly significant impact on one’s daily functioning
(Tomaszewski Farias et al., 2009), are reductions in complex/divided attention (e.g., see
Sarter & Turchi, 2001) and episodic memory (Burke & Mackay, 1997; Hoyer &
Verhaeghen, 2006). It is possible that these very same neurocognitive changes may
impact on emotional processing as well as our response to emotional (i.e., negative or
positive) stimuli. The above-mentioned neurocognitive changes may alter older adults’
perceptions of emotional stimuli or, in other words, how emotional information is
recognised or appraised (e.g., Ruffman, Henry, Livingstone, & Phillips, 2008; Williams et al., 2006). As a result of older adults having reduced neurocognitive capacity when compared to younger adults, they may not process emotional stimuli in the same way that younger adults do and thus may respond differently to emotional stimuli and experience less anxiety as a result.

As discussed earlier, the decline that the frontal lobes (specifically the PFC) undergo during healthy ageing (Driscoll et al., 2009) has consequences for higher-level attention and a suite of other executive functions (including inhibition, planning, and working memory; see Phillips & Henry, 2008; Rypma, & D'Esposito, 2000), and in turn flow-on effects onto other cognitive functions such as memory (Clarys et al., 2009). This means that older adults may be less able to focus their attention on multiple sources of emotional stimuli (i.e., to use their divided attention) and thus may not be processing some emotional stimuli. As a result they may respond less negatively to such stimuli when compared to younger adults who have less difficulty with divided attention. It is possible that this age difference in divided attention capacity manifests as an apparent non-responsiveness to negativity in older adults when compared to younger adults. Moreover, neurological changes to the temporal lobes during healthy ageing means that older adults demonstrate reduced episodic memory and learning compared to younger adults (Craik & Bosman, 1992; Erickson & Barnes, 2003). Thus older adults may have poorer memory for emotional stimuli they are exposed to. Consequently, any emotional stimuli may be less anxiety provoking than it would be for younger adults. While not directly linked to anxiety, interestingly previous research has found that older adults are worse at recognising some emotions (such as anger and sadness) across various modalities (i.e., faces, voices, bodies/contexts and matching faces to voices). A neuropsychological account emphasising frontal and temporal lobe decline was found to explain this tendency (see Ruffman et al., 2008, for a review). Thus, age-related changes
to higher-level attention (i.e., divided attention) and memory appear to be good candidates for areas of neurocognitive decline, linking how older adults recognise and respond to emotional information, and demonstrate less anxiety vulnerability than younger adults.

Furthermore, negative stimuli may be more cognitively demanding to process than positive stimuli. If so, given that it is well established that older adults (at least generally, or on average) have reduced neurocognitive capacity relative to younger adults, it follows that older adults may be more likely than younger adults to process less negative stimuli in light of their reduced cognitive resources. This may lead to older adults appearing to show a preference for positive than negative stimuli when compared to younger adults, and thereby demonstrating less anxiety vulnerability than younger adults.

In light of the ways in which age-related neurological and neurocognitive changes may lead to a difference in how older adults respond to emotional stimuli and thus experience less anxiety, it is hypothesised in the current research that neurocognitive capacity (i.e., specifically memory and divided attention) would alter the extent to which age impacts on expectancy. This is investigated in two different ways across two different experiments in the current research. In line with this hypothesis it is predicted that age-related differences in memory (with older adults likely having poorer memory functioning than younger adults) may potentially mimic an age-linked bias in negative expectancy on an experimental task assessing relative expectancy, given that such a task involves retaining information regarding various current experiences in memory. Consequently, an age-linked bias in negative expectancy may be disproportionately more evident in the experimental condition that requires participants to retain information regarding current experiences in memory for a longer period of time (i.e., greater retention interval), than that which requires such information to be
retained in memory for a shorter period of time before recalling this information to provide expectancy ratings of future events (i.e., reduced retention interval). This may be due to older adults forgetting the information regarding current experiences to a greater extent in the greater retention interval condition than the reduced retention interval condition when compared to younger adults. This would result in greater age group differences in expectancy ratings of future events in the greater retention interval condition.

Also in line with the Age-related Decline in Neurocognitive Capacity Account, it is hypothesised that older adults with poorer divided attention capacity will show less evidence of an anxiety-linked bias in negative expectancy than those with greater divided attention capacity. In other words, older adults with poorer neurocognitive (divided attention) capacity will demonstrate a greater ‘positivity’ effect and thus less of an anxiety-linked bias in negative expectancy than those with greater neurocognitive (divided attention) capacity who will demonstrate less of a ‘positivity’ effect and more of an anxiety-linked bias in negative expectancy.

**Age-related Enhancement of Wisdom and Experience Account**

Other explanations in the literature for why anxiety vulnerability may be less common with increasing age involve other aspects of our neuropsychological functioning that improve rather than decline with advancing age: wisdom and experience. As people get older they are exposed to various situations and experiences which result in the accumulation of expertise through such life experiences. This may mean that despite the neurological and neurocognitive decline that occurs during healthy ageing, people actually get better at preventing, dealing with, and responding to, emotional stressors because they have encountered the same or similar stressors before. Older adults may have developed algorithms or heuristics to more efficiently deal with emotional stressors. These algorithms or heuristics would likely involve ‘shortcuts’ or
‘strategies’ to cope with various emotional experiences which have developed by older adulthood in order to compensate for no longer having as intact memory or attentional/executive skills. Therefore in one way the cognitive system of older adults becomes more efficient as these ‘shortcuts’ and ‘strategies’ are practiced through life experiences and previous exposure to various emotional stressors and situations.

One theoretical account belonging to this class of explanations for less anxiety vulnerability in older adults is Socioemotional Selectivity Theory (SST; Carstensen, Isaacowitz, & Charles, 1999), which makes predictions regarding the relative prioritising of goals over the lifespan (Löckenhoff & Carstensen, 2004). SST states that, with advancing age, people begin to perceive the remaining time in their lives as limited, and thus tend to be motivated to prioritise present-oriented goals such as emotional goals (i.e., gaining emotional fulfilment) over other life goals (Carstensen, Fung, & Charles, 2003; Löckenhoff & Carstensen, 2004). This leads to older adults tending to have greater emotional well-being, compared to younger adults who tend to perceive the future as open-ended and thus appear more likely to pursue goals related to optimising the future (such as knowledge acquisition) despite unpleasant emotional experiences associated with knowledge acquisition (Carstensen, 2006; Löckenhoff & Carstensen, 2004). In a number of research studies (see Fredrickson & Carstensen, 1990; Fung, Carstensen, & Lutz, 1999; Fung, Carstensen, & Lang, 2001), participants were told to imagine they had half an hour of free time with no pressing commitments and had chosen to spend that time with another person. They were given three options for this other person to be either a member of their immediate family, the author of a book they had just read, or an acquaintance with whom they appeared to have a lot in common. The familiar social partner represented an “emotionally meaningful goal” while the novel social partners represented a “future-oriented goal” related to gathering information and forming new relationships, respectively. Across these aforementioned
studies, older adults tended to prefer the familiar social partner whilst younger adults did not show this preference (see Löckenhoff & Carstensen, 2004). Evidence for SST theory has also been found in other situations in which the future may be perceived as limited and thus present-oriented emotional goals become prioritised over future-oriented goals. For example, these age differences were no longer demonstrated when older and younger adults were told to imagine that they were going to relocate to another part of the country in the near-future (Fredrickson & Carstensen, 1990). In this experimental condition, all participants (regardless of age) tended to prefer familiar social partners.

Another theoretical account, referred to as the Strength and Vulnerability Integration (SAVI) model (Charles, 2010), extends SST by proposing that age-related improvements in emotional well-being become apparent when older adults are able to utilise the strengths of ageing (which include skills pertaining to the frequent and successful use of appraisals, behaviour and attentional strategies) to avoid or neutralise a negative event. In contrast, when negative experiences cannot be easily avoided with the use of such skills, age-related improvements in emotional well-being are attenuated and can disappear altogether. According to Charles (2010), such occasions may include situations in which there is a threat to, or loss of, social acceptance, exposure to chronic stress and neurobiological dysregulation which make using these skills challenging.

Theoretical accounts such as SST lead to an opposing hypothesis and contrary predictions to that of the age-related decline in neurocognitive capacity class of explanations. Specifically, according to theoretical accounts like SST it is hypothesised that neurocognitive capacity would not significantly alter the extent to which age impacts on an anxiety-linked bias in negative expectancy. This is because it is the age-related enhancement of wisdom and experience (and according to SST particularly the motivated prioritisation of present-oriented emotional goals) rather than neurocognitive
decline with increasing age, that leads to less of an anxiety-linked bias in negative expectancy in older adults. Consistent with this hypothesis it is predicted that an anxiety-linked bias in negative expectancy in older adults will not differ as a function of neurocognitive capacity (i.e., whether they show better or worse divided attention). This would suggest that an age-related difference in an anxiety-linked bias in negative expectancy may be due to factors other than age-linked differences in neurocognitive capacity. One such factor may be the emotionally adaptive, motivation-related changes that accompany healthy ageing.

**Experimental Approach to Discriminate Between Two Alternative Neuropsychological Accounts of Age-related Differences in Negative Expectancy**

In order to test both these neuropsychological accounts of age-related changes and their potential contribution to an age-linked bias in negative expectancy, a sample of younger and older adults is required. It is also necessary that these samples include individuals high and low in anxiety vulnerability and that they complete an experimental task designed to assess expectancy as well as a neuropsychological measure to assess divided attention capacity. Furthermore it is important that these samples be exposed to two different conditions of the experimental task (greater retention interval vs. reduced retention interval) as a measure of any age differences in memory.

**Summary of the Present Research Programme**

**Main Objectives**

Given the lack of research into: (1) the mechanisms underlying an anxiety-linked bias in negative expectancy, (2) the possibility of an age-linked bias in negative expectancy and (3) the neuropsychological basis of this age-linked bias, the current research addresses three main questions. Firstly, what are the mechanisms that may give rise to an anxiety-linked bias in negative expectancy? Secondly, is there an age-linked
bias in negative expectancy? If so, what are the mechanisms that give rise to this age-related effect, and does this age-linked bias in negative expectancy represent an independent effect of age on expectancy, or does age moderate the expression of an anxiety-linked bias in negative expectancy? Thirdly, should an age-linked bias in negative expectancy be observed (whether it be the result of an independent effect of age on expectancy or an interactive effect of age and anxiety on expectancy), what is the neuropsychological basis of this age-linked effect?

In line with these research questions, the present research has a number of main objectives which include: (1) to develop and deploy an experimental task capable of sensitively assessing relative expectancy for negative and positive future events, and the mechanisms that underpin anxiety-linked and age-linked differences in such relative expectancies, in order to (2) use this experimental task to further determine the existence of an age-linked bias in negative expectancy and to reveal the mechanisms that give rise to such an age-linked effect should it be obtained, (3) to establish whether an age-linked bias in negative expectancy reflects age independently ameliorating negative expectancy or age attenuating an anxiety-linked bias in negative expectancy, and (4) to reveal whether the neuropsychological basis of any observed age-related differences in expectancy is that of age-related decline in neurocognitive capacity or age-related enhancement of wisdom and experience. On the basis of the existing literature, any of the proposed mechanisms and hypotheses may be supported. It should be noted that this program of research was not designed to “champion” one of these possibilities in preference to the others. Rather this research was designed to test which, if any, of these possibilities is supported by the empirical evidence.

Method

The current research involved developing a task that presents high and low trait anxious participants with hypothetical scenarios and then asks them to rate the
likelihood of future events occurring in each of these scenarios. This task not only assesses the relative expectancy for negative and positive future events (as have tasks used in previous studies), but also provides the opportunity to manipulate the emotional tone of the information contained in current scenarios, to observe the impact of this on expectancy for future events in these scenarios. Such a manipulation enables the emotional tone of the current scenarios to be either predominantly negative, predominantly positive, or emotionally balanced (that is, neither predominantly negative nor predominantly positive in emotional tone). This, in turn, allows the degree to which the introduction of a predominantly negative or predominantly positive current emotional tone impacts on the relative expectancies for negative and positive future events to be assessed. This enables the differentiation between the three proposed alternative mechanisms that may give rise to an anxiety-linked bias in negative expectancy.

Once such a task was developed (i.e., the Expectancy Assessment Task – discussed in more detail in Chapter 2), this task was first used in Experiment 1 to investigate the alternative mechanisms that may give rise to an anxiety-linked bias in negative expectancy in a younger adult sample (see Chapter 2). The results did reveal an anxiety-linked bias in negative expectancy such that those with high trait anxiety show greater expectancy for negative than positive future events when compared to the low trait anxious. The mechanisms giving rise to this anxiety-linked bias in negative expectancy were also revealed.

The Expectancy Assessment Task was then used in younger and older adult samples comprised of low and high trait anxiety groups in Experiment 2 order to investigate the existence of an age-linked bias in negative expectancy. This task was also used to assess whether this age-linked effect (should it exist) represents an independent effect of age on expectancy or an interactive effect of age and anxiety on
expectancy, as well as to illuminate the mechanisms that may give rise to any observed age-related effects (see Chapter 3). Additionally, there were two experimental conditions of the Expectancy Assessment Task, which differed in the period of time for which participants had to retain information regarding current experiences in memory (i.e., greater retention interval vs. reduced retention interval). This was to investigate whether age-related differences in memory may potentially mimic an age-linked bias in negative expectancy on this task. Along with replicating the previously found anxiety-linked bias in negative expectancy, the results also confirmed the existence of an age-linked bias in negative expectancy such that older adults show greater expectancy for positive than negative future events when compared to younger adults. This age-linked bias in negative expectancy was found to represent an interactive effect of age and anxiety on expectancy, such that age moderates the expression of an anxiety-linked bias in negative expectancy. The mechanisms that give rise to this observed age-linked effect were also illuminated. Moreover, there was a strong trend for an age-related difference in expectancy (characterised by age independently ameliorating negative expectancy) being disproportionately more evident in the greater retention interval, with no age differences in expectancy in the reduced retention interval. This suggests that age differences in memory appear to mimic an age-linked bias in negative expectancy characterised by age independently ameliorating negative expectancy.

After obtaining these results (as noted above), the possibility was identified that, in principle, the observed impact of age on the expression of an anxiety-linked bias in negative expectancy in this experiment potentially may instead have been carried by an unintended age group difference in state anxiety, due to the older adults being less familiar with the testing environment than the younger adults and as a result perhaps more state anxious. The Expectancy Assessment Task was then used in Experiment 3 to test the viability of this alternative account (see Chapter 4), by determining whether the
experimental induction of elevated state anxiety would lead younger adults to display the pattern of findings exhibited by the older adults in the previous experiment. This was not the case, rendering implausible the state anxiety account of the previously observed impact of age on the expression of an anxiety-linked bias in negative expectancy.

Finally, the Expectancy Assessment Task was used (along with a neuropsychological measure of divided attention/dual task processing) in an experiment designed to discriminate the validity of two competing neuropsychological accounts of the observed age-linked bias in negative expectancy. One of these accounts implicates an age-related decline in neurocognitive capacity, and the other implicates an age-related enhancement of wisdom and experience (see Chapter 5). To investigate this, younger and older adult samples comprised of low and high trait anxiety groups were recruited as participants in Experiment 4 in order to allow for comparisons across age and trait anxiety groups. The results provided support for the former account, by revealing that neurocognitive capacity (particularly divided attention/dual task processing capacity) influences the impact that age has on the expression of an anxiety-linked bias in negative expectancy. Specifically, an anxiety-linked bias in negative expectancy was found to be most evident (rather than least evident) in older participants who demonstrate least evidence of neurocognitive deficits. In other words, an attenuated anxiety-linked bias in negative expectancy was observed in older adults who showed greater neurocognitive deficits (i.e., in divided attention/dual task processing) rather than those who demonstrated more intact neurocognitive capacity.
CHAPTER 2: EXPERIMENT 1 - Anxiety-linked Bias in Negative Expectancy in Younger Adults

Introduction

As outlined in Chapter 1, there is evidence that anxiety is characterised by, predominantly, future-oriented concerns (e.g., Barlow, 2002; Brown et al., 1993; Kendall & Watson, 1989). Individuals with high anxiety vulnerability appear to exhibit an elevated tendency to anticipate negative or harmful future events (e.g., Borkovec, Alcaine, & Behar, 2004; MacLeod et al., 1997; Miranda & Mennin, 2007). This is true of both clinical and analogue samples. For example, those with generalised anxiety disorder (Miranda & Mennin, 2007), panic disorder (MacLeod et al., 1997) and high trait anxiety (Stöber, 2000) make more pessimistic predictions of the future compared to those without such disorders or who are low in anxiety vulnerability. This propensity for individuals with high anxiety vulnerability compared to those with low anxiety vulnerability to have relatively heightened expectations for negative relative to positive future events is referred to here as an anxiety-linked bias in negative expectancy.

Numerous research studies have demonstrated that other anxiety-linked biases (e.g., anxiety-linked attentional bias) are characterised by a preference for negative relative to positive information of a social nature, when anxiety vulnerability is associated with social concerns (such as in social phobia), and by a preference for negative relative to positive information of a physical nature, when anxiety vulnerability is associated with physical concerns, such as in panic disorder (see Bar-Haim et al., 2007; e.g., Foa, Franklin, Perry, & Herbert, 1996; Lucock & Salkovskis, 1988). Moreover, younger adults have been found to show increased anxiety when faced with social anxiety provocations when compared to older adults, for whom physical health

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2 Experiment 1 is reported in a published, peer-reviewed journal article of which the PhD candidate is a co-first author (see Cabeleira et al., 2014). However, this experiment has been reanalysed and rewritten here for thematic consistency within this PhD thesis.
Anxiety-linked Bias in Negative Expectancy

triggers are a common source of anxiety (Teachman & Gordon, 2009). Few studies to the author’s knowledge have compared an anxiety-linked bias in expectancy for future negative events of a social nature to anxiety-linked bias in expectancy for future negative events of a physical nature, such as events concerning physical/health-related matters. While the impact of the content of scenarios (i.e., constituting either social or physical concerns) on an anxiety-linked bias in negative expectancy has not specifically been investigated, it seems plausible (given previous research findings) that such a bias may be more evident for events that are likely to have greater personal relevance for the particular groups of participants being assessed.

Although there is research evidence that those high in anxiety vulnerability display disproportionately more negative than positive expectations of the future compared to those who are low in anxiety vulnerability, the mechanisms that may give rise to this anxiety-linked bias in negative expectancy have not been established (as highlighted in Chapter 1). Thus, (i) developing an experimental task to assess an anxiety-linked bias in negative expectancy, (ii) verifying the capacity of this task to detect such a bias, and (iii) determining what mechanisms may account for an anxiety-linked bias in negative expectancy, remains an important research focus that would add to current knowledge of the cognitive processes involved in anxiety vulnerability. This would, in turn, inform what cognitive processes could be targeted in therapeutic approaches to treat anxiety.

As explored in detail in Chapter 1, there are several proposed candidate mechanisms that may account for an anxiety-linked bias in negative expectancy. In terms of the first candidate mechanism (i.e., according to the Pervasive Negative Expectancy Hypothesis; PNEH) it may be that the cognitive system of those with high anxiety vulnerability (compared to that of those with low anxiety vulnerability) may add a constant to the probability of negative future events when considering possible
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outcomes. This results in negative outcomes being considered as more likely to occur than positive outcomes, in those with high anxiety vulnerability compared to those with low anxiety vulnerability. This hypothesis generates the prediction that those high in anxiety vulnerability will consistently display an inflated expectancy for negative compared to positive future events, relative to those low in anxiety vulnerability, no matter whether current experiences are predominantly negative, predominantly positive, or emotionally balanced.

The second candidate mechanism assumes that people will generally extrapolate from the emotional tone of current events such that their expectancy for future events that are consistent with the emotional tone of current events will be heightened. In other words, the way in which individuals construe the present will determine their expectations of the future. According to the Emotional Extrapolation Hypothesis (EEH), this second candidate mechanism concerns those with high anxiety vulnerability showing a strong general tendency to extrapolate from current experiences to inform their future expectations, to a greater extent than those with low anxiety vulnerability. Thus the way in which those with high anxiety vulnerability construe the present will determine their expectations of the future to a greater degree than it would for those with low anxiety vulnerability. This means that when those with high anxiety vulnerability are currently experiencing negative events (which has been proposed as likely for those with high trait anxiety) then this heightened emotional extrapolation will lead to disproportionately greater expectations for negative future events than it would for those with low anxiety vulnerability. Those with high anxiety vulnerability will also show heightened expectations for positive future events when current events are positive, to a greater extent than those with low anxiety vulnerability. Therefore, it is predicted that those with high anxiety vulnerability will show greater expectancy for negative than positive future events in predominantly negative scenarios, and greater
expectancy for positive than negative future events in predominantly positive scenarios than those with low anxiety vulnerability. This effect would be equally evident across predominantly negative and predominantly positive scenarios. Furthermore, it is predicted that there would be no anxiety-linked difference in expectancy for negative or positive future events in emotionally balanced scenarios.

The third candidate mechanism also assumes that emotional extrapolation from current events to inform expectations of the future will occur. However, this mechanism attributes an anxiety-linked bias in negative expectancy to a disproportionate tendency to exhibit such emotional extrapolation from current negative events as opposed to current positive events in those with high anxiety vulnerability. Therefore this mechanism (i.e., according to the Negative Extrapolation Hypothesis; NEH) involves those with high anxiety vulnerability differentially engaging in extrapolation concerning the likelihood of future experiences, based on the emotional valence of the present experience. More specifically, when the current experience is negative, those high in anxiety vulnerability (compared to those low in anxiety vulnerability) will be disproportionately inclined to have greater expectancy for negative than positive future events. Importantly, this will be greater than their elevated expectancy for positive than negative future events when the current experience is positive. Therefore, this NEH generates the prediction that those with high anxiety vulnerability (relative to those with low anxiety vulnerability) will show inflated expectancy for negative compared to positive future events in predominantly negative scenarios to a greater degree than their inflated expectancy for positive compared to negative future events in predominantly positive scenarios.

Testing these three hypotheses concerning the alternative mechanisms that may give rise to an anxiety-linked bias in negative expectancy requires assessing the degree to which a group of high trait anxious and low trait anxious individuals differ on a task
Anxiety-linked bias in negative expectancy that: 1) assesses the relative expectancy for future negative and positive events, and 2) provides the opportunity to manipulate the emotional tone of the information contained in current scenarios made available to these individuals prior to assessing their expectancy for future events that will likely transpire in these scenarios. This manipulation enables the emotional tone of current scenarios to be either predominantly negative, predominantly positive, or emotionally balanced (that is, neither predominantly negative nor predominantly positive in emotional tone). This will allow the degree to which the introduction of a predominantly negative and the introduction of a predominantly positive current emotional tone impacts on the relative expectancies for negative and positive future events to be assessed. To investigate whether an anxiety-linked bias in expectancy differs between materials that may be of greater personal relevance for some groups of participants than others, a task including different types of materials that may be personally relevant to different groups of participants was required. Specifically, scenarios containing information relevant to social and physical concerns were needed. Should an anxiety-linked bias in expectancy be observed, this may be restricted to social or physical scenarios for different groups of participants.

The current study had two aims. The first aim was to develop an experimental task to assess relative expectancy for negative and positive future events and an anxiety-linked bias in negative expectancy, as well as to verify the capacity of this task to detect such an anxiety-linked effect. The finding that those with high trait anxiety display heightened expectancy for negative relative to positive future events compared to the low trait anxious would provide support for the sensitivity of the task in detecting an anxiety-linked bias in negative expectancy.

The second aim was to determine what mechanisms may give rise to an anxiety-linked bias in negative expectancy. Achieving this aim involved testing the differing predictions made by the three hypotheses concerning the proposed alternative
mechanisms and the manner in which such an anxiety-linked bias will be influenced by experimental manipulation. This anxiety-linked effect may (as predicted by the EEH and NEH) or may not (as predicted by the PNEH) be affected by the emotional valence of the current scenario. The PNEH predicts that the degree to which negative relative to positive future events are rated as more probable will be greater for the high compared to the low trait anxious, no matter whether current scenarios are predominantly negative, predominantly positive, or emotionally balanced. The EEH predicts that the degree to which future events that are emotionally congruent with the predominant valence of the current scenario are rated as more probable will be greater in the high than the low trait anxious. This effect will be equally evident across predominantly negative and predominantly positive scenarios, and there will be no trait anxiety group difference in emotionally balanced scenarios. The NEH predicts that the high trait anxious will show inflated expectancy for negative compared to positive future events in predominantly negative scenarios to a greater degree than their inflated expectancy for positive compared to negative future events in predominantly positive scenarios, when compared to the low trait anxious. As mentioned, an anxiety-linked bias in negative expectancy could be more evident in scenarios that may have greater personal relevance to a particular group of individuals (regardless of the mechanisms found to give rise to this bias). As such it may be expected that this anxiety-linked bias would be more evident in social than physical scenarios given that the sample in the current experiment is comprised of younger adults, who have been found in previous research to show increased anxiety when faced with social anxiety provocations when compared to older adults.
Method

Participants

To investigate an anxiety-linked bias in negative expectancy in young adults, two groups of young adults between the ages of 17 and 25 were needed, with these groups differing significantly in terms of trait anxiety (i.e., constituting a high trait anxiety and a low trait anxiety group). Further, it was required that the two groups did not differ significantly in terms of age or gender ratio.

Thirty-two young adult first year psychology undergraduates were recruited based on age (i.e., between the ages of 17 and 25), gender (i.e., to ensure equal numbers of males and females within and across groups) and score on the Trait form of the State-Trait Anxiety Inventory (STAI-T; Spielberger, 1983). Cut-off scores for inclusion in the high trait anxiety and low trait anxiety groups were determined using the mean trait anxiety score for college students found in the STAI-T manual (Spielberger). For inclusion in the high trait anxiety group, participants were required to score at least one standard deviation (SD = 9.67) above the mean trait anxiety score (M = 39.35) for college students, therefore scoring 50 or above on the STAI-T. For inclusion in the low trait anxiety group, participants were required to score at least one standard deviation below this mean trait anxiety score, therefore scoring 29 or below on the STAI-T. In total there were 16 low trait anxious participants (age M = 17.75 years, SD = 1.39) and 16 high trait anxious participants (age M = 17.38 years, SD = 0.89), with gender balanced within each group (i.e., 8 females and 8 males in each trait anxiety group).

An independent samples t-test revealed that, as required, the low trait anxious and high trait anxious groups differed significantly in terms of trait anxiety, \( t(30) = 27.79, p < .001, d = 9.82 \), such that the high trait anxious had higher trait anxiety scores (High trait anxious M = 54.81, SD = 3.23) than the low trait anxious (Low trait anxious
M = 25.88, SD = 2.63). As required, no significant trait anxiety group difference in age was observed, \( t(30) = 0.91, p = .370, d = 0.32. \)

Materials

**Trait anxiety questionnaire measure.**

The Trait form of the State-Trait Anxiety Inventory (STAI-T; Spielberger, 1983) was used to measure dispositional anxiety. The STAI-T consists of 20 items, describing symptoms of anxiety, which are rated on a 4-point scale ranging from 1 (“Almost never”) to 4 (“Almost always”) in terms of the tendency to experience these symptoms. Total scores on this inventory can vary from 20 to 80, with higher scores representing higher levels of trait anxiety. Both the reliability (Barnes, Harp, & Jung, 2002) and validity (Spielberger, 1983) of the STAI-T are well recognised. Cronbach’s alpha was .96 for the STAI-T in Experiment 1.

**Expectancy assessment task stimuli.**

The Expectancy Assessment Task presented scenarios describing everyday situations. These scenarios were predominantly negative, predominantly positive or emotionally balanced (i.e., neither predominantly negative, nor predominantly positive). In total, 64 Scenario Stimulus Clusters were required as experimental stimuli, from which scenarios could be generated for the Expectancy Assessment Task. Each Scenario Stimulus Cluster contained 11 items including: a title, an orienting sentence, 3 candidate negative events, 3 candidate positive events and 3 candidate filler events. It was required that emotional events within each of the Scenario Stimulus Clusters be designed to be similar in absolute emotional intensity, whether positive or negative in nature. All filler events within each of the Scenario Stimulus Clusters were required to be devoid of any emotional tone. Half the Scenario Stimulus Clusters were required to represent one of two domain types since these may be differentially associated with an anxiety-linked bias in expectancy. Specifically, 32 Scenario Stimulus Clusters
representing social scenarios, and 32 Scenario Stimulus Clusters representing physical/health-related scenarios were required.

**Stimulus development and selection.**

First, a total of 75 Scenario Stimulus Clusters were created, each consisting of 15 possible events with 5 of these designed to be positive, 5 designed to be negative and 5 designed to be fillers (i.e., devoid of any emotional tone), respectively. These scenario stimulus clusters were presented to an independent sample of 16 participants (8 males and 8 females) aged 17 to 75 (M = 39.13, SD = 20.65) in order to maximise the relevance of ratings to both younger and older adult groups for subsequent experiments. Participants rated each of the 15 possible events for each of the 75 scenario stimulus clusters, in terms of emotional valence and domain type. When rating emotional valence, ratings ranged from -3 (“Extremely negative”) to 3 (“Extremely positive”). For rating domain type, each statement was rated either as a social event (indicated by “S”) or physical event (indicated by “P”).

After gathering the ratings provided by the independent sample of participants, a final set of 64 Scenario Stimulus Clusters were selected using these rating data. Events for which fewer than 75% of raters agreed that they were either a social or physical scenario type were excluded. For an event to be selected as an emotionally negative event, its average rating had to be -1 or lower. For an event to be selected as an emotionally positive event, its average rating had to be 1 or above. For an event to be selected as a filler (i.e., devoid of any emotional tone), its average rating had to be within 0.5 of the zero midpoint. Finally, Scenario Stimulus Clusters that contained fewer than 3 eligible events per emotional valence (negative, positive and filler) were excluded.

Across the 64 Scenario Stimulus Clusters selected as experimental stimuli, half represented social scenarios, and the other half represented physical/health-related
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scenarios. An example of a selected Social Scenario Stimulus Cluster consisting of 11 items can be seen below in Example 1. An example of a selected Physical Scenario Stimulus Cluster consisting of 11 items can be seen below in Example 2.

Example 1
Example Social Scenario Stimulus Cluster

The Party (Title)

Your friend invites you to attend a party, you arrive at the party (Orienting sentence)

You are not introduced to any other guests (Negative Candidate Event A)

You stumble over a step as you enter a room (Negative Candidate Event B)

You find it difficult to join in with others’ conversations (Negative Candidate Event C)

Everyone enjoys an anecdote you tell (Positive Candidate Event A)

You have a great night making new friends (Positive Candidate Event B)

Someone compliments your smile (Positive Candidate Event C)

You check your keys are in your pocket (Filler Candidate Event A)

You ask where the bathroom is (Filler Candidate Event B)

You notice another guest is wearing red glasses (Filler Candidate Event C)

Example 2
Example Physical Scenario Stimulus Cluster

Going to the Doctor (Title)

You go to the doctor’s rooms (Orienting sentence)

You find out you need a biopsy done (Negative Candidate Event A)

The doctor prescribes you medication that can have bad side effects (Negative Candidate Event B)
The doctor warns you all your family is at risk of diabetes (Negative Candidate Event C)

The doctor says your heart sounds very healthy (Positive Candidate Event A)

The doctor informs you that you are at a healthy weight (Positive Candidate Event B)

The doctor says she is happy with your exercise regime (Positive Candidate Event C)

A bird flies past the window (Filler Candidate Event A)

The telephone rings (Filler Candidate Event B)

You notice a car drive by outside (Filler Candidate Event C)

The absolute values of the mean valence ratings for the emotionally positive and emotionally negative selected events were found to be very similar (-1.86 for negative and 1.94 for positive), indicating that these differently valenced events were similar in terms of emotional intensity. Selected filler events had an average rating of 0.10, indicating the absence of emotional tone.

**Apparatus.**

The task was presented on a 22in wide-screen computer and participants responded using numerical keys on the keyboard for ratings and the spacebar to request the next sentence and/or screen. All letters presented were 6mm by 6mm in size and each item/sentence was presented on a single line, no more than 80 characters in length.

**Expectancy Assessment Task**

In the Expectancy Assessment Task, participants were instructed to read and imagine themselves in hypothetical scenarios (which were either predominantly negative, predominantly positive or emotionally balanced) presented event by event on a computer screen (referred to as the Scenario Reading Component), then to make judgements concerning the likelihood of candidate future events occurring next in each scenario (referred to as the Expectancy Rating Component). Scenarios presented in the
Scenario Reading Component of the task were created using the 64 Scenario Stimulus Clusters selected as experimental stimuli. Each scenario consisted of 6 of the 11 items contained in a Scenario Stimulus Cluster: a Title, an Orienting sentence and the same number of possible events. Two events for each emotional valence (e.g., negative and positive) was deemed necessary to ensure that the valence of events was adequately encoded for predominantly negative and predominantly positive scenarios, respectively. Therefore, emotionally balanced scenarios (which were neither predominantly negative nor predominantly positive) contained 2 negative and 2 positive events (i.e., containing the following from a Scenario Stimulus Cluster: Negative Candidate Event A, Negative Candidate Event B, Positive Candidate Event A and Positive Candidate Event B). Given that predominantly negative and predominantly positive scenarios would only contain 2 negative (i.e., Negative Candidate Event A and Negative Candidate Event B) or 2 positive events (i.e., Positive Candidate Event A and Positive Candidate Event B) respectively, 2 filler events (i.e., Filler Candidate Event A and Filler Candidate Event B) were included in such scenarios to ensure the same number of events (i.e., 4 events) across the 3 types of differently valenced scenarios (i.e., predominantly negative, predominantly positive and emotionally balanced scenarios). During the Expectancy Rating Component, the remaining 3 of the 11 items contained in a Scenario Stimulus Cluster were presented, each of a different type of emotional valence (i.e., Negative Candidate Event C, Positive Candidate Event C, and Filler Candidate Event C).

**Format of individual trials.**

**Scenario reading trials.**

On a scenario reading trial of the Expectancy Assessment Task, participants were instructed to read and imagine themselves in hypothetical scenarios, which were either predominantly negative (see Example 3), predominantly positive (see Example 4)
or emotionally balanced (see Example 5), presented event by event on a computer screen (please refer to Appendix 2 for the verbatim instructions provided to participants).

Example 3
Example of a Predominantly Negative Scenario

Going to the Doctor (Title)
You go to the doctor’s rooms (Orienting sentence)
You find out you need a biopsy done (Negative Candidate Event A)
The doctor prescribes you medication that can have bad side effects (Negative Candidate Event B)
A bird flies past the window (Filler Candidate Event A)
The telephone rings (Filler Candidate Event B)

Example 4
Example of a Predominantly Positive Scenario

Going to the Doctor (Title)
You go to the doctor’s rooms (Orienting sentence)
The doctor says your heart sounds very healthy (Positive Candidate Event A)
The doctor informs you that you are at a healthy weight (Positive Candidate Event B)
A bird flies past the window (Filler Candidate Event A)
The telephone rings (Filler Candidate Event B)
Example 5

Example of an Emotionally Balanced Scenario

Going to the Doctor (Title)

You go to the doctor’s rooms (Orienting sentence)

You find out you need a biopsy done (Negative Candidate Event A)

The doctor prescribes you medication that can have bad side effects (Negative Candidate Event B)

The doctor says your heart sounds very healthy (Positive Candidate Event A)

The doctor informs you that you are at a healthy weight (Positive Candidate Event B)

Sentences were read at a self-paced rate. Participants were instructed to press the spacebar key once they had read each sentence and were ready for the next sentence. After the next sentence appeared, the sentence they had just read became a line of crosses. Thus, in each scenario, the participant pressed the spacebar key to be presented with the Title, then pressed the spacebar again to see the Orienting sentence. Pressing the spacebar a third time resulted in one of the possible events appearing. Pressing the spacebar a fourth, fifth and sixth time (after reading each sentence) brought up another possible event occurring in that scenario.

*Expectancy rating trials.*

On each expectancy rating trial of the Expectancy Assessment Task, first, the Title of a previously read scenario appeared at the top of the screen, along with the Orienting sentence for that scenario. Below this were 4 lines of crosses, representing the sequence of events presented earlier in that scenario. In the middle of the screen, 3 future events, each of a different emotional valence (negative, positive or filler), were presented (see Example 6). Each described an event that might or might not happen next. Participants were told that, although they could not be sure of what would happen
next, they were required to judge the subjective likelihood of each of the three events happening next, given what had already happened in that scenario. The first of the 3 future events was presented in yellow (instead of white) text, indicating that this event needed to be rated first. Once a rating was provided, the next event was presented in yellow text until a rating was provided. Then the last of the 3 events was presented in yellow text until a rating was provided. At the bottom of the screen a scale ranging from 1 to 4, along with verbal anchors for each score was presented: with 1 indicating the event is “Very unlikely”, 2 “Somewhat unlikely”, 3 “Somewhat likely” and 4 “Very likely” to happen next. Participants were required to press the corresponding numerical key to indicate their response.

Example 6
Example of the three Future Events presented during the Expectancy Rating Trial of a Physical Scenario

The doctor warns you all your family is at risk of diabetes (Negative Future Event / Negative Candidate Event C)

The doctor says she is happy with your exercise regime (Positive Future Event / Positive Candidate Event C)

You notice a car drive by outside (Filler Future Event / Filler Candidate Event C)

**Trial conditions.**

For each participant, half of the scenarios (i.e., 32 scenarios) were presented as either predominantly negative (i.e., 16 scenarios) or predominantly positive (i.e., 16 scenarios). In these scenarios, the four events presented in the Scenario Reading Component of the task constituted a pair of emotional events (negative or positive) and a pair of filler events. The order of these pairs was counter-balanced. The other half of
the scenarios (i.e., 32 scenarios) were presented as emotionally balanced scenarios. In these scenarios, the four events presented in the Scenario Reading Component of the task constituted a pair of emotionally negative events and a pair of emotionally positive events. Again, order was counter-balanced.

**Trial blocking.**

Four scenarios were sequentially presented (i.e., 4 scenario reading trials) before requiring expectancy ratings for potential future events in each of these scenarios (i.e., 4 expectancy rating trials). This will be referred to as a presentation block of 4 scenarios. It was recognised that requiring expectancy ratings for potential future events immediately after each scenario (i.e., a presentation block of 1 scenario) could potentially encourage participants to adopt the strategy of basing their reported expectancies directly on the emotional tone of the immediately preceding passage. Thus it was considered desirable to present blocks of scenarios, then ask participants to report their expectations concerning future events pertaining to each of the scenarios in the preceding block. It was also thought to be important that not too much time should pass between reading scenarios and rating future events for each scenario, to ensure that participants did not forget what they had read. Four scenarios was considered to be an appropriate number of scenarios to present in each block (i.e., 4 scenario reading trials) before requiring expectancy ratings for future events associated with each of the scenarios in the preceding block (i.e., 4 expectancy rating trials).

Across the study, a total of 64 scenarios were presented in 16 presentation blocks of 4 scenarios. For each participant, half of the predominantly negative, predominantly positive and emotionally balanced scenarios were social scenarios while the other half of each type of valenced scenarios were physical scenarios. Across participants, the probability of a scenario being encountered in any one of the three valenced conditions was equivalent.
Computation of expectancy indices.

Three Expectancy Index scores were calculated using the mean expectancy scores obtained on the Expectancy Assessment Task. These were calculated in order to investigate each of the three hypotheses regarding alternative mechanisms that may give rise to an anxiety-linked bias in negative expectancy, as proposed earlier.

**Negative expectancy index.**

A Negative Expectancy Index was computed to investigate the PNEH. This index expressed the degree to which there was greater expectancy for negative relative to positive future events across predominantly negative, predominantly positive, and emotionally balanced scenarios. This Index was calculated by computing the degree to which expectancy ratings for negative future events were higher, on average, than expectancy ratings for positive future events in predominantly negative, predominantly positive and emotionally balanced scenarios. Given that the raw expectancy ratings that can be made by participants on the Expectancy Assessment Task range from 1 to 4, scores on the Negative Expectancy Index can range from -3 to 3, with lower scores indicating relatively greater positive than negative pervasive expectancy (i.e., greater expectancy for positive than negative future events across conditions), and greater scores indicating relatively greater negative than positive pervasive expectancy (i.e., greater expectancy for negative than positive future events across conditions).

**Emotional extrapolation index.**

The Emotional Extrapolation Index was computed to investigate the EEH. This Index expressed the degree to which expectancy ratings for emotional future events that match the emotional valence of the predominantly positive or predominantly negative scenarios are higher, on average, than the expectancy ratings for emotional future events that contradict the emotional valence of these scenarios. Scores on this Index may range
from -3 to 3, with lower scores indicating less emotional extrapolation and greater scores indicating greater emotional extrapolation.

**Negative extrapolation index.**

A Negative Extrapolation Index was computed to investigate the NEH. The degree to which the elevation of expectancy for negative relative to positive future events is greater in predominantly negative scenarios than in emotionally balanced scenarios was computed as an index of Relatively Negative Extrapolation. The degree to which the elevation of expectancy for positive compared to negative future events is greater in predominantly positive scenarios than in emotionally balanced scenarios was then computed as an index of Relatively Positive Extrapolation. The Negative Extrapolation Index is expressed as the degree to which the former (i.e., Relatively Negative Extrapolation) is greater than the latter (i.e., Relatively Positive Extrapolation). Scores on the Negative Extrapolation Index can range from -3 to 3, with lower scores indicative of more positive than negative extrapolation, and higher scores suggestive of more negative than positive extrapolation.

**Procedure**

Participants were tested individually, seated in front of a computer. They were told that the experiment aimed to investigate how people differ in their understanding of hypothetical scenarios. Instructions for the Expectancy Assessment Task were provided. Participants then completed eight practice scenarios from the Expectancy Assessment Task, including the Scenario Reading Component and Expectancy Rating Component for 2 presentation blocks of 4 scenarios. Thus, participants read 4 practice scenarios, then provided expectancy ratings for future events in these 4 scenarios, then read another 4 practice scenarios and provided expectancy ratings for future events in these 4 scenarios. Participants subsequently completed the full Expectancy Assessment Task.
Finally, participants were debriefed at the end of the session and received course credit for their participation.

**Results**

Mean expectancy ratings for negative and positive candidate future events presented during the Expectancy Rating Trials of the experimental task were calculated for each participant. These mean expectancy ratings can be seen, together with the Negative Expectancy, Emotional Extrapolation, and Negative Extrapolation Index scores computed from these expectancy ratings (as described earlier) in Table 1.
Table 1. Mean expectancy ratings for negative and positive candidate future events, and computed Negative Expectancy Index, Emotional Extrapolation Index and Negative Extrapolation Index scores.

<table>
<thead>
<tr>
<th>Trait Anxiety Group</th>
<th>Scenario Domain</th>
<th>Scenario Valence</th>
<th>Future Event Expectancy Ratings</th>
<th>Expectancy Index</th>
<th>Emotional Extrapolation Index</th>
<th>Negative Extrapolation Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Negative Future Event M (SD)</td>
<td>Positive Future Event M (SD)</td>
<td>Negative Expectancy Index M (SD)</td>
<td>Emotional Extrapolation Index M (SD)</td>
</tr>
<tr>
<td>Low trait anxious n = 16</td>
<td>Social Scenarios</td>
<td>Negative Scenarios</td>
<td>2.1 (0.6)</td>
<td>2.9 (0.5)</td>
<td>-1.0 (0.7)</td>
<td>0.2 (0.5)</td>
</tr>
<tr>
<td></td>
<td>Positive Scenarios</td>
<td></td>
<td>1.8 (0.5)</td>
<td>3.1 (0.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Balanced Scenarios</td>
<td></td>
<td>2.0 (0.5)</td>
<td>3.0 (0.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physical Scenarios</td>
<td>Negative Scenarios</td>
<td>2.2 (0.8)</td>
<td>2.9 (0.5)</td>
<td>-1.0 (0.6)</td>
<td>0.3 (0.6)</td>
</tr>
<tr>
<td></td>
<td>Positive Scenarios</td>
<td></td>
<td>1.9 (0.5)</td>
<td>3.2 (0.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Balanced Scenarios</td>
<td></td>
<td>2.1 (0.4)</td>
<td>2.9 (0.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High trait anxious n = 16</td>
<td>Social Scenarios</td>
<td>Negative Scenarios</td>
<td>2.9 (0.4)</td>
<td>2.0 (0.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Positive Scenarios</td>
<td></td>
<td>2.0 (0.6)</td>
<td>3.1 (0.4)</td>
<td>0.0 (0.5)</td>
<td>1.0 (0.5)</td>
</tr>
<tr>
<td></td>
<td>Balanced Scenarios</td>
<td></td>
<td>2.6 (0.4)</td>
<td>2.6 (0.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physical Scenarios</td>
<td>Negative Scenarios</td>
<td>2.8 (0.5)</td>
<td>2.2 (0.4)</td>
<td>-0.1 (0.4)</td>
<td>0.7 (0.5)</td>
</tr>
<tr>
<td></td>
<td>Positive Scenarios</td>
<td></td>
<td>2.2 (0.4)</td>
<td>3.0 (0.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Balanced Scenarios</td>
<td></td>
<td>2.6 (0.5)</td>
<td>2.8 (0.4)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Negative Expectancy Index, Emotional Extrapolation Index, and Negative Extrapolation Index scores were each subjected to a mixed design, 2 x 2 analysis of variance (ANOVA). The between-groups factor was Trait Anxiety Group (Low trait anxious, High trait anxious). The within-groups factor was Scenario Domain (Social, Physical).

The first aim of the current experiment was to verify the sensitivity of the newly developed Expectancy Assessment Task to detect an anxiety-linked bias in negative expectancy. This would be evidenced by expectancy for negative relative to positive future events differing as a function of anxiety vulnerability, with high trait anxious compared to low trait anxious individuals displaying a greater tendency towards heightened expectancy for negative relative to positive future events. An anxiety-linked bias in negative expectancy would give rise to a main effect of Trait Anxiety Group when analysing the various index scores.

A second aim of this experiment was to determine what mechanisms may give rise to an anxiety-linked bias in negative expectancy, should the Expectancy Assessment Task be found capable of detecting such an anxiety-linked effect. This involved testing the three hypotheses regarding alternative mechanisms that may give rise to an anxiety-linked bias in negative expectancy. These three hypotheses differ with respect to the predictions they make about the manner in which such an anxiety-linked bias will be influenced by experimental manipulation. The PNEH predicts that an anxiety-linked bias in negative expectancy will not be affected by differences in the emotional valence of the current scenario. Thus the degree to which negative relative to positive future events are rated as more probable will be greater for the high compared to the low trait anxious, no matter whether current scenarios are predominantly negative, predominantly positive, or emotionally balanced. This would give rise to a main effect of Trait Anxiety Group being demonstrated when analysing Negative
Anxiety-linked Bias in Negative Expectancy

Expectancy Index scores (with greater Negative Expectancy Index scores in the high than the low trait anxious), and the absence of a main effect of Trait Anxiety Group when analysing Emotional Extrapolation Index and Negative Extrapolation Index scores.

The EEH predicts that an anxiety-linked bias in negative expectancy will be affected by the emotional valence of the current scenario. Specifically, the degree to which future events that are emotionally congruent with the predominant valence of the current scenario are rated as more probable will be greater in the high than the low trait anxious. This effect will be equally evident across predominantly negative and predominantly positive scenarios. This would give rise to a main effect of Trait Anxiety Group being demonstrated when analysing Emotional Extrapolation Index scores (with greater Emotional Extrapolation Index scores in the high than the low trait anxious), and the absence of a main effect of Trait Anxiety Group when analysing Negative Extrapolation Index scores.

The NEH also predicts that an anxiety-linked bias in negative expectancy will be affected by the emotional valence of the current scenario. However this involves the high trait anxious showing inflated expectancy for negative compared to positive future events in predominantly negative scenarios to a greater degree than their inflated expectancy for positive compared to negative future events in predominantly positive scenarios, when compared to the low trait anxious. This would give rise to a main effect of Trait Anxiety Group being demonstrated when analysing Negative Extrapolation Index scores (with greater Negative Extrapolation Index scores in the high than the low trait anxious), and the absence of a main effect of Trait Anxiety Group when analysing Emotional Extrapolation Index scores.

As mentioned earlier, regardless of the mechanisms that may be observed to give rise to an anxiety-linked bias in negative expectancy, this anxiety-linked bias could
be more evident in scenarios that may have greater personal relevance to a particular group of individuals. If so, then it may be expected that it would be more evident in social than physical scenarios given that the sample in the current experiment is comprised of younger adults. This would give rise to any observed main effect of Trait Anxiety Group being modified by Scenario Domain, such that the high trait anxious may show greater scores on the relevant Index than the low trait anxious to a greater extent in social than physical scenarios.

**Expectancy Index Analyses**

**Negative expectancy index analysis.**

First, the Negative Expectancy Index scores presented in the column third from the right in Table 1 were subjected to a mixed design, 2 x 2 ANOVA. This analysis revealed a significant main effect of Trait Anxiety Group, $F(1, 30) = 22.75, p < .001, \eta^2_{\text{partial}} = .43$, such that the high trait anxious showed significantly greater Negative Expectancy Index scores than the low trait anxious (High trait anxious $M = -0.09, SD = .44$; Low trait anxious $M = -1.01, SD = .64$). Thus, the high trait anxious showed greater expectancy for negative than positive future events when compared to the low trait anxious. No other significant effects resulted from this analysis, including no 2-way interaction of Trait Anxiety Group and Scenario Domain ($p = .250$), suggesting that the anxiety-linked bias in negative expectancy on this Index did not differ according to scenario content.

**Emotional extrapolation index analysis.**

Second, the Emotional Extrapolation Index scores presented in the second column from the right in Table 1 were subjected to a mixed design, 2 x 2 ANOVA. This analysis revealed a significant main effect of Trait Anxiety Group, $F(1, 30) = 12.22, p = .001, \eta^2_{\text{partial}} = .29$, such that the high trait anxious showed significantly greater Emotional Extrapolation Index scores than the low trait anxious (High trait anxious $M = \ldots$
0.88, SD = .48; Low trait anxious M = 0.29, SD = .48). Therefore, the high trait anxious showed greater emotional extrapolation from predominantly negative and predominantly positive scenarios than the low trait anxious, such that they showed greater expectancy for negative than positive future events in predominantly negative scenarios, and greater expectancy for positive than negative future events in predominantly positive scenarios when compared to the low trait anxious.

This analysis also revealed that a main effect of Trait Anxiety Group was modified by Scenario Domain, resulting in a significant 2-way interaction of Trait Anxiety Group and Scenario Domain, $F(1, 30) = 7.14, p = .012, \eta^2_{\text{partial}} = .19$ (see Figure 1). In social scenarios, the high trait anxious showed significantly greater Emotional Extrapolation Index scores than the low trait anxious, $F(1, 30) = 21.21, p < .001, \eta^2_{\text{partial}} = .41$; High trait anxious M = 1.04, SD = .50, Low trait anxious M = 0.24, SD = .47, whereas this was not the case for physical scenarios, $F(1, 30) = 3.98, p = .055, \eta^2_{\text{partial}} = .12$; High trait anxious M = 0.72, SD = .55, Low trait anxious M = 0.33, SD = .57. Thus, it appears that the anxiety-linked difference in emotional extrapolation was evident only on the social scenarios and not on the physical scenarios.
Figure 1. Mean Emotional Extrapolation Index scores displaying a significant 2-way interaction of Trait Anxiety Group and Scenario Domain.

Negative extrapolation index analysis.

Third, the Negative Extrapolation Index scores presented in the right-most column of Table 1 were subjected to a mixed design, 2 x 2 ANOVA, revealing no significant effects. Specifically, there was no significant main effect of Trait Anxiety Group (\( p = .493 \)), indicating no anxiety-linked bias in negative expectancy on this Index (i.e., as associated with greater negative extrapolation in the high than the low trait anxious). Moreover, there was no 2-way interaction of Trait Anxiety Group and Scenario Domain (\( p = .497 \)), suggesting that there was no anxiety-linked bias in negative expectancy on this Index that differed by scenario content.

Discussion

Experiment 1 used the newly developed Expectancy Assessment Task to achieve two aims. The first aim was to verify the capacity of this task to detect an anxiety-linked bias in negative expectancy (i.e., the high trait anxious showing heightened expectancy for negative relative to positive future events compared to the low trait anxious). The second aim was to determine what mechanisms may give rise to
an anxiety-linked bias in negative expectancy by testing the differing predictions made by the three hypotheses concerning the alternative mechanisms proposed to possibly give rise to such a bias.

The results of the current experiment provide support for the sensitivity of the Expectancy Assessment Task in detecting an anxiety-linked bias in negative expectancy, since those with high trait anxiety did indeed show heightened expectancy for negative relative to positive future events compared to the low trait anxious. This is consistent with previous research, which has found that those with high and low anxiety vulnerability differ significantly in their anticipation of future events such that those with high anxiety vulnerability tend to be more negative in their expectations of the future (e.g., Borkovec et al., 2004; MacLeod et al., 1997; Miranda & Mennin, 2007).

The results of this experiment also revealed the mechanisms that may give rise to an anxiety-linked bias in negative expectancy. Although an anxiety-linked bias in negative expectancy was observed when analysing Negative Expectancy Index scores, such a bias was also observed when analysing Emotional Extrapolation Index scores, with the latter revealing that an anxiety-linked bias in negative expectancy differs as a function of the emotional valence of the current scenario. This appears to contradict the PNEH which predicts that an anxiety-linked bias in negative expectancy will not be affected by differences in the emotional valence of the current scenario and thus an anxiety-linked bias in negative expectancy would only be observed on Negative Expectancy Index scores and not on Emotional Extrapolation or Negative Extrapolation Index scores. Therefore, the results do not provide support for the PNEH and the suggestion that the cognitive system of those with high anxiety vulnerability (compared to that of those with low anxiety vulnerability) appears to add a constant to the probability of negative future events when considering possible future outcomes, regardless of how current experiences are proceeding.
The anxiety-linked difference found on Emotional Extrapolation Index scores revealed that those with high trait anxiety show significantly greater Emotional Extrapolation Index scores relative to those with low trait anxiety. More specifically, the high trait anxious show an inflated expectancy for future events that are emotionally congruent with the current scenario, such that they showed greater expectancy for negative than positive future events in predominantly negative scenarios, and greater expectancy for positive than negative future events in predominantly positive scenarios when compared to the low trait anxious. These anxiety-linked differences in emotional extrapolation do not appear to differ between negative and positive scenarios, with no disproportionately greater elevation of negative expectancy in negative situations compared to the elevation of positive expectancy in positive situations in the high than the low trait anxious being observed (since no anxiety-linked difference was found on Negative Extrapolation Index scores). Therefore, the current results provide support for the EEH rather than the NEH.

This strong general tendency of those with high trait anxiety to extrapolate from current experiences to inform their future expectations, to a greater extent than those with low anxiety vulnerability means that the way in which the former construe the present will determine their expectations of the future to a greater degree than it would for those with low anxiety vulnerability. This highlights the importance of the well-established phenomenon of an anxiety-linked interpretive bias (i.e., those with high trait anxiety showing a tendency to interpret current ambiguity in a more negative than positive manner than those with low trait anxiety) as how those with high trait anxiety construe current situations would likely contribute to their elevated negative expectancy of the future through their strong tendency to emotionally extrapolate from current information. This strong tendency for emotional extrapolation (from both negative and positive current information) in the high trait anxious suggests that it would be
important to focus on reducing a negative interpretive bias (i.e., by reducing the anxiety-related tendency to misconstrue current emotional information as negative and encouraging a tendency for more positive interpretations). This may effectively diminish an anxiety-linked bias to expect the worst (i.e., an anxiety-linked bias in negative expectancy) and increase expectations for positive rather than negative future events. Reducing an anxiety-linked negative interpretive bias has been the focus of much cognitive bias modification research in recent years (e.g., Murphy, Hirsch, Mathews, Smith, & Clark, 2007; Steinman & Teachman, 2010). Overall, the current results suggest how such cognitive bias modification may contribute to reduced anxiety-linked differences in expectations for the future.

The finding of greater emotional extrapolation from negative and positive situations in the high compared to the low trait anxious may also suggest that those who are high trait anxious are more emotionally reactive than those who are low in trait anxiety. On a similar note, in a study by Greaves-Lord et al. (2007), anxiety vulnerability was associated with marked physiological hyperarousal.

Additionally, the current results shed further light on the nature of an anxiety-linked bias in negative expectancy, revealing that it differs depending on the type of content (social or physical) pertaining to current situations. Specifically, it was found that the high trait anxious show greater emotional extrapolation than the low trait anxious in social rather than physical scenarios. This supports the anticipation that social concerns may be more personally relevant to young adults than physical concerns. Although, to the author’s knowledge, social and physical concerns have not been directly compared with regard to their personal relevance for trait anxious younger samples, younger adults have been found to show increased anxiety when faced with social anxiety provocations compared to older adults, for whom physical health triggers are accompanied by greater anxiety (Teachman & Gordon, 2009). It remains to be
determined whether this finding (i.e., greater evidence of an anxiety-linked bias in negative expectancy in social than physical scenarios in younger adults) is a general finding relevant to other age groups.

While Experiment 1 provides important information regarding: 1) the sensitivity of the newly developed Expectancy Assessment Task in assessing an anxiety-linked bias in negative expectancy, as well as 2) information pertaining to the mechanisms underlying this bias and how this bias may differ depending on the content of the information being processed, it would also be important to determine how an anxiety-linked bias in negative expectancy may differ with age. Interestingly, older adults appear to show lower levels of anxiety vulnerability when compared to younger adults (e.g., Wolitzky-Taylor, Castriotta, Lenze, Stanley & Craske, 2010; Kryla-Lighthall & Mather, 2009), despite the losses and new challenges which typically accompany advancing age and which may be expected to undermine resilience in older adults (e.g., Garrett, 1987). Older adults also appear to demonstrate a ‘positivity effect’ as reflected in their tendency to selectively attend to and recall positive rather than negative information (e.g., Isaacowitz et al., 2008; Mather, 2006), and to interpret ambiguous information more positively than negatively (e.g., Werntz, Green, & Teachman, 2011).

These previous findings strongly suggest that in terms of expectancy for future events, older adults may show a decreased tendency to expect negative relative to positive future events than younger adults. The next experiment (see Chapter 3) investigates potential age differences in expectancy as such differences have not been previously investigated, and since these age differences (should they exist) may be associated with why older adults show less anxiety vulnerability compared to younger adults. As will be further explored in the next Chapter, there are two quite different possibilities regarding the nature of these potential age differences in expectancy. Firstly, there may just be an age group difference in the expected probability of negative
relative to positive future events. Thus, age may independently ameliorate negative expectancy such that older adults show reduced expectancy for negative relative to positive future events when compared to younger adults and that could lead to older adults not being as high in anxiety vulnerability. Secondly, it may be that the relationship between anxiety vulnerability and expectancy differs with age, so that there is an age-linked difference in the degree to which there is an anxiety-linked bias in negative expectancy. In other words, age may attenuate an anxiety-linked bias in negative expectancy. This means that older adults may show a reduced association between expectancy and anxiety vulnerability in that an anxiety-linked bias in negative expectancy (i.e., the degree to which those with high anxiety vulnerability show greater expectancy for negative relative to positive future events when compared to those low in anxiety vulnerability) is attenuated in older than younger adults. Potential age differences in expectancy as well as these two possibilities regarding the nature of these age differences in expectancy (should they be found to exist) will be discussed further in Chapter 3 which reports the experiment undertaken to assess these issues.
CHAPTER 3: EXPERIMENT 2 – Age-linked Bias in Negative Expectancy and the Role of Memory

Introduction

While it is required in Experiment 2 that the anxiety-linked bias in negative expectancy found in the previous experiment be replicated, the current experiment takes the important further step of examining whether this anxiety-linked bias in negative expectancy differs as a function of age. Older adults appear to show decreased vulnerability to anxiety, compared to younger adults and generally experience lower levels of anxiety symptoms and anxiety disorders (Kryla-Lighthall & Mather, 2009; Wolitzky-Taylor, Castriotta, Lenze, Stanley & Craske, 2010).

Along with these age differences in anxiety vulnerability, there is a wealth of research evidence suggesting that there may be age-related differences in expectancy, such that older adults may show a tendency to expect a ‘brighter’, more positive future and thus demonstrate less negative expectancy compared to younger adults. With regards to the literature reviewed earlier in Chapter 1, there is evidence that older adults exhibit fewer patterns of selective processing (i.e., anxiety-linked cognitive biases) which, according to MacLeod, Campbell, Rutherford, and Wilson (2004) have been shown causally to contribute to anxiety vulnerability in younger adults. This tendency demonstrated in older adults has been referred to as a ‘positivity effect’ and is characterised by selectively attending to, and remembering more, positive than negative information compared to younger adults (see Mather & Carstensen, 2005; Reed & Carstensen, 2012) and interpreting ambiguous information more positively than negatively (e.g., Werntz, Green, & Teachman, 2011). These findings regarding a ‘positivity effect’ in older adults strongly suggest that older adults would show a tendency to expect more positive than negative future events compared to younger adults. Thus, although age-related differences in future expectancy have not (to the
Anxiety-linked Bias in Negative Expectancy

author’s knowledge) been previously investigated, it is anticipated that older adults would show less evidence of inflated negative relative to positive future expectancy than younger adults. This is termed ‘an age-linked bias in negative expectancy’ in the current research.

If evidence is found to support the existence of age differences in expectancy (i.e., an age-linked bias in negative expectancy), this can be explained by two very different patterns of selective processing in expectancy which could lead to age-related reductions in anxiety vulnerability. One possibility (and hypothesis) is that age independently ameliorates negative expectancy such that expectancy for negative relative to positive future events differs as a function of age group and leads to older adults not being as high in anxiety vulnerability when compared to younger adults. This leads to the prediction that older adults would show reduced expectancy for negative relative to positive future events when compared to younger adults.

Another possibility (and hypothesis) regarding how patterns of selective processing in expectancy may differ with age in ways that could lead to an age-related reduction in anxiety vulnerability is that age attenuates an anxiety-linked bias in negative expectancy. This involves the relationship between anxiety vulnerability and expectancy differing with age such that there is an age-linked difference in the degree to which there is an anxiety-linked bias in negative expectancy. The association between expectancy and anxiety vulnerability may be reduced in older adults such that an anxiety-linked bias in negative expectancy is attenuated in older than younger adults. In other words, older adults may not differ from younger adults in terms of their general tendency to expect negative relative to positive future events. However this same tendency to expect more negative than positive future events may be less anxiogenic and does not produce elevated anxiety vulnerability in older adults as it does in younger adults. Thus greater negative than positive future expectancy may be less strongly
predictive of elevated anxiety vulnerability in older adults compared to younger adults. This hypothesis leads to the prediction that extent to which individuals with high trait anxiety show greater negative than positive future expectancy than those with low trait anxiety will be less pronounced in older adults when compared to younger adults.

Given that an age-linked bias in negative expectancy has not previously been investigated, the mechanisms that may give rise to such a bias (should it exist) are also unknown. Any of the three proposed candidate mechanisms that may give rise to an anxiety-linked bias in negative expectancy as in the previous Chapter (i.e., according to the PNEH, EEH and NEH) may also be found to give rise to either of the two above-mentioned possibilities regarding how patterns of selective processing in expectancy may differ with age.

Firstly, older adults may show a tendency to expect things to go well in the future and do not consider how the current situation is proceeding (i.e., whether it is going well or badly at present). This would be consistent with the PNEH, in that the cognitive system of older adults (compared to that of younger adults) may add a constant to the probability of positive future events when considering possible future outcomes. This results in positive outcomes being considered as more likely to occur than negative outcomes, in older than younger adults. This hypothesis generates the prediction that with regards to age, older adults will consistently display an inflated expectancy for positive compared to negative future events (and thus less inflated expectancy for negative compared to positive future events), relative to younger adults. This would not differ according to the (negative or positive) emotional tone of the current scenario.

Secondly, older adults may show less of a general tendency to extrapolate from the emotional tone of the current experience than younger adults, such that older adults will show reduced emotional extrapolation from current experiences to inform their
future expectations. The EEH thus predicts that older adults will show reduced emotional extrapolation from the current scenario, whether these are negative or positive (with this being equally evident across negative and positive scenarios) when compared to younger adults. In other words, while younger adults will show greater expectancy for negative than positive future events when the current scenario is negative and greater expectancy for positive than negative future events when the current scenario is positive, older adults will show this to a lesser extent.

Thirdly, it could be that older adults only focus on current experiences that are positive and thus expect more positive than negative future events. Therefore, according to the NEH, older adults may differentially engage in extrapolation concerning the likelihood of future events, based on the emotional valence of the current experience. More specifically, according to this hypothesis, when the current scenario is positive, older adults (when compared to younger adults) will be disproportionately more inclined to have greater expectancy for positive than negative future events to a greater degree than they will have greater expectancy for negative than positive future events when the current scenario is negative.

In the previous experiment, an anxiety-linked bias in negative expectancy was characterised by emotional extrapolation, such that high trait anxious young adults showed a general tendency to extrapolate from current emotional experiences to inform their future expectations, to a greater extent than low trait anxious young adults. In particular, the former showed greater expectancy for negative than positive future events in predominantly negative scenarios, and greater expectancy for positive than negative future events in predominantly positive scenarios when compared to the low trait anxious. It is hypothesised that an anxiety-linked bias in negative expectancy will again be characterised by emotional extrapolation in this experiment. More importantly, it is hypothesised that this effect of emotional extrapolation will differ by age (rather
than an age-linked bias in negative expectancy being characterised by pervasive negative expectancy or negative extrapolation).

While investigating a potential age-linked bias in negative expectancy, it is necessary to rule out the possibility that age differences in memory functioning are mimicking age-related differences in expectancy. In other words, there is the possibility that age differences found in expectancy may be incorrectly attributed to differences in age, when these effects may instead be due to poorer memory functioning in older adults. There is well-established evidence regarding the gradual decline in memory functioning during healthy ageing (see Drag & Bieliauskas, 2010; Hoyer & Verhaeghen, 2006; Nyberg et al., 2012), with older adults showing poorer episodic memory and a reduced ability to learn and recall lists of words compared to younger adults (see Craik & Bosman, 1992; e.g., Zelinski & Burnight, 1997).

There are a number of ways in which age differences in memory functioning may mimic age differences in expectancy on the Expectancy Assessment Task. It may be that older adults are possibly forgetting most of the content of the scenarios they have read by the time they are required to provide expectancy ratings for future events for each of these previously read scenarios. Thus, while older adults may show less expectancy for negative relative to positive future events (i.e., less pervasive negative expectancy) than younger adults, these older adults may not be re-engaging with the previously presented information through recall (given their poorer memory abilities) prior to providing their expectancy ratings of future events. Older adults may generally extrapolate less from negative and positive scenarios (i.e., demonstrate less emotional extrapolation) than younger adults due to forgetting more of the scenarios they have read by the time they are required to provide expectancy ratings for future events for each of these previously read scenarios. Moreover, if older adults show less selective extrapolation from negative scenarios (i.e., less negative emotional extrapolation) than
Anxiety-linked Bias in Negative Expectancy

younger adults, this may be due to older adults forgetting more of the negative content of the scenarios they have read by the time they are required to provide expectancy ratings for future events for previously read scenarios.

In order to replicate the anxiety-linked bias in negative expectancy observed in Experiment 1, the Expectancy Assessment Task was again used in Experiment 2. This anxiety-linked bias in negative expectancy was characterised by emotional extrapolation, and thus if replicated in the current Experiment, should be observed on the Emotional Extrapolation Index with the high trait anxious showing greater emotional extrapolation from negative and positive scenarios than the low trait anxious. With regards to the main aim of Experiment 2, in order to investigate the existence of a possible age-linked bias in negative expectancy, older and younger adult participants were required. More importantly, to differentiate between such an age-linked bias (should it exist) being characterised by age independently ameliorating negative expectancy or by age attenuating an anxiety-linked bias in negative expectancy, it was important that these samples of older and younger adults were comprised of high trait anxious and low trait anxious participants. This would allow for comparisons across age and anxiety groups and thus allow for the validity of these two possibilities regarding the nature of an age-linked bias in negative expectancy to be discriminated. In terms of the secondary aim of Experiment 2, to enable the assessment of the potential role of memory in mimicking group differences in expectancy, the length of time which scenarios had to be retained in memory, before participants were asked to provide expectancy ratings for future events relating to these scenarios, was varied.

Overall, the current experiment had one main aim. This was to examine a potential age-linked bias in negative expectancy. One hypothesis was that this could be characterised by age independently ameliorating negative expectancy. Another hypothesis was that it could involve age attenuating an anxiety-linked bias in negative
Anxiety-linked Bias in Negative Expectancy

It was also hypothesised that this age-related bias (no matter its nature as per the above two possibilities) would involve age differences in emotional extrapolation, with older adults extrapolating less from negative and positive scenarios when compared to younger adults (according to the EEH).

A secondary aim was to assess whether age-related differences in memory may potentially be mimicking an age-linked bias in negative expectancy. Should this be the case, then an age-linked bias in negative expectancy would be disproportionately evident in the condition of the Expectancy Assessment Task that requires participants to retain scenarios in memory for a longer period of time than that which requires scenarios to be retained in memory for a shorter period of time before recalling these scenarios to provide expectancy ratings of future events.

Method

Participants

One hundred and twenty five participants differing on 2 independent factors were recruited. No participants in this experiment had taken part in the previous experiment. To create the factor of Age Group, these 125 participants comprised a younger adult cohort (consisting of 64 young adult first year psychology undergraduates) aged 17 to 25 (M = 18.48, SD = 1.60), and an older adult cohort (consisting of 61 community dwelling older adults who were recruited from a pool of community volunteers and from those who responded to advertisements placed on local community noticeboards or in newsletters), aged 60 or over (M = 70.54, SD = 6.91, ranging from 60-88 years). To create the orthogonal factor of Trait Anxiety Group, each of the above-mentioned cohorts was comprised of a low trait anxious group and a high trait anxious group, resulting in 4 groups (i.e., younger low trait anxious, younger high trait anxious, older low trait anxious, and older high trait anxious). Cut-off scores for inclusion in the high trait anxious group and low trait anxious group were determined
using the mean trait anxiety scores for college students (M = 39.35, SD = 9.67) and older adults (M = 32.83, SD = 8.32) found in the STAI-T manual (Spielberger, 1983). Since mean trait anxiety scores on the Trait form of the STAI differ for younger and older adults, participants were classified as low trait anxious if their trait anxiety score fell below the mean STAI-T score of both college students and older adults (i.e., below 32.83), while participants were classified as high trait anxious if their trait anxiety score fell above the mean STAI-T score for college students and older adults (i.e., above 39.35). Of the 125 participants that were recruited, 64 participants formed part of the low trait anxious group (32 younger and 32 older), while 61 formed part of the high trait anxious group (32 younger and 29 older). The older high trait anxious contained slightly fewer participants due to the difficulty in locating and recruiting anxious older adults. The trait anxiety scores of the low trait anxious group ranged from 21 to 31 (M = 26.42, SD = 2.56), whereas those of the high trait anxious group ranged from 39 to 61 (M = 44.67, SD = 6.97). When referring to younger and older adults regardless of anxiety, the terms younger adult cohort or older adult cohort will be used, respectively. Similarly, when referring to high and low trait anxious participants regardless of age, the terms high trait anxious group and low trait anxious group will be used, respectively.

It was required that the magnitude of the discrepancy in trait anxiety scores between the high trait anxious and low trait anxious groups should not differ between the younger adult and older adult cohorts. Similarly, it was required that the discrepancy in age between the younger adult and older adult cohorts should not differ between the high trait anxious and low trait anxious groups. It was also required that gender was not confounded with either or both of the two between group factors of Age Group and Trait Anxiety Group.

A 2 x 2 mixed design analysis of variance (ANOVA) of Trait Anxiety Group (Low trait anxious, High trait anxious) and Age Group (Younger, Older) on STAI-T
scores was conducted. This revealed the required significant main effect of Trait Anxiety Group, $F(1, 121) = 381.61, p < .001, \eta^2_{\text{partial}} = .76$, confirming the high trait anxious group had significantly greater STAI-T scores than the low trait anxious group (High trait anxious $M = 44.67, SD = 6.97$, Low trait anxious $M = 26.42, SD = 2.56$). Also, as required, there was no significant main effect of Age Group ($p = .344$), indicating no significant Age Group difference in STAI-T scores. There was no significant interaction of Trait Anxiety Group and Age Group, ($p = .361$) indicating that, as required, the discrepancy in trait anxiety scores between the high and low trait anxious groups did not differ for the younger and older adult cohorts.

An equivalent 2 x 2 mixed design ANOVA was conducted on age. This revealed the required significant main effect of Age Group, $F(1, 121) = 3470.21, p < .001, \eta^2_{\text{partial}} = .97$, confirming that the older adult cohort was significantly older than the younger adult cohort (Older $M = 70.54, SD = 6.91$, Younger $M = 18.48, SD = 1.60$). Furthermore, there was no significant main effect of Trait Anxiety Group ($p = .106$), indicating no significant Trait Anxiety Group difference in age as required. There was also no significant interaction of Trait Anxiety Group and Age Group, ($p = .306$) indicating that as required, the magnitude of the discrepancy in age between younger and older adult cohorts did not differ for the low trait anxious and high trait anxious groups.

Finally, chi-square tests of independence were performed to examine the relationship between gender, and Trait Anxiety Group, and between gender and Age Group, respectively. As required, the relationship between gender and Trait Anxiety Group was not significant, $X^2(1, N=125) = 0.20, p = .659$, indicating that the low trait anxious and high trait anxious groups did not differ in terms of gender ratio. Likewise, and also as required, the relationship between gender and Age Group was not significant, $X^2(1, N = 125) = 0.01, p = .934$, indicating that younger and older adult
cohorts did not differ significantly in terms of gender ratio. Descriptive statistics for age, gender and trait anxiety scores for each of the 4 groups of participants are presented in Table 2.

Table 2. Descriptive statistics for age, gender and trait anxiety scores for younger and older low and high trait anxious groups.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Trait Anxiety Group</th>
<th>Age M (SD)</th>
<th>Gender n = male (n = female)</th>
<th>STAI-T M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Younger adults (n = 64)</td>
<td>Low trait anxious (n = 32)</td>
<td>18.75 (1.78)</td>
<td>15 (17)</td>
<td>26.44 (2.49)</td>
</tr>
<tr>
<td>Older adults (n = 61)</td>
<td>Low trait anxious (n = 32)</td>
<td>71.66 (7.06)</td>
<td>15 (17)</td>
<td>26.41 (2.66)</td>
</tr>
<tr>
<td></td>
<td>High trait anxious (n = 29)</td>
<td>69.31 (6.66)</td>
<td>15 (14)</td>
<td>43.76 (6.18)</td>
</tr>
</tbody>
</table>

Note. STAI-T = State-Trait Anxiety Inventory - Trait Score (Spielberger, 1983).
Materials

**Trait anxiety questionnaire measure.**

As in Experiment 1, the Trait form of the State-Trait Anxiety Inventory (STAI-T; Spielberger, 1983) was used to measure dispositional anxiety. Cronbach’s alpha was .88 for the STAI-T in Experiment 2.

**Expectancy assessment task stimuli.**

The same stimuli used in the Expectancy Assessment Task in Experiment 1, were also used in Experiment 2. A detailed discussion of the requirements for stimuli included in the Expectancy Assessment Task as well as the final stimuli included in the task can be found in Chapter 2.

**Apparatus.**

As in Experiment 1, the task was presented on a 22in wide-screen computer and participants responded using the numerical keys on the keyboard for ratings and the spacebar for the next sentence and/or screen to appear. All letters presented were 6mm by 6mm in size and each item/sentence presented was one line long in length and consisted of no more than 80 characters.

**Experimental Assessment Task**

In the Expectancy Assessment Task, participants again were instructed to read and imagine themselves in hypothetical scenarios presented event by event on a computer screen, and to then make judgements concerning the likelihood of candidate future events occurring next in each scenario (see Chapter 2 for more detail regarding the Expectancy Assessment Task). Given that a secondary aim of Experiment 2 was to assess the potential role of age-related differences in episodic memory in producing the pattern of effects that could be interpreted as an age-linked bias in negative expectancy, the retention interval (i.e., the number of scenarios presented before requiring expectancy ratings of candidate future events for those scenarios) was varied in the
Expectancy Assessment Task. This resulted in two different experimental conditions. This experimental manipulation is the only way in which the Expectancy Assessment Task used in Experiment 2 differed from that described in Experiment 1. In the Expectancy Assessment Task used in Experiment 1, a 4 scenario retention interval was used (i.e., 4 scenarios were presented in the Scenario Reading Component of the task before ratings were required for candidate future events for these 4 scenarios in the Expectancy Rating Component of the task). In Experiment 2, there was one experimental condition in which the Expectancy Assessment Task included a shorter, 1 scenario retention interval (referred to from here onwards as the 1 scenario retention interval condition), and another condition which had a longer, 16 scenario retention interval (referred to from here onwards as the 16 scenario retention interval condition). In total, participants were presented with 64 scenarios, presented as either 64 series of 1 scenario (i.e., in the 1 scenario retention interval condition), or 4 series of 16 scenarios (i.e., in the 16 scenario retention interval condition).

**Computation of expectancy indices.**

As in Experiment 1, the Expectancy Assessment Task in both experimental conditions yielded three Expectancy Index scores (Negative Expectancy Index, Emotional Extrapolation Index, and Negative Extrapolation Index), which were calculated using the raw expectancy scores obtained on the Expectancy Assessment Task. These were calculated in order to investigate each of the three hypotheses regarding proposed alternative mechanisms that may give rise to an anxiety-linked bias in negative expectancy and an age-linked bias in negative expectancy, as discussed earlier. Details regarding how these Indices were computed can be found in Chapter 2, and will not be repeated here to avoid redundancy.
Negative expectancy index.

A Negative Expectancy Index was computed to investigate the PNEH and express the degree to which there was greater expectancy for negative relative to positive future events across predominantly negative, predominantly positive, and emotionally balanced scenarios. Lower scores on the Negative Expectancy Index indicate relatively greater positive than negative pervasive expectancy (i.e., greater expectancy for positive than negative future events across conditions), and greater scores indicate relatively greater negative than positive pervasive expectancy (i.e., greater expectancy for negative than positive future events across conditions).

Emotional extrapolation index.

An Emotional Extrapolation Index was computed to investigate the EEH and to express the degree to which expectancy ratings for emotional future events that match the emotional valence of the predominantly positive or predominantly negative scenarios are higher, on average, than the expectancy ratings for emotional future events that contradict the emotional valence of these scenarios. Lower scores indicate less emotional extrapolation and greater scores indicate greater emotional extrapolation.

Negative extrapolation index.

A Negative Extrapolation Index was computed to investigate the NEH. The degree to which the elevation of expectancy for negative relative to positive future events is greater in predominantly negative scenarios than in emotionally balanced scenarios was computed as a measure of Relatively Negative Extrapolation. The degree to which the elevation of expectancy for positive compared to negative future events is greater in predominantly positive scenarios than in emotionally balanced scenarios was then computed as a measure of Relatively Positive Extrapolation. The Negative Extrapolation Index is expressed as the degree to which the former (i.e., Relatively Negative Extrapolation) is greater than the latter (i.e., Relatively Positive Extrapolation).
Extrapolation). Thus, lower scores indicate more positive (than negative) extrapolation, and higher scores indicate more negative (than positive) extrapolation.

**Procedure**

Participants were, as in Experiment 1, tested individually and seated in front of a computer. The aim was for half of all participants in each of the 4 groups (i.e., older low trait anxious, older high trait anxious, younger low trait anxious and younger high trait anxious) to be assigned to the 1 scenario retention interval condition with the other half of each group being assigned to the 16 scenario retention interval condition of the Expectancy Assessment Task. They were told that the experiment aimed to investigate how people differ in their understanding of hypothetical scenarios. The same verbal instructions provided for the Expectancy Assessment Task in Experiment 1, were subsequently provided (i.e., participants were instructed to read and imagine themselves in hypothetical scenarios and then to make judgements concerning the likelihood of future events occurring next in each scenario). Participants then completed eight practice scenarios of the Expectancy Assessment Task. For those completing the 1 scenario retention interval condition of the task, these practice scenarios were presented as 8 presentation blocks of 1 scenario, while for participants completing the 16 scenario retention interval condition, these practice scenarios were presented as 1 presentation block of 8 scenarios. Participants subsequently completed the full Expectancy Assessment Task (i.e., either the 1 or 16 scenario retention interval condition), with 61 participants completing the 1 scenario retention interval condition and 64 participants completing the 16 scenario retention interval condition of the Expectancy Assessment Task. At the end of the session, participants were debriefed. Older adult participants were offered reimbursement for their travel expenses while younger participants received course credit for their participation.
Results

Mean expectancy ratings for negative and positive candidate future events presented during the Expectancy Rating Trials of the experimental task were calculated for each participant. These mean expectancy ratings are presented together with the Negative Expectancy Index, Emotional Extrapolation Index, and Negative Extrapolation Index scores computed from the expectancy ratings (as described earlier) in Table 3.
Table 3. Mean expectancy ratings for negative and positive candidate future events, and computed Negative Expectancy Index, Emotional Extrapolation Index and Negative Extrapolation Index scores.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Trait Anxiety Group</th>
<th>Retention Interval</th>
<th>Scenario Domain</th>
<th>Scenario Valence</th>
<th>Future Event Expectancy Ratings</th>
<th>Expectancy Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Negative Future Event M (SD)</td>
<td>Positive Future Event M (SD)</td>
</tr>
<tr>
<td>Younger adults</td>
<td>Low trait anxious</td>
<td>n = 64</td>
<td>Social Scenarios</td>
<td>Negative Scenarios</td>
<td>2.3 (0.6)</td>
<td>2.8 (0.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>n = 16</td>
<td></td>
<td>Positive Scenarios</td>
<td>1.8 (0.5)</td>
<td>3.3 (0.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
<td>2.1 (0.5)</td>
<td>3.1 (0.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Physical Scenarios</td>
<td>Negative Scenarios</td>
<td>2.2 (0.6)</td>
<td>2.8 (0.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Positive Scenarios</td>
<td>1.8 (0.4)</td>
<td>3.3 (0.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
<td>2.1 (0.5)</td>
<td>3.0 (0.4)</td>
</tr>
<tr>
<td>16 Scenario Interval</td>
<td>n = 32</td>
<td></td>
<td>Social Scenarios</td>
<td>Negative Scenarios</td>
<td>2.2 (0.7)</td>
<td>2.8 (0.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Positive Scenarios</td>
<td>1.6 (0.3)</td>
<td>3.1 (0.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
<td>1.9 (0.4)</td>
<td>3.0 (0.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Physical Scenarios</td>
<td>Negative Scenarios</td>
<td>2.1 (0.6)</td>
<td>2.8 (0.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Positive Scenarios</td>
<td>1.8 (0.5)</td>
<td>3.2 (0.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
<td>1.9 (0.5)</td>
<td>3.0 (0.5)</td>
</tr>
<tr>
<td>Age Group</td>
<td>Trait Anxiety Group</td>
<td>Retention Interval</td>
<td>Scenario Domain</td>
<td>Scenario Valence</td>
<td>Negative Future Event M (SD)</td>
<td>Positive Future Event M (SD)</td>
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<tr>
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</tr>
<tr>
<td>Older adults</td>
<td>Low trait anxious</td>
<td>1 Scenario Interval</td>
<td>Social Scenarios</td>
<td>Negative Scenarios</td>
<td>2.1 (0.6)</td>
<td>2.8 (0.4)</td>
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<tr>
<td>High trait anxious n = 32</td>
<td></td>
<td></td>
<td>Social Scenarios</td>
<td>Negative Scenarios</td>
<td>2.4 (0.5)</td>
<td>2.5 (0.4)</td>
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<td>High trait anxious n = 32</td>
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<td>Positive Scenarios</td>
<td>Positive Scenarios</td>
<td>1.9 (0.3)</td>
<td>3.1 (0.4)</td>
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<td>High trait anxious n = 32</td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
<td>Balanced Scenarios</td>
<td>2.2 (0.4)</td>
<td>2.8 (0.4)</td>
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<tr>
<td>16 Scenario Interval n = 16</td>
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<td></td>
<td>Physical Scenarios</td>
<td>Negative Scenarios</td>
<td>2.5 (0.5)</td>
<td>2.5 (0.5)</td>
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<tr>
<td>16 Scenario Interval n = 16</td>
<td></td>
<td></td>
<td>Positive Scenarios</td>
<td>Positive Scenarios</td>
<td>1.9 (0.4)</td>
<td>3.0 (0.7)</td>
</tr>
<tr>
<td>16 Scenario Interval n = 16</td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
<td>Balanced Scenarios</td>
<td>2.3 (0.5)</td>
<td>2.7 (0.5)</td>
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<tr>
<td>1 Scenario Interval n = 16</td>
<td></td>
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<td>Social Scenarios</td>
<td>Negative Scenarios</td>
<td>2.6 (0.5)</td>
<td>2.6 (0.4)</td>
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<tr>
<td>1 Scenario Interval n = 16</td>
<td></td>
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<td>Positive Scenarios</td>
<td>Positive Scenarios</td>
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<td>2.9 (0.4)</td>
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<td>1 Scenario Interval n = 16</td>
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<td>Balanced Scenarios</td>
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<td>High trait anxious n = 32</td>
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<td>Social Scenarios</td>
<td>Negative Scenarios</td>
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<td>2.7 (0.5)</td>
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<td>High trait anxious n = 32</td>
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<td>Positive Scenarios</td>
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<td>2.2 (0.4)</td>
<td>2.8 (0.5)</td>
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<tr>
<td>High trait anxious n = 32</td>
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<td>Balanced Scenarios</td>
<td>Balanced Scenarios</td>
<td>2.4 (0.4)</td>
<td>2.7 (0.3)</td>
</tr>
</tbody>
</table>
### Anxiety-linked Bias in Negative Expectancy

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Trait Anxiety Group</th>
<th>Retention Interval</th>
<th>Scenario Domain</th>
<th>Scenario Valence</th>
<th>Future Event Expectancy Ratings</th>
<th>Expectancy Index</th>
</tr>
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<td>n = 32</td>
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<tr>
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<td>Positive Scenarios</td>
<td>Balanced Scenarios</td>
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<td>Negative Scenarios</td>
<td>Positive Scenarios</td>
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<td>Balanced Scenarios</td>
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<td>3.2 (0.6)</td>
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<td>Negative Scenarios</td>
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<td>2.8 (0.4)</td>
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<td>Positive Scenarios</td>
<td>1.8 (0.6)</td>
<td>2.7 (0.5)</td>
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<td>2.9 (0.9)</td>
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<tr>
<td></td>
<td></td>
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<td>Physical Scenarios</td>
<td>Negative Scenarios</td>
<td>2.0 (0.5)</td>
<td>2.9 (0.6)</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>2.8 (0.6)</td>
</tr>
<tr>
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<td>2.6 (0.6)</td>
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<td></td>
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<td></td>
<td></td>
<td>Positive Scenarios</td>
<td></td>
<td>2.1 (0.4)</td>
<td>2.8 (0.3)</td>
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</tbody>
</table>

- **Future Event Expectancy Ratings**
  - Negative Future Event M (SD)
  - Positive Future Event M (SD)
- **Expectancy Index**
  - Negative Expectancy Index M (SD)
  - Emotional Extrapolation Index M (SD)
  - Negative Extrapolation Index M (SD)
<table>
<thead>
<tr>
<th>Age Group</th>
<th>Trait Anxiety Group</th>
<th>Retention Interval</th>
<th>Scenario Domain</th>
<th>Scenario Valence</th>
<th>Future Event Expectancy Ratings</th>
<th>Expectancy Index</th>
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<td>Scenarios</td>
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<td>Negative Future Event M (SD)</td>
<td>Positive Future Event M (SD)</td>
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<td>Physical Scenarios</td>
<td>Balanced Scenarios</td>
<td>2.3 (0.4)</td>
<td>2.8 (0.4)</td>
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</tbody>
</table>
Negative Expectancy Index, Emotional Extrapolation Index, and Negative Extrapolation Index scores were each subjected to a mixed design, 2 x 2 x 2 x 2 ANOVA. In each ANOVA, the between-groups factors were Trait Anxiety Group (Low trait anxious, High trait anxious), Age Group (Younger, Older), and Retention Interval (1 scenario, 16 scenario). The within-groups factor was Scenario Domain (Social, Physical).

Experiment 1 found an anxiety-linked bias in negative expectancy which was characterised by emotional extrapolation such that the high trait anxious young adult participants showed greater emotional extrapolation than the low trait anxious. Replication of this anxiety-linked bias in negative expectancy would be revealed in the current experiment by a main effect of Trait Anxiety Group only when analysing Emotional Extrapolation Index scores.

A new major aim in Experiment 2, however, was to examine a potential age-linked bias in negative expectancy. This could be characterised by two possible effects. First, it may be that age independently ameliorates negative expectancy. Thus, it was hypothesised that older adults would show less evidence of inflated negative relative to positive expectancy than younger adults. This would be revealed in the current experiment by a significant main effect of Age Group. Secondly, it may be that age attenuates an anxiety-linked bias in negative expectancy. In terms of this second possibility it was hypothesised that an anxiety-linked bias in negative expectancy would be attenuated in older than younger adults. This leads to the prediction that the extent to which individuals with high trait anxiety show greater negative than positive future expectancy than those with low trait anxiety will be less pronounced in older adults when compared to younger adults. This would be revealed in the current experiment by a significant 2-way interaction of Age Group and Trait Anxiety Group. Given that the anxiety-linked bias in negative expectancy was characterised by emotional extrapolation
in Experiment 1, it was hypothesised that either of these two possibilities with regards to an age-related bias would be observed only when analysing Emotional Extrapolation Index scores. Specifically, it was predicted according to the EEH that older adults (or older high trait anxious adults) would show less emotional extrapolation from negative and positive scenarios than the younger (or younger high trait anxious, respectively).

A secondary aim of Experiment 2 was to determine whether age-related differences in memory might potentially be mimicking any age-related differences found in expectancy. Should this be the case, an age-linked bias in negative expectancy (whether characterised by age independently ameliorating negative expectancy or by age attenuating an anxiety-linked bias in negative expectancy) would be disproportionately more evident in the longer retention interval condition of the Expectancy Assessment Task than the shorter retention interval condition. This would be revealed by a main effect of Age Group (indicating that age independently ameliorates negative expectancy) differing significantly by Retention Interval, such that this main effect of Age Group is more evident at the longer retention interval (i.e., 16 scenario retention interval condition) than the shorter retention interval (i.e., 1 scenario retention interval condition). This would also be revealed by a significant 2-way interaction of Age Group and Trait Anxiety Group (indicating that age attenuates an anxiety-linked bias in negative expectancy) differing significantly by Retention Interval such that this 2-way interaction is more evident at the 16 scenario retention interval than the 1 scenario retention interval.

Expectancy Index Analyses

Negative expectancy index analysis.

First, the Negative Expectancy Index scores presented in the column third from the right in Table 3 were subjected to the mixed design, 2 x 2 x 2 x 2 ANOVA. This analysis revealed a trend towards a main effect of Scenario Domain, $F(1, 117) = 3.35, p$
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=.070, η²partial = .03, such that individuals generally showed greater Negative Expectancy Index scores in physical than social scenarios (Physical M = -0.70, SD = .57; Social M = -0.78, SD = .59). Thus participants generally showed inflated expectancy for negative than positive future events to a greater extent in physical than social scenarios.

More importantly, it revealed a significant main effect of Trait Anxiety Group, $F(1, 117) = 20.63, p < .001, \eta^2_{\text{partial}} = .15$, such that the high trait anxious showed significantly greater Negative Expectancy Index scores than the low trait anxious (High trait anxious M = -0.54, SD = .45; Low trait anxious M = -1.00, SD = .51). Thus, the high trait anxious showed greater expectancy for negative than positive future events when compared to the low trait anxious. This replicates the finding made on this Index in the previous experiment.

There was no significant main effect of Age Group, $(p = .637)$, indicating no age-linked bias in negative expectancy characterised by age independently ameliorating negative expectancy.

This main effect of Age Group did not differ significantly by Retention Interval in a significant 2-way interaction $(p = .811)$, indicating that age group differences in memory did not appear to be mimicking an age-linked bias in negative expectancy characterised by age independently ameliorating negative expectancy, on this Index.

There was a trend towards a main effect of Trait Anxiety Group differing by Age Group in a 2-way interaction, $F(1, 117) = 3.91, p = .050, \eta^2_{\text{partial}} = .03$. However, subsequent analyses revealed no significant age group difference in Negative Extrapolation Index Scores in the low trait anxious $(p = .213$; Younger Low trait anxious M = -1.04, SD = .60; Older Low trait anxious M = -0.88, SD = .38) or the high trait anxious $(p = .244$; Younger High trait anxious M = -0.48, SD = .50; Older High trait anxious M = -0.61, SD = .40). Therefore, there was no significant evidence for an
age-linked bias in negative expectancy being characterised by age attenuating an anxiety-linked bias in negative expectancy on this Index.

Lastly, this 2-way interaction did not differ significantly by Retention Interval in a significant 3-way interaction of Trait Anxiety group, Age Group and Retention Interval \((p = .626)\). This indicates that age group differences in memory did not appear to be mimicking an age-linked bias in negative expectancy characterised by age attenuating an anxiety-linked bias in negative expectancy on this Index.

**Emotional extrapolation index analysis.**

The Emotional Extrapolation Index scores presented in the second column from the right in Table 3 were subjected to a mixed design, 2 x 2 x 2 x 2 ANOVA. This analysis also revealed a trend towards a main effect of Scenario Domain, \(F(1, 117) = 3.71, p = .056, \eta^2_{\text{partial}} = .03\), with individuals generally showing greater Emotional Extrapolation Index scores in social than physical scenarios (Social \(M = 0.36, SD = .50\); Physical \(M = 0.28, SD = .46\)).

While this analysis did not reveal a significant main effect of Trait Anxiety Group \((p = .442)\), there was a significant 2-way interaction of Scenario Domain and Trait Anxiety Group, \(F(1, 117) = 4.78, p = .031, \eta^2_{\text{partial}} = .04\). The nature of this interaction was such that there was a trend towards the low trait anxious showing greater Emotional Extrapolation Index scores than the high trait anxious in physical scenarios, \(F(1, 123) = 3.44, p = .066, \eta^2_{\text{partial}} = .03\); Low trait anxious \(M = 0.35, SD = .39\), High trait anxious \(M = 0.20, SD = .51\), though there was no significant Trait Anxiety Group difference in Emotional Extrapolation Index scores in social scenarios \((p = .607)\). This indicates that the low trait anxious showed greater emotional extrapolation compared to the high trait anxious in physical scenarios. While this provides evidence of an anxiety-linked bias in negative expectancy which differs according to scenario content, this did not replicate the nature of the anxiety-linked bias in negative
expectancy characterised by emotional extrapolation that was found in Experiment 1. This effect in Experiment 1 involved greater (not attenuated) emotional extrapolation in the high compared to the low trait anxious.

There was a significant main effect of Age Group, $F(1, 117) = 9.47, p = .003, \eta^2_{\text{partial}} = .08$, such that younger adults showed significantly greater Emotional Extrapolation Index scores than older adults (Younger M = 0.43, SD = .41; Older M = 0.21, SD = .38). This indicates that younger adults showed significantly greater emotional extrapolation than older adults and provides support for an age-linked bias in negative expectancy being characterised by age independently ameliorating negative expectancy.

There was also a tendency for this age-linked bias in negative expectancy to differ as a function of Retention Interval, with a trend towards a 2-way interaction of Age Group and Retention Interval, $F(1, 117) = 3.65, p = .059, \eta^2_{\text{partial}} = .03$. Although this effect failed to reach statistical significance, on follow up analyses this appeared to result from younger adults showing greater Emotional Extrapolation Index scores compared to the older adults (Younger M = 0.48, SD = .46; Older M = 0.13, SD = .31) in the 16 scenario retention interval of the task, $F(1, 62) = 12.60, p = .001, \eta^2_{\text{partial}} = .17$, with no significant Age Group difference being observed in the 1 scenario retention interval of the task ($p = .448$). Therefore, the age-linked bias in negative expectancy was characterised by greater extrapolation in younger than older adults, and there was a strong tendency for this age-related effect to be observed only when there was a greater load rather than a reduced load on memory. This provides some evidence of age-related differences in memory mimicking an age-linked bias in negative expectancy, the latter characterised by age independently ameliorating negative expectancy.

This main effect of Age Group did not differ significantly by Trait Anxiety Group ($p = .165$), thus providing no evidence of an age-linked bias in negative
expectancy being characterised by age attenuating an anxiety-linked bias in negative expectancy on this Index.

Moreover, there was no significant 3-way interaction of Age Group, Trait Anxiety Group and Retention Interval ($p = .125$), indicating that age differences in memory did not appear to mimicking an age-linked bias in negative expectancy characterised by age attenuating an anxiety-linked bias in negative expectancy on this Index.

**Negative extrapolation index analysis.**

Negative Extrapolation Index scores presented in the right-most column of Table 3 were subjected to the mixed design, $2 \times 2 \times 2 \times 2$ ANOVA. This analysis revealed no significant main effect of Anxiety Group ($p = .774$), indicating no anxiety-linked bias in negative expectancy on this Index.

There was no significant main effect of Age Group ($p = .616$), indicating that there was no age-linked bias in negative expectancy characterised by age independently ameliorating negative expectancy on this Index.

This analysis revealed a significant 2-way interaction of Trait Anxiety Group and Age Group, $F(1, 117) = 4.96, \ p = .028, \ \eta^2_{\text{partial}} = .04$. Subsequent analyses demonstrated a trend for higher Negative Extrapolation Index Scores in the older high trait anxious than the younger high trait anxious, $F(1, 59) = 3.39, \ p = .071, \ \eta^2_{\text{partial}} = .05$, (Older High trait anxious M = 0.02, SD = .65; Younger High trait anxious M = -0.31, SD = .72), compared to no significant age group difference in Negative Extrapolation Index Scores in the low trait anxious ($p = .227$; Younger Low trait anxious M = 0.00, SD = .58; Older Low trait anxious M = -0.21, SD = .79). Thus, older high trait anxious adults demonstrated greater negative extrapolation when compared to younger high trait anxious adults, with no age group differences in the low trait anxious. This provided some evidence of an age-linked bias in negative expectancy, which
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contrary to the effect anticipated, was characterised by age amplifying (rather than attenuating) an anxiety-linked bias in negative expectancy.

This significant 2-way interaction of Trait Anxiety Group and Age Group did not differ as a function of Retention Interval \((p = .905)\), indicating that age differences in memory did not appear to mimicking an age-linked bias in negative expectancy (characterised by age amplifying, rather than attenuating, an anxiety-linked bias in negative expectancy) on this Index.

**Discussion**

Experiment 2 aimed to replicate the anxiety-linked bias in negative expectancy previously observed in Experiment 1. The main aim however was to investigate the existence of an age-linked bias in negative expectancy, and if a bias was indeed present, to investigate whether it involves age independently ameliorating negative expectancy or age attenuating an anxiety-linked bias in negative expectancy. A secondary aim was to assess whether any age-related difference in memory may be simulating an age-linked bias in negative expectancy.

One finding in Experiment 2 was that an anxiety-linked bias in negative expectancy was again observed. The results of this experiment also revealed the mechanisms that may give rise to an anxiety-linked bias in negative expectancy. More specifically, and as in Experiment 1, a significant anxiety-linked bias in negative expectancy was only observed in the current experiment when analysing Negative Expectancy Index scores and Emotional Extrapolation Index scores, and not when analysing Negative Extrapolation Index scores. The anxiety-linked bias in negative expectancy observed on Negative Expectancy Index scores revealed that the high trait anxious again showed greater expectancy for negative than positive future events, compared to the low trait anxious. However, as in Experiment 1, although an anxiety-linked bias in negative expectancy was observed when analysing Negative Expectancy
Index scores, such a bias was also observed when analysing Emotional Extrapolation Index scores, with the latter revealing that an anxiety-linked bias in negative expectancy differs as a function of the emotional valence of the current scenario. This contradicts the PNEH which predicts that an anxiety-linked bias in negative expectancy will not be affected by differences in the emotional valence of the current scenario and thus an anxiety-linked bias in negative expectancy would only be observed on Negative Expectancy Index scores and not on Emotional Extrapolation or Negative Extrapolation Index scores. Thus, for a second time, the results do not provide support for the PNEH and the suggestion that the cognitive system of those with high anxiety vulnerability (compared to that of those with low anxiety vulnerability), appears to add a constant to the probability of negative future events when considering possible future outcomes, regardless of how current experiences are proceeding.

The anxiety-linked bias in negative expectancy observed on Emotional Extrapolation Index scores, differed according to the type of concerns in the current scenario and did not replicate the nature of the anxiety-linked bias in negative expectancy characterised by emotional extrapolation that was found in Experiment 1. This effect in Experiment 1 involved greater (not attenuated) emotional extrapolation in the high compared to the low trait anxious. However, in Experiment 2, there was a strong trend for the high trait anxious to show reduced emotional extrapolation compared to the low trait anxious in physical scenarios, with no anxiety group difference in emotional extrapolation in social scenarios. This contradictory nature of the anxiety-linked bias in negative expectancy characterised by emotional extrapolation bias found in this experiment, may be due to the Expectancy Assessment Task in this experiment (i.e., 1 vs.16 scenario retention intervals) differing to that in Experiment 1 (which had presentation blocks of 4 scenarios). Moreover, post-hoc inspection revealed that the spread of STAI-T scores for the high trait anxious in Experiment 2 is quite wide
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(High trait anxious M = 44.7, SD = 7.0; Low trait anxious M = 26.4, SD = 2.6). This may have resulted in there not being a great enough difference in levels of trait anxiety between the high and low trait anxious in this experiment. This in turn may have contributed to the contradictory nature of the anxiety-linked bias in negative expectancy characterised by emotional extrapolation bias found in this experiment.

Like in Experiment 1, the anxiety-linked bias in negative expectancy characterised by emotional extrapolation (although involving the opposite effect when compared to that in Experiment 1), again differed significantly as a function of the type of concerns presented in scenarios. In the current experiment, this was such that there was a tendency for the high trait anxious to show reduced emotional extrapolation compared to the low trait anxious in physical scenarios, with no anxiety group difference in emotional extrapolation in social scenarios. In Experiment 1, this was such that the high trait anxious showed greater emotional extrapolation compared to the low trait anxious, to a greater extent in social than physical scenarios. The opposite nature of the anxiety-linked difference in emotional extrapolation being now found to a greater extent in physical rather than social scenarios is unexpected, and may have also been obscured by differences in the experimental task used in both experiments. This finding was unexpected because in previous research, younger adults have been found to show increased anxiety when faced with social anxiety provocations when compared to older adults, for whom physical health triggers are accompanied by greater anxiety (Teachman & Gordon, 2009). Alternatively, this finding may suggest that physical concerns were more personally relevant to the high trait anxious than social concerns in this experiment.

A finding in terms of the main aim of Experiment 2 was evidence of an age-linked bias in negative expectancy. This appeared to be characterised by age independently ameliorating negative expectancy when analysing Emotional
Extrapolation Index scores. The effect observed on these Index scores involved greater emotional extrapolation in younger than older adults. This appears consistent with the literature regarding evidence of an age-related ‘positivity effect’ and the resulting hypothesis that older adults would extrapolate less from negative and positive scenarios (i.e., demonstrate less emotional extrapolation) when compared to younger adults. In terms of the potential implications of younger adults showing greater emotional extrapolation than older adults, this suggests that younger adults may experience greater positive feelings in positive situations given their heightened expectancy of the future being more positive than negative in such situations when compared to older adults. It may also suggest that younger adults experience greater negative feelings in negative situations in light of their heightened expectancy of the future being more negative than positive in such situations when compared to older adults. Whilst this finding is consistent with somewhat related research findings showing higher levels of emotional reactivity being observed in younger compared to older adults for negative stimuli (e.g., Neupert, Almeida & Charles, 2007), few if any studies appear to have examined age-related differences in reactivity to positive stimuli. It would be interesting for future research to determine whether greater emotional extrapolation in younger than older adults, is indeed associated with a tendency for younger adults to show greater emotional reactivity when compared to older adults. Such studies may benefit from employing the Expectancy Assessment Task along with measures of salivary cortisol which are frequently used to measure emotional distress or reactivity (Applehans & Luecken, 2006).

In relation to the secondary aim of the current experiment, there was a strong trend towards this above-mentioned age-related effect being observed only when there was a greater load rather than a reduced load on memory. This finding suggests that when there was a greater load on memory, the older adults may have forgotten the
scenarios they had read, with this giving rise to a greater age-related difference in expectancy (i.e., in emotional extrapolation) under such conditions, since there was no age-related difference in expectancy when there was a reduced load on memory. Thus, what may appear to be an age-related difference in emotional extrapolation, is likely (and simply) an age-related difference in memory. As mentioned, it is well documented that healthy ageing involves a gradual decline in episodic memory (see Drag & Bieliauskas, 2010; Hoyer & Verhaeghen, 2006; Nyberg et al., 2012) and indeed such age differences in memory appear to simulate an age-linked bias in negative expectancy (the latter characterised by age independently ameliorating negative expectancy).

Rather, an age-linked bias in negative expectancy was characterised by age amplifying an anxiety-linked bias in negative expectancy and was observed on Negative Extrapolation Index scores. More specifically, older high trait anxious adults demonstrated greater negative extrapolation when compared to younger high trait anxious adults, with no age group differences in the low trait anxious. This provided some evidence of an age-linked bias in negative expectancy, which contrary to the effect anticipated, was characterised by age amplifying (rather than attenuating) an anxiety-linked bias in negative expectancy. This appears contrary to literature regarding a ‘positivity effect’ in older adults, whereby older adults show a preference for positive over negative information when compared to younger adults (e.g., Reed & Carstensen, 2012). It also does not provide support for the hypothesis, based on this literature, that older adults would demonstrate less evidence of an anxiety-linked bias in expectancy than younger adults, such that they would demonstrate less selective extrapolation from negative scenarios (i.e., less negative emotional extrapolation) than younger adults. However, this finding is consistent with the SAVI model (Charles, 2010), which proposes that when negative experiences cannot be easily avoided using the skills acquired with increasing age, then age-related improvements in emotional well-being
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will be attenuated or absent. Thus, the older high trait anxious may have been less able to utilise the skills typically associated with ageing and improved emotion regulation, resulting in them demonstrating greater rather than less negative extrapolation when compared to the younger high trait anxious.

A limitation of the current research is that cognitive screening was not undertaken and the outcome used to determine inclusion/exclusion criteria. This means that the older adults in this sample may have had above average or below average cognitive abilities. This in turn may have impacted on this age-linked effect observed being contrary to that anticipated. There is also some previous research evidence to suggest that those older adults who are high in anxiety vulnerability may have higher levels of anxiety symptoms than younger adults (Kunzmann & Grühn, 2005). This may be why older high trait anxious adults in this Experiment showed more (rather than less) negative relative to positive extrapolation when compared to younger high trait anxious adults.

Again with regards to the secondary aim of Experiment 2, the observed age-linked bias in negative expectancy characterised by age amplifying an anxiety-linked bias in negative expectancy (observed on the Negative Extrapolation Index) did not differ as a function of memory load. In particular, this effect was not disproportionately more evident in the 16 scenario retention interval than the 1 scenario retention interval of the Expectancy Assessment Task. Therefore, age group differences in memory do not appear to be simulating this age-linked effect.

It is surprising to note that an age-linked bias in negative expectancy characterised by age amplifying (rather than attenuating) an anxiety-linked bias in negative expectancy was observed only on Negative Extrapolation Index scores, and not on Emotional Extrapolation Index or Negative Expectancy Index scores where an anxiety-linked bias in negative expectancy was found in Experiment 1 and in the current
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experiment. This could indicate that the nature of an anxiety-linked bias in negative expectancy differ with increasing age such that differentially engaging with the emotional valence of the current experience to inform expectations about the future becomes more pertinent in older age.

It is reassuring that the Expectancy Assessment Task indeed measures a true age-linked bias in negative expectancy (characterised by age amplifying an anxiety-linked bias in negative expectancy), rather than this finding instead reflecting age differences in memory ability. This is particularly reassuring given previous research findings regarding an important association between increasing age and poorer memory (e.g., Nyberg et al., 2012) and thus the clear possibility that age differences in memory ability may have been mimicking such a bias on the Expectancy Assessment Task. Of course it may be that the older and younger adults did differ in their actual recall of scenarios, which was not directly tested. Some may consider the absence of a memory check to be a limitation of the current experiment. However, the problem with the more direct approach of assessing participants’ recall for the scenarios is that this would have inadvertently reconsolidated their memory for the scenarios. This would, in turn, make assessing the possibility that differences in memory may be mimicking an age-linked bias in negative expectancy more difficult. To circumvent this problem, introducing a memory load factor (i.e., higher and lower memory load) to the current experimental paradigm to assess the role of memory was deemed a more valid approach.

Nevertheless, the current findings suggest that any group differences in the recall of scenarios, whether these were present or not, are not related to an age-linked bias in negative expectancy (characterised by age amplifying an anxiety-linked bias in negative expectancy). Moreover, while the memory ability of younger and older adult participants was also not directly tested using neuropsychological measures, it can reasonably be expected that any significant age group differences in memory ability
would have been observed in terms of the memory load factor introduced into the task.

Overall, while the current experiment has demonstrated the existence of an age-linked bias in negative expectancy and revealed that this is characterised by age amplifying (rather than attenuating) an anxiety-linked bias in negative expectancy, an important next step would be to determine whether the this age-linked effect in Experiment 2 could instead be attributed to differences in induced levels of state anxiety rather than to group differences in age. As mentioned earlier, older adult participants in this experiment may have been more state anxious in the testing situation compared to the younger adult participants. This may have obscured the hypothesised nature of an age-linked bias in negative expectancy. The possibility that this age-linked bias may be attributed to differences in induced levels of state anxiety raises the importance of differentiating the role of trait anxiety and induced stated anxiety in an anxiety-linked bias in negative expectancy, before further investigating an age-linked bias in negative expectancy. Up until this point in the current research, an anxiety-linked bias in negative expectancy had been investigated only as a function of trait anxiety.

In order to explore this possibility it would be important to examine whether group differences in induced state anxiety would produce the effects which were observed to distinguish older from younger adults participants in this Experiment. This would require high and low trait anxious participants to complete the Expectancy Assessment Task while state anxiety was manipulated such that one condition was designed to minimise state anxiety (i.e., low state anxiety condition) whilst the other was designed to maximise state anxiety (i.e., high state anxiety condition). Thus, a high and low trait anxiety group would each include a group of high and low state anxious participants. This is the focus of the next experiment and allowed for the contributions of trait anxiety and induced state anxiety to an anxiety-linked bias in negative expectancy to be differentiated.
There are four possibilities regarding the role of state and trait anxiety in an anxiety-linked bias in negative expectancy, which need to be explored. First, an anxiety-linked bias in negative expectancy could be associated with trait anxiety alone and be unaffected by state anxiety (which has been assumed thus far in the current research). Second, an anxiety-linked bias in negative expectancy could be associated with state rather than trait anxiety, and thus when there are greater trait anxiety group differences in state anxiety, a greater bias in expectancy effect is observed. Third, an anxiety-linked bias in negative expectancy may be associated with both trait anxiety and state anxiety independently, with group differences in both trait and state anxiety resulting in a greater anxiety-linked bias in negative expectancy. Lastly, given that those who are high trait anxious tend to be more state anxious than those who are low in trait anxiety (e.g., Hanton et al., 2002), an anxiety-linked bias in negative expectancy may be associated with trait anxiety and moderated by state anxiety such that state anxiety amplifies the trait anxiety-linked bias in negative expectancy effect found. This experiment is reported in the next Chapter.
CHAPTER 4: EXPERIMENT 3 – The Role of State Anxiety in an Anxiety-linked Bias in Negative Expectancy

Introduction

As mentioned in the previous Chapter, and given the findings from Experiment 2, it appears important to differentiate the role of trait anxiety and induced levels of state anxiety in an anxiety-linked bias in negative expectancy before further examining an age-linked bias in negative expectancy. This will aid in determining whether the age-linked bias in negative expectancy characterised by age amplifying (rather than attenuating) an anxiety-linked bias in negative expectancy in Experiment 2 could instead be attributed to greater induced levels of state anxiety in older than younger adults. This could be achieved by examining whether group differences in induced state anxiety would produce the effects observed to distinguish older from younger participants in Experiment 2.

An anxiety-linked bias in negative expectancy had only been investigated in relation to trait anxiety in the current research. However, it is well established that those who are high trait anxious tend to be more state anxious than those who are low in trait anxiety (e.g., Hanton et al., 2002). There is also substantial and longstanding evidence to suggest that state anxiety impacts on patterns of selective processing and dispositional anxiety-linked patterns of selective processing (see Mathews & MacLeod, 1994, for a review). For example, attentional bias towards negative information has been robustly demonstrated in those with both high trait and state anxiety (e.g., Mogg et al., 2000; Richards, French, Adams, Eldridge, & Papadopolou, 1999). Moreover, those who are high trait anxious show greater attentional orientation to negative information compared to low trait individuals when experiencing greater levels of state anxiety (MacLeod & Mathews, 1988; MacLeod & Rutherford, 1992). Therefore, an anxiety-linked bias in negative expectancy may be associated with trait anxiety and be
unaffected by state anxiety (which has been assumed thus far in terms of the current research). Or this bias may be associated with state anxiety rather than trait anxiety. Furthermore, it may the case that an anxiety-linked bias in negative expectancy is associated with both trait anxiety and state anxiety independently, or associated with trait anxiety and moderated by state anxiety such that state anxiety amplifies the trait anxiety effect.

To investigate the role of trait anxiety and induced levels of state anxiety in an anxiety-linked bias in negative expectancy, the manipulation of state anxiety in a group of high and low trait anxious participants was required. This necessitated a group of high and low trait anxious participants completing the Expectancy Assessment Task in a high or low (induced) state of anxiety. Thus, two experimental conditions were needed: one to minimise state anxiety and another designed to maximise state anxiety. A mood rating task to measure the levels of induced state anxiety was also required.

The four possibilities regarding the role of trait anxiety and induced state anxiety in an anxiety-linked bias in negative expectancy (which were mentioned earlier), lead to different predictions regarding the results of the current experiment. One hypothesis in Experiment 3 is that an anxiety-linked bias in negative expectancy is associated with trait anxiety and unaffected by state anxiety. This leads to the prediction that expectancy will differ between trait anxiety groups and be unaffected by different levels (i.e., high and low) of induced state anxiety. A second hypothesis is that an anxiety-linked bias in negative expectancy is associated with state anxiety whilst being unrelated to trait anxiety. In line with this hypothesis, it is predicted that expectancy will differ between high and low (induced) state anxiety conditions, and will not differ between high and low trait anxiety groups. A third hypothesis is that an anxiety-linked bias in negative expectancy is associated with both trait and state anxiety, independently. Thus, it is predicted that expectancy will differ significantly between trait anxiety groups and
between state anxiety conditions, without any interaction of trait and state anxiety. A fourth hypothesis is that an anxiety-linked bias in negative expectancy is associated with trait anxiety and modified by state anxiety such that state anxiety amplifies the trait anxiety effect on expectancy. According to this hypothesis, expectancy will differ significantly between trait anxiety groups, with this trait anxiety group difference in expectancy being disproportionately more evident in the high state anxiety than the low state anxiety condition. Of course, any of the three proposed alternative mechanisms (i.e., according to the PNEH, EEH, and NEH) may give rise to any of this four possibilities regarding the role of trait anxiety and induced state anxiety. However, given that the anxiety-linked bias in negative expectancy was found to be characterised by emotional extrapolation in Experiment 1 and 2, it is hypothesised that should an anxiety-linked bias in negative expectancy be found to be associated with trait anxiety only, then this will be characterised by emotional extrapolation.

Method

Participants

As in Experiment 1, two groups of younger adults between the ages of 17 and 25 were needed. It was required that these groups differed significantly in terms of trait anxiety such that one group was characterised by high trait anxiety while the other by low trait anxiety. It was also necessary that the two trait anxiety groups did not differ significantly in terms of age or gender ratio.

Sixty-four young adult, first year psychology undergraduates were recruited based on age (i.e., between the ages of 17 and 25), gender (i.e., to ensure equal numbers of males and females within and across groups) and score on the Trait form of the State-Trait Anxiety Inventory (STAI-T; Spielberger, 1983). No participants in this experiment had taken part in the experiments reported in the previous chapters. Cut-off scores for inclusion in high trait and low trait anxiety groups were determined using the mean trait
anxiety score for college students found in the STAI-T manual (Spielberger). For inclusion in the high trait anxiety group, participants were required to score at or above the mean trait anxiety score ($M = 39.35$ $SD = 9.67$) for college students, therefore scoring 39 or above on the STAI-T. For inclusion in the low trait anxiety group, participants were required to score below this mean trait anxiety score, consequently scoring 38 or below on the STAI-T. In total there were 32 low trait anxious participants (17 to 23 years) and 32 high trait anxious participants (17 to 23 years), with gender equally balanced within each trait anxiety group.

It was required that half the high trait anxious and the low trait anxious participants be assigned to the low state anxiety manipulation condition and the other half of each trait anxiety group be assigned to the high state anxiety manipulation condition. It was also necessary that participants in the two state anxiety manipulation conditions (i.e., high and low state anxiety) did not differ significantly in terms of age or gender ratio. Assigning half of each trait anxiety group to the low state anxiety manipulation condition and the other half of each trait anxiety group to the high state anxiety manipulation condition, resulted in 4 groups of participants (i.e., low trait anxious in the low state anxiety manipulation condition, low trait anxious in the high state anxiety manipulation condition, high trait anxious in the low state anxiety manipulation condition, and high trait anxious in the high state anxiety manipulation condition). It was vital that the difference in trait anxiety scores between the high trait anxious and low trait anxious groups be equivalent across the high and low state anxiety manipulation conditions. As mentioned, it was required that there be no significant age differences between the low and high trait anxious groups, however it was also necessary that this absence of significant age differences remained when comparing low and high trait anxious groups across low and high state anxiety manipulation conditions.
It was essential that gender be similarly balanced across low and high state anxiety manipulation conditions as well as across the low and high trait anxious groups.

A 2 x 2 mixed design analysis of variance (ANOVA) of Trait Anxiety Group (Low trait anxious, High trait anxious) and State Anxiety Manipulation Condition (Low state anxious, High trait anxious) on STAI-T scores was conducted. This revealed a significant main effect of Trait Anxiety Group, $F(1, 60) = 144.34, p < .001$, $\eta^2_{\text{partial}} = .71$, and that, as required, the high trait anxious had significantly greater STAI-T scores than the low trait anxious (High trait anxious $M = 44.19$, $SD = 3.04$, Low trait anxious $M = 33.59$, $SD = 3.88$). Furthermore, there was no significant main effect of State Anxiety Manipulation Condition ($p = .460$), indicating no significant State Anxiety Manipulation Condition difference in STAI-T scores as required. There was no significant 2-way interaction of Trait Anxiety Group and State Anxiety Manipulation Condition, ($p = .751$) suggesting that as required, the difference in trait anxiety scores between the high and low trait anxious was equivalent across the high and low state anxiety manipulation conditions.

An equivalent 2 x 2 mixed design ANOVA was conducted on age. This revealed no significant main effect of Trait Anxiety Group ($p = .678$), and thus that as required the low and high trait anxious did not differ significantly in terms of age. Furthermore, there was no significant main effect of State Anxiety Manipulation Condition ($p = .678$), indicating no significant difference in age between the high and low state anxiety manipulation conditions. There was also no significant 2-way interaction of Trait Anxiety Group and State Anxiety Manipulation Condition, ($p = .803$) suggesting that, as required, there were no significant age differences between the low and high trait anxious groups across the low and high state anxiety manipulation conditions.

Finally, chi-square tests of independence were performed to examine the relationship between gender and Trait Anxiety Group, and between gender and State Anxiety.
Anxiety Manipulation Condition, respectively. The relationship between gender and Trait Anxiety Group was not significant as required, $X^2(1, N=64) = 0, p = 1.000$, thus the low trait anxious and high trait anxious did not differ significantly in terms of gender ratio. Furthermore, the relationship between gender and State Anxiety Manipulation Condition was not significant as required, $X^2(1, N=64) = 0, p = 1.000$, thus gender ratio did not differ significantly between low and high state anxiety manipulation conditions. Descriptive statistics for age, gender and trait anxiety scores for each of the 4 groups of participants are presented in Table 4.

Table 4. Descriptive statistics for age, gender and trait anxiety scores for low and high trait anxious groups across low and high state anxiety manipulation conditions.

<table>
<thead>
<tr>
<th>Trait anxiety group</th>
<th>State anxiety manipulation condition</th>
<th>Age M (SD)</th>
<th>Gender % female</th>
<th>STAI-T M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low trait anxious</td>
<td>High state anxious (n = 32)</td>
<td>18.50 (1.16)</td>
<td>50</td>
<td>33.13 (4.62)</td>
</tr>
<tr>
<td></td>
<td>Low state anxious (n = 16)</td>
<td>18.75 (1.81)</td>
<td>50</td>
<td>34.06 (3.07)</td>
</tr>
<tr>
<td>High trait anxious</td>
<td>High state anxious (n = 32)</td>
<td>18.44 (1.37)</td>
<td>50</td>
<td>44.00 (2.66)</td>
</tr>
<tr>
<td></td>
<td>Low state anxious (n = 16)</td>
<td>18.50 (1.59)</td>
<td>50</td>
<td>44.38 (3.46)</td>
</tr>
</tbody>
</table>

Note. STAI-T = State-Trait Anxiety Inventory - Trait Score (Spielberger, 1983).
Materials

**Trait anxiety questionnaire measure.**

As in Experiments 1 and 2, the Trait form of the State-Trait Anxiety Inventory (STAI-T; Spielberger, 1983) was used to measure dispositional anxiety. Cronbach’s alpha was .83 for the STAI-T in Experiment 3.

**Expectancy assessment task stimuli.**

The same Expectancy Assessment Task stimuli used in Experiments 1 and 2, were used in Experiment 3. A detailed discussion of the requirements for stimuli included in the Expectancy Assessment Task as well as the final stimuli included in the task can be found in Chapter 2.

**State anxiety manipulation task stimuli.**

The State Anxiety Manipulation Task involved an anagram task (based on that employed by Mogg, Mathews, Bird, & Macgregor-Morris, 1990, and MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002), that contained anagrams, which were either challenging or relatively easy to solve depending on which of the two conditions participants were assigned to. Overall, two sets of 200 anagram letter strings were created. One set of anagrams was challenging and was used in the high state anxiety condition of the task. The other set of anagrams was easy to solve and was used in the low state anxiety condition.

**Apparatus.**

As in Experiments 1 and 2, the experimental tasks were presented on a 22in wide-screen computer. For the Expectancy Assessment Task and State Anxiety Manipulation Task, participants responded using the keyboard. For the Mood Rating Task, participants responded using the mouse. All letters presented in the Expectancy Assessment Task were 6mm by 6mm in size and each item/sentence presented was one line long in length and consisted of no more than 80 characters. In both the State
Anxiety Manipulation Task and the Mood Rating Task, all the letters presented were 30mm by 30mm in size. For the Mood Rating Task, the verbal anchors for each scale were presented on either end of a 60-point scale line that measured 270mm in length.

**Experimental Tasks**

**Expectancy assessment task.**

Participants were presented with the computerised Expectancy Assessment Task and were instructed to read and imagine themselves in hypothetical scenarios and to then make judgements concerning the likelihood of future events occurring next in each scenario as in the two previous experiments (see Experiment 1 for more detail regarding the Expectancy Assessment Task). The Expectancy Assessment Task used in Experiment 1, which presented blocks of 4 scenarios in the Scenario Reading Component of the task before requiring ratings for future events relating to these 4 scenarios in the Expectancy Rating Component of the task was used in Experiment 3. For the Expectancy Assessment Task, participants made responses using the spacebar for the next sentence and/or screen to appear and the numerical keys on the keyboard for ratings of future events.

Three Expectancy Index scores (i.e., Negative Expectancy Index, Emotional Extrapolation Index and Negative Extrapolation Index scores) were calculated as in Experiment 1 and 2, using the mean expectancy scores obtained on the Expectancy Assessment Task, in order to investigate each of the three proposed candidate mechanisms that may give rise to an anxiety-linked bias in negative expectancy. Details regarding how these Indices were computed can be found in Chapter 2, and will not be repeated here (unless where deemed necessary) to avoid redundancy.

**Negative expectancy index.**

A Negative Expectancy Index was computed to investigate the PNEH and express the degree to which there was greater expectancy for negative relative to
positive future events across predominantly negative, predominantly positive, and emotionally balanced scenarios. Lower scores on the Negative Expectancy Index indicate relatively greater positive than negative pervasive expectancy (i.e., greater expectancy for positive than negative future events across conditions), and greater scores indicate relatively greater negative than positive pervasive expectancy (i.e., greater expectancy for negative than positive future events across conditions).

*Emotional extrapolation index.*

An Emotional Extrapolation Index was computed to investigate the EEH and to express the degree to which expectancy ratings for emotional future events that match the emotional valence of the predominantly positive or predominantly negative scenarios are higher, on average, than the expectancy ratings for emotional future events that contradict the emotional valence of these scenarios. Lower scores indicate less emotional extrapolation and greater scores indicate greater emotional extrapolation.

*Negative extrapolation index.*

A Negative Extrapolation Index was computed to investigate the NEH. The degree to which the elevation of expectancy for negative relative to positive future events is greater in predominantly negative scenarios than in emotionally balanced scenarios was computed as a measure of Relatively Negative Extrapolation. The degree to which the elevation of expectancy for positive compared to negative future events is greater in predominantly positive scenarios than in emotionally balanced scenarios was then computed as a measure of Relatively Positive Extrapolation. The Negative Extrapolation Index is expressed as the degree to which the former (i.e., Relatively Negative Extrapolation) is greater than the latter (i.e., Relatively Positive Extrapolation). Thus, lower scores indicate more positive (than negative) extrapolation, and higher scores indicate more negative (than positive) extrapolation.
**State anxiety manipulation task.**

Given that the main aim of Experiment 3 was to investigate the role of trait anxiety and induced state anxiety in an anxiety-linked bias in negative expectancy, the experimental manipulation of state anxiety was required. As mentioned earlier, this involved an anagram task which contained anagrams that were either challenging or relatively easy to solve depending on which of two conditions participants were assigned to. These two state anxiety manipulation conditions included one to maximise state anxiety (i.e., induce high state anxiety) and another to minimise state anxiety (i.e., lower state anxiety). In the high state anxiety condition, participants were presented with difficult (though soluble) anagrams, while in the low state anxiety condition, participants were presented with easily soluble anagrams.

In order to achieve these differing levels of state anxiety it was required that participants in both conditions see a measure of what they were told was their own performance and a measure that they were told was the average of others who had previously completed the task. This measure of the average performance of others was specifically described to participants as representing how many anagrams previous participants had typically solved by that point in time during the task (i.e., rate of solved anagrams). In the low state anxiety manipulation condition, the measure participants saw of their own performance was designed to exceed the visible measure of the average of others who had previously completed the task, and thus designed to exceed their performance expectations. The purpose of this was to induce a level of confidence in these participants that would attenuate levels of state anxiety. In the high state anxiety manipulation condition, the measure participants saw of their own performance was designed to fall below the visible measure of the average of others who had previously completed the task, and thus designed to fall short of their performance expectations.
The purpose of this was to reduce the level of confidence these participants had, in order to induce higher levels of state anxiety.

First, they were presented with a string of jumbled letters appearing at the top of the screen. Letter strings from the relevant anagram stimulus set (depending on the state anxiety manipulation condition) were displayed in a random order. To complete the anagram task, participants were required to keep the Caps Lock key on, and to press the spacebar, type their response in and to press Enter thereafter to bring up the next anagram. They were given 10 seconds to solve each anagram. If they did not provide an answer within 10 seconds, no points were received for that anagram and the next anagram appeared at the top of the screen.

**High state anxiety condition.**

As mentioned, participants were presented with difficult (though soluble) anagrams in the high state anxiety condition. Participants in this condition were informed that the task was easy and that most people perform well on this task. Therefore, they would be quite likely to find themselves scoring above the displayed average score, and this should be expected. They were also told to try their best to end up in the Upper 25%, as indicated by the label assigned to their own performance. In this condition the visible measure of the average performance of others always increased more rapidly than the measure of a participant’s own performance. However, this was calibrated such that it was responsive to performance. Specifically, if participants were solving the difficult anagrams in this condition, the measure of the average performance of others only slightly outpaced the measure of their own performance. Yet, if participants were solving no anagrams then the measure of the average performance of others outpaced the measure of their own performance more rapidly. A percentile rank, indicating the participant’s supposed rank as being in the
Lower 21% among previous students, was also displayed above the measure of his or her own performance and that of the average performance of others.

**Low state anxiety condition.**

As previously stated, participants were presented with easily soluble anagrams in the low state anxiety condition. Participants in this condition were told that the task was difficult and that most people do not perform well. Thus, they would be quite likely to find themselves scoring below the displayed average score, and this should be expected. They were also told, nevertheless, to try their best not to end up in the Lower 25% of the group, as indicated by the label assigned to their own performance. In this condition the measure of a participant’s own performance always increased more rapidly than the visible measure of the average performance of others. However, this was calibrated such that it was responsive to performance. If participants were solving the easy anagrams in this condition, the measure of their own performance outpaced that of the average performance of others more rapidly. If they were solving no anagrams then the measure of their own performance only slightly outpaced that of the average performance of others. A percentile rank, indicating the participant’s supposed rank amongst previous students as being in the Upper 21%, was also displayed above the measure of his or her own performance and that of the average performance of others.

**Mood rating task.**

It was necessary that participants provide ratings of their current mood state, in order to assess the effectiveness of the State Anxiety Manipulation Task and to investigate any differences in an anxiety-linked bias in negative expectancy as a function of state anxiety. A computerised Mood Rating Task involving the use of scales (based on those adopted by MacLeod et al., 2002) was used to measure state anxiety. While the current experiment involved inducing different levels of state anxiety, it was not implausible that the State Anxiety Manipulation Task would also influence
depressed mood. Thus, it was also considered useful to use a mood rating scale as a measure of depression, since if a state anxiety-linked bias in negative expectancy were found, it would not otherwise be possible to determine whether this effect were a state anxiety effect specifically, or related to negative affect more generally. Participants were instructed to rate their current mood, at that moment. The mood rating scale assessing state anxiety measured the degree to which participants expressed being (state) anxious at that time. The mood rating scale used as a measure of depression assessed the degree to which participants expressed being sad at that time. Scores on both mood rating scales ranged from 0 to 60, with 60 being the highest level of state anxiety or depression, and 0 being the absence of state anxiety or depression. Participants used the computer mouse for ratings on the mood scales, and were required to drag the mouse cursor along the scale and to click the left mouse button to make a rating.

**Interleaving of Tasks**

It was desired that the State Anxiety Manipulation Task would induce differing levels of state anxiety that would last across the full experiment. More specifically, it was required that high and low trait anxious participants complete the Expectancy Assessment Task under two significantly different levels of state anxiety (i.e., with half the high and low trait anxious completing the Expectancy Assessment Task in a significantly higher state of anxiety than the other half). This was achieved by ensuring that, regardless of state anxiety manipulation condition, the State Anxiety Manipulation Task and the Expectancy Assessment Task were interleaved with first the State Anxiety Manipulation Task (i.e., 3 minutes of anagrams) being presented followed by one presentation block of the Expectancy Assessment Task (i.e., 4 scenarios to be read, and then being required to rate the likelihood of future events occurring in each of these 4 scenarios). This pattern was repeated 16 times throughout the experiment with the
intention of inducing a state anxiety difference at the start of each block of the Expectancy Assessment Task. It was hoped that this state anxiety difference would persist across presentation blocks of the Expectancy Assessment Task. In order to determine whether this was indeed the case, the Mood Rating Task was delivered immediately before each presentation block of the Expectancy Assessment Task (and thus just after a block of the State Anxiety Manipulation Task) and immediately after each presentation block of the Expectancy Assessment Task (which is thus just before the next block of the State Anxiety Manipulation Task).

**Procedure**

Participants were, as in both Experiments 1 and 2, tested individually and seated in front of a computer. They were told that the experiment was aimed to investigate the impact of mood on concentration and that it would involve frequently reporting their mood and then switching between two other tasks (i.e., the State Anxiety Manipulation task and Expectancy Assessment Task), each of which require concentration.

Instructions for each of the three experimental tasks were provided and each component was practiced separately. Participants first completed one pair of practice mood scales by rating their mood at that moment for each scale. Next, participants were shown 13 practice anagrams, which were a mixture of difficult and easy anagrams. The experimenter demonstrated solutions for, and failure to solve, these anagrams, for each participant, such that the first two anagrams were solved correctly, the next four were not correctly solved, and the last two anagrams were correctly solved. This was to let the participants see the way in which the visible measures of their own performance and that of the average performance of others moved on the screen. The way in which these visible measures moved during the practice anagrams made logical sense given the correctness or incorrectness of the answers provided (i.e., the measure of the participants own performance increased for every correct answer, while the measure of
the average performance of others increased for every incorrect answer as programmed. Half of all the participants (n = 32), including an equal number of low trait anxious and high trait anxious participants, were assigned to the high state anxiety condition, while the other half (n = 32), again including an equal number of low trait anxious and high trait anxious participants, were assigned to the low state anxiety condition. Instructions for the State Anxiety Manipulation Task then differed depending on the state anxiety manipulation condition to which participants were assigned (as discussed earlier).

Participants across both state anxiety manipulation conditions were then given verbal instructions for the Expectancy Assessment Task (as described in previous chapters). Participants then completed eight practice scenarios from the Expectancy Assessment Task, including the Scenario Reading Component and Expectancy Rating Component for 2 presentation blocks of 4 scenarios. The full experiment was subsequently completed with all three experimental tasks interleaved with one another, as described. At the end of the session, participants were debriefed about the nature of the experiment and the reason for being provided with deceptive feedback. Participants received course credit for their participation.

**Results**

**Analysis of Mood Rating Task Scores**

Mean Mood Rating Task scores obtained prior to the Expectancy Assessment Task trials and those obtained following the Expectancy Assessment Task trials for each State Anxiety Manipulation Condition for each Trait Anxiety Group are presented in Table 5.
Table 5. Summary of mean Mood Rating Task scores obtained prior to the Expectancy Assessment Task trials and those obtained following the Expectancy Assessment Task trials for each State Anxiety Manipulation Condition by Trait Anxiety Group.

<table>
<thead>
<tr>
<th>State anxiety manipulation condition</th>
<th>High state anxious (n = 32)</th>
<th>Low state anxious (n = 32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Pre-Expectancy</td>
<td>Post-Expectancy</td>
</tr>
<tr>
<td>Trait anxiety group</td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>Low trait anxious (n = 32)</td>
<td>State anxiety scale</td>
<td>21.8 (8.1)</td>
</tr>
<tr>
<td></td>
<td>Depression scale</td>
<td>19.0 (9.2)</td>
</tr>
<tr>
<td>High trait anxious (n = 32)</td>
<td>State anxiety scale</td>
<td>28.9 (5.9)</td>
</tr>
<tr>
<td></td>
<td>Depression scale</td>
<td>27.9 (7.0)</td>
</tr>
</tbody>
</table>

First, the state anxiety scores obtained on the Mood Rating Task were analysed to determine whether the State Anxiety Manipulation Task was successful in inducing elevations or reductions in state anxiety, in the high and low state anxiety conditions, respectively, such that high and low trait anxious participants in both conditions
completed the Expectancy Assessment Task while experiencing significantly different levels of state anxiety. It was also important to determine whether such significantly different levels of induced state anxiety were maintained across blocks of the Expectancy Assessment Task trials throughout the experiment. This was achieved by analysing the mean state anxiety ratings obtained prior to Expectancy Assessment Task trials and those obtained following Expectancy Assessment Task trials using a mixed design, 2 x 2 x 2 ANOVA. The between-groups factors were State Anxiety Manipulation Condition (Low state anxious, High state anxious) and Trait Anxiety Group (Low trait anxious, High trait anxious), and the within-subjects factor was Time (Pre-Expectancy Assessment Task trials, Post-Expectancy Assessment Task trials).

This analysis revealed a significant main effect of Trait Anxiety Group, $F(1, 60) = 8.74, p = .004, \eta^2_{\text{partial}} = .13$, reflecting that state anxiety scores were significantly higher in the high trait anxious (M = 24.02, SD = 10.52) compared to the low trait anxious (M = 18.71, SD = 10.06). This significant main effect of Trait Anxiety Group differed significantly by Time in a significant 2-way interaction of Trait Anxiety Group and Time, $F(1, 60) = 11.92, p = .001, \eta^2_{\text{partial}} = .17$, demonstrating that the high trait anxious had significantly higher state anxiety scores before blocks of Expectancy Assessment Task trials than the low trait anxious ($p = .007$), however this significant difference between Trait Anxiety Groups was not maintained across (until after) blocks of the Expectancy Assessment Task trials ($p = .170$). More importantly, there was also a significant main effect of State Anxiety Manipulation Condition, $F(1, 60) = 66.11, p < .001, \eta^2_{\text{partial}} = .52$, reflecting that state anxiety scores were indeed significantly higher in the high state anxiety condition (M = 28.67, SD = 7.69) compared to the low state anxiety condition (M = 14.07, SD = 7.56), as required. There was no significant 2-way interaction of State Anxiety Manipulation Condition and Trait Anxiety Group ($p = .287$), indicating that as required, differing levels of state anxiety between high and low
state anxiety conditions did not differ significantly between high and low trait anxiety groups. This main effect of State Anxiety Manipulation Condition differed significantly by Time, such that there was a significant 2-way interaction between State Anxiety Manipulation Condition and Time, $F(1, 60) = 325.66, p < .001, \eta^2_{\text{partial}} = .84$, revealing that state anxiety scores differed significantly between the high and low state anxiety conditions prior to blocks of the Expectancy Assessment Task trials ($p < .001$), and that this significant difference was maintained after blocks of the Expectancy Assessment Task trials ($p < .001$). This significant 2-way interaction between State Anxiety Manipulation Condition and Time, differed significantly as a function of Trait Anxiety Group such that there was a significant 3-way interaction of State Anxiety Manipulation Condition, Time and Trait Anxiety Group, $F(1, 60) = 14.98, p < .001, \eta^2_{\text{partial}} = .20$. This revealed that state anxiety scores were significantly higher in the high than the low state anxiety conditions prior to blocks of the Expectancy Assessment Task trials ($p = .001$), and that this significant difference was maintained after blocks of the Expectancy Assessment Task trials ($p < .001$) in both the high and low trait anxious ($p = .009$ and $p < .001$, respectively). Overall this confirms that the State Anxiety Manipulation Task was effective in inducing significantly different levels of state anxiety between State Anxiety Manipulation Conditions, and that this difference was maintained across blocks of the Expectancy Assessment Task trials throughout the experiment for both the low and high trait anxious. Thus, participants completed the Expectancy Assessment Task while experiencing significantly different states of anxiety.

As mentioned earlier, a secondary issue pertaining to the State Anxiety Manipulation Task possibly also influencing depressed mood was also considered. Thus, depression scores obtained on the Mood Rating Task were analysed to determine whether the State Anxiety Manipulation Task also induced elevations or reductions in
Anxiety-linked Bias in Negative Expectancy

depression, in the high and low state anxious conditions, respectively and whether such changes were maintained across blocks of the Expectancy Assessment Task for both the high and low trait anxious. This was achieved by analysing the mean depression ratings obtained prior to Expectancy Assessment Task trials and those obtained following Expectancy Assessment Task trials using a mixed design, 2 x 2 x 2 ANOVA. The between-groups factors were State Anxiety Manipulation Condition (Low state anxious, High state anxious) and Trait Anxiety Group (Low trait anxious, High trait anxious), and the within-subjects factor was Time (Pre-Expectancy Assessment Task trials, Post-Expectancy Assessment Task trials).

This analysis revealed a significant main effect of Trait Anxiety Group, \(F(1, 60) = 11.37, p = .001, \eta^2_{\text{partial}} = .16\), reflecting that depression scores were significantly higher in the high trait anxious (M = 24.59, SD = 9.29) compared to the low trait anxious groups (M = 17.56, SD = 9.04). This significant main effect of Trait Anxiety Group differed significantly by Time, \(F(1, 60) = 10.81, p = .002, \eta^2_{\text{partial}} = .15\), demonstrating that the high trait anxious had significantly higher depression scores than the low trait anxious before blocks of Expectancy Assessment Task trials (\(p = .001\)), and this significant difference between trait anxiety groups was maintained across (until after) blocks of the Expectancy Assessment Task trials (\(p = .009\)). There was also a significant main effect of State Anxiety Manipulation Condition, \(F(1, 60) = 13.99, p < .001, \eta^2_{\text{partial}} = .19\), reflecting that depression scores were significantly higher in the high state (M = 24.97, SD = 9.33) compared to the low state anxiety condition (M = 17.17, SD = 8.67). There was no significant 2-way interaction of State Anxiety Manipulation Condition and Trait Anxiety Group (\(p = .358\)), indicating that differing levels of depression between high and low state anxiety conditions did not differ significantly between high and low trait anxiety groups. However, this main effect of State Anxiety Manipulation Condition did differ significantly by Time, \(F(1, 60) = \)
Anxiety-linked Bias in Negative Expectancy

223.86, \( p < .001, \eta^2_{\text{partial}} = .79 \), revealing that depression scores in the high and low state anxiety conditions differed significantly prior to blocks of the Expectancy Assessment Task trials (\( p = .021 \)), as well as this significant difference being maintained after blocks of the Expectancy Assessment Task trials (\( p < .001 \)). This significant 2-way interaction between State Anxiety Manipulation Condition and Time, differed significantly between Trait Anxiety Groups such that there was a significant 3-way interaction of State Anxiety Manipulation Condition, Time and Trait Anxiety Group, \( F(1, 60) = 12.76, \ p = .001, \eta^2_{\text{partial}} = .18 \), such that depression scores were significantly higher in the high than the low state anxiety conditions for the high trait anxious prior to blocks of the Expectancy Assessment Task trials (\( p = .024 \)), as well as this significant difference being maintained after blocks of the Expectancy Assessment Task trials in the high trait anxious (\( p < .001 \)), while in the low trait anxious, depression scores were not significantly higher in the high than the low state anxiety conditions prior to blocks of the Expectancy Assessment Task trials (\( p = .203 \)), though they were after blocks of the Expectancy Assessment Task trials (\( p = .017 \)). Overall this analysis confirms that the State Anxiety Manipulation Task also induced significantly different levels of depression between State Anxiety Manipulation Conditions across the low and high trait anxious groups, which was maintained across blocks of the Expectancy Assessment Task trials throughout the experiment for the high trait anxious, and only obtained after blocks of the Expectancy Assessment Task trials for the low trait anxious. Thus, participants completed the Expectancy Assessment Task under significantly different levels of state anxiety and depression. Nevertheless, as mentioned earlier in this chapter, should expectancy be found to be significantly associated with state anxiety, then it will be important to consider whether that effect is a state anxiety effect specifically, or related to negative affect more generally given that the State Anxiety Manipulation Task also induced differing levels of depression in participants.
Expectancy Index Analyses

Mean expectancy ratings for negative and positive candidate future events presented during the Expectancy Rating Trials of the Expectancy Assessment Task were calculated for each participant. These mean expectancy ratings can be seen, together with Negative Expectancy Index, Emotional Extrapolation Index, and Negative Extrapolation Index scores computed from these expectancy ratings (as described earlier) in Table 6.
Table 6. Summary of mean expectancy ratings for negative and positive future events, and resulting Negative Expectancy Index, Emotional Extrapolation Index, and Negative Extrapolation Index scores.

<table>
<thead>
<tr>
<th>Trait anxiety group</th>
<th>State anxiety manipulation condition</th>
<th>Scenario Domain</th>
<th>Scenario Valence</th>
<th>Future Event Expectancy Ratings</th>
<th>Expectancy Index</th>
<th>Negative Extrapolation Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>High trait anxious</td>
<td>Low state anxious n = 16</td>
<td>Social Scenarios</td>
<td>Negative Scenarios</td>
<td>2.7 (0.5)</td>
<td>2.5 (0.4)</td>
<td></td>
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<tr>
<td>n = 16</td>
<td></td>
<td></td>
<td>Positive Scenarios</td>
<td>2.1 (0.2)</td>
<td>3.1 (0.4)</td>
<td>-0.4 (0.3)</td>
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<td></td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
<td>2.3 (0.3)</td>
<td>2.7 (0.2)</td>
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<tr>
<td></td>
<td>Low state anxious n = 16</td>
<td>Physical Scenarios</td>
<td>Negative Scenarios</td>
<td>2.5 (0.3)</td>
<td>2.5 (0.3)</td>
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<td></td>
<td></td>
<td></td>
<td>Positive Scenarios</td>
<td>2.1 (0.4)</td>
<td>2.9 (0.3)</td>
<td>-0.4 (0.3)</td>
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<td></td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
<td>2.4 (0.2)</td>
<td>2.7 (0.3)</td>
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<tr>
<td>Low trait anxious</td>
<td>Low state anxious n = 16</td>
<td>Social Scenarios</td>
<td>Negative Scenarios</td>
<td>2.4 (0.5)</td>
<td>2.6 (0.4)</td>
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<tr>
<td>n = 32</td>
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<td>3.1 (0.3)</td>
<td>-0.7 (0.5)</td>
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<td></td>
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<td>Balanced Scenarios</td>
<td>2.3 (0.5)</td>
<td>3.0 (0.3)</td>
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<td></td>
<td>High state anxious n = 16</td>
<td>Physical Scenarios</td>
<td>Negative Scenarios</td>
<td>2.5 (0.5)</td>
<td>2.5 (0.4)</td>
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<td></td>
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<td></td>
<td>Positive Scenarios</td>
<td>2.0 (0.3)</td>
<td>3.2 (0.3)</td>
<td>-0.6 (0.4)</td>
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<td>Balanced Scenarios</td>
<td>2.4 (0.5)</td>
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<td>High trait anxious</td>
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<td>Social Scenarios</td>
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<td>n = 16</td>
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<td>Positive Scenarios</td>
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<td>Balanced Scenarios</td>
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<td>State anxiety manipulation condition</td>
<td>Scenario Domain</td>
<td>Scenario Valence</td>
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<td>Expectancy Index</td>
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<td>Negative Future Event</td>
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</table>

Anxiety-linked Bias in Negative Expectancy
Negative Expectancy Index, Emotional Extrapolation Index, and Negative Extrapolation Index scores were each subjected to a mixed design, 2 x 2 x 2 ANOVA. The between-groups factors were Trait Anxiety Group (Low trait anxious, High trait anxious), and State Anxiety Manipulation Condition (Low state anxious, High state anxious). The within-groups factor was Scenario Domain (Social, Physical).

The main aim in Experiment 3 was to investigate the role of trait anxiety and induced levels of state anxiety in an anxiety-linked bias in negative expectancy. More specifically, the aim was to investigate the degree to which each of the three Expectancy Indices (including those which have and have not been found to characterise an anxiety-linked bias in negative expectancy in the previous two experiments), were a function of individual differences in either trait anxiety, state anxiety, or both trait anxiety and state anxiety independently, or both trait anxiety and state anxiety additively. One hypothesis is that an anxiety-linked bias in negative expectancy is associated with trait anxiety and unaffected by state anxiety, leading to the prediction that expectancy will be found to differ between trait anxiety groups and be unaffected by different (i.e., high and low) levels of induced state anxiety. This would be demonstrated by a significant main effect of Trait Anxiety Group, with no significant main effect of State Anxiety Manipulation Condition and no significant 2-way interaction of Trait Anxiety Group and State Anxiety Manipulation Condition. A second hypothesis is that an anxiety-linked bias in negative expectancy is associated with state anxiety while not being related to trait anxiety. Should evidence be found to support this hypothesis, then expectancy would differ between high and low (induced) state anxiety conditions, but not between high and low trait anxiety groups. This would be demonstrated by a significant main effect of State Anxiety Manipulation Condition, with no significant main effect of Trait Anxiety Group and no significant 2-way interaction of State Anxiety Manipulation Condition and Trait Anxiety Group. A third hypothesis is that an anxiety-linked bias in negative expectancy...
Anxiety-linked Bias in Negative Expectancy

expectancy may be associated with both trait and state anxiety, independently. This leads to the prediction that expectancy will differ significantly between trait anxiety groups and between state anxiety conditions, without this trait anxiety-linked bias in negative expectancy itself also further differing between state anxiety conditions or this state anxiety-linked bias in negative expectancy itself also further differing between trait anxiety groups (i.e., without there being an interaction of trait and state anxiety). This would be demonstrated by a significant main effect of Trait Anxiety Group and a significant main effect of State Anxiety Manipulation Condition, with no significant 2-way interaction of Trait Anxiety Group and State Anxiety Manipulation Condition. The final hypothesis is that an anxiety-linked bias in negative expectancy may be associated with trait anxiety and modified by state anxiety such that state anxiety amplifies the trait anxiety effect on expectancy. According to this hypothesis, expectancy would differ significantly between trait anxiety groups, with this trait anxiety group difference in expectancy being disproportionately more evident in the high than the low state anxiety condition. This would be demonstrated by a significant 2-way interaction of Trait Anxiety Group and State Anxiety Manipulation Condition.

**Negative expectancy index analysis.**

Negative Expectancy Index scores are presented in the column third from the right in Table 6. As mentioned earlier, these scores were subjected to a mixed design, 2 x 2 x 2 ANOVA. The only significant effect to emerge was a main effect of Scenario Domain, $F(1, 60) = 7.58, p = .008, \eta^2_{\text{partial}} = .11$, with significantly greater Negative Expectancy Index scores in physical than social scenarios (Physical $M = -.43, SD = .42$; Social $M = -.55, SD = .48$). Thus participants generally showed inflated expectancy for negative than positive future events to a greater extent in physical than social scenarios. This analysis did not reveal a significant main effect of Trait Anxiety Group ($p = .533$), providing no evidence of expectancy being associated with trait
anxiety. Therefore, unlike the findings in Experiments 1 and 2, no trait anxiety-linked bias in negative expectancy was observed when analysing Negative Expectancy Index scores. This analysis did not reveal a significant main effect of State Anxiety Manipulation Condition \( (p = .382) \), indicating that no state anxiety-linked bias in negative expectancy was observed. The absence of main effects of both Trait Anxiety Group and of State Anxiety Manipulation Condition suggests that an anxiety-linked bias in negative expectancy is not associated with both trait and state anxiety, independently. There was also no significant 2-way interaction of Trait Anxiety Group and State Anxiety Manipulation Condition \( (p = .098) \) indicating that the possibility of expectancy being associated with trait anxiety and modified (i.e., amplified) by state anxiety was not observed.

**Emotional extrapolation index analysis.**

The Emotional Extrapolation Index scores presented in the second column from the right in Table 6 were subjected to a mixed design, 2 x 2 x 2 ANOVA. There was a significant main effect of Trait Anxiety Group, \( F(1, 60) = 6.27, p = .015, \eta^2_{\text{partial}} = .10 \), with the high trait anxious showing significantly lower Emotional Extrapolation Index scores than the low trait anxious (High trait anxious M = 0.27, SD = .42; Low trait anxious M = 0.54, SD = .42). This indicates that the high trait anxious showed less emotional extrapolation compared to the low trait anxious. This significant main effect of Trait Anxiety Group provides evidence of expectancy being associated with trait anxiety, as well as evidence of a trait anxiety-linked bias in negative expectancy being characterised by emotional extrapolation as in Experiments 1 and 2. However, the exact nature of such emotional extrapolation is contrary to that observed in Experiment 1, with emotional extrapolation being attenuated in the high trait anxious compared to the low trait anxious in the current experiment (rather than this effect being greater in the high than low trait anxious). This analysis did not reveal a significant main effect of
State Anxiety Manipulation Condition \((p = .642)\), indicating that no state anxiety-linked bias in negative expectancy was observed. The absence of both a significant main effect of Trait Anxiety Group and a significant main effect of State Anxiety Manipulation Condition suggests that an anxiety-linked bias in negative expectancy is not be associated with both trait and state anxiety, independently. There was also no significant 2-way interaction of Trait Anxiety Group and State Anxiety Manipulation Condition \((p = .862)\) demonstrating that no anxiety-linked bias in negative expectancy associated with trait anxiety was modified (i.e., amplified) by state anxiety. No other significant effects emerged from this analysis.

**Negative extrapolation index analysis.**

The Negative Extrapolation Index scores presented in the right-most column of Table 6 were subjected to a mixed design, \(2 \times 2 \times 2\) ANOVA. This analysis revealed no significant effects. There was no significant main effect of Trait Anxiety Group \((p = .596)\) indicating that no trait anxiety-linked bias in negative expectancy was observed. Moreover, this is consistent with the results obtained in Experiment 1 and 2 in which no anxiety-linked bias in negative expectancy was observed when analysing Negative Extrapolation Index scores. Thus a trait anxiety-linked bias in negative expectancy does not appear to be charactered by negative extrapolation. There was also no significant main effect of State Anxiety Manipulation Condition \((p = .646)\), revealing that there was no evidence of a state anxiety-linked bias in negative expectancy. The absence of both a significant main effect of Trait Anxiety Group and a significant main effect of State Anxiety Manipulation Condition suggests that an anxiety-linked bias in negative expectancy is not associated with both trait and state anxiety, independently. There was also no significant 2-way interaction of Trait Anxiety Group and State Anxiety Manipulation Condition \((p = .629)\) suggesting that no anxiety-linked bias in negative expectancy associated with trait anxiety was modified (i.e., amplified) by state anxiety.
Discussion

Experiment 3 used the Expectancy Assessment Task along with a State Anxiety Manipulation Task and Mood Rating Task to achieve a new major aim of investigating the role of trait anxiety and induced levels of state anxiety in an anxiety-linked bias in negative expectancy. The results of the current experiment revealed evidence of expectancy being associated with trait anxiety, and not associated with either state anxiety, or both trait and state anxiety, independently or additively. More specifically, a trait anxiety-linked bias in negative expectancy was characterised by emotional extrapolation, such that the high trait anxious showed significantly less emotional extrapolation compared to the low trait anxious. No significant effects regarding expectancy being associated with either trait anxiety, state anxiety, or by both trait and state anxiety, independently or additively, were found when analysing Negative Expectancy Index or Negative Extrapolation Index scores.

As mentioned earlier, this trait anxiety-linked bias in negative expectancy, characterised by emotional extrapolation, is consistent with a trait anxiety-linked bias in negative expectancy also characterised by emotional extrapolation in Experiments 1 and 2. However, the exact nature of the emotional extrapolation was inconsistent with that observed in Experiment 1, with emotional extrapolation being attenuated in the high trait anxious compared to the low trait anxious in the current experiment (rather than this effect being greater in the high than low trait anxious as in Experiment 1). Thus while emotional extrapolation appears to be an important variable, the contradictory nature of this effect across experiments demonstrates that its impact is not consistent. However, it should be noted that the current experiment, while also only including only younger adults like Experiment 1, contained a State Anxiety Manipulation Task which was not included in Experiment 1. Thus, it may be that the addition of this task to the current research paradigm led to a failure to replicate this exact effect in this
Anxiety-linked Bias in Negative Expectancy

experiment. By contrast, this finding is more consistent with that found in Experiment 2, where there was a strong trend for the high trait anxious to show less emotional extrapolation than the low trait anxious in physical scenarios, with no significant trait anxiety group difference in emotional extrapolation in social scenarios. However, the current finding of less emotional extrapolation in the high compared to the low trait anxious in the current experiment is also at least partially inconsistent with what was found in Experiment 2 in that it did not differ according to whether scenarios presented social or physical concerns. Rather this finding in Experiment 3 indicates that the high trait anxious show less emotional extrapolation than the low trait anxious, that does not differ according to the content of situation. This suggests that trait anxiety-linked emotional extrapolation may be irrelevant to personal concerns or it may indicate that, among these younger adults, social and physical concerns were similarly personally relevant.

In terms of the Negative Expectancy Index scores, no trait anxiety group difference was found. This is in direct contrast to the trait anxiety-linked differences found in the Negative Expectancy Index scores in both previous experiments (i.e., significantly higher Negative Expectancy Index scores in the high trait anxious than the low trait anxious). These findings in Experiments 1 and 2 were characterised by the high trait anxious showing greater expectancy for negative than positive future events when compared to the low trait anxious. The addition of the State Anxiety Manipulation Task to the current research paradigm may have led to this effect not being replicated in this experiment. It may be that this trait anxiety-linked effect is more readily observed on this Index when individuals are in a natural mood state, and since the current experiment involved inducing two different levels of state anxiety, this effect was not observed. It may also be the case that the State Anxiety Manipulation Task posed a distraction or increased cognitive/attentional load (in terms of a greater load on divided
anxiety), which resulted in this trait anxiety-linked effect not being observed on this Index as it may be under conditions of a reduced cognitive/attentional load on divided attention. Nevertheless, as discussed in Experiment 1 and 2, given that a (trait) anxiety group difference was found on the Negative Expectancy Index and Emotional Extrapolation Index in those two experiments (the latter indicating that a trait anxiety-linked bias in negative expectancy does differ as a function of the current emotional tone), a (trait) anxiety-linked bias was considered to be characterised by emotional extrapolation rather than pervasive negative expectancy.

In analysing Negative Extrapolation Index scores, no trait anxiety group difference was found, as in Experiment 1 and 2. This again suggests that a trait anxiety-linked bias in negative expectancy is not characterised by negative extrapolation. A trait anxiety group difference in Negative Extrapolation Index scores was only found as part of an age-linked effect in Experiment 2 (i.e., with trait anxiety group differences in Negative Extrapolation Index scores differing between age groups). This involved a strong trend for higher Negative Extrapolation Index Scores in the older high trait anxious than the younger high trait anxious, compared to no significant age group difference in Negative Extrapolation Index Scores in the low trait anxious. This finding of greater negative than positive extrapolation in the older high trait anxious compared to the younger high trait anxious will be discussed in more detail below in terms of further investigating this effect in the next experiment.

Despite the State Anxiety Manipulation Task being effective in inducing significantly different levels of state anxiety between State Anxiety Manipulation Conditions, and maintaining this difference in state anxiety throughout the Expectancy Assessment Task for both the low and high trait anxious, the observed trait anxiety-linked bias in negative expectancy did not appear to differ as a function of state anxiety. Thus, although participants did indeed complete the Expectancy Assessment Task under
significantly different levels of state anxiety, a trait anxiety-linked bias in negative expectancy was not disproportionately more evident in the high state than the low state anxiety condition, as hypothesised. These results appear to contrast with previous research, which has found evidence of state and trait anxiety-linked effects on patterns of selective processing favouring negative information. For example, in a study by MacLeod and Rutherford (1992), elevated state anxiety resulted in increased selective interference from threat-related stimuli on a variant of the Stroop task in the high trait anxious, while decreasing selective interference from threat-related stimuli for the low trait anxious. This was described as suggesting that the high trait anxious show an increased automatic tendency to selectively process threat-related information as they become increasingly state anxious (thus state anxiety appears to amplify the trait anxiety effect observed), while the low trait anxious show the opposite effect characterised by an increasing automatic tendency to selectively avoid processing such threat-related information as they become more state anxious (MacLeod & Rutherford, 1992).

There are possible limitations associated with the current experiment. Of course, it may indeed be the case that expectancy is not associated with state anxiety, or that a trait anxiety-linked bias in negative expectancy is not modified (i.e., amplified) by state anxiety, or that trait and state anxiety do not both independently contribute to differences in expectancy. However, it may also be the case that a state anxiety-linked bias in negative expectancy is only observed under extreme levels of low and high state anxiety. Thus, perhaps the State Anxiety Manipulation Task may not have induced a sufficiently extreme level of state anxiety for such differences to be observed. For example, in cognitive bias modification (CBM) research employing attentional bias training procedures, a number of studies have employed more naturalistic State Anxiety Manipulation Tasks, such as participants walking into a crowded room. One such study
found that the attentional training procedure was effective for participants exposed to these situations compared to those who were not (see Kuckertz et al., 2014). In another study employing an attentional bias training procedure (see Dandeneau & Baldwin, 2009), the State Anxiety Manipulation Task involved participants being overtly rejected by a peer to induce feelings of rejection along with them completing a set of 3 difficult anagrams to induce feelings of failure. The attentional training procedure in this study was successful in training less vigilance for rejection and resulted in less feelings of rejection. This appears to contrast with other CBM research which has not used such naturalistic State Anxiety Manipulation Tasks. This point was highlighted by Grafton (2014), who employed a State Anxiety Manipulation Task involving the use of anagrams (like that used in the current experiment) in an attentional bias modification experiment. It was found in that research that an attentional training procedure was not effective in modifying certain aspects of attentional selectivity that were of particular interest. Thus, similarly, not having used a more naturalistic State Anxiety Manipulation Task in the current experiment may have led to lower levels of state anxiety being induced, with this in turn leading to differences in expectancy not being found to be associated with state anxiety.

The use of more naturalistic State Anxiety Manipulation Tasks, perhaps involving more direct social evaluation, also appears to be important to consider. Salivary cortisol is widely used as an objective measure of emotional distress (Applehans & Luecken, 2006). Salivary cortisol increases have been observed in participants who are exposed to paradigms involving direct social evaluation (e.g., giving a speech in front of a group of evaluators) while no such increases are observed when there is no or indirect social evaluation (i.e., giving a speech while alone in a room). These findings have been observed despite anxiety not differing significantly as a function of social evaluation context (e.g., Gruenewald, Kemeny, Aziz, & Fahey,
Future studies investigating an anxiety-linked bias in negative expectancy and whether this bias in expectancy is associated with state anxiety, could include low and high state anxiety conditions of a more real-world situation (such as being exposed to an uncomfortable/anxiety-provoking social situation or a comfortable social situation) to induce higher levels of state anxiety in one group of participants than another, respectively.

The addition of the State Anxiety Manipulation Task to the Expectancy Assessment Task may have provided participants with a greater cognitive load (i.e., required them to expend greater cognitive/mental effort). Given the nature of the State Anxiety Manipulation Task (and the involvement of anagrams), the addition may have provided a greater load specifically on cognitive functions such as working memory, divided or shifting attention, or verbal memory. Furthermore, heightened anxiety vulnerability has been found to be associated with a number of neuropsychological deficits, including reductions in episodic memory and executive functioning (Airaksinen, Larsson, & Forsell, 2005; Kashyap, Kumar, Kandavel, & Reddy, 2013), divided and selective attention (Lautenbacher, Spernal, & Krieg, 2002), and working memory, even for non-emotional stimuli (Eysenck, Payne, & Derakshan, 2005; Hayes, Hirsch, & Mathews, 2008). Thus, it is interesting to consider the possibility that an anxiety-linked bias in negative expectancy may be differentially associated with neurocognitive capacity. It is possible that, in the current experiment, anxiety group differences in neurocognitive capacity may have masked the potential finding of expectancy differing as a function of state anxiety. Thus, it would be important to investigate how compromised neurocognitive capacity is related to patterns of selective processing in anxiety vulnerability (i.e., an anxiety-linked bias in negative expectancy), as some studies have suggested a significant association between these. For example, a study conducted by Hakamata, Matsui, and Tagaya (2014) found that general attentional
ability as measured by a standard neuropsychological test was significantly associated with an attentional bias toward threatening information. In particular, individuals with poorer attentional ability showed greater attentional bias towards negative stimuli.

Given the findings in the current experiment, state anxiety does not appear to be having an effect on a (trait) anxiety-linked bias in negative expectancy, which suggests that varying levels of state anxiety (i.e., older adults possibly becoming more state anxious in the testing environment compared to younger adults), may not have produced the age-linked bias in negative expectancy characterised by age amplifying (rather than attenuating) an anxiety-linked bias in negative expectancy observed in Experiment 2. This effect in Experiment 2 was characterised by the older high trait anxious showing greater negative than positive extrapolation than the younger high trait anxious, with no age group differences in negative relative to positive extrapolation in the low trait anxious. This appears contrary to the hypothesis that older adults would show an attenuation of the anxiety-linked bias in negative expectancy found in younger adults, which would be expected given the ‘positivity effect’ (e.g., Isaacowitz et al., 2008; Kennedy et al., 2004; McDowell, Harrison, & Demaree, 1994) described in the ageing literature whereby older adults show a preference for positive over negative information. This unexpected finding in Experiment 2 may be related to an aspect of the sample in that experiment that was not well characterised, such as the neurocognitive capacity of participants (particularly older adults) included in the sample. As previously mentioned, a limitation of the current research is that cognitive screening was not employed to determine inclusion/exclusion criteria. Thus, participants (and particularly the older adults) in the previous experiment may have had above average or below average cognitive abilities. This may have in turn contributed to the contrary nature of the age-linked bias in negative expectancy found. There is widespread evidence of relatively poorer neurocognitive capacity in older than younger adults with some
neurocognitive decline occurring during the healthy ageing process (Harada et al., 2013). Older adults show a general slowing of processing speed (Salthouse, 2010), and declines in executive functioning (West, 1996), and episodic memory (Nyberg et al., 2012). This neurocognitive ageing account has been put forward in the literature as a possible reason for reduced anxiety vulnerability in older adults (e.g., Ruffman et al., 2008; Williams et al., 2006). Therefore, the next experiment now turns to exploring the possibility that an age-linked bias in negative expectancy may differ as a function of neurocognitive capacity.
CHAPTER 5: EXPERIMENT 4 – Anxiety-linked Bias in Negative Expectancy and the Impact of Age and Neurocognitive Capacity

Introduction

As mentioned in the previous chapter, it is possible that an age-linked bias in negative expectancy may differ according to neurocognitive capacity. With regards to the findings in Experiment 3, state anxiety does not appear to be associated with an anxiety-linked bias in negative expectancy. This suggests that varying levels of state anxiety (i.e., older adults possibly becoming more state anxious in the testing environment compared to younger adults) may not have produced the age-linked bias in negative expectancy characterised by age amplifying (rather than attenuating) an anxiety-linked bias in negative expectancy observed in Experiment 2. This effect of age moderating an anxiety-linked bias in negative expectancy in Experiment 2 was unexpectedly characterised by the older high trait anxious greater negative than positive extrapolation than the younger high trait anxious, with no age group differences in negative relative to positive extrapolation in the low trait anxious. It is worth noting that perhaps there was an aspect of the sample (and particularly the older adult sample) in Experiment 2 that was not well characterised. One such aspect may be neurocognitive capacity, which was not assessed though may have contributed to this unlikely age-linked effect, the nature of which contradicted the hypothesised effect.

There is evidence that older adults exhibit fewer patterns of selective processing (i.e., anxiety-linked cognitive biases) which, according to MacLeod et al. (2004), have been shown causally to contribute to anxiety vulnerability in younger adults. Contrary to the negative processing biases that characterise increased anxiety vulnerability in younger adults, older adults appear to display a ‘positivity effect’ (Carstensen & Mikels, 2005), focusing on positive information more than younger adults (Leclerc & Kensinger, 2008). For example, older adults are less likely to recognise negative
emotions (such as sadness, anger, and fear) in facial expressions compared to younger adults, despite no age differences in recognising happy expressions (McDowell et al., 1994). According to Mather and Carstensen (2005), older adults also tend to use more of their time processing positive than negative emotional information compared to younger adults. In particular, older adults have been found to focus on positive images for longer (Isaacowitz et al., 2006) and recall more positive information (Kennedy et al., 2004) than younger adults.

There are two main classes of neuropsychological accounts that appear to dominate the ageing literature to explain age differences in anxiety-linked cognitive biases and why anxiety may be less common with increasing age. Firstly, there is the Age-related Enhancement of Wisdom and Experience Account. One theoretical account belonging to this class of accounts is Socioemotional Selectivity Theory (SST; Carstensen et al., 1999). According to SST, with advancing age people begin to perceive the remaining time in their lives as limited, and thus tend to prioritise emotional goals (such as gaining emotional fulfilment) over other life goals (Carstensen et al., 2003). This leads to older adults tending to have greater emotional well-being, compared to younger adults who appear more likely to pursue goals related to knowledge acquisition despite unpleasant emotional experiences (Carstensen, 2006).

Secondly, there is the Age-related Decline in Neurocognitive Capacity Account that attributes these age-related differences in anxiety vulnerability and anxiety-linked cognitive biases to being the inadvertent consequence of the ageing brain, with older adults showing a gradual decline in various neurocognitive abilities. As discussed earlier in Chapter 1, while there are areas of neurocognitive capacity that remain essentially preserved/stable during normal ageing (such as semantic knowledge and autobiographical memory), there is a wealth of evidence demonstrating changes in other areas of neurocognitive capacity during the healthy ageing process (see Hedden &
Gabrieli, 2004, for a review). These neurocognitive abilities that undergo gradual decline include: processing speed (Finkel et al., 2009; Salthouse, 1996, 2010), executive functions (see Drag & Bieliauskas, 2010, for a review; Phillips & Henry, 2008; Salthouse et al., 2003), and memory (e.g., see Drag & Bieliauskas, 2010; Hoyer & Verhaeghen, 2006; Nyberg et al., 2012).

In light of the above-mentioned literature (particularly that pertaining to a decline in neurocognitive capacity during normal ageing), it is possible that any moderating effect of age on an anxiety-linked bias in negative expectancy is in fact a function of differences in neurocognitive capacity. For example, older adults may demonstrate an anxiety-linked bias in negative expectancy like that observed in younger adults (i.e., greater expectancy for negative than positive future events in the high trait anxious when compared to the low trait anxious) to the extent that these older adults are more neurocognitively intact, like younger adults. Moreover, older adults may demonstrate an attenuated anxiety-linked bias in negative expectancy, compared to that observed in younger adults, to the extent that these older adults are less neurocognitively intact/more neurocognitively impaired. This may explain the unusual nature of the moderating impact of age on an anxiety-linked bias in negative expectancy found in Experiment 2 (which was contrary to that expected), since the neurocognitive capacity of participants (particularly that of older adults) included in that sample was not examined. To investigate whether or not differences in neurocognitive capacity may be responsible for the age-related differences in an anxiety-linked bias in negative expectancy found in Experiment 2, it would be important to assess whether the impact of age on an anxiety-linked bias in negative expectancy, itself differs as a function of neurocognitive capacity.

In investigating the relationship between age and neurocognitive capacity and the impact of such on the relationship between anxiety and expectancy, it would be
necessary to examine a particularly important aspect of neurocognitive capacity known
gradually to decline during normal ageing and which is also relevant to anxiety and
forming expectations of the future. As mentioned earlier, executive functioning is one
area of neurocognitive abilities that is known to undergo gradual deterioration with
increasing age (e.g., Andrès & Van Der Linden, 2000). Specifically, reductions in
complex/divided attention are consistently observed during normal ageing (e.g., see
Logie, Della Sala, MacPherson, & Cooper, 2007; Naveh-Benjamin, Craik, Guez, &
Kreuger, 2005; Sarter & Turchi, 2001; Verhaeghen & Cerella, 2002; Verhaeghen, Steiz,
Sliwinski, & Cerella, 2003, for a review) and have a particularly significant impact on
person’s daily functioning (Tomaszewski Farias et al., 2009). Therefore dual task
processing/divided attention is considered an important and very relevant area of
neurocognitive capacity to assess in the current experiment. It is also not unexpected
that dual-task processing/divided attention would be required when forming
expectations about the future, particularly in the presence of anxiety, given that there
may be concurrent external and internal demands on attentional processing. External
demands on attention would include being required to process the current situation and
the way in which current events are proceeding (i.e., in a manner considered negative or
positive) as well as forming expectations regarding how subsequent or future events
may proceed (i.e., in either a negative or positive manner). At the same time internal
demands on attention would likely be in the form of anxious thought processes.
Therefore, the degree to which a person’s dual task processing capacity/divided
attention is compromised (which may be more so in older than younger adults), may
impact on how he or she responds to a current situation, and thus his or her expectations
about the future. Given its relevance to age-related neurocognitive decline and its likely
impact on an anxiety-linked bias in negative expectancy, dual-task processing/divided
attention was selected as a critical area of neurocognitive capacity to be assessed in Experiment 4.

It is hypothesised that neurocognitive capacity (i.e., divided attention/dual task processing) will moderate the impact that age has on an anxiety-linked bias in negative expectancy. Should support for this hypothesis be found, then older adults with greater neurocognitive capacity (i.e., better dual task processing/divided attention) will demonstrate greater evidence of an anxiety-linked bias in negative expectancy than those with poorer neurocognitive capacity (i.e., poorer dual task processing/divided attention). This effect may be observed on Negative Expectancy Index, Emotional Extrapolation Index or Negative Extrapolation Index scores. However, given that an age-linked bias in negative expectancy (characterised by age amplifying rather than attenuating an anxiety-linked bias in negative expectancy) in Experiment 2 involved negative extrapolation, it is hypothesised that in this experiment an age-linked bias in negative expectancy will be observed on Negative Extrapolation Index scores.

To again investigate whether age moderates an anxiety-linked bias in negative expectancy (as in Experiment 2), it was required that high trait anxious and low trait anxious groups comprised of similar numbers of younger and older adults complete the Expectancy Assessment Task. To enable the assessment of whether neurocognitive capacity (particularly dual task processing/divided attention) moderates the impact of age on an anxiety-linked bias in negative expectancy, high trait anxious and low trait anxious younger and older adult participants were also required to complete a neuropsychological measure. It was necessary that this was a neuropsychological measure of a critical neurocognitive ability known to decline during normal ageing and which is also relevant to anxiety and future expectancy (i.e., dual task processing/divided attention).
Participants

Fifty-seven participants differing along 2 independent factors were recruited. Again, no participants in this experiment had taken part in the experiments reported in the previous chapters. To create the factor of Age Group, these 57 participants included a younger adult cohort (consisting of 32 young adult first year psychology undergraduates) aged 17 to 25 (M = 18.44, SD = 1.81), and an older adult cohort (consisting of 25 community dwelling older adults who were recruited from a pool of community volunteers and from those who responded to advertisements placed on local community noticeboards or in newsletters), aged 60 or over (M = 71.36, SD = 5.63, ranging from 62-86 years). To create the orthogonal factor of Trait Anxiety Group, each of the above-mentioned cohorts consisted of a low trait anxious group and a high trait anxious group, resulting in a total of 4 groups (i.e., younger low trait anxious, younger high trait anxious, older low trait anxious, and older high trait anxious). Cut-off scores for inclusion in the high trait anxious group and low trait anxious group were determined using the mean trait anxiety scores for college students (M = 39.35, SD = 9.67) and older adults (M = 32.83, SD = 8.32) found in the STAI-T manual (Spielberger, 1983). Since mean trait anxiety scores on the Trait form of the STAI differ for younger and older adults, participants were classified as low trait anxious if their trait anxiety score fell at or below the mean STAI-T score of both college students and older adults (i.e., below 32.83), while participants were classified as high trait anxious if their trait anxiety score fell at or above the mean STAI-T score for college students and older adults (i.e., above 39.35). Of the 57 participants that were recruited, 28 participants formed part of the low trait anxious group (15 younger and 13 older), while 29 formed part of the high trait anxious group (17 younger and 12 older). Like Experiment 2, the older high trait anxious contained slightly fewer participants due to
Anxiety-linked Bias in Negative Expectancy

the difficulty in locating and recruiting anxious older adults. The trait anxiety scores of the low trait anxious group ranged from 20 to 32 (M = 26.29, SD = 3.44), whereas those of the high trait anxious group ranged from 39 to 54 (M = 44.07, SD = 4.93).

It was required that the magnitude of the difference in trait anxiety scores between the high trait anxious and low trait anxious groups should not differ between the younger adult and older adult cohorts. Likewise, it was required that the difference in age between the younger adult and older adult cohorts should not differ between the high trait anxious and low trait anxious groups. It was also required that gender be similarly balanced across younger adult and older adult cohorts, and across high trait anxious and low trait anxious cohorts.

A 2 x 2 mixed design analysis of variance (ANOVA) of Trait Anxiety Group (Low trait anxious, High trait anxious) and Age Group (Younger, Older) on STAI-T scores was conducted. This revealed a significant main effect of Trait Anxiety Group, \( F(1, 53) = 238.63, p < .001, \eta^2_{\text{partial}} = .82, \) confirming that as required, the high trait anxious showed significantly greater STAI-T scores than the low trait anxious. Furthermore, as required, there was no significant main effect of Age Group (\( p = .439 \)), indicating no significant Age Group difference in STAI-T scores. There was also no significant interaction of Trait Anxiety Group and Age Group (\( p = .668 \)) indicating that as required, the difference in trait anxiety scores between the high and low trait anxious groups did not differ for the younger and older adult cohorts.

A equivalent 2 x 2 mixed design ANOVA was conducted on age. This revealed a significant main effect of Age Group, \( F(1, 53) = 2423.59, p < .001, \eta^2_{\text{partial}} = .98, \) confirming that, as required, the older adult cohort was significantly older than the younger adult cohort. Furthermore, there was no significant main effect of Trait Anxiety Group (\( p = .705 \)), indicating no significant Trait Anxiety Group difference in age as required. There was also no significant interaction of Trait Anxiety Group and Age
Anxiety-linked Bias in Negative Expectancy

Group, \( (p = .576) \) revealing that as required, the difference in age between younger and older adult cohorts did not differ for the low trait anxious and high trait anxious groups.

Finally, chi-square tests of independence were performed to examine the relationship between gender and Trait Anxiety Group, and between gender and Age Group, respectively. As required, the relationship between gender and Trait Anxiety Group was not significant, \( X^2(1, N=57) = 0.15, p = .696 \), revealing that the low trait anxious and high trait anxious groups did not differ in terms of gender ratio. Similarly, and as required, the relationship between gender and Age Group was not significant, \( X^2(1, N=57) = 0.01, p = .933 \), indicating that younger and older adult cohorts did not differ significantly in terms of gender ratio. Descriptive statistics for age, gender, and trait anxiety scores for each of the 4 groups of participants are presented in Table 7.
Table 7. Descriptive statistics for age, gender, and trait anxiety scores for younger and older low and high trait anxious groups.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Anxiety Group</th>
<th>Age</th>
<th>Gender n = male</th>
<th>STAI-T M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Younger adults (n = 32)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low trait anxious (n = 15)</td>
<td>18.33 (2.13)</td>
<td>6 (9)</td>
<td>26.93 (3.53)</td>
<td></td>
</tr>
<tr>
<td>High trait anxious (n = 17)</td>
<td>18.53 (1.55)</td>
<td>9 (8)</td>
<td>44.24 (4.88)</td>
<td></td>
</tr>
<tr>
<td>Older adults (n = 25)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low trait anxious (n = 13)</td>
<td>71.85 (5.15)</td>
<td>8 (5)</td>
<td>25.54 (3.31)</td>
<td></td>
</tr>
<tr>
<td>High trait anxious (n = 12)</td>
<td>70.83 (6.31)</td>
<td>4 (8)</td>
<td>43.83 (5.20)</td>
<td></td>
</tr>
</tbody>
</table>

Note. STAI-T = State-Trait Anxiety Inventory - Trait Score (Spielberger, 1983).

Materials

Trait anxiety questionnaire measure.

As in the previous three experiments, the Trait form of the State-Trait Anxiety Inventory (STAI-T; Spielberger, 1983) was used to measure dispositional anxiety. Cronbach’s alpha was .98 for the STAI-T in Experiment 4.

Expectancy assessment task stimuli.

The same stimuli used in the Expectancy Assessment Task in all three previous experiments, were also used in Experiment 4. A detailed discussion of the requirements
for stimuli included in the Expectancy Assessment Task as well as the final stimuli included in the task can be found in Chapter 2.

**Dual task processing capacity/divided attention measure.**

Participants completed the Telephone Search and Telephone Search While Counting subtests from the Test of Everyday Attention (TEA; Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994), which was used as a neuropsychological measure of divided attention (i.e., dual task processing). The Telephone Search subtest involves participants searching a simulated telephone directory for pairs of symbols. As described in the TEA manual (Robertson et al., 1994), participants are told to imagine they are on a trip and that while on this trip they are using a telephone directory to look up various services (for example, plumbers, restaurants or hotels). Specifically, they are told that while on their trip, they are staying in a house belonging to a friend who is away and not reachable by telephone. They are then instructed to imagine that the kitchen sink begins to leak and that they require the services of a plumber. They are advised to consider using only those plumbers listed in the telephone directory who have certain ratings for their services (i.e., two identical symbols) listed next to their telephone number. Participants are instructed to look through the telephone directory and to circle every set of two identical symbols, working as quickly and as accurately as they can. Their performance on this task is timed. To score a participant’s performance on this task, the number of correctly detected symbols is calculated, ignoring any false positives. The time taken to complete the task is then divided by the number of correctly identified symbols, which provides a time per target score. This time per target score is a measure of selective attention.

The Telephone Search While Counting subtest involves participants again searching a simulated telephone directory for pairs of symbols, however in this subtest they are required to perform this task while at the same time counting a series of strings
of tones. Participants are asked to imagine that they are interested in finding out which restaurants are in the area where they are staying while on their trip, and to imagine that they have been told that the restaurants that are most recommended are those which have two identical symbols next to their listing. Thus, they are required to look through a different simulated telephone directory and to circle every set of two identical symbols, working as quickly and as accurately as they can. Participants are also informed that at the same time they will need to count a number of series of tones. They are presented with a sample of these series of tones before the actual task begins and informed that while circling the double symbols and listening to the series of tones, they will have to say out loud how many tones there were in each series when they hear a ‘how many?’ query. Their performance on this task is timed. It is stressed to participants that they need to give equal importance to both the telephone search and counting tasks. To calculate the dual task decrement score, the total time taken to complete the task is divided by the number of correctly circled pairs of symbols to obtain a time-per-target score. Then the number of strings of tones correctly counted is divided by the number of strings of tones attempted to obtain a figure for the proportion of tone-strings correctly counted. The time-per-target score obtained is then divided by the proportion of tone-strings correctly counted to obtain a time-per-target weighted for accuracy of tone-counting. Finally, the time-per-target score from the previously administered Telephone Search subtest is subtracted from the time-per-target weighted for accuracy of tone-counting to obtain a dual task decrement score. A greater dual task decrement score indicates poorer dual task processing/divided attention, while a lower dual task decrement score indicates better dual task processing/divided attention.

According to Robertson, Ward, Ridgeway, and Nimmo-Smith (1994), test-retest reliability coefficients for the TEA Telephone Search While Counting – dual task decrement score range from 0.59 to 0.61 over a one-week interval using a normative
sample. It is noted in the TEA manual (Robertson et al., 1994) that reliability for the Telephone Search While Counting – dual task decrement score is poorer than that for other subtests of the TEA possibly due to the large learning effects which take place from one version to the other. Nevertheless, this measure is highly sensitive to extreme difficulties with this relatively simple task, resulting in dual task decrement scores well outside the normal range.

**Apparatus.**

As in Experiments 1, 2 and 3, the Expectancy Assessment Task was presented on a 22in wide-screen computer and participants responded using the numerical keys on the keyboard for ratings and the spacebar for the next sentence and/or screen to appear. All letters presented were 6mm by 6mm in size and each item/sentence presented was one line long in length and consisted of no more than 80 characters. The Telephone Search and Telephone Search While Counting subtests from the Test of Everyday Attention (TEA; Robertson et al., 1994) were administered using the simulated telephone directory test materials which are encased in clear plastic. Participants used a water-based coloured pen to circle target symbols on these test materials which were then wiped with a damp cloth for the next participant.

**Experimental Assessment Task**

In the Expectancy Assessment Task, participants were instructed to read and imagine themselves in hypothetical scenarios and to then make judgements concerning the likelihood of future events occurring next in each scenario (see Chapter 2 for more detail regarding the Expectancy Assessment Task). The Expectancy Assessment Task used in Experiment 1, which presented blocks of 4 scenarios in the Scenario Reading Component of the task before requiring ratings for future events relating to these 4 scenarios in the Expectancy Rating Component of the task, was used in Experiment 4. In total, 64 trials were presented in 16 presentation blocks, with each presentation block
consisting of 4 scenarios to be read followed by expectancy ratings being provided for possible future events in each of these previously read 4 scenarios.

Three Expectancy Index scores (i.e., Negative Expectancy Index, Emotional Extrapolation Index, and Negative Extrapolation Index scores) were calculated as in the previous three experiments, using the mean expectancy scores obtained on the Expectancy Assessment Task. This was done in order to investigate each of the three accounts regarding the proposed candidate mechanisms that may give rise to an anxiety-linked bias in negative expectancy. Details regarding how these Indices were computed can be found in Chapter 2, and will not be repeated here to avoid redundancy.

Procedure

Participants were, as in the previous experiments, tested individually and seated in front of a computer. They were told that the experiment was aimed to investigate how people differ in their understanding of hypothetical scenarios. The same verbal instructions provided for the Expectancy Assessment Task in the previous experiments were subsequently provided (i.e., participants were instructed to read and imagine themselves in hypothetical scenarios and then to make judgements concerning the likelihood of future events occurring next in each scenario). Participants then completed eight practice scenarios of the Expectancy Assessment Task (including the Scenario Reading Component and Expectancy Rating Component for 2 presentation blocks of 4 scenarios). Therefore in this practice task, participants read 4 scenarios, then provided ratings for the likelihood of future events in these 4 previously read scenarios, then read another 4 scenarios and provided ratings for the likelihood of future events in the 4 latter read scenarios. Participants subsequently completed the full Expectancy Assessment Task. Participants were then told that they were going to be administered tasks to assess certain neurocognitive abilities (or ‘thinking skills’). The Test of Everyday Attention (TEA; Robertson et al., 1994) Telephone Search and Telephone
Search While Counting subtests were then administered. At the end of the session, participants were debriefed. Older adult participants were offered reimbursement for their travel expenses while younger participants received course credit for their participation.

**Results**

**Expectancy Index Scores**

Mean expectancy ratings for negative and positive candidate future events presented during the Expectancy Rating Trials of the Expectancy Assessment Task were calculated for each participant. These mean expectancy ratings can be seen, together with the Negative Expectancy Index, Emotional Extrapolation Index, and Negative Extrapolation Index scores computed from these expectancy ratings (as described earlier in Chapter 2) in Table 8.
Table 8. Summary of mean expectancy ratings for negative and positive candidate future events, and resulting Negative Expectancy Index, Emotional Extrapolation Index, and Negative Extrapolation Index scores.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Trait Anxiety Group</th>
<th>Scenario Domain</th>
<th>Scenario Valence</th>
<th>Future Event Expectancy Rating</th>
<th>Expectancy Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Negative Future Event M (SD)</td>
<td>Positive Future Event M (SD)</td>
</tr>
<tr>
<td>Younger adults</td>
<td>Low trait anxious n = 32</td>
<td>Social Scenarios</td>
<td>Negative Scenarios</td>
<td>2.1 (0.5)</td>
<td>2.6 (0.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Positive Scenarios</td>
<td>1.7 (0.4)</td>
<td>3.0 (0.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
<td>1.9 (0.3)</td>
<td>2.9 (0.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physical Scenarios</td>
<td>Negative Scenarios</td>
<td>2.3 (0.5)</td>
<td>2.7 (0.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Positive Scenarios</td>
<td>1.8 (0.3)</td>
<td>3.0 (0.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
<td>2.0 (0.4)</td>
<td>2.9 (0.3)</td>
</tr>
<tr>
<td></td>
<td>High trait anxious n = 32</td>
<td>Social Scenarios</td>
<td>Negative Scenarios</td>
<td>2.1 (0.5)</td>
<td>2.5 (0.6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Positive Scenarios</td>
<td>2.0 (0.3)</td>
<td>2.7 (0.6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
<td>2.2 (0.3)</td>
<td>2.7 (0.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physical Scenarios</td>
<td>Negative Scenarios</td>
<td>2.4 (0.5)</td>
<td>2.5 (0.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Positive Scenarios</td>
<td>2.3 (0.5)</td>
<td>2.8 (0.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
<td>2.2 (0.4)</td>
<td>2.9 (0.4)</td>
</tr>
<tr>
<td>Older adults</td>
<td>Low trait anxious n = 32</td>
<td>Social Scenarios</td>
<td>Negative Scenarios</td>
<td>1.7 (0.3)</td>
<td>2.6 (0.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Positive Scenarios</td>
<td>1.5 (0.3)</td>
<td>2.8 (0.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
<td>1.7 (0.4)</td>
<td>2.7 (0.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physical Scenarios</td>
<td>Negative Scenarios</td>
<td>2.0 (0.5)</td>
<td>2.7 (0.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Positive Scenarios</td>
<td>1.9 (0.4)</td>
<td>3.0 (0.5)</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>Balanced Scenarios</td>
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<td>2.9 (0.3)</td>
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<tr>
<td></td>
<td>High trait anxious n = 29</td>
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<td>Negative Scenarios</td>
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<td>2.8 (0.4)</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>Positive Scenarios</td>
<td>2.0 (0.4)</td>
<td>3.0 (0.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
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<td>2.7 (0.3)</td>
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<tr>
<td></td>
<td></td>
<td>Physical Scenarios</td>
<td>Negative Scenarios</td>
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<td>2.6 (0.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Positive Scenarios</td>
<td>2.1 (0.5)</td>
<td>2.9 (0.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Balanced Scenarios</td>
<td>2.2 (0.3)</td>
<td>2.7 (0.4)</td>
</tr>
</tbody>
</table>
**Dual Task Processing/Divided Attention Scores**

The mean raw scores obtained on the TEA Telephone Search While Counting subtest, which were calculated for each of the four participant groups, are presented in Table 9. It is important to note that raw scores were included in all statistical analyses instead of age-normed scaled scores due to the need to make direct comparisons between younger and older adults as well as comparisons between adults within each age group.

Table 9. Summary of mean raw scores obtained on the TEA Telephone Search While Counting subtest for each Age Group by Trait Anxiety Group.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Younger adults</th>
<th>Older adults</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n = 32</td>
</tr>
<tr>
<td>Trait Anxiety Group</td>
<td>Low trait anxious</td>
<td>High trait anxious</td>
</tr>
<tr>
<td></td>
<td>n = 15</td>
<td>n = 17</td>
</tr>
<tr>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEA Telephone Search While Counting Dual Task Decrement Raw Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.96 (0.96)</td>
</tr>
</tbody>
</table>

**Note.** Higher Dual-Task Decrement scores indicate greater difficulty with dividing attention between two tasks (dual-task processing).
A 2 x 2 ANOVA of Trait Anxiety Group (Low trait anxious, High trait anxious) and Age Group (Younger, Older) on the TEA divided attention scores, revealed a strong trend towards a main effect of Age Group, \( F(1, 53) = 3.55, p = .065, \eta^2_{\text{partial}} = .06 \), with older adults demonstrating marginally greater TEA divided attention scores compared to younger adults. Thus, the older adults showed a tendency for poorer dual task processing/divided attention than the younger adults. There was no significant main effect of Trait Anxiety Group \((p = .335)\), revealing no significant difference in TEA divided attention scores between the high and low trait anxious. There was also no significant 2-way interaction of Age Group and Trait Anxiety Group \((p = .186)\), indicating that the difference in TEA divided attention scores between older and younger adults did not differ between the low and high trait anxious groups.

Conditional Process Analysis

TEA divided attention scores for younger and older, low trait anxious and high trait anxious participants (as presented in Table 9), along with the calculated Negative Expectancy Index scores (see Table 8), were analysed using a moderated moderation Conditional Process Analysis with the PROCESS Procedure for SPSS (Model 3; Hayes, 2013), in which the effect of X on Y is conditional on the effect of M, which itself is conditional on the effect of W. The independent variable (X) was Trait Anxiety Group (Low trait anxious, High trait anxious). The outcome variable (Y) was Negative Expectancy Index scores averaged across Scenario Domain (i.e., social and physical scenarios). The moderator variable (M) was Age Group (Younger, Older). The second moderator variable (W) was TEA divided attention scores. A graphical representation of this, and subsequently, reported moderated moderation models, can be seen in Figure 2.

\(^3\) Negative Expectancy Index, Emotional Extrapolation Index, and Negative Extrapolation Index scores were each subjected to a mixed design, 2 x 2 x 2 ANOVA (see Appendix 3). The between-groups factors were Trait Anxiety Group (Low trait anxious, High trait anxious), and Age Group (Younger, Older). The within-group factor was Scenario Domain (Social, Physical). No significant effects of Scenario Domain were found. Thus, for the sake of parsimony, each of the Expectancy Index scores were collapsed across Scenario Domain for all the analyses reported in this chapter.
Anxiety-linked Bias in Negative Expectancy

Figure 2. A graphical representation of the moderated moderation model, Conditional Process Analysis using the PROCESS Procedure for SPSS (Model 3; Hayes, 2013).

This moderated moderation model was used to analyse TEA divided attention scores as a measure of dual task processing/divided attention for younger and older, low trait anxious and high trait anxious participants along with the calculated Expectancy Index scores. Each type of Expectancy Index score was analysed using separate moderated moderation models.

The overall model was significant, $R^2 = .28$, $F(7, 49) = 2.67, p = .020$, explaining 27.7% of variance in Negative Expectancy Index scores. TEA divided attention scores were a significant predictor of Negative Expectancy Index scores, $t(49) = -2.25, p = .029$, with those with lower TEA divided attention scores (and thus greater dual task processing) showing higher Negative Expectancy Index scores, which is consistent with greater expectancy for negative than positive future events.

Trait Anxiety Group ($p = .690$) and Age Group ($p = .159$) were not significant predictors of Negative Expectancy Index scores. However, there was a significant 2-way interaction of Trait Anxiety Group and TEA divided attention scores, $t(49) = 2.17, p = .034$. There
was also a significant 2-way interaction of Age Group and TEA divided attention scores, $t(49) = 2.34, p = .023$.

Most importantly, a significant 3-way interaction of Trait Anxiety Group, Age Group and TEA divided attention scores was observed, $t(49) = -2.26, p = .028$, which significantly accounted for an additional 7.5% of variance in Negative Expectancy Index scores, $R^2 = .08, F(7, 49) = 5.10, p = .028$. In terms of the conditional effect of Trait Anxiety Group on Negative Expectancy Index scores at values of the moderators, Age Group and TEA divided attention scores indicated that in younger adult participants with better dual task processing/divided attention, the high trait anxious did not differ from the low trait anxious in Negative Expectancy Index scores, ($p = .789$; see Figure 3). In older adult participants with better dual task processing/divided attention), the high trait anxious showed a strong trend towards greater Negative Expectancy Index scores (thus greater expectancy for negative than positive future events) compared to the low trait anxious, $t(49) = 1.85, p = .070$ (see Figure 3).

In younger participants with poorer dual task processing/divided attention, the high trait anxious showed significantly greater Negative Expectancy Index scores (thus greater expectancy for negative than positive future events) compared to the low trait anxious, $t(49) = 2.49, p = .016$ (see Figure 4). In older participants with poorer dual task processing/divided attention, the high trait anxious did not differ from the low trait anxious in Negative Expectancy Index scores, ($p = .728$; see Figure 4).
Anxiety-linked Bias in Negative Expectancy

Figure 3. Mean Negative Expectancy Index scores for younger and older high and low trait anxious adults with better dual task processing/divided attention (see left).

Figure 4. Mean Negative Expectancy Index scores for younger and older high and low trait anxious adults with poorer dual task processing/divided attention (see right).

The same Moderated moderation model, Conditional Process Analysis was again conducted with Emotional Extrapolation Index scores as the outcome variable (Y). The overall model was not significant, \( p = .174 \), indicating that TEA divided attention scores, Age Group and Trait Anxiety Group did not account for a significant amount of the variance in Emotional Extrapolation Index scores.

The same Moderated moderation model, Conditional Process Analysis was also conducted with Negative Extrapolation Index scores as the outcome variable (Y). The overall model was not significant, \( p = .311 \), indicating that TEA divided attention scores, Age Group and Trait Anxiety Group did not account for a significant amount of the variance in Negative Extrapolation Index scores.

**Discussion**

Experiment 4 involved the use of the Expectancy Assessment Task along with a neuropsychological measure of dual task processing/divided attention in order to
achieve a major aim unique to the current experiment, which was to determine whether neurocognitive capacity moderates the impact that age has on an anxiety-linked bias in negative expectancy.

With regards to the main aim of the current experiment, and as hypothesised, neurocognitive capacity (i.e., specifically dual task processing capacity/divided attention) altered age group differences in an anxiety-linked bias in negative expectancy. As predicted, older adults with better neurocognitive capacity (i.e., greater dual task processing/divided attention) showed more evidence of an anxiety-linked bias in negative expectancy than those with poorer neurocognitive capacity (i.e., poorer dual task processing/divided attention), the latter demonstrating less evidence of an anxiety-linked bias in negative expectancy. In other words, older adults demonstrated a reversal of the effect found in younger adults, with less evidence of an anxiety-linked bias in negative expectancy in the older compared to the younger in those with poor dual task processing/divided attention, while greater evidence of an anxiety-linked bias in negative expectancy in the older than the younger was observed in those with better dual task processing/divided attention. Therefore, poorer dual task processing/divided attention is required for older adults to show an attenuated an anxiety-linked bias in negative expectancy observed in the younger.

In terms of the debate in the literature, this suggests that attenuated anxiety-linked cognitive biases (such as in expectancy) in older adults compared to that observed in younger adults may be due to poorer cognition in those who are older. This provides support for the Age-related Decline in Neurocognitive Capacity Account and the idea that intact neurocognitive capacity is required for the formation of cognitive biases associated with anxiety in older adults. At the same time, these results appear to contradict the Age-related Enhancement of Wisdom and Experience Account as a potential (or at least main) explanation for age-related differences (i.e., age-related
attenuation) in anxiety and anxiety-linked cognitive biases. Thus an attenuation of an anxiety-linked bias in negative expectancy in older adults appears to more likely be the result of a neurocognitively ageing brain rather than due to an experiential gain with healthy ageing as proposed by Socioemotional Selectivity Theory (SST; Carstensen et al., 1999). Should an attenuated anxiety-linked bias in negative expectancy in the older compared to the younger adults have been due to an experiential/motivated gain with healthy ageing rather than due to age-related differences in neurocognitive capacity in the current experiment, then dual task processing would not have significantly impacted on the effect of age on the relationship between anxiety and expectancy. If this effect had been found, this would then have suggested that age differences in an anxiety-linked bias in negative expectancy are likely not a product of the interaction between age and cognitive functioning, though rather due to age differences in something other than cognition (of which one possibility may be the prioritisation of emotional goals in older adults as discussed in SST). Of course, it would be important for future research to replicate the effect found in the current experiment using the Expectancy Assessment Task. Additionally, it would be helpful if such research also included a direct measure of age-related experiential/motivated gain (which may be somewhat challenging) in order to more confidently rule out the possibility of an Age-related Enhancement of Wisdom and Experience Account contributing to an attenuation of an anxiety-linked bias in negative expectancy in older than younger adults.

Despite the reduced prevalence of anxiety disorders with increasing age and particularly in older adulthood (e.g., Wolitzky-Taylor, Castriotta, Lenze, Stanley & Craske, 2010), there is some suggestion in the literature that older adults who are high in anxiety vulnerability may experience more severe symptoms of anxiety than younger adults with high anxiety vulnerability (Kunzmann & Grühn, 2005). The current finding (i.e., that more neurocognitively intact older adults show greater evidence of an anxiety-
Anxiety-linked bias in negative expectancy than those with less intact neurocognitive capacity) may account for this. It may be that in previous studies, those older adult samples that demonstrated more severe anxiety than younger adults (and thus likely greater evidence of cognitive biases typically associated with anxiety), were generally more cognitively intact than other older adult samples in which reduced anxiety compared to younger adults are reported. Indeed, in a study by Kunzmann and Grühn (2005), older adults were noted to report higher levels of anxiety compared to younger adults after watching film clips focused on age-relevant themes (such as death, family loss and being diagnosed with Alzheimer’s disease), however, the cognitive functioning of participants (particularly the older adults) was not considered or assessed.

The findings in the current experiment were observed only when analysing Negative Expectancy Index scores (and not when analysing Emotional Extrapolation Index or Negative Extrapolation Index scores), indicating that an age-linked bias in negative expectancy was characterised by pervasive negative expectancy. This was somewhat unexpected given that the previous finding of age moderating an anxiety-linked bias in negative expectancy in Experiment 2 was observed only when analysing Negative Extrapolation Index scores (and thus characterised by age-differences in anxiety-linked negative extrapolation). This may be due to differences in the Expectancy Assessment Task in both these experiments. In Experiment 2 the Expectancy Assessment Task had two experimental conditions that differed in terms of memory load (1 vs. 16 scenario retention interval), while that in the current experiment included presentation blocks of 4 scenarios. Thus difference in the experimental task across these two experiments may have obscured the mechanisms that give rise to an age-linked bias in negative expectancy.

Despite the age-related findings in the current experiment pertaining to a pervasive negative expectancy mechanism rather than to a negative extrapolation
mechanism (as in Experiment 2), these current findings still aid in providing a likely explanation for the effect of age on an anxiety-linked bias in negative expectancy, which was found in Experiment 2. This effect in Experiment 2 was specifically characterised by the older high trait anxious showing greater negative than positive extrapolation than the younger high trait anxious, with no age group differences in negative relative to positive extrapolation in the low trait anxious. This initially appeared contrary to the hypothesis that older adults would show an attenuation of the anxiety-linked bias in negative expectancy found in younger adults. However, given the current finding in Experiment 4 of an attenuation of an anxiety-linked bias in negative expectancy in older adults with poorer neurocognitive capacity than those with more intact neurocognitive capacity, this suggests that the older adult sample in Experiment 2 may have been generally quite neurocognitively intact as a whole sample.

With regards to the limitations of the current experiment, the finding that there was no significant difference in divided attention scores between the younger and older adults (despite it being anticipated that the older adults would perform significantly worse), suggests that the older adult sample in this experiment may have had above average cognitive abilities. This highlights the limitation of not having included cognitive screening of older adults and the results of such not being used as inclusion/exclusion criteria in the current research. Moreover, some studies have found that scores on executive function tests are less reliable in older adults (e.g., Lemay, Bédard, Rouleau, & Tremblay, 2004).

It could also be considered a limitation that younger and older adults were compared on their raw scores on the divided attention task rather than using normed scores for their relative age groups, as the latter would have provided information about whether the older and younger adults were performing cognitively above their normative samples or not. However, the major aim of this experiment was to investigate
whether neurocognitive capacity moderates the impact that age has on an anxiety-linked bias in negative expectancy. This aim required direct comparisons between younger and older adults, which in turn necessitated comparisons between these age groups using raw scores, rather than comparing each of these age groups to their respective normative samples.

It should be acknowledged that no adjustments were performed for multiple comparisons in the statistical analyses carried out. However, the statistical analyses performed were examining exploratory hypotheses, and as Perneger (1998) and Rothman (1990) suggest, the Bonferroni correction (which is the standard adjustment for multiple comparisons), increases the risk of a Type II error, and thus, increases the chance that any important differences will be found to be non-significant. Nonetheless, the effects found are interesting in terms of their implications (as discussed earlier) and require further investigation in order to be replicated. Certainly, there appear to be important interactions between neurocognitive capacity (particularly dual task processing capacity/divided attention), age, and anxiety that need to be examined further in future research. It could be viewed as a limitation that only divided attention/dual task processing was focused on in the current experiment. However, it was considered to be a critical area of neurocognitive capacity to assess, given age-related changes in this area of neurocognition and its relevance to anxiety and forming expectations of the future. Therefore, it would be important for future research to replicate these results pertaining to divided attention/dual task processing, and to extend such investigation to other relevant areas of neurocognitive capacity. For example, assessing memory perhaps in a different way to how it was assessed in the current research (i.e., using neuropsychological measures of episodic memory) would be helpful. Moreover, processing speed, which is another area of neurocognition known to undergo changes during healthy ageing (Salthouse 1996, 2010), could be assessed.
Processing speed may impact how quickly older adults process information regarding the current experience and thus may affect their expectations of the future.

Overall, these findings have important implications for considering psychological interventions for older adults with high anxiety vulnerability, as it appears more complex than just needing to consider age or cognition, with an important interplay between these factors being involved in anxiety-related information processing/cognitive biases. Taking into account individual neurocognitive profiles appears to be important in measuring and attempting to alter anxiety-related cognitive biases, particularly in older populations.
CHAPTER 6: GENERAL DISCUSSION

Research Questions and Main Objectives

The current research aimed to address three main questions. Firstly, what are the mechanisms that may give rise to an anxiety-linked bias in negative expectancy? Secondly, is there an age-linked bias in negative expectancy? If so, what are the mechanisms that give rise to this age-related effect, and does this age-linked bias in negative expectancy represent an independent effect of age on expectancy, or does age moderate the expression of an anxiety-linked bias in negative expectancy? Thirdly, should an age-linked bias in negative expectancy be observed (whether it be the result of an independent effect of age on expectancy or an interactive effect of age and anxiety on expectancy), what is the neuropsychological basis of this age-linked effect? The main objectives related to these research questions and the relevant findings made in the present research will now be discussed in turn.

Main Findings

Anxiety-linked Bias in Negative Expectancy

Sensitivity of the expectancy assessment task.

The first main objective in the current research was to develop an experimental task which can sensitively assess relative expectancy for negative and positive future events, and the mechanisms that underpin anxiety-linked differences in these relative expectancies. The finding of an anxiety-linked bias in negative expectancy across all four experiments (which each employed independent samples of participants) in the current research provides support for the sensitivity of the Expectancy Assessment Task in detecting such a bias. The fact that this bias (which refers to relative anxiety group differences in negative expectancy, and does not represent a bias in an absolute sense) was reliably observed, is consistent with previous research, which has found that those with high and low anxiety vulnerability do differ significantly in their anticipation of
Anxiety-linked Bias in Negative Expectancy

future events (e.g., Borkovec et al., 2004; MacLeod et al., 1997; Miranda & Mennin, 2007).

There are debates in the literature concerning whether cognitive experimental measures such as the Expectancy Assessment Task, are amenable to conventional psychometric analysis. Traditional cognitive measures (such as intelligence tests) typically aim to measure a cognitive construct and to assess where individuals performs relative to others in terms of that construct. However, cognitive experimental measures are different in that they often aim to uncover what mechanisms underpin a specific cognitive construct. The Expectancy Assessment Task, for example, aims to assess mechanisms that may underpin an anxiety-linked bias in negative expectancy and was not developed to assess negative expectancy as a diagnostic measure or indicator of anxiety. Moreover, this task was designed to compare groups of people to one another rather than to diagnose or compare an individual to other individuals or to a group. In order to establish the psychometric properties of a measure, knowledge regarding its reliability and validity is important. To establish at least test-retest reliability the task would need to be repeated on the same sample of participants. However, this may require parallel materials and ensuring that the a priori probabilities are the same. To establish its validity, another concurrent measure of expectancy would be required. Thus it would be somewhat challenging to establish the psychometric properties of tasks such as the Expectancy Assessment Task.

Nevertheless, finding that the Expectancy Assessment Task is sensitive to detecting an anxiety-linked bias in negative expectancy enabled investigation into the proposed alternative mechanisms that may give rise to this bias.
Alternative mechanisms giving rise to an anxiety-linked bias in negative expectancy.

Along with establishing the sensitivity of the Expectancy Assessment Task, the first objective of the current research also involved using this task to investigate the three proposed alternative mechanisms that may underpin an anxiety-linked bias in negative expectancy. Future expectancy is a higher-level cognitive process and therefore there may be a multitude of factors potentially contributing to an anxiety-linked bias in negative expectancy (e.g., prior life experiences and genetic factors). However, within a cognitive framework and given previous research, there are three alternative mechanisms that may give rise to such an anxiety-linked bias.

The first candidate mechanism (i.e., according to the Pervasive Negative Expectancy Hypothesis; PNEH) is that the cognitive system of those with high anxiety vulnerability (compared to that of those with low anxiety vulnerability) may add a constant to the probability of negative future events when considering possible outcomes. This results in negative outcomes being considered as more likely to occur than positive outcomes, in those with high anxiety vulnerability compared to those with low anxiety vulnerability, regardless of whether the present experience is negative or positive in emotional tone.

The second candidate mechanism assumes that people will generally extrapolate from the emotional tone of current events such that the way in which individuals construe the present will determine their expectations of the future. However, according to the Emotional Extrapolation Hypothesis (EEH), this second candidate mechanism concerns those with high anxiety vulnerability showing this general tendency to extrapolate from current experiences to inform their future expectations, to a greater extent than those with low anxiety vulnerability. Thus the way in which those with high anxiety vulnerability construe the present will determine their expectations of the future.
to a greater degree than it would for those with low anxiety vulnerability. This would be equally evident across negative and positive experiences.

The third candidate mechanism also assumes that people will engage in emotional extrapolation from current experiences to inform their expectations of the future. However, this mechanism (i.e., according to the Negative Extrapolation Hypothesis; NEH) involves those with high anxiety vulnerability differentially engaging in extrapolation to inform their expectations of the future, based on the emotional valence of the present experience. In particular, when the current experience is negative, those high in anxiety vulnerability (compared to those low in anxiety vulnerability) will be disproportionately inclined to have greater expectancy for negative than positive future events. Importantly, this will be greater than their elevated expectancy for positive than negative future events when the current experience is positive.

**Pervasive negative expectancy hypothesis.**

An anxiety-linked bias in negative expectancy was observed when analysing Negative Expectancy Index scores in Experiment 1 and 2, though not in Experiment 3 (the latter possibly due to the introduction of the State Anxiety Manipulation Task having masked the potential of finding this effect). This effect involved the high trait anxious showing greater expectancy for negative than positive future events, compared to the low trait anxious. However, this effect does not provide support for an anxiety-linked bias in negative expectancy being characterised by pervasive negative expectancy according the PNEH. As mentioned in Chapter 2 (Experiment 1) and Chapter 3 (Experiment 2), an anxiety-linked bias was also observed when analysing Emotional Extrapolation Index scores, which indicates that an anxiety-linked bias in negative expectancy differs as a function of the emotional valence of the current scenario. This contradicts the PNEH which predicts that an anxiety-linked bias in
Anxiety-linked Bias in Negative Expectancy

negative expectancy will be observed regardless of the emotional valence of the current scenario and that this bias would only be observed on Negative Expectancy Index scores and not on Emotional Extrapolation or Negative Extrapolation Index scores. Consequently, the findings observed on Negative Expectancy Index scores in Experiment 1 and 2 do not provide support for the PNEH and the suggestion that the cognitive system of those with high anxiety vulnerability (compared to those with low anxiety vulnerability), appears to add a constant to the probability of negative future events when considering possible future outcomes, regardless of how current experiences are proceeding.

At first glance this may appear to contradict previous research evidence regarding an anxiety-linked bias in negative expectancy. A number of studies (e.g., MacLeod et al., 1997; Miranda & Mennin, 2007; Stöber, 2000) have found an anxiety-linked bias in negative expectancy to be characterised by elevated expectancy for negative than positive future events in those high in anxiety vulnerability. However, the experimental tasks used in these studies did not involve manipulating the emotional valence of the current experience in order to investigate whether this elevated expectancy for negative than positive future events in those with high anxiety vulnerability occurred regardless of the current experience. As noted, given the findings in the present research, the current experiences is an important aspect of an anxiety-linked bias in negative expectancy, as it contributes to one’s expectations of the future, and even more so for those with high anxiety vulnerability.

Certainly, an anxiety-linked bias in pervasive negative expectancy (as proposed by the PNEH) could have alternatively been defined as an anxiety-linked effect that is consistently observed, regardless of its magnitude. By this definition, this mechanism would then not have been incompatible with the other two proposed mechanisms (as proposed by the EEH and NEH), which concern the impact of the emotional valence of
the current experience on anxiety-linked differences in expectancy. The current results would not have provided support for this alternative definition of an anxiety-linked bias in pervasive negative expectancy, as such an effect was not consistently observed across the current experiments.

*Emotional extrapolation hypothesis.*

An anxiety-linked bias in negative expectancy was more consistently characterised by emotional extrapolation in the present research. In Experiments 1, 2, and 3, the high trait anxious used the information provided (i.e., the emotional valence) regarding the current experience to inform their expectations of the future as hypothesised by the EEH. However, while this effect was more consistently observed, the direction of the effect differed across experiments. In Experiment 1, this anxiety-linked emotional extrapolation involved greater emotional extrapolation from (negative and positive) current experiences in the high trait anxious compared to the low trait anxious. Yet, in Experiment 2 and 3, this effect was observed to be in the opposite direction, with emotional extrapolation (from negative and positive current experiences) being attenuated in the high trait anxious compared to the low trait anxious.

While finding the same effect across these experiments is informative regarding an anxiety-linked bias in negative expectancy, the direction of this effect in Experiment 2 is questionable. The size of this effect in Experiment 2 is small ($\eta^2_{\text{partial}} = .04$), indicating that only 4% of the variance in expectancy is accounted for by trait anxiety. It became evident on post-hoc inspection of these results compared to those obtained in Experiment 1, that comparisons between these Experiments may be at least somewhat limited in some regards. The spread of STAI-T scores for the high trait anxious in Experiment 2 is quite wide (High trait anxious $M = 44.7$, $SD = 7.0$; Low trait anxious $M = 26.4$, $SD = 2.6$), and thus there may not be a great enough difference in levels of trait anxiety between the high and low trait anxious in Experiment 2. Moreover, the
Emotional Extrapolation Index scores obtained by the low and high trait anxious in Experiment 2 (Low trait anxious $M = 0.4$, $SD = 0.4$; High trait anxious $M = 0.3$, $SD = 0.4$) appear quite similar to those obtained by the low trait anxious in Experiment 1 (Low trait anxious $M = 0.3$, $SD = 0.5$) and more different from (i.e., lower than) those obtained by the high trait anxious in Experiment 1 (High trait anxious $M = 0.9$, $SD = 0.5$). Therefore, the high trait anxious in Experiment 2 demonstrated anxiety-linked emotional extrapolation similar to that of the low trait anxious in Experiment 1 (i.e., reduced negative and positive emotional extrapolation). Experiment 1 and 2 also differed in terms of the Expectancy Assessment Task used in each experiment. The Expectancy Assessment Task used in Experiment 1 had presentation blocks of 4 scenarios while that in Experiment 2 involved two different experimental conditions (i.e., 1 vs. 16 scenario retention interval) providing differences in memory load to investigate hypotheses regarding an age-linked bias in negative expectancy (to be discussed later in this Chapter). While the anxiety-linked bias in negative expectancy found in Experiment 2 did not differ significantly by memory load, the task was different to that delivered in Experiment 1 and may have somewhat obscured the results pertaining to the direction of anxiety-linked emotional extrapolation.

Less confidence is also placed in the direction of the effect observed in Experiment 3. While it was anticipated that anxiety-linked emotional extrapolation would at the very least be similar across Experiment 1 and 3 since the Expectancy Assessment Task used in both these experiments was exactly the same (i.e., involving presentation blocks of 4 scenarios), Experiment 3 also contained a State Anxiety Manipulation Task which was not included in Experiment 1. Thus, although this effect in Experiment 3 was a larger and medium-sized effect ($\eta^2_{\text{partial}} = .10$) compared to that observed in Experiment 2, it might be that the addition of the State Anxiety Manipulation Task to Experiment 3 obscured the direction of this effect. Again when
considering the Emotional Extrapolation Index scores in the high and low trait anxious in Experiment 3 (Low trait anxious M = 0.5; SD = 0.4; High trait anxious M = 0.3; SD = 0.4), these scores also appeared similar to those of the low trait anxious in Experiment 1 (Low trait anxious M = 0.3, SD = 0.5) and more different from (i.e., lower than) those obtained by the high trait anxious in Experiment 1 (High trait anxious M = 0.9; SD = 0.5). Therefore, the high trait anxious in Experiment 3 showed anxiety-linked emotional extrapolation similar to that demonstrated by the low trait anxious in Experiment 1 (i.e., reduced negative and positive emotional extrapolation).

Despite the nature (i.e., direction) of this anxiety-linked emotional extrapolation varying between experiments (and thereby indicating that the impact of this factor is not consistent), this significant effect being found across experiments strongly indicates that there is indeed an association between trait anxiety and emotional extrapolation and that information about the current experience is important. There was a larger difference in levels of trait anxiety according to STAI-T scores (and thus a greater distinction) between the high and low trait anxious in Experiment 1 (Low trait anxious M = 25.9, SD = 2.6; High trait anxious M = 54.8, SD = 3.2; d = 9.91), compared to that observed in Experiment 2 (Low trait anxious M = 26.4, SD = 2.6; High trait anxious M = 44.7, SD = 7.0; d = 3.47) and Experiment 3 (Low trait anxious M = 33.6, SD = 3.9; High trait anxious M = 44.2, SD = 3.0; d = 3.05). This, together with trait anxiety being found to account for a large proportion (i.e., 29%) of the variance in expectancy in Experiment 1, strengthens confidence in the finding in Experiment 1 and hypothesis that the high trait anxious show greater rather than attenuated (negative and positive) emotional extrapolation than the low trait anxious. This finding is also at least somewhat consistent with that anticipated given previous research. As discussed by Niles, Mesri, Burkun, Lieberman and Craske (2013), individuals with high anxiety vulnerability report greater negative affect when viewing negative images (Goldin, Manber, Kahimi,
Anxiety-linked Bias in Negative Expectancy

Canli, & Gross, 2009) and demonstrate greater bilateral amygdala and insula activity (cerebral areas associated with emotional processing) than those with low anxiety vulnerability when viewing these negative images (Brühl et al., 2011; Shah & Angstadt, 2009). Similarly, in a study by Condren, O’Neill, Ryan, Barrett, and Thakore (2002), individuals with high anxiety vulnerability showed a greater adrenocortical response/reactivity when placed in a stressful (thus negative) situation. Very few studies to the author’s knowledge have compared the emotional reactivity of those with low and high anxiety vulnerability to positive stimuli.

Overall there is evidence in the current research to support an anxiety-linked bias in negative expectancy being characterised by a general tendency in those with high anxiety vulnerability to extrapolate more strongly from recent events (that have happened to date) to inform their future expectations when compared to those with low anxiety vulnerability. Despite the inconsistent impact of this effect (in terms of its direction), as proposed by the EEH, current experiences (or events that have occurred to date) and the emotional valence of these experiences are important, as the way in which these individuals construe the present will determine their expectations of the future. This appears fairly consistent with the idea that those with high anxiety vulnerability use their emotions to make judgements (Lerner, Li, Valdesolo, & Kassam, 2015), and thus may seem emotionally labile (e.g., Jollant et al., 2007).

Another interesting finding regarding this anxiety-linked bias in negative expectancy (involving the high trait anxious showing greater emotional extrapolation than the low trait anxious), is that it differs depending on the type of content or (social or physical) concerns pertaining to current experiences. More specifically, this anxiety-linked effect was more evident in social than physical scenarios, in Experiment 1. This experiment only contained a sample of young adults. Thus this finding suggests that content relating to social concerns may be more personally relevant for young adults.
than content relating to physical concerns. While only a few studies have directly compared social and physical (or non-social) concerns with regard to their personal relevance for those with high anxiety vulnerability (e.g., Foa, Franklin, Perry, & Herbert, 1996), this finding appears consistent with previous research demonstrating that younger adults show increased anxiety when faced with social anxiety provocations when compared to older adults, for whom physical health triggers are accompanied by greater anxiety (Teachman & Gordon, 2009). The current finding is interesting in that although participants were recruited based on levels of trait anxiety (using the STAI-T) and not specifically on levels of social anxiety, social concerns appear more salient to young high trait anxious adults in terms of how they use current (emotional) information to inform their expectations of the future. Certainly there is some evidence to support anxiety vulnerability being associated with higher levels of empathy (Tibi-Elhanany & Shamay-Tsoory, 2011). Therefore, it is somewhat unsurprising that such individuals with high anxiety vulnerability would likely be quite aware of, and concerned about their social context.

**Negative extrapolation hypothesis.**

No evidence for an anxiety-linked bias in negative expectancy being characterised by negative extrapolation was found across experiments in the current research. This provides somewhat consistent evidence to suggest that those high in anxiety vulnerability do not appear to differentially engage in extrapolation as a function of the emotional valence of the present experience (as proposed by the NEH). This means that there was no evidence that when the current experience is negative, those high in anxiety vulnerability are inclined to have more negative than positive expectations of the future compared to having more positive than negative expectations of the future when the current experience is positive. This could be considered surprising in terms of findings related to other anxiety-linked patterns of selective
processing. This is particularly so in terms of the evolutionary history of man’s attentional bias to negative stimuli (see Öhman, Flykt & Esteves, 2001) and related research showing that those with high anxiety vulnerability tend to show this vigilance for negative stimuli to a greater extent than those with low anxiety vulnerability (e.g., Mogg, Bradley, Miles, & Dixon, 2004). However, the finding that the high trait anxious in the current research instead use both negative and positive information regarding the current experience to inform their expectations about the future could be considered consistent with evidence that the emotions of these individuals influence their judgements (Lerner, Li, Valdesolo, & Kassam, 2015). Perhaps those with even higher levels of anxiety vulnerability (for example, those with a clinically diagnosed anxiety disorder) than those recruited as participants in the current research, may demonstrate differential extrapolation from negative rather than positive information regarding the current experience to inform their expectations of the future, in line with the NEH. Moreover, evidence of differential extrapolation from negative rather than positive information may arise from examining levels of depression, with this possibly being observed in those with depressed mood.

Overall, none of the proposed alternative mechanisms fully account for the variation in anxiety vulnerability as the highest correlation between each of these mechanisms and trait anxiety scores across all four experiments was $r = 0.684$, accounting for only 46.7% of the variance in trait anxiety scores. Therefore, there are many other mechanisms that may contribute to differences in anxiety vulnerability, and it would probably be premature to be using the measurement of such mechanisms in the diagnosis of anxiety dysfunction.

Nevertheless, the fact that an anxiety-linked bias in negative expectancy was more consistently characterised by emotional extrapolation across experiments, provides evidence for this proposed mechanism giving rise to an anxiety-linked bias in
Anxiety-linked Bias in Negative Expectancy rather than the other two mechanisms (i.e., of pervasive negative expectancy and negative extrapolation). Given that participants in the current research were selected based on their scores on the STAI-T, these findings pertaining to an anxiety-linked bias in negative expectancy (characterised by emotional extrapolation) can most confidently be generalised to individuals who score highly on such measures of trait anxiety. This is important to note because, while the STAI-T is a measure of state anxiety frequency intended to index trait anxiety, some who score highly on the STAI-T may do so because they have recently been experiencing more negative than positive events. Therefore, any anxiety group differences found in the current research could have been driven (at least partially) by differences in recent experiences, despite trait anxiety referring to disposition/temperament. Moreover, it is thus not possible to ascertain from the current results whether these biases are characteristics of elevated state anxiety or elevated trait anxiety.

Age-linked Bias in Negative Expectancy

The second objective of the current research was to use the Expectancy Assessment Task to determine the existence of an age-linked bias in negative expectancy and to reveal the mechanisms that may give rise to such an age-linked effect should it be found. The same three alternative mechanisms that were proposed to possibly underpin an anxiety-linked bias in negative expectancy (i.e., according to the PNEH, EEH and NEH) could also give rise to an age-linked bias in negative expectancy.

According to the PNEH, older adults may show a tendency to expect things to go well in the future and do not consider how the current situation is proceeding (i.e., whether it is going well or badly at present). Thus the cognitive system of older adults (compared to that of younger adults) may add a constant to the probability of positive future events when considering possible future outcomes. This results in inflated
expectancy for positive compared to negative future events (and thus less inflated expectancy for negative compared to positive future events), in older compared to younger adults, regardless of whether the current experience is negative or positive in emotional tone.

The EEH proposes that the emotional tone of the current experience contributes to the occurrence of an age-linked bias in negative expectancy. Older adults may show less of a general tendency to extrapolate from the emotional tone of the current experience such that their expectancy for future events that are consistent with the emotional tone of the current experience will be reduced to a greater extent than younger adults, such that older adults will show less extrapolation from current experiences to inform their future expectations. The EEH thus predicts that older adults will show reduced emotional extrapolation from the current experience, with this being equally evident across negative and positive experiences when compared to younger adults.

Alternatively, it could be that while the emotional tone of the current experience contributes to the occurrence of an age-linked bias in negative expectancy, older adults only focus on positive current experiences and thus expect more positive than negative future events. Therefore, according to the NEH, older adults may differentially engage in extrapolation concerning the likelihood of future experiences, based on the emotional valence of the current experience. More specifically, according to this hypothesis, when the present experience is positive, older adults will be disproportionately more inclined to have greater expectancy for positive than negative future events to a greater degree than they will have greater expectancy for negative than positive future events when the present experience is negative.

The third objective of this research (also pertaining to an age-linked bias in negative expectancy) was to establish whether such an age-linked bias reflects age
independently ameliorating negative expectancy or age attenuating an anxiety-linked bias in negative expectancy. On one hand, an age-linked bias in negative expectancy could be characterised by age independently ameliorating negative expectancy. In other words older adults may just show reduced expectancy for negative relative to positive future events compared to younger adults. On the other hand, an age-linked bias in negative expectancy could also be characterised by age attenuating an anxiety-linked bias in negative expectancy. This involves the relationship between anxiety vulnerability and expectancy differing with age such that older adults show a reduced association between expectancy and anxiety vulnerability. This results in an anxiety-linked bias in negative expectancy being attenuated in older than younger adults.

**Age independently ameliorating negative expectancy.**

There was evidence of an age-linked bias in negative expectancy being characterised by age independently ameliorating negative expectancy in the current research (in Experiment 2). This age-linked bias in negative expectancy was found to involve emotional extrapolation such that younger adults showed greater emotional extrapolation than older adults. This indicates that as proposed by the EEH, older adults show a reduced general tendency to extrapolate from current experiences to inform their future expectations when compared to younger adults. However, this age-linked effect differed significantly between the two conditions of the Expectancy Assessment Task involving different loads on memory. This was such that younger adults showed inflated emotional extrapolation than older adults when there was a greater load on memory (i.e., in the 16 scenario retention interval), with this age effect not being observed when there was a reduced load on memory (i.e., in the 1 scenario retention interval). This finding suggests that when there was a greater load on memory, the older adults may have forgotten the scenarios they had read when compared to the younger adults, with this giving rise to a greater age-related difference in expectancy (i.e.,
particularly in emotional extrapolation) under such conditions, since there was no age-related difference in expectancy when there was a reduced load on memory. Thus, what appears to be an age-related difference in emotional extrapolation (with age independently ameliorating negative expectancy), in principle simply seems to be an age-related difference in memory simulating such an age-linked effect. There is well-established evidence regarding the gradual decline in memory functioning during healthy ageing (see Drag & Bieliauskas, 2010; Hoyer & Verhaeghen, 2006; Nyberg et al., 2012). This type of neurocognitive decline appears to account for age-related differences in expectancy when such age group differences do not involve anxiety.

**Age attenuating an anxiety-linked bias in negative expectancy.**

Rather, an age-linked bias in negative expectancy appeared to be characterised by age amplifying (rather than attenuating) an anxiety-linked bias in negative expectancy (see Experiment 2). In particular, an age-related difference in anxiety-linked negative extrapolation was revealed, such that there was a tendency for older high trait anxious adults to show more negative than positive extrapolation when compared to younger high trait anxious adults. There were no age group differences in negative relative to positive extrapolation in the low trait anxious. This finding is broadly consistent with the NEH, though is in the opposite direction to that proposed by this hypothesis. It suggests that older high trait anxious adults show a greater (rather than reduced) tendency to differentially engage in extrapolation as a function of the emotional valence of the present experience, when compared to younger high trait anxious adults. More specifically, when the current experience is negative, the older high trait anxious are inclined to have more negative than positive expectations of the future compared to having more positive than negative expectations of the future when the current experience is positive, relative to the younger high trait anxious. This appears to contradict the hypothesis that older high trait anxious adults would show a
reduced tendency to differentially engage in extrapolation as a function of the emotional valence of the present experience, when compared to younger high trait anxious adults, and thus show less selective extrapolation from negative scenarios (i.e., less negative emotional extrapolation). Furthermore this seems contrary to literature regarding a ‘positivity effect’ in older adults and the resulting anticipation that differences in expectancy may not be linked to anxiety vulnerability in older adults in the way they are in younger populations in that these differences in expectancy would be less associated with anxiety vulnerability in older adults than younger adults. The finding in Experiment 2 shows that instead, expectancy appears to be more strongly associated with anxiety vulnerability in older than younger adults, with the older adults showing the anxiety-linked effect commonly observed in younger adults, but to a greater degree.

It may be that the effect anticipated in older adults is negated or altered by high trait anxiety. As previously discussed, it is well known in the literature that people who are high trait anxious show greater expectancy for negative than positive future events (e.g., Miranda & Mennin, 2007). Moreover, while there is evidence in the ageing literature of a general ‘positivity effect’ in older adults which is associated with high anxiety vulnerability being less prevalent in older adulthood, those older adults who are high in anxiety vulnerability may show more severe symptoms of anxiety than younger adults with high anxiety vulnerability (Kunzmann & Grühn, 2005). This may explain why older high trait anxious adults in the present research showed more (rather than less) negative relative to positive extrapolation when compared to younger high trait anxious adults.

As mentioned earlier, this finding is consistent with the SAVI model (Charles, 2010). Thus, as proposed by this model, it may be that the older high trait anxious could not utilise the skills typically gained with increasing age and which are associated with greater emotion regulation. This could be why, when confronted with negative
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Information concerning the current experience, they showed greater rather than reduced negative (relative to positive) extrapolation when compared to younger high trait anxious adults.

This age-related difference in an anxiety-linked bias in negative expectancy (characterised by negative extrapolation) did not differ by memory load in the current research. That is, this age-linked effect was not more evident under the higher than lower memory load condition of the Expectancy Assessment Task (in Experiment 2). This suggests that age differences in memory functioning cannot be simulating this type of age-linked effect.

The possibility was also considered that the older adults (in Experiment 2 where this effect was found) may have been more state anxious than the younger adults given that they were being assessed, with the younger adults (who were first-year university students) likely being more familiar and accustomed to testing situations. This raised the possibility that varying (induced) levels of state anxiety may have obscured the results obtained regarding age-differences in an anxiety-linked bias in negative expectancy, with possibly greater induced state anxiety in the older adults leading to an amplified (rather than attenuated) anxiety-linked bias in negative expectancy (i.e., greater negative than positive extrapolation). Thereafter, it was considered important to differentiate the role of trait and induced state anxiety in an anxiety-linked bias in negative expectancy in younger adults (in Experiment 3), before then further investigating age differences in an anxiety-linked bias in negative expectancy.

However, given the findings in Experiment 3, state anxiety did not appear to be having a significant effect on an anxiety-linked bias in negative expectancy, which was instead significantly associated with only trait anxiety. This suggests that varying levels of (induced) state anxiety may not have produced the age-linked bias in negative expectancy observed in Experiment 2. In particular it suggests that an anxiety-linked
bias in negative expectancy would likely not have differed as a function of state anxiety (i.e., been disproportionately more evident under higher levels of induced state anxiety, and thus been more readily observed in the older than younger adults).

These results regarding state anxiety appear to contrast previous research investigating similar anxiety-linked patterns of selective processing and how these patterns may be differentially associated with trait and state anxiety. For example, in a study by MacLeod and Rutherford (1992), those who were high trait anxious showed an increased automatic tendency to selectively process threat-related information as they became increasingly state anxious (with state anxiety thus appearing to amplify the trait anxiety effect observed). The low trait anxious in this study showed the opposite effect characterised by an increasing automatic tendency to selectively avoid processing such threat-related information as they became more state anxious.

It is interesting to note that an age-related difference in an anxiety-linked bias in negative expectancy (characterised by age amplifying, rather than attenuating, an anxiety-linked bias in negative expectancy) was observed on Negative Extrapolation Index scores in Experiment 2, rather than on Pervasive Negative Expectancy Index or Emotional Extrapolation Index scores where the anxiety-linked bias in negative expectancy effect was found in younger adults in Experiment 1. This suggests that the nature of an anxiety-linked bias in negative expectancy may differ with increasing age such that differentially engaging with the emotional valence of the current experience to inform expectations about the future becomes more pertinent in older age. This finding of an age-related difference in an anxiety-linked bias in negative expectancy (characterised by age amplifying, rather than attenuating, an anxiety-linked bias in negative expectancy) is discussed further and clarified under the section below regarding the role of neurocognitive capacity in this age-linked effect.
Alternative Neuropsychological Accounts of Age-related Differences in Negative Expectancy

Lastly, given that an age-linked bias in negative expectancy was found, a fourth objective of the current research was to investigate whether the neuropsychological basis of the observed age-related differences in expectancy is that of age-related decline in neurocognitive capacity or age-related enhancement of wisdom and experience. It was particularly important to determine whether any moderating effect of age on an anxiety-linked bias in negative expectancy is in fact a function of differences in neurocognitive capacity. It was hypothesised (in Experiment 4) that age would moderate the relationship between anxiety and expectancy, and that neurocognitive capacity (i.e., dual-task processing/divided attention) would in turn moderate the impact of age on the relationship between anxiety and expectancy. Specifically, it was predicted that older adults with more intact neurocognitive capacity (i.e., greater dual task processing/divided attention), would demonstrate greater evidence of an anxiety-linked bias in negative expectancy than those with poorer neurocognitive capacity (i.e., poorer dual task processing/divided attention), the latter who would demonstrate less evidence of an anxiety-linked bias in negative expectancy.

Indeed, as hypothesised, neurocognitive capacity (i.e., dual task processing capacity/divided attention) was found to significantly moderate the extent to which age group significantly moderates the relationship between anxiety and expectancy. In particular, and as predicted, older adults with more intact neurocognitive capacity (i.e., greater dual task processing/divided attention) showed greater evidence of an anxiety-linked bias in negative expectancy than those with poorer neurocognitive capacity (i.e., poorer dual task processing/divided attention). In other words, older adults demonstrated a reversal of the effect found in younger adults, with less evidence of an anxiety-linked bias in negative expectancy in the older compared to the younger in
those with poor dual task processing/divided attention. In contrast, greater evidence of an anxiety-linked bias in negative expectancy in the older than the younger was observed in those with better dual task processing/divided attention. Therefore, poorer dual task processing/divided attention is required for older adults to show an attenuated anxiety-linked bias in negative expectancy observed in younger adults.

This finding appears to provide support for the Age-related Neurocognitive Decline Account as an explanation for why anxiety vulnerability may in fact be less common with increasing age and for why older adults also exhibit fewer anxiety-linked patterns of selective processing (i.e., anxiety-linked cognitive biases). As mentioned in Chapter 1, older adults appear to show decreased vulnerability to anxiety, when compared to younger adults, including experiencing lower levels of anxiety symptoms and anxiety disorders (Kryla-Lighthall & Mather, 2009; Wolitzky-Taylor, Castriotta, Lenze, Stanley & Craske, 2010). Moreover, contrary to the negative processing biases that characterise increased anxiety vulnerability in younger adults (Grady, Hongwanishkul, Keightley, Lee, & Hasher, 2007), older adults display a ‘positivity effect’ (Carstensen & Mikels, 2005), focusing on positive information more than younger adults (Leclerc & Kensinger, 2008). The Age-related Neurocognitive Decline Account proposes that a decline in the neurocognitive capacity of older adults may result in an attenuation of anxiety-linked cognitive biases observed in younger adults. Similarly, previous research (though not focused on investigating anxiety) has found that neurocognitive decline in older adults is associated with less sensitivity to emotional information during normal ageing (e.g., Ruffman et al., 2008; Williams et al., 2006). This may be linked to why older adults tend to show reduced anxiety when compared to younger adults, with neurocognitive decline appearing to be an important contributing factor. This finding in Experiment 4 is thus consistent with this idea in the
literature that intact neurocognitive capacity is required for the formation of cognitive biases associated with anxiety in older adults.

The current finding specifically provides support for the importance of dual-task processing/divided attention in an anxiety-linked bias in negative expectancy. Dual-task processing/divided attention would certainly be required when forming expectations about the future, particularly in the presence of anxiety, given that there may be concurrent external and internal demands on attentional processing. Being required to process the current situation and the way in which the current experience is proceeding (i.e., in a manner considered negative or positive) as well as forming expectations regarding how subsequent or future events may proceed (i.e., in either a negative or positive manner) would constitute external demands on attention. Simultaneously, internal demands on attention would likely be in the form of anxious thought processes. Therefore, the degree to which a person’s dual task processing capacity/divided attention is compromised (which may be more so in older than younger adults), may impact on how he or she responds to a current situation, and thus his or her expectations about the future. This finding also provides some support for the vulnerability of this, and perhaps other, executive functions to age-related decline, with this having been suggested in previous ageing research (see Drag & Bieliauskas, 2010, for a review; Phillips & Henry, 2008; Salthouse et al., 2003). Indeed, as mentioned in Chapter 1, the frontal cortex has emerged more recently from a phylogenetic perspective and thus is more vulnerable to decline than other (older) cortical regions of the brain (Kalpouzos et al., 2009). The prefrontal cortex (PFC) has been found to show greater rates of atrophy than other cortical regions in older adults (Driscoll et al., 2009; see Raz et al., 2005). There are also decreases in dopamine (Volkow et al., 2000), and greater white matter atrophy (Kennedy & Raz, 2009) and white matter lesions (Guttman et al., 1998) in the PFC with increasing age. These age-related changes to the PFC are associated with
poorer inhibition, attentional switching and planning abilities (Phillips & Henry, 2008; Salthouse et al., 2003), as well as reductions in other executive abilities such as divided attention/dual task processing (e.g., see Sarter & Turchi, 2001, for a review).

In providing support for the Age-related Neurocognitive Decline Account, the finding in Experiment 4 simultaneously appears to contradict the Age-related Enhancement of Wisdom and Experience Account as a potential (or at least a main) explanation for age-related differences (i.e., an age-related attenuation) in anxiety vulnerability and anxiety-linked patterns of selective processing. In other words, the attenuation of an anxiety-linked bias in negative expectancy in older adults appears to more likely be the result of a neurocognitively ageing brain rather than due to a motivated prioritisation of emotional goals with healthy ageing as proposed by the Socioemotional Selectivity Theory (SST; Carstensen et al., 1999). Of course, it could be seen as a limitation that the Age-related Enhancement of Wisdom and Experience Account (for example, SST) was not directly tested in the current research. However, should an attenuated anxiety-linked bias in negative expectancy in the older compared to the younger adults have been more due to a motivated change in the prioritisation of emotional goals that occurs with healthy ageing rather than due to age-related differences in neurocognitive capacity (in Experiment 4), then dual task processing/divided attention would not have been found to significantly moderate the impact of age on the relationship between anxiety vulnerability and expectancy. In that case it would then have instead been likely that only age would have been found to moderate the relationship between anxiety vulnerability and expectancy, with neurocognitive capacity (i.e., dual task processing/divided attention) not significantly moderating this impact of age. If such an effect had been found, this would then have suggested that the age differences in an anxiety-linked bias in negative expectancy are likely not a product of the interaction between age and neurocognitive capacity, though
rather due to age differences in something other than neurocognitive capacity (of which one possibility may be the prioritisation of emotional goals in older adults as proposed by SST).

Importantly, as highlighted in the previous chapter, the finding of less intact neurocognitive capacity being associated with an attenuated anxiety-linked bias in negative expectancy in older adults, provides a likely explanation for the age-linked bias in negative expectancy (characterised by age amplifying rather than attenuating an anxiety-linked bias in negative expectancy), found in Experiment 2. The finding (in Experiment 4) of an attenuation of an anxiety-linked bias in negative expectancy in older adults with poorer neurocognitive capacity than those with more intact neurocognitive capacity suggests that the older adult sample in Experiment 2 may have been generally more neurocognitively intact as a sample. Certainly, age differences in memory did not appear to be simulating age differences in an anxiety-linked bias in negative expectancy in Experiment 2, suggesting that these older adults likely had more intact memory functioning. Although neurocognitive capacity was not directly assessed in Experiment 2 (which is considered a limitation of that experiment), more intact neurocognitive functioning may have led to this older adult sample showing an amplified rather than attenuated anxiety-linked bias in negative expectancy. Given the current research findings it appears of critical importance that neurocognitive capacity is measured in older adults since anxiety-related patterns of selective processing may differ as a result of different levels of neurocognitive functioning. Some studies investigating how anxiety-related patterns of selective processing differ between younger and older adults have assessed different aspects of neurocognitive capacity (e.g., Isaacowitz et al., 2006) in order to rule out the possibility of the observed age effects being due to age-related neurocognitive decline. However, other studies in this research area have not tended to include measures of neurocognitive capacity (e.g.,
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Isaacowitz et al., 2008). When these have been included such measures (e.g., Tomaszczyk, Fernandes, & MacLeod, 2008), they are comprised of very general and brief screening measures such as the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975), or measures which aid in estimating premorbid general intellectual functioning such as the National Adult Reading Test-Revised (NART-R; Nelson, 1992), neither of which would be particularly sensitive to the more subtle age-related changes in neurocognitive capacity associated with normal ageing (e.g., Jorm et al., 1996).

It is interesting to note that the mechanisms giving rise to an age-linked bias in negative expectancy differed between Experiment 2 and 4. In the former, an age-linked bias was characterised by negative extrapolation (with a tendency for the older high trait anxious adults to show more negative than positive extrapolation when compared to younger high trait anxious adults, with no age group difference in the low trait anxious). In Experiment 4, this bias was characterised by pervasive negative expectancy (with greater expectancy for negative than positive future events in the older high than low trait anxious with more intact dual task processing/divided attention, compared to no anxiety group difference in older adults with less intact dual task processing/divided attention). However, the Expectancy Assessment Task used in these experiments differed from one another, with that used in Experiment 2 providing different memory loads (i.e., a 1 vs. 16 scenario retention interval), while that in Experiment 4 involved a presentation block of 4 scenarios. It is uncertain if, and how, this may have altered the mechanisms found to give rise to an age-linked bias in negative expectancy. Moreover, neurocognitive capacity was not assessed in Experiment 2 and thus it is unclear how neurocognitive capacity may have contributed to a different mechanism being found to underlie an age-linked bias in that experiment compared to Experiment 4. It would be helpful to replicate Experiment 4, again using the Expectancy Assessment Task.
involving a presentation block of 4 scenarios and including an assessment of neurocognitive capacity.

**General Limitations**

The limitations associated with individual experiments have been discussed above in the context of the findings pertaining to each of the research objectives. The remaining general limitations of the current research will now be discussed.

First, as with most laboratory-based studies conducted in the university setting, young adult participants were comprised of young university students. As a result, these young adult samples in the current research may not be fully representative of the young adult population more generally. Therefore, the generalisability of the current findings to a young adult population may be at least somewhat limited. Future studies could recruit young adults from the general population (not necessarily from a university setting) as participants and assess whether or not educational level is significantly associated with the effects of interest.

Second, the community samples of older adults used in the current research are considered to be relatively high functioning. Given the well-established finding that on average, greater socio-economic status is associated with better health (e.g., Adler & Ostrove, 1999), caution is needed in generalising the current results to older adult populations in less developed and affluent societies or to those in poor health. Nevertheless, it is interesting to note that there was still evidence to suggest that some of these relatively high functioning older adults were high in anxiety vulnerability (see Experiment 2 and 4) and less neurocognitively intact (see Experiment 4).

Third, comparisons between younger and older adults in the present research may be somewhat limited. As with most ageing research involving cross-sectional studies (as noted by Hofer, Sliwinski, & Flaherty, 2002), there are various cohort effects that may confound the results obtained. For example, the younger adults in the current
research may generally be more educated than the older adult sample, with educational opportunities and attainment for adolescents having increased over a number of decades (e.g., Le & Miller, 2002; Schaie, Willis, & Pennak, 2005). It is a limitation of the current research that younger and older adults were not matched on educational level or IQ. This leaves uncertain how the current findings pertaining to how an anxiety-linked bias in negative expectancy may change with age would differ should younger and older adults have been matched on these factors. While of course longitudinal designs are ideal in that they assess change over time, more readily assess cause and effect (Rajulton, 2001), and control for cohort effects (Hofer et al., 2002), these are often impractical and expensive (Farrington, 1991). There is a great amount of literature that discusses how challenging it is to simultaneously match younger and older adults on various factors in cross-sectional research. In fact it has been noted that is impossible to match age groups on all the possible factors that could contribute to cohort effects (Stuart-Hamilton, 2006). Therefore, this limitation regarding cohort effects in the current research is to some extent a problem inherent in many ageing research studies that is not easily solved. Nevertheless, future studies investigating age differences in such a bias should match age groups on at least educational level and IQ.

Fourth, the potential role of a response bias in the observed effects (e.g., an inflated tendency to endorse more extreme negative or positive responses, regardless of the question) should also be considered. However, for example, the finding of an anxiety-linked bias in negative expectancy (characterised by greater emotional extrapolation in the high than the low trait anxious) being observed to a greater degree in social than physical scenarios (in Experiment 1), argues against a response bias playing a significant role in the observed effects. Regardless, it could be useful for future research more directly to evaluate the possible influence of a response bias. For example, negative and positive foil items that do not plausibly continue on from
presented scenarios could be included in the Expectancy Assessment Task as possible future events to check these are not preferentially endorsed as a function of trait anxiety status. Implicit measures that infer differences in expectancy using indirect measures, such as comprehension latency, could also be employed.

Fifth, one objective of the current research was to investigate age-related differences in negative expectancy and indirectly, explore why on average older adults show less anxiety vulnerability than younger adults. However, younger and older adults were matched on trait anxiety in the present research, in order to create comparable high and low trait anxious groups across both age groups and reveal how high and low levels of trait anxiety are associated with expectancy for future events in each age group. Therefore, the older adults in this research were likely higher in anxiety vulnerability than older adults would be on average in the general population. While this was necessary, as mentioned, in order to create high and low trait anxious groups in both age groups that were similar in terms of levels of trait anxiety, this may have led to different results being obtained than would have been observed if a sample of older adults from the general population were recruited not based on their STAI-T scores. Given that the older adults in the current research may likely have had levels of trait anxiety that are more similar to older adults with diagnosed anxiety disorders than to older adults in the general population, caution is required when generalising the current findings to the latter population of older adults. The difficulty in making comparisons in terms of trait anxiety between younger and older adults is further complicated by the differing distributions of trait anxiety observed in older adulthood. There is also a well-known U-shaped function of trait anxiety across older adulthood whereby those in their fifth to seventh decades of life show a decline in anxiety, followed by an increase in anxiety in the eighth decade of life (e.g., Lee, Gatz, Pederson, & Prescott, 2016).

Sixth, investigating the aspects of neurocognitive capacity that may contribute to
an age-linked bias in negative expectancy was confined to assessing episodic memory and divided attention/dual task processing in the present research. Thus, one cannot generalise the current results to overall neurocognitive capacity without other areas of neurocognitive capacity being assessed in relation to age differences in expectancy. This limitation is further explored later under Future Directions pertaining to alternative neuropsychological accounts of age-related differences in negative expectancy.

Seventh, levels of depressed mood were not controlled for in the current research. Given that depressed mood is commonly comorbid with anxiety (e.g., Gorman, 1996), this means that differences between the anxiety groups in depressed mood may have contributed to the observed group differences in negative expectancy.

Eighth, the risk of Type I error across all four experiments must be acknowledged, particularly given that marginal trend level effects were subjected to follow-up analyses. This makes it important that firm conclusion await confirmation that these effects reliably replicate in future research studies. Moreover, each of the experiments in the current research had limited power, and thus future research should aim to use larger sample sizes where possible.

Lastly, it should be acknowledged that the approach of computing negative relative to positive future expectancy ratings, used in the current research is different to that used in many other research studies, which have typically involved analysing negative and positive future expectancy ratings separately. Though this could be viewed as a limitation, the adoption of this approach was specifically tailored to address the current hypotheses under scrutiny, which make predictions about negative relative to positive future expectancy. Consequently, analysing negative and positive future expectancy ratings separately in the present research would have resulted in the effects of interest emerging as higher order interactions, while also revealing the significant (or otherwise) effects irrelevant to evaluation of the hypotheses under test. Thus, the
approach taken has restricted the resulting information to that which is of relevance to
the hypotheses being tested, in the interest of clarity. The full set of data is archived and
will be made available upon request should other hypotheses need to be addressed
which would require negative and positive future expectancy ratings to be analysed
separately.

Implications and Future Directions

Notwithstanding these general limitations, the current research provides valuable
information regarding an anxiety-linked bias in negative expectancy using a novel
Expectancy Assessment Task, and has a number of important theoretical and applied
implications as well as future directions that could be explored.

Anxiety-linked Bias in Negative Expectancy

The current findings of an anxiety-linked bias in negative expectancy
consolidate previous research findings of such a bias. The present findings of this bias
also make a unique contribution to previous research in that the mechanisms giving rise
to an anxiety-linked bias in negative expectancy have now been illuminated (as this had
not previously been investigated). Additionally, the current findings of an anxiety-
linked bias in negative expectancy have important implications for how such a bias is
conceptualised, in terms of whether or not it is affected by the emotional valence of a
current experience. Previous research studies examining an anxiety-linked bias in
negative expectancy have primarily done so with the aim of distinguishing future
expectancy in anxiety from that in depression (e.g., MacLeod et al., 1997; Miranda &
Mennin, 2007; Stöber, 2000). These same studies have also focused only on
expectations for differently valenced future events rather than also considering the
potential impact of the emotional valence of current experience. The present research
theoretically (and empirically) differentiated between such a bias being affected by the
emotional valence of the current experience either generally (as per the Emotional
Extrapolation Hypothesis; EEH) or differentially (according to the Negative Extrapolation Hypothesis; NEH) as well as such a bias perhaps not being at all affected by the emotional valence of the current experience (as stipulated by the Pervasive Negative Expectancy Hypothesis; PNEH). Given that an anxiety-linked bias in negative expectancy was found to more consistently be generally affected by the (negative and positive) emotional valence of the current experience (i.e., more consistent support for the EEH in the present research), it appears important for theoretical accounts of an anxiety-linked bias in negative expectancy to consider not only the emotion valence of future events but also that of the current experiences.

Moreover, this greater tendency of those with high anxiety vulnerability to use (negative and positive) information about the current situation in order to inform their expectations of the future seems to be particularly evident in social situations. This being observed in younger adulthood in the current research is consistent with the idea that one’s development and sense of self in young adulthood is largely influenced by social context (Crockett & Crouter, 2014). Furthermore, this appears at least somewhat related to Erikson’s Stages of Psychosocial Development Theory (Erikson, 1994), in which the transition from adolescence to adulthood involves adolescents and young adults wanting to belong and fit in in society (the Identity vs. Role confusion stage). According to this developmental theory, failure to establish a sense of identity within society can lead to role confusion, which involves being uncertain regarding oneself or place in society which can in turn lead to unhappiness (Erikson, 1994). Research suggests that role confusion is frequently associated with clinical disorders (Demir, Dereboy, & Dereboy, 2009). Therefore, theoretical accounts of an anxiety-linked bias in negative expectancy also need to consider social situations and concerns.

While further research would certainly be important to replicate and confirm the mechanisms that may give rise to an anxiety-linked bias in negative expectancy found
in the present research, another important theoretical implication of the current findings pertains to such a bias also being more widely considered theoretically as another one of the areas in which individuals high in anxiety vulnerability also demonstrate patterns of selective processing. Previous research reviews highlight three main areas in which anxiety-linked patterns of selective processing have been found: attention, memory, and interpretation (for example, see Mathews & MacLeod, 2005; MacLeod & Mathews, 2012). More specifically, and as mentioned in Chapter 1, those with high anxiety vulnerability show a preference for selectively processing negative information in their attentional processes, memory and interpretation of information, such that they exhibit selective attention towards (see Yiend, 2010), and selective recall of (e.g., Ghassemzadeh et al., 2003) negative information, and tend to interpret ambiguous information as negative rather than positive (e.g., Hirsch & Mathews, 1997).

In terms of important applied implications, anxious individuals who seek psychological treatment are more likely to have higher levels of anxiety than those that do not seek treatment (Vogel & Wei, 2005), and are likely having less frequent positive (and thus more negative) experiences (see Kashdan, Weeks, & Savostyanova, 2011). The finding of greater negative and positive emotional extrapolation in those with high anxiety vulnerability in the present research has implications for psychological assessments of young adults with high anxiety vulnerability and appears consistent with the cognitive distortions proposed by Burns (1980), which are typically targeted with the use of Cognitive Therapy. For example, if anxious individuals are having more negative than positive experiences (which may be likely as noted above), then given their inflated emotional extrapolation, they would engage in: 1) mental filtering (whereby they would appear to be dwelling on the negative and ignoring the fewer occurring positive experiences), 2) discounting the positive (which refers to insisting that the fewer occurring positive experiences or accomplishments don’t count), and 3)
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overgeneralisation (meaning they would view a negative event as a “never-ending defeat” or ongoing experience).

In terms of implications for psychological interventions or treatment, it appears that it would be important to not consider the expectations of the future that these individuals have in isolation, but to also consider their current emotional experiences and how they extrapolate from these experiences to form expectations regarding the future. It may also be beneficial in a therapeutical context to encourage activities that can generate more positive than negative experiences for a client with high anxiety vulnerability, as is typically done using behavioural activation strategies for depressed individuals (see Ekers, Webster, Van Straten, Cuijpers, Richards, & Gilbody, 2014). Indeed, there is some evidence for the value of behavioural activation in those with high anxiety vulnerability (e.g., Chen, Liu, Rapee & Pillay, 2013). Given the current findings it would also be helpful to try alter anxious individuals’ negative perceptions of current experiences (to become more positive) so that they will extrapolate less negatively and more positively from these situations. This could be done with the use of treatments such as Cognitive Behavioural Therapy (e.g., Espejo, Gorlick, & Castiotta, 2016). This should in turn lead to greater expectations for positive than negative future events in these individuals and thereby aid in reducing their levels of anxiety about the future, since anxiety is typically characterised by ‘future-oriented concerns’ which tend to be negative (Barlow, 2002; see Miloyan, Pachana, & Suddendorf, 2014, for a review). This would hopefully also mean that such individuals with an anxious temperament (i.e., high trait anxiety) would be able to live more functionally with such anxiety-linked cognitive biases (i.e. a tendency to extrapolate from negative and positive experiences) as long as they are having more positive than negative life experiences.

Given that a (trait) anxiety-linked bias in negative expectancy is more evident in social situations, it may be helpful to target the social concerns and context of the young
adult client when implementing therapeutic interventions, whether they present only with an anxious temperament or meet criteria for more intensely socially-focused anxiety disorders (like Social Phobia). With regards to possible prevention strategies, young adults in tertiary education or work places who may be vulnerable to anxiety and anxiety disorders could be identified using trait anxiety and social anxiety questionnaire measures, such as the STAI-T (Spielberger, 1983) and the Liebowitz Social Anxiety Scale (Liebowitz, 1987), respectively. The individuals then identified as being high in anxiety vulnerability and particularly anxious regarding social concerns could then be provided with psychoeducation in order to aid in reducing their vulnerability and/or symptomatology. Indeed previous research shows that psychoeducation, or in other words increasing a person’s understanding about his or her condition or symptoms, aids in lowering symptomatology (see Donker, Griffiths, Cuijpers & Christensen, 2009, for a meta-analysis).

As mentioned earlier, further research would certainly be important to replicate and confirm the mechanisms giving rise to an anxiety-linked bias in negative expectancy (i.e., characterised by negative and positive emotional extrapolation) found in the present research. This would involve again using the Expectancy Assessment Task used in Experiment 1 (i.e., with the presentation block of 4 scenarios) in a young adult sample of high and low trait anxious individuals. In terms of future directions, it would be interesting to investigate an anxiety-linked bias in negative expectancy within a clinically anxious population. It may be that those with a diagnosed anxiety disorder would differentially extrapolate more from negative than positive current situations when forming expectations of the future, unlike those who are high in trait anxiety who extrapolate from both negative and positive current situations in terms of their future expectations. Should this be found, this may help explain why those with high trait anxiety may be less likely to seek treatment until their anxiety becomes increasingly
severe (e.g., Dugas & Robichaud, 2007). That is, because they extrapolate from both negative and positive current situations they are still able to have some positive expectations of the future whereas those with clinical anxiety may no longer be able to extrapolate from positive situations, and do so only from negative situations leading to a far bleaker view of the future.

It would also be interesting for future research to investigate whether interpersonal variability in imagery ability (i.e., the vividness and controllability of mental imagery) is associated with an anxiety-linked bias in negative expectancy as measured by the Expectancy Assessment Task, and whether the mechanisms underlying such an anxiety-linked bias differ depending on imagery ability. This could involve administering a questionnaire measure of mental imagery ability (such as the Vividness of Visual Imagery Questionnaire – revised version; Marks, 1995), along with the Expectancy Assessment Task in a sample of high and low trait anxious younger adults.

Previous research has found that, when provided with subsequent information about the future, healthy individuals maintain their optimistic expectations, whereas patients diagnosed with Major Depressive Disorder do not show this optimistic bias. Indeed, severely depressed participants actually showing a more pessimistic updating of their expectations once provided with subsequent information about the future (i.e., Korn, Sharot, Walter, Heekeren, & Dolan, 2014). It would be interesting for future research to examine whether those with high anxiety vulnerability may alter their expectations after being challenged with information about the future, in ways that differ from people with low anxiety vulnerability.

After replicating and confirming the mechanisms giving rise to an anxiety-linked bias in negative expectancy, it would be valuable for future research to investigate whether such a bias may also causally contribute to anxiety vulnerability, like other patterns of selective processing associated with anxiety vulnerability (i.e.,
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Attentional and interpretive biases. Like some of these other patterns of selective processing associated with anxiety vulnerability, an anxiety-linked bias in negative expectancy may also causally contribute to anxiety vulnerability. Cognitive Bias Modification (CBM) research involves employing experimental tasks to determine the causal contribution of patterns of selective processing in the development of anxiety vulnerability. This is done by modifying these patterns or biases through lengthy practice on a task developed to bring about such change, and then assessing the impact of these modifications (or changes in biases) on anxiety vulnerability (MacLeod & Mathews, 2012). Should an anxiety-linked cognitive bias be causally linked to anxiety vulnerability, then modification of the bias should impact on anxiety vulnerability. For example, Dandeneau and Baldwin (2004) developed a visual search task, which aimed to suppress attention to negative information while encouraging attentional vigilance for positive information. Participants were required to search for a single positive stimulus in a matrix which otherwise contained negative distractor stimuli. This resulted in attentional vigilance for negative information being reduced when compared to a control condition (as indicated by less interference on rejection words during a Stroop task which was completed following the visual search task). In terms of a CBM experiment to investigate whether an anxiety-linked bias in negative expectancy (characterised by emotional extrapolation) may also causally contribute to anxiety vulnerability, participants with mid-range STAI-T scores could be recruited. They would then be exposed to an experimental task including three training conditions. One condition would involve training or inducing greater positive extrapolation (i.e., greater expectancy for positive than negative future events in positive scenarios) as well as greater negative extrapolation (i.e., greater expectancy for negative than positive future events in negative scenarios). Another condition would involve reducing positive extrapolation (i.e., less expectancy for positive than negative future events in positive
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scenarios) as well as reducing negative extrapolation (i.e., less expectancy for negative than positive future events in negative scenarios). And a third (control) condition would involve participants being exposed to neutral scenarios (which are void of any emotional tone) and involve no training. It would then be important to measure state and trait anxiety before and after each episode of training. It would be hypothesised that heightened state and trait anxiety would be observed in the first condition inducing greater positive and negative extrapolation (given that an anxiety-linked bias in negative expectancy is characterised by negative and positive extrapolation and should such a bias be causally associated with anxiety). It would also be hypothesised that reduced state and trait anxiety would be observed in the second condition aimed at reducing positive and negative extrapolation. No significant change in state or trait anxiety would be anticipated in the neutral (control) condition.

Age-linked Bias in Negative Expectancy

While previous research has suggested that there may indeed be an age-linked bias in negative expectancy, this has never (to the author’s knowledge) been investigated. Thus this research has confirmed that such age differences in expectancy exist. This research has also extended previous findings of age-differences in patterns of selective processing in attention, interpretation and memory, to now also include expectations for the future (i.e., expectancy). The current research findings pertaining to an age-linked bias in negative expectancy also have important implications for how such a bias is conceptualised now that it has been found to exist. The present research raised two possibilities regarding age-related differences in patterns of selective processing. First, the possibility that older adults may just generally differ from younger adults in patterns of selective processing (i.e., in that they show less of these selective patterns compared to younger adults) was considered. This was referred to as age independently ameliorating negative expectancy. Second, the possibility that there may
be a reduced association between patterns of selective processing and anxiety vulnerability in older than younger adults (such that while older adults may show these patterns as much as younger adults do, they are still not as high in anxiety vulnerability as younger adults) was raised. This possibility was referred to as age attenuating an anxiety-linked bias in negative expectancy. Previous research into age differences in cognitive biases that are typically found in younger adults with high anxiety vulnerability, have not tended to differentiate between these two possibilities. Specifically, while previous studies have found that older adults tend to focus their attention on positive rather than negative information (e.g., Isaacowitz et al., 2008), are less likely to interpretive information negatively (e.g., McDowell et al., 1994), and appear to recall more positive than negative information (e.g., Kennedy et al., 2004) when compared to younger adults, none of these studies included participants with high and low anxiety vulnerability. Thus the two possibilities of age independently ameliorating negative expectancy and age attenuating an anxiety-linked bias in negative expectancy could not be differentiated. The current research provided support for the latter possibility, though age was found to amplify (rather than attenuate) an anxiety-linked bias in negative expectancy. This shows how important it is that future research differentiates between these two possibilities, which may give rise to age-related differences in patterns of selective processing, both theoretically and empirically.

Additionally, the current findings of an age-linked bias in negative expectancy also have theoretical implications in terms of the mechanisms that give rise to this age-linked bias. In particular, it is interesting to note that older adults with high anxiety vulnerability, like younger adults with high anxiety vulnerability, use emotional information regarding the current situation to inform their expectations of the future. However, older adults with high anxiety vulnerability appear to extrapolate more from negative than positive information (rather than extrapolating from both negative and
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positive information) about the current situation. Despite the reduced prevalence of anxiety disorders with increasing age and particularly in older adulthood (e.g., Wolitzky-Taylor, Castriotta, Lenze, Stanley & Craske, 2010), there is some suggestion in the literature that older adults who are high in anxiety vulnerability may experience more severe symptoms of anxiety than younger adults with high anxiety vulnerability (Kunzmann & Grühn, 2005). This suggests that the nature of anxiety vulnerability and thus perhaps the mechanisms giving rise to anxiety vulnerability may actually change with age. This finding regarding the mechanisms that give rise to an age-linked bias in negative expectancy provides valuable theoretical knowledge about individual factors (such as age) that differentiate high trait anxious individuals from one another and how an anxiety-linked bias in negative expectancy may change with age.

This tendency to extrapolate more from negative than positive information about the current situation in older adults with high anxiety vulnerability did not differ between social situations and those pertaining to physical/health-related concerns. This is interesting since older adulthood tends to be accompanied by an increase in health-related issues and concerns (Fries, 2002). Thus, one might expect an anxiety-linked bias in negative expectancy in older adults to be more evident in terms of physical rather than social concerns. Theoretically, this finding is important since it suggests that while social concerns are more pertinent during younger adulthood (particularly in terms of anxiety and expectancy, as discussed earlier), physical concerns may become equally important with increasing age.

In terms of applied implications for older adults, it appears that (like in younger adults) it would be important to not only consider their expectations of the future in isolation, but to also consider their current emotional experiences and how they extrapolate from these experiences to form future expectations. Yet, it appears that psychological treatment for anxiety in older adults may need to differ to that for
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younger adults in a few ways. Since older adults with high anxiety vulnerability appear to extrapolate more from negative than positive information about the current situation, it would be important in therapeutic interventions (such as behavioural activation) to encourage activities that might lead to more positive experiences in these older adults. It may then also be helpful to support or emphasise greater extrapolation from these positive experiences in terms of their expectations of the future, using treatments such as CBT. It is hoped that this would result in greater expectations for positive than negative future events in these older adults and be associated with less anxiety and less negative concerns regarding the future. This may also be more effective by not only targeting or focusing on the social concerns and contexts of the older adult when providing them with psychological treatment. Rather, since the current research suggests that from a lifespan perspective, physical/health-related concerns become as important as social concerns for older adults, it may be important to apply therapeutic techniques to their concerns about both social and physical aspects of their lives. The applied implications of an age-linked bias in negative expectancy (and the future directions with regards to this bias) will be further explored in the section below given the strong link between neurocognitive capacity and age.

Alternative Neuropsychological Accounts of Age-related Differences in Negative Expectancy

The present research findings regarding the role of neurocognitive capacity in an age-linked bias in negative expectancy have important implications for theoretical accounts of what may be underlying age-related differences in patterns of selective processing. Older adults with poorer neurocognitive capacity (i.e., reduced dual task processing/divided attention) showing less evidence of an anxiety-linked bias in negative expectancy provides support for the Age-related Neurocognitive Decline Account as an explanation for why anxiety vulnerability may in fact be less common
with increasing age. It also provides support for this account as an explanation for why older adults also exhibit fewer anxiety-linked patterns of selective processing (as discussed earlier).

The age-linked bias in negative expectancy as well as findings pertaining to the role of neurocognitive capacity in this age-related bias, have significant (applied) implications for the psychological treatment of elevated anxiety vulnerability in older adults. It appears particularly more complex than just needing to consider age in such interventions, since there appears to be an important interplay between age and neurocognitive capacity in terms of its influence on anxiety-related information processing/cognitive biases. Assessing and taking into account an individual’s neurocognitive profile appears to be important in attempting to alter anxiety-related cognitive biases, particularly in older populations. Should older adults seeking treatment for anxiety be found to have poor neurocognitive capacity (particularly divided attention), they may be suffering from lower levels of anxiety and have a less pronounced anxiety-linked bias in negative expectancy (i.e., a weaker association between their anxiety and future expectancy) than other anxious older adults who have more intact neurocognitive capacity/divided attention. Obtaining information about an individual’s neurocognitive profile would likely also alter how therapy is presented and targeted in these older individuals with poorer neurocognitive functioning.

The current findings are consistent with a neurocognitive model of late-life anxiety proposed by Mohlman, Deckersbach and Weissman (2015). According to this neurocognitive model, older adults with late-life anxiety who have sound executive skills and intact structure and function of their PFC appear to experience more severe and intense worry. Given their intact PFC and executive functions they experience a better outcome in terms of a reduction in their anxiety when undergoing CBT. However, older adults with late-life anxiety who have poor executive skills and reduced volume
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and function of their PFC, appear to experience less severe and intense worry. This group of older adults tend to have a poorer outcome with CBT (i.e., in terms of aiming to reduce their anxiety) due to their less intact PFC and reduced executive abilities. Should this latter group of older adults experience improvement in their executive skills (i.e., with cognitive rehabilitation or lifestyle changes) then the use of CBT is recommended. If their executive skills do not improve, then medication for their anxiety is recommended along with supportive therapy (rather than CBT).

It would be important for future research to replicate the finding of poorer divided attention/dual task processing being associated with an attenuated anxiety-linked bias in negative expectancy in older adults, using the Expectancy Assessment Task. This could involve additionally using other neuropsychological measures of divided attention (such as the Trail Making Test, Part B; Reitan & Wolfson, 1985) in future research, to see if the current findings are replicated. It would also be valuable if such research were broadened to also include other areas of neurocognitive capacity that might undergo changes during normal ageing and impact on future expectancy. For example, processing speed is another area of neurocognitive capacity that declines during the healthy ageing process (Finkel et al., 2009; Salthouse 1996, 2010). This is associated with white matter changes within the brain (Birren & Fisher, 1995; Lu et al., 2011). Neurocognitive slowing in older adulthood may be associated with an attenuated anxiety-linked bias in negative expectancy since older adults may not be able to process all the information regarding the current situation as quickly as younger adults, and thus only process some aspects of the current situation. This may in turn lead to them processing expectations of the future differently compared to younger adults. There are a number of ways this could be assessed in research studies. Neuropsychological measures such as the Symbol Search or Coding subtests from the Wechsler Adult Intelligence Scale – Fourth Edition (WAIS-IV; Wechsler, 2008) or Symbol Digit
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Modalities Test (SDMT; Smith, 1982) could be administered. In such an experiment, participants would again have to complete the Expectancy Assessment Task along with a neuropsychological measure of processing speed. It would be predicted that older adults with slower processing speed would show an attenuated anxiety-linked bias in negative expectancy, while those with more intact processing speed would show an amplified anxiety-linked bias in negative expectancy. Alternatively, the potential role of processing speed in an age-linked bias in negative expectancy could be assessed by manipulating the amount of time that participants are exposed to the scenarios in the Expectancy Assessment Task, prior to providing ratings regarding the likelihood of future events for each of the previously read scenarios. One experimental condition would involve the scenarios being presented for a short amount of time while in the other condition each scenario would be presented for a longer period of time. Should processing speed impact on an age-linked bias in negative expectancy, then an age-linked bias would be more evident in the short exposure condition than the longer exposure condition. This would be due to older adults perhaps not being able to process all the information provided regarding the current scenarios and thus showing greater differences in their future expectancy ratings compared to younger adults.

Another direction for future research that arises from the present research relates to more directly testing the Age-related Enhancement of Wisdom and Experience Account (e.g., SST) as potentially underlying an age-linked bias in negative expectancy. This would aid in being able to more confidently rule out the possibility of a motivated prioritisation of emotional goals with healthy ageing (as proposed by SST) or just more general increases in wisdom and life experiences contributing to an attenuation of an anxiety-linked bias in negative expectancy in older than younger adults. As mentioned earlier, it could be considered a limitation that the Age-related Enhancement of Wisdom and Experience Account (e.g., SST) was not directly tested in the current research. Thus
while support for the Age-related Neurocognitive Decline Account was found, there may also have been other factors at play, which if found, would have also provided support for the Age-related Enhancement of Wisdom and Experience Account. For example, factors like emotional intelligence and lifetime emotional experience were not assessed. This is certainly a somewhat more challenging account to assess directly when compared to the Age-related Neurocognitive Decline Account, the latter which can be more readily (and more objectively/quantitatively) assessed with the use of neuropsychological measures.

Future research could again present high and low trait anxious younger and older adult participants with the Expectancy Assessment Task as a measure of expectancy, and a number of neuropsychological measures to assess more aspects of neurocognitive capacity than were assessed in the current research. Participants could then be given a task like that employed by Fredrickson and Carstensen (1990), Fung et al. (1999), and Fung et al. (2001), which involves asking participants to imagine that they have half an hour of free time with no pressing commitments and that they have decided to spend that time with another person. They are then given three options for this other person; either a member of their immediate family, the author of a book they had just read, or an acquaintance with whom they appeared to have a lot in common with. The familiar social partner represents an “emotionally meaningful goal” while the novel social partners represent a “future-oriented goal” related to gathering information and forming new relationships. Of note, these studies all found evidence of older adults tending to prefer the familiar social partner (and thus selecting the emotional meaningful goal as postulated by SST) while the younger adults did not show this preference (see Löckenhoff, & Carstensen, 2004). Other measures, such as the Emotional Quotient Inventory: Short (EQ-I:S; Bar-On, 2004) could be used to assess emotional intelligence, or interviews about lifetime emotional experiences, including
asking about any exposure to traumatic events and emotional support (the latter as examined by Krause, 2004) could also be conducted. Personality has also been found to change with increasing age, with older adults becoming more agreeable or acquiescent (e.g., Reker & Woo, 2011). This may mean that when exposed to negative stimuli or situations, these individuals with greater agreeableness may respond in a different way. They may place less emphasis on such negative information and this may be associated with older adults demonstrating reduced anxiety vulnerability than younger adults. Thus it may be worthwhile including personality measures that assess dimensions of personality like agreeableness, such as the Big Five Inventory (BFI; John & Srivastava, 1999) or the NEO Five Factor Inventory (NEO-FFI; Costa & McCrae, 1989) when further investigating the Age-related Enhancement of Wisdom and Experience Account.
Concluding Remarks

In conclusion, this research has shed light on the mechanisms that may give rise to an anxiety-linked bias in negative expectancy. The results indicate that emotional information about the current experience is of great relevance in terms of how those with high anxiety vulnerability form their future-oriented expectations or concerns. This research has also taken the important first step of establishing that there are indeed age differences in this anxiety-linked bias, as this had not yet been established. Moreover, it has contributed towards delineating the neuropsychological basis of why an anxiety-linked bias in negative expectancy may change with age and why older adults generally show reduced levels of anxiety vulnerability. In the present research, neurocognitive capacity (and particularly divided attention) was crucial to how an anxiety-linked bias in negative expectancy manifested in older adults. Less intact divided attention in older adults was associated with an attenuated/reduced anxiety-linked bias in negative expectancy. This provides support for age-related declines in neurocognitive capacity being associated with reduced anxiety-linked cognitive biases in older adults and is likely linked to why older adults generally show reduced levels of anxiety vulnerability. There is a scarcity of research over the last decade pertaining to future expectancy, particularly amongst anxiety and cognitive bias researchers. It is hoped that the present research will encourage further investigation not only into anxiety-linked patterns of expectancy, but also into how these patterns change with increasing age and the neuropsychological basis of these age-related changes.
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Anxiety-linked Bias in Negative Expectancy


Anxiety-linked Bias in Negative Expectancy


Appendix 1

Expectancy bias in anxious samples

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Abstract

While it is well documented that anxious individuals have negative expectations about the future, it is unclear what cognitive processes give rise to this expectancy bias. Two studies are reported that use the Expectancy Task, which is designed to assess expectancy bias and illuminate its basis. This task presents individuals with valenced scenarios (Positive Valence, Negative Valence, or Conflicting Valence), and then evaluates their tendency to expect subsequent future positive relative to negative events.

The Expectancy Task was used with low and high trait anxious (Study 1: N = 32) and anxiety sensitive (Study 2: N = 138) individuals. Results suggest that in the context of physical concerns, both high anxious samples display a less positive expectancy bias. In the context of social concerns, high trait anxious individuals display a negative expectancy bias only when negatively valenced information was previously presented. Overall, this suggests that anxious individuals display a less positive expectancy bias, and that the processes that give rise to this bias may vary by type of situation (e.g., social or physical) or anxiety difficulty.

Key Words: Trait Anxiety, Anxiety Sensitivity, Expectancy Bias, Extrapolation
Anxiety-linked Bias in Negative Expectancy

Expectancy Bias in Anxious Samples

It is well documented that the content of maladaptive cognitions in anxiety tends to be concerned with the prospect of harmful future events (Beck & Clark, 1988; Kendall & Ingram, 1989). Those who are clinically anxious are more likely to have negatively distorted expectations of the future than are non-anxious individuals (e.g., MacLeod, Tata, Kentish, & Jacobsen, 1997; Miranda & Mennin, 2007). Consistent with this focus, an anxiety-linked negative expectancy bias reflects an inflated tendency for anxious individuals to expect an increased probability of negative relative to positive events. This anticipation of a wide range of negative events has been demonstrated not only in individuals who are clinically anxious (e.g., Borkovec, Alcaine, & Behar, 2004; Dugas et al., 1998), but also in non-clinical individuals who are highly trait anxious (e.g., MacLeod & Byrne, 1996; Stöber, 2000). Although an anxiety-linked negative expectancy bias has been documented, current paradigms do not illuminate the conditions that give rise to this bias.

In this article, two studies are reported that use a paradigm that provides individuals with valenced information, and then evaluates their tendency to expect positive or negative events to occur in the future. This paradigm is used with both highly trait anxious (HTA) and highly anxiety sensitive (HAS) samples. Trait anxiety reflects the propensity to become anxious across many different contexts (Spielberger, 1983), while anxiety sensitivity reflects the fear of symptoms related to anxiety (e.g., bodily sensations, such as a racing heart) and the belief that these sensations have negative physical, social, or psychological consequences (Reiss, 1991; Reiss & McNally, 1985).

While the anxiety-linked tendency to anticipate negative future events has been demonstrated using a variety of paradigms, no methodology has revealed the conditions that give rise to this expectancy bias in anxious samples. Specifically, it is unclear
whether this bias occurs regardless of the valence of previously presented information, or whether it is moderated by the valence of previously presented information. In this paper, we consider three potential hypotheses regarding conditions that may lead to an expectancy bias.

First, it may be that the expectancy bias seen among anxious individuals is pervasive, such that it is shown across situations. Specifically, anxious individuals may have a more negative expectancy bias (relative to non-anxious individuals), regardless of whether current or recent events are emotionally negative, are emotionally positive, or are conflicting in emotional valence (i.e., containing negative and positive elements). This possibility is referred to as the Pervasive Expectancy Bias Hypothesis (Pervasive-EBH). Pervasive in this context refers to the bias occurring irrespective of differently valenced prior information or preceding events; it does not imply that expectancy biases will persist regardless of context. If an anxiety-linked tendency to show a more negative expectancy bias (relative to non-anxious individuals) is found, but it is moderated by the valence of previously presented information, this would refute the validity of the Pervasive-EBH. The Expectancy Task allows us to test two such hypotheses.

The Extrapolation Expectancy Bias Hypothesis (Extrapolation-EBH) suggests that the anxiety-linked elevation in expectations of negative future events is moderated by the (negative or positive) valence of previously presented information. Thus, anxious individuals may expect relatively more negative future events because they exhibit biased extrapolation from current events, relative to non-anxious individuals. For example, anxious individuals may be disproportionately inclined to infer that negative current events will lead to negative future events. Should this be observed, then the degree to which anxious (compared to non-anxious) participants inflate the probability of future negative events will be disproportionately greater when the information they are given indicates that these prior events proceeded in a negative manner.
A third hypothesis, the Emotional Weighting Expectancy Bias Hypothesis (Emotional Weighting-EBH), refers to the possibility that the anxiety-linked expectancy bias is moderated by whether or not previously presented information is unresolved or mixed with respect to valence. It is hypothesized that, following the presentation of both positive and negative previous information, anxious individuals may be more likely than non-anxious individuals to assign more weight to the negative (rather than positive) information, construing the overall event as relatively more negative. Consequently, following the presentation of both positive and negative previous information, anxious individuals may be more likely to expect negative future events to occur. The current research presents participants with conflicting (negative and positive) information in order to test this hypothesis. In summary, the three hypotheses presented here differ in terms of whether an anxiety-linked expectancy bias is moderated by the valence of previously presented information.

Evaluating these hypotheses requires a task that provides information about the manner in which a range of scenarios proceed, and then assesses participants’ expectancies for alternative possible future events that differ in their emotional valence. By manipulating the valence of information initially presented in each scenario, it is possible to investigate the circumstances under which biased expectation for future positive versus negative events will characterize anxious participants.

In the current paper, a paradigm that meets these requirements is used with two anxious samples: the Expectancy Task (Cabeleira, Bucks, Teachman, & MacLeod, 2010). Originally introduced and developed by Cabeleira et al. (2010) and further validated by Steinman, Smyth, Bucks, MacLeod, and Teachman (2013), the Expectancy Task presents participants with information about a range of hypothetical scenarios. The scenarios relate to physical or social events, which may be processed differently by people with different types and levels of anxiety. Most importantly, the scenarios vary
in valence, and can be negative (including only negative and neutral events), positive (including only positive and neutral events), or conflicting in valence (including an equal number of positive and negative events). After reading and imagining themselves in the scenarios, participants are required to rate the likelihood of three future events occurring next, which can be negative, positive, or neutral in valence, on a scale of 1 (“very unlikely to happen next”) to 4 (“very likely to happen next”). These ratings reveal anxiety-related bias in the relative tendency to expect positive versus negative future events. By examining whether such expectancy bias is influenced by the valence of the information provided in the initial scenarios, the three anxiety-linked expectancy bias hypotheses described above can be tested.

In summary, the current studies have two key aims: 1) to determine whether anxious individuals (HTA in Study 1, HAS in Study 2) show an inflated tendency to anticipate relatively more negative future events relative to non-anxious individuals, which we term an anxiety-linked negative expectancy bias; and 2) to test the three hypotheses described above by evaluating whether such a bias is moderated by the valence of previous events.

**Study 1**

**Method**

**Participants**

Thirty-two first year psychology undergraduates from the University of Western Australia were recruited based on their score on the Trait form of the State-Trait Anxiety Inventory (STAI-T; Spielberger, 1983). The mean trait anxiety score for college students (Spielberger) was used to determine cut-off scores for inclusion in HTA and LTA groups. To be included in the HTA group, participants had to score at least one standard deviation (SD = 9.67) above this mean trait anxiety score (M = 39.35) for college students, thus scoring 50 or above on the STAI-T. To be included in
the LTA group, participants had to score at least one standard deviation below this mean trait anxiety score for college students, thus scoring 29 or below on the STAI-T. There were 16 LTA participants (50% female), and 16 HTA participants (50% female). The mean age of the sample was 17.6 years (SD = 1.16; range 17–22 years), and race was reported as: 68.8% White, 21.9% Asian, 6.3% African, and 3.1% “other.” The University of Western Australia’s Human Research Ethics Committee (HREC) approved this study.

**Materials**

Anxiety symptoms.

The 20-item STAI (Spielberger, 1983) includes one scale to assess state anxiety (STAI-S) and one scale to assess dispositional trait anxiety (STAI-T). The reliability (Barnes, Harp, & Jung, 2002) and validity (Spielberger) of the scales are well established, and Cronbach’s alpha was .96 for the STAI-T and .91 for the STAI-S in the current study.

Expectancy Task.

The Expectancy Task (Cabeleira et al., 2010) is a computerized reading judgment task designed to evaluate an individual’s tendency to anticipate positive or negative events to occur (labeled ‘expectancy bias’). The Expectancy Task involves presenting 64 scenarios (in 16 blocks of four) that vary in the extent to which positive, neutral, or negative events occur, then asking participants to judge the likelihood of future valenced events occurring in each of these scenarios. The Expectancy Task includes a Scenario Presentation Component and an Expectancy Rating Component.

In the Scenario Presentation Component, participants were asked to read and imagine themselves in a number of scenarios, each described by six statements: a Title, an Orienting Sentence, and four events (see Appendix for examples). The Title

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4 Additional self-report measures were used in this study and are reported elsewhere. For a complete list of measures, please contact Cindy M. Cabeleira.
remained in the center of the computer screen for the duration of the scenario presentation, while the other five statements appeared directly below the Title, and each remained on the screen only until the participant pressed the spacebar, signaling that he or she had read the statement and was ready for the next statement to be shown. The four events in a scenario could be shown in any of three Passage Valence Conditions. In the Positive Valence condition, two positive and two neutral events were presented. In the Negative Valence condition, two negative and two neutral events were presented. In the Conflicting Valence condition, two negative and two positive events were presented. The neutral events were included to control for amount of information presented in each combination (i.e., such that each scenario consistently included four events, and each valence was consistently represented by two events). Order of valenced events (e.g., positive versus neutral) within a scenario was counterbalanced. A graphical depiction of the Scenario Presentation Component of the Expectancy Task is presented in Figure 1, which provides an illustrative example using a scenario relating to physical concerns delivered in the Conflicting Valence condition.

In the Expectancy Rating Component of the task, participants were asked to think about the likelihood of different specified candidate future events for each of the scenarios they had previously read and imagined themselves in. On each trial, participants read the Title and Orienting Sentence from one of the previously seen scenarios (and the four events previously presented as part of that scenario were represented as lines of stars below the orienting sentence), which remained on screen while participants were asked to rate their beliefs concerning the likelihood that each of the three specific events would happen to them within the scenario they imagined themselves experiencing. These candidate future events included one positive event, one negative event, and one neutral event, presented in a random order. These three candidate future events were displayed in the middle of the screen and participants were
instructed to use a scale ranging from 1 (“very unlikely to happen next”) to 4 (“very likely to happen next”) to rate the subjective likelihood of each event. A graphical depiction of the Expectancy Rating Component of the Expectancy Task is presented in Figure 2, which provides an illustrative example using a scenario relating to physical concerns delivered in the Conflicting Valence condition. Scenarios were presented in blocks of four so that the load on memory would be minimal, with each block being followed by the expectancy ratings for the future events for the four scenarios. In total, 16 blocks of four scenarios were presented in this manner, totaling 64 scenarios.

Scenario event sets. Each of the 64 scenarios presented in the study was derived from its own Scenario Event Set. Each Scenario Event Set represented a hypothetical scenario related to either a physical or social concern, and included 11 items: a Title, an Orienting Sentence, and nine candidate events. Of the nine candidate events, three were positive, three were negative, and three were neutral (see Appendix). The four events actually presented in the Expectancy Task for any scenario were selected from its Scenario Event Set, in a manner that took account of the Passage Valence Condition for that scenario. Two of the three events of each valence to be presented in the scenario were randomly selected for display in the Scenario Presentation Component of the task, while the third event of each valence was shown in the Expectancy Rating Component of the task. All Scenario Event Sets were previously validated by an independent sample of 16 raters (see Cabeleira, 2010). Specifically, all Scenario Event Sets used in the current study were judged to be relevant to either physical or social concerns, and valenced ratings for events were consistent with the intended valence of each event (i.e., positive, negative, or neutral). Additionally, the positive and negative events were rated to have equivalent valence intensity.

Procedure
Participants were informed that the experiment was designed to illuminate how people differ in terms of their understandings of hypothetical scenarios. Participants began the session by completing the STAI-S. Participants then completed eight practice scenarios of the Expectancy Task, followed by the full Expectancy Task. At the end of the session, participants received course credit for their participation and were debriefed.

Results

Descriptive Statistics.

Chi-square tests revealed that the LTA and HTA groups did not differ by gender ($\chi^2 = .00, p = 1.000$) or race ($\chi^2 = 4.06, p = .541$), and an independent samples t-test demonstrated there was no significant difference between the LTA and HTA groups in terms of age ($t(30) = .91, p = .37, d = 0.32$). An independent samples t-test was used to compare both trait and state anxiety scores at baseline between groups (LTA vs. HTA). As expected, this revealed a significant group difference in trait anxiety, $t(30) = 27.79, p < .001, d = 9.82$, such that HTA participants reported higher trait anxiety than LTA participants. Unsurprisingly, a significant group difference was also observed for state anxiety, $t(30) = 5.16, p < .001, d = 1.82$, such that HTA participants reported higher state anxiety than LTA participants. Descriptive statistics for age, trait and state anxiety scores for each anxiety group are presented in Table 1.

Evidence for Expectancy Effects.$^5$

The Expectancy Task was scored by subtracting participants’ average likelihood ratings for negative future events from their average likelihood ratings for positive future events to yield an expectancy bias index. The decision to create this relative, rather than absolute, bias index derived from a desire to simultaneously...
consider the valuing of positive and negative choices, given the external validity of needing to weigh multiple options simultaneously when predicting the future. A score of zero on this index would indicate that there was no difference between participants’ ratings for the likelihood of negative and positive future events. A score on this index that is greater for participant A than for participant B would indicate that the former participant exhibited a relatively greater tendency to expect positive events, while the latter participant demonstrated a relatively greater tendency to expect negative events. A summary of the mean probability ratings for negative and positive future event statements is presented in Table 2, with mean ratings organized by Passage Valence condition (Negative Valence, Positive Valence, Conflicting Valence), Scenario domain (Physical, Social), and Anxiety group (LTA, HTA).

A repeated measures analysis of variance (ANOVA) with one between-subjects factor of Anxiety Group (LTA, HTA), and two within-subjects factors of Passage Valence Condition (Positive Valence, Negative Valence, Conflicting Valence) and Scenario Domain (Physical, Social), was conducted to examine whether an anxiety-linked difference in negative expectancy bias was evident, and, if so, under which experimental conditions it was observed. The results of the ANOVA revealed a significant main effect of Anxiety Group ($F(1, 30) = 22.71, p < .001, \eta^2_p = .43$), reflecting the anticipated lower positive expectancy bias index scores for the HTA group ($M = 0.86, SD = 0.44$) compared to the LTA group ($M = 1.01, SD = 0.64$).

There was also a main effect of Passage Valence Condition ($F(2, 29) = 22.74, p < .001, \eta^2_p = .61$). Follow-up analyses showed that ratings of future events differed significantly across the three passage valence types in the expected direction (all $p < .001$), such that Negative Valence passages ($M = -0.01, SD = 1.14$) yielded a relatively less positive expectancy index compared to the Conflicting Valence passages ($M = 0.50, SD = 0.73$), which in turn yielded a less positive expectancy index relative to the
Positive Valence passages ($M = 1.16$, $SD = 0.68$). This suggests that the Expectancy Task is sufficiently sensitive to show expectancies are influenced by the valence of prior information.

Importantly, there was a significant 2-way interaction between Anxiety Group and Passage Valence Condition ($F(2, 29) = 6.46$, $p = .005$, $\eta^2_p = .31$). This was further embedded in a significant 3-way interaction of Anxiety Group, Passage Valence Condition, and Scenario Domain ($F(2, 29) = 3.92$, $p = .031$, $\eta^2_p = .21$; see Figure 3). No other significant effects emerged from this analysis. To understand the 3-way interaction, between group differences in the expectancy rating data were analyzed separately for each Scenario Domain.

For scenarios related to physical concerns, there was a main effect of Anxiety Group ($F(1, 17.19) = 19.94$, $p < .001$, $\eta^2_p = .40$), such that HTA individuals had a less positive expectancy bias relative to LTA individuals (HTA $M = 0.13$, $SD = 0.42$; LTA $M = 0.98$, $SD = 0.63$). No significant 2-way interaction of Passage Valence Condition and Anxiety Group ($F(2, 29) = 2.14$, $p = .137$, $\eta^2_p = .13$) was observed. In other words, both HTA and LTA individuals’ expectancies were similarly affected by the valence of initial scenarios, indicating that extrapolation from valence of initial events did not vary by anxiety group, though the HTA group expected relatively less positive future events in general.

For scenarios related to social concerns, there was a main effect of Anxiety Group ($F(1, 24.13) = 20.88$, $p < .001$, $\eta^2_p = .41$), that was subsumed by a significant 2-way interaction of Passage Valence Condition and Anxiety Group ($F(2, 29) = 11.73$, $p < .001$, $\eta^2_p = .45$). Independent samples t-tests were conducted to compare the Anxiety Groups’ expectancy index ratings for each Passage Valence type for the social scenarios. Results revealed that HTA participants showed less positive expectancy bias than LTA participants when scenarios were initially presented in the Negative Valence
Anxiety-linked Bias in Negative Expectancy

condition ($t(30) = 5.96, p < .001, d = 2.11$; HTA $M = -0.98, SD = 0.67$, LTA $M = 0.84, SD = 1.02$), or in the Conflicting Valence condition ($t(30) = 4.38, p < .001, d = 1.55$; HTA $M = 0.00, SD = 0.57$, LTA $M = 0.97, SD = 0.68$). There was no significant Anxiety Group difference in expectancy bias scores when scenarios were initially presented in the Positive Valence condition ($t(30) = 0.79, p = .435; HTA M = 1.09, SD = 0.85$, LTA $M = 1.32, SD = 0.77$), with both groups similarly rating positive future events as more likely to occur than negative future events. Thus, whenever the initial social scenario contained negative events (i.e., in both the Negative Valence and Conflicting Valence conditions), the HTA participants showed lower expectancy bias for future positive events, compared to the LTA participants. However, this was not the case when the initial scenario did not contain negative events (i.e., in the Positive Valence condition).

To further understand the significant 3-way interaction of Anxiety Group, Passage Valence Condition, and Scenario Domain, within anxiety group differences were examined next. For the LTA group, there was the expected main effect of Passage Valence Condition ($F(1.43, 21.44) = 4.94, p = .026, \eta_p^2 = .25$). Least Significant Difference (LSD) comparisons revealed relatively greater positive expectancy when the preceding information was Positive ($M = 1.34, SD = .65$) relative to that containing negative information (i.e. Negative $M = 0.77, SD = .99; p = .031$, and Conflicting Valence passages $M = 0.92, SD = .62; p = .012$, respectively). There was no significant difference between the observed positive expectancy when preceding information was of a Negative Valence compared to a Conflicting Valence ($p = .370$). There was no significant 2-way Passage Valence Condition by Scenario domain interaction ($F(2, 30) = 0.53, p = .592, \eta_p^2 = .03$). Notably, the absolute value of the expectancy bias was positive across all three Passage Valence Conditions (i.e., t-tests indicated the bias value was significantly greater than zero; all $p < .05$).
For the HTA group, there was again a main effect of Passage Valence Condition ($F(2, 30) = 39.67$, $p = .000$, $\eta^2_p = .73$), which was subsumed by a significant 2-way Passage Valence Condition by Scenario domain interaction ($F(2, 30) = 5.95$, $p = .007$, $\eta^2_p = .28$). For social scenarios, LSD comparisons revealed relatively greater positive expectancy when the preceding information was of a Positive Valence ($M = 1.09$, $SD = .85$) compared to Conflicting Valence ($M = 0.00$, $SD = .57$; $p < .001$), which in turn resulted in greater positive expectancy than when the preceding information was of a Negative Valence ($M = -0.98$, $SD = .67$; $p < .001$). Further, the HTA group displayed a relatively negative expectancy bias (i.e., less than zero) in social scenarios when the preceding information was of a Negative Valence, ($t(15) = 5.83$, $p < .001$, $d = 1.46$), no expectancy bias (i.e., bias is not significantly different from zero, $t(15) = 0.00$, $p = 1.000$) when preceding information was of a Conflicting Valence (i.e., contains negative and positive information), and a positive expectancy bias when preceding information was of a Positive Valence ($t(15) = 5.15$, $p < .001$, $d = 1.28$).

For physical scenarios, LSD comparisons revealed a more positive expectancy bias when the preceding information was of a Positive Valence ($M = 0.85$, $SD = .65$), rather than being of a Conflicting Valence ($M = 0.14$, $SD = .67$; $p = .004$), which in turn resulted in greater positive expectancy than when the preceding information was of a Negative Valence ($M = -0.59$, $SD = .70$; $p = .002$). Further, participants displayed a negative expectancy bias in physical scenarios when the preceding information was of a Negative Valence, ($t(15) = 3.37$, $p = .004$, $d = 0.84$) and no expectancy bias was observed when preceding information was of a Conflicting Valence (i.e., contains negative and positive information; $t(15) = 0.84$, $p = .416$), and a positive expectancy bias when preceding information was of a Positive Valence ($t(15) = 5.27$, $p < .001$, $d = 1.31$).
Taken together, these results confirm the presence of an anxiety-linked expectancy bias. Interestingly, when examining the between-group effects, the cognitive mechanisms underpinning this anxiety-linked negative expectancy bias appear to differ for scenarios relating to physical concerns versus social concerns. With respect to physical scenarios, there was no evidence that valence of the prior information provided in the scenarios affected the magnitude of this anxiety-linked effect, thus providing no basis for refuting the Pervasive-EBH. With respect to social concerns, the HTA participants displayed a more negative/less positive expectancy bias only when negative events had already initially occurred within these scenarios. These results for the HTA participants appear attributable to greater (negative) extrapolation from previous negative events, consistent with the Extrapolation-EBH. When examining the within-group effects, the LTA were pervasively more positive in their expectations of future events, while the expectancies of the HTA group were more consistent with the valence of previously presented information.

**Discussion**

This study had two aims: 1) to determine whether HTA individuals do indeed show an inflated tendency to expect negative future events relative to LTA individuals, and 2) to investigate whether such an anxiety-linked bias is moderated by the emotional tone of previously presented information. The findings confirmed that, compared to LTA participants, HTA participants showed a more negative/less positive expectancy bias, consistent with previous research (e.g., Miranda & Mennin, 2007). Furthermore, the present study also sheds light on the nature of this bias, revealing that it differs between high and low anxiety groups depending on the type of concerns (physical or social) depicted in events.

In scenarios relating to physical concerns, the observed anxiety-linked expectancy bias was not moderated by the emotional tone of previous events. Of course
the absence of an interaction here cannot be interpreted as absolute evidence for the Pervasive-EBH, given that a conclusion cannot be sustained on the basis of confirming predicted null results. Perhaps with greater power (e.g., a larger sample size), valence may have moderated the anxiety-linked expectancy bias in physical scenarios, and there are of course numerous other factors not investigated here that could have moderated the anxiety-linked effect. Notwithstanding, with respect to the factors investigated here, the Pervasive-EBH appears to most parsimoniously accommodate the results.

When participants were required to judge the likelihood of future events in scenarios related to social concerns, the anxious participants only demonstrated a more negative/less positive expectancy bias than non-anxious participants when negative events had already occurred within the initial description of these scenarios (i.e., in the Negative Valence and Conflicting Valence conditions). This pattern of results is consistent with greater negative extrapolation, whereby anxious individuals showed an elevated tendency to infer that future events will continue to be negative when previous events have been negative (matching the Extrapolation-EBH).

These different findings for the physical versus social scenarios were unexpected. As mentioned earlier, sample sizes were small in this study, thus limiting power to detect significant effects. It is possible that a pattern of results consistent with the Extrapolation-EBH may have occurred for the physical scenarios if the study was conducted with a larger sample. Another challenge in interpreting this difference is that social concerns may be more personally relevant for this sample of young, HTA individuals than physical concerns, given the automatic “attention-grabbing power of negative social information” (Pratto & John, 1991, p. 380). Thus, perhaps these individuals were more likely to make greater use of previously presented, valenced information in forming their future expectations about socially related matters.
In terms of the within anxiety group effects observed, the LTA appeared to have a pervasively positive expectancy bias regardless of scenario type (i.e., physical or social) or prior valence (though degree of positivity clearly differed by prior valence), while the expectancies of the HTA were more consistent with the valence of preceding information (i.e., positive bias in Positive Valence passages, negative bias in Negative Valence passages, and no significant bias in Conflicting Valence passages) for scenarios relating to both social and physical concerns.

To address issues of power and relevance of scenario concerns, and replicate and extend the findings of Study 1, Study 2 uses a much larger, alternate anxious sample for which physical concerns tend to be more personally relevant.

**Study 2**

While the presence of an expectancy bias in trait anxious samples has been previously explored, it is unclear whether this phenomenon is consistent across different types of anxious samples, or if anxiety subtypes differ in their expectancies and the conditions under which negative expectancy biases arise. Anxiety sensitivity involves the fear of anxiety-related symptoms, including various bodily sensations (Cox, Parker, & Swinson, 1996) and the belief that these sensations have negative physical, social, or psychological consequences (Reiss, 1991; Reiss & McNally, 1985). Study 2 aims to explore if an anxiety-linked expectancy bias in scenarios relating to physical concerns will once again not be moderated by the valence of previous events and linked to a Pervasive Expectancy Bias (in line with the Study 1 findings), or whether an Extrapolation Expectancy Bias will emerge (akin to findings for the social scenarios in Study 1). Given high anxiety sensitive (HAS) individuals are known to have concerns about the physical consequences of anxiety, the physical scenarios may be more relevant than they were for the HTA group in Study 1. No research to the authors’ knowledge has investigated expectancy bias in HAS individuals in a manner that can
test whether results are consistent with a Pervasive-EBH, Extrapolation-EBH, or Emotional Weighting-EBH account.

In Study 2, the Expectancy Task was used with low anxiety sensitive (LAS) and HAS samples. Only scenarios related to physical events (e.g., going to the doctor, or exercising) were included in this version of the Expectancy task given our interest in better understanding the nature of expectancies for this material in a sample known to have concerns about physical sensations (Clark, 1986). Note that the scenarios included did not all perfectly align with fears of bodily sensations. Rather, the scenarios included a broad range of physical concerns. Given the relationship between health anxiety and anxiety sensitivity (e.g., Wheaton, Berman, & Abramowitz, 2010), it is probable that many of the scenarios were personally relevant for participants with HAS, and we wanted to sample the physical domain broadly. Of note, we used a much larger sample in Study 2, which addresses power concerns in Study 1.

Additionally, in Study 2, we consider another potential moderator of expectancies – the role of priming concerns tied to the physical scenarios to make those concerns salient before forming expectancies. The inclusion of this moderator follows mixed results in the field about the role of such primes in the expression of cognitive biases in anxious samples. For instance, priming concerns related to specific fears have led to enhancement of recall biases in a spider-fearful sample (e.g., Smith-Janik & Teachman, 2008), but also reduction of attention biases in a snake-fearful sample (e.g., Mathews & Sebastian, 1993). On the contrary, priming concerns related to specific fears had no effect on memory biases in another spider phobic sample (see Study 1 in Watts & Dalgeish, 1991). Thus, we are interested in how an analogous prime tied to physical concerns will alter the expression of expectancy bias. It is hypothesized that priming physical concerns will increase state anxiety for the HAS group, but not the LAS group. In response to this prime, it is tentatively hypothesized that the difference in expectancy
bias between LAS and HAS individuals will be magnified following priming of physical concerns because the prime will make those concerns salient, but given prior mixed results, this evaluation is somewhat exploratory.

Finally, to test whether expectancy bias is related to markers of anxiety beyond only questionnaire measures of anxious symptoms, a measure of anxiety experienced during an anxiety sensitivity-relevant stressor was included. It is predicted that expectancy bias will be related to anxiety experienced during an anxiety-relevant trigger, speaking to the predictive validity of expectancy bias.

Method

Participants

Participants were recruited through the University of Virginia’s psychology department participant pool, based on their responses to the Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & McNally, 1986). Students who scored 14 or below on the total ASI (so they were at least .5 standard deviations below ASI college student norms; Peterson & Reiss, 1992) were invited to participate in the LAS group. Students who scored 23 or greater on the total ASI (so they were at least .5 standard deviations above ASI college students norms; Peterson & Reiss) were invited to participate in the HAS group. One hundred and thirty-nine students participated in the study. One participant was excluded from analyses, due to being an outlier in age (8.16 years above the rest of the sample’s mean). Sixty-eight LAS students (63.2% female) and 70 HAS students (65.7% female) were included in analyses. The mean age was 18.84 (SD = .93, range = 17 – 22 years). Seventy-one percent of participants reported their race as White, 14.5% as Asian, 8.0% as Black/African American, 5.1% as Bi- or multiracial, and 1.4%
as “other.” The University of Virginia’s Institutional Review Board (IRB) approved this study.

Materials.\(^7\)

**Anxiety symptoms.**

The Anxiety Sensitivity Index (ASI; Reiss et al., 1986) is a 16-item questionnaire that measures an individual’s concern over symptoms associated with anxiety (e.g., “It scares me when my heart beats rapidly”). The ASI has good reliability and validity (Peterson & Reiss, 1993), and includes items relevant to physical, social, and mental incapacitation concerns. Cronbach’s alpha for the ASI was .95 in the current study.

The Positive and Negative Affect Schedule-Fear Subscale (PANAS-FS; Watson & Clark, 1994) is a widely used self-report measure of affect based on adjective ratings. The PANAS has good reliability and validity (Watson & Clark). In the current study, only the 6-item fear subscale was administered to determine if the physical sensations prime affected state fear. Across administrations, the average Cronbach’s alpha was .82 (range = .74 - .87).

**Physical Sensation Prime Manipulation.**

Participants were randomly assigned to either a physical sensation Prime or No Prime condition to test the impact of a prime on the expression of expectancies. To prime physical sensations relevant to anxiety (and, in turn, presumably alter state fear for the HAS group), participants in the Prime condition were asked to complete the Candle-Blowing task. This task was derived from the widely used Panic Control Treatment manual (Barlow & Craske, 1994) and has been used in previous studies examining anxiety reactions (e.g., Gordon & Teachman, 2008; Steinman & Teachman, 2010). In the Candle-Blowing task, participants were asked to imagine that their index

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\(^7\) The materials reported are part of a larger study assessing cognitive biases in anxiety sensitivity. For a complete listing of measures, please contact Shari A. Steinman.
finger was a candle that they must blow out repeatedly for 45 seconds. To standardize the tempo of breathing, participants were asked to blow with the beat of a metronome set to 100 beats per minute. Although this task is harmless, it produces temporary physical sensations, such as sweating, numbness, dizziness, hot flashes, and tingling.

In the No Prime condition, participants were asked to work on a Word Search Task, which was related to animals. This task was designed to match the conditions for overall time, but not to prime anxiety-sensitive relevant concerns or alter state fear.

**Expectancy Measure.**

The Expectancy Task (Cabeleira et al., 2010) used in Study 1 was also used in Study 2 to evaluate the tendency to expect relatively positive versus negative future events to occur in the described scenarios. However, this study presented only the 32 scenarios relating to physical concerns (and excluded the 32 scenarios relevant to social concerns). Additionally, given the Expectancy Task was originally developed in Australia, minor modifications were made so that the wording was more prototypical of American English (e.g., “queuing” was changed to “waiting in line”).

**Physical Sensation Stressor.**

To evaluate how expectancy bias is related to anxiety following an anxiety sensitivity-relevant stressor, participants were asked to complete the Straw Breathing task. Note this task was completed after the Expectancy Task by all participants, unlike the Candle-Blowing task, which was a between-subjects manipulation that preceded the Expectancy Task. Similar to the Candle-Blowing task, the Straw Breathing task was derived from the widely used Panic Control Treatment manual (Barlow & Craske, 1994) and has been used in previous studies examining anxiety reactions (e.g., Gordon & Teachman, 2008; Steinman & Teachman, 2010). In the Straw Breathing task, participants were asked to breathe through a thin straw for up to two minutes, while holding their nostrils shut. Similar to the Candle-Blowing task, the straw breathing task
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Anxiety is harmless, but elicits temporary sensations, such as dizziness, suffocation, and lightheadedness. Anxiety was measured by the PANAS-FS by asking participants to indicate how they felt when their anxiety was at its peak during the task.

**Procedure**

Participants were informed that the purpose of the study was to investigate how people decide what happens next after reading short stories. Participants were unaware that they were recruited for the study based on their level of anxiety sensitivity. After informed consent, participants completed a brief demographics form, followed by the PANAS-FS to get a baseline measure of state fear. Next, participants were assigned to the Prime (n = 70) or No Prime (n = 68) condition. The prime conditions were balanced for AS group and for gender. Participants in the Prime condition completed the Candle-Blowing task, while those in the No Prime condition completed the Word Search task. The PANAS-FS was administered after both tasks. Next, all participants completed four practice Expectancy Task scenarios that were unrelated to physical concerns, followed by the full Expectancy Task (and the PANAS-FS). All participants then completed the Straw Breathing physical sensation stressor followed by the PANAS-FS. Next, participants completed a final administration of the PANAS-FS to ensure they did not have residual anxiety at the end of the study. Finally, all participants were fully debriefed.

**Results**

**Descriptive Statistics.**

As predicted, chi-square tests revealed that the LAS and HAS groups did not differ by gender ($\chi^2 = .09, p = .761$) or race ($\chi^2 = 5.77, p = .217$). An independent samples t-test demonstrated there was not a significant difference between the LAS and HAS groups in terms of age ($t(136) = 1.88, p = .063, d = .32$). As expected, the LAS group had significantly lower baseline levels of state anxiety ($M = 6.62, SD = 1.43$)
relative to the HAS group (M = 7.81, SD = 2.52; t(107.87) = 3.42, p = .001, d = .58).
Additionally, as expected, chi-square tests revealed that gender ratio ($\chi^2 = .09, p = .761$)
and race ($\chi^2 = 3.05, p = .550$) did not differ between participants assigned to the Prime
and No Prime conditions. Further, independent samples t-tests revealed that there was
no significant difference between the prime conditions in baseline fear as measured by
the PANAS-FS ($t(135) = .78, p = .439, d = .13$) or age ($t(136) = 1.63, p = .106, d = .28$).
See Table 3 for descriptive statistics separated by Anxiety Group and Prime Condition.

**Effect of Prime Condition on State Fear.**

To evaluate the effect of the physical sensation prime condition on state fear
(measured by the PANAS-FS), a repeated measures ANOVA with two between-
subjects factors: Anxiety Group (LAS, HAS) and Prime Condition (Prime, No Prime),
and one within-subjects factor: Time (Baseline, Post Prime Condition Task), was
conducted. Results indicated a main effect of Time, such that on average, all
participants reported higher levels of state fear following the prime condition task
relative to baseline ($F(1,132) = 5.30, p = .023, \eta_p^2 = .04$). Not surprisingly, there was
also a main effect of Anxiety group, indicating that participants in the HAS group
reported higher levels of state fear than participants in the LAS group ($F(1, 132) =
15.85, p < .001, \eta_p^2 = .11$). Finally, there was the expected significant Time by Anxiety
group by Prime Condition interaction ($F(1, 132) = 5.93, p = .016, \eta_p^2 = .04$).

Follow up tests to understand the interaction showed that, for the LAS group,
there was a main effect of Prime Condition, such that participants in the Prime condition
reported higher state fear than those in the No Prime condition ($F(1, 65) = 5.14, p =
.027, \eta_p^2 = .07$). However, no main or interactive effects with Time emerged (all p >
.10). For the HAS group, there was not a significant main effect of Prime Condition
($F(1, 67) = .38, p = .543, \eta_p^2 = .01$), or Time ($F(1, 67) = 3.81, p = .055, \eta_p^2 = .05$), but
there was the expected significant Time by Prime Condition interaction ($F(1, 67) =
6.50, \( p = .013, \eta_p^2 = .09 \)). As expected, for HAS participants in the No Prime condition, reported state fear was not significantly different at the two time points (\( t(33) = .43, p = .673, d = .07 \)). However, for HAS participants in the Prime condition, reported state fear was significantly higher following the Candle-Blowing task, relative to baseline (\( t(34) = 3.16, p = .003, d = .55 \)). Overall, these results suggest that the Candle Blowing prime increased state fear for the HAS group, but did not change state fear over time for the LAS group, supporting interpretation of the prime as an anxiety sensitivity-relevant stressor.\(^8\) Of note, on average, PANAS-FS scores following the prime condition tasks were low (\( M = 7.49, SD = 2.24, \text{range} = 6-17 \)), suggesting that while the prime increased fear for the HAS group, the prime was somewhat weak.

**Evidence for Expectancy Effects.**\(^9\)

As in Study 1, an expectancy bias index was calculated by subtracting the likelihood of future negative events from the likelihood of future positive events. A summary of the mean probability ratings for negative and positive future event statements is presented in Table 4, with mean ratings organized by Passage Valence condition (Negative Valence, Positive Valence, Conflicting Valence), Anxiety Group (LAS, HAS), and Prime condition (No Prime, Prime). A repeated measures ANOVA with two between-subjects factors: Anxiety Group (LAS, HAS) and Prime Condition (Prime, No Prime), and one within-subjects factor: Passage Valence Condition (Conflicting Valence, Positive Valence, Negative Valence) was conducted.

As in Study 1, the ANOVA revealed a main effect of Anxiety Group (\( F(1,134) = 4.02, p = .047, \eta_p^2 = .03 \)), such that the HAS group had a more negative/less positive

\(^8\) Note that PANAS data were positively skewed, so analyses were re-run with log transformed data. This did not change the pattern of results. Additionally, each group (i.e., LAS No Prime, LAS Prime, HAS No Prime, HAS Prime) had at least one outlier at both time-points (baseline PANAS-FS, and after the Prime condition administration of PANAS-FS) prior to transformation, so it is unlikely that outliers specific to one group are driving effects. Outliers were defined as data points at least 1.5 box lengths outside of interquartile range when looking at boxplots.

\(^9\) Similar to Study 1, an ANOVA revealed that the order of events (e.g., negative-neutral vs. neutral-negative) presented in the Scenario Presentation Component of the task did not influence the ratings made in the Expectancy Rating Component of the task (all \( p > .05 \)). Thus, order of events was not included as a factor in the analyses presented.
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expectancy bias index score ($M = 0.53, SD = 0.43$) than the LAS group ($M = 0.68, SD = 0.44$). Thus, this second study confirmed that anxious (compared to non-anxious) participants demonstrated a lowered relative expectation for positive (vs. negative) future events.\(^\text{10}\) As can be seen in Figure 4, the average expectancy bias score (averaged across the difference passage valence conditions) was significantly different from zero, suggesting a general tendency to expect positive relative to negative future events ($t(137) = 16.18, p < .001, d = 1.38$). However, the tendency to display a positive expectancy bias was lower for HAS participants, relative to LAS participants. Also as in Study 1, there was a main effect of Passage Valence Condition ($F(2,133) = 52.45, p < .001, \eta_p^2 = .44$). Follow-up analyses showed that expectancy bias index scores across the three passage valence types all significantly differed from each other in the anticipated direction (all $p < .001$), with Negative Valence passages ($M = 0.09, SD = 0.77$) yielding a relatively less positive expectancy index compared to Conflicting Valence passages ($M = 0.63, SD = 0.53$), which in turn were less positive than Positive Valence passages ($M = 1.10, SD = 0.71$). These findings replicate Study 1. Notably, there was not a significant Anxiety Group by Passage Valence Condition interaction ($F(2, 133) = .91, p = .406, \eta_p^2 = .01$). Hence, both anxious and non-anxious individuals’ expectations concerning future events were equally affected by the valence of initial events that occurred in each scenario, indicating that extrapolation from the valence of initial events did not vary by anxiety level, though the HAS group expected relatively less positive future events in general. This replicates the pattern of effects shown by HTA participants on these same physical passages in Study 1.

Finally, there were no main or interactive effects of Prime Condition (all $p > .10$), suggesting that prime condition did not affect expectancy. This is consistent with some prior null findings for the effect of anxiety-relevant primes on cognitive expectations.

\(^{10}\) Note that when the outlier due to age is included, this main effect becomes $F(1,135) = 3.40, p = .067, \eta_p^2 = .03$. 
processing biases (e.g., Watts & Dalgeish, 1991), but counter to the expectation that the prime would make the physical concerns salient, enhancing the expression of an expectancy bias.

**Relationship between Expectancy Bias and Response to the Stressor.**

To test whether the expectancy bias is related to in vivo fear responding, a correlation was computed between the expectancy index score and fear in response to the physical sensation stressor (Straw-Breathing). Scores on the PANAS-FS following the physical sensation stressor ranged from 6 to 24, with a mean of 11.69 (SD = 4.36). As expected, results suggested that a less positive expectancy bias is related to greater state fear during the physical sensation stressor, as measured by the PANAS-FS ($r(135) = -.19, p = .023$).

**Discussion**

As was found for HTA individuals in Study 1, participants with HAS also displayed a less positive expectancy bias relative to participants with LAS. Furthermore, replicating the pattern of effects shown on physical scenarios by HTA participants in Study 1, the anxiety-linked expectancy bias observed on these physical scenarios in Study 2 was unaffected by the valence of the preceding events that occurred within these physical scenarios. Although the current study included a larger sample and thus greater power to detect significant effects than Study 1, the replicated absence of an interaction with valence still needs to be interpreted with caution given it relies on a null result. However, Pervasive-EBH remains the most parsimonious account for the obtained results. Given that Study 2 only included physical scenarios, we do not know what type of expectancy bias HAS individuals would have when presented with scenarios relevant to other domains (e.g., social). In retrospect, it would have been ideal to include social scenarios along with physical scenarios in Study 2; however, due to
practical reasons (e.g., added time it took to do candle blowing and straw breathing tasks), we were unable to include the social scenarios in this study.

Further, Study 2 demonstrated a relationship between expectancy bias index scores and fear experienced during a physical sensation stressor. This suggests that expectancy bias is related to actual anxiety experienced in response to a stressor (vs. only a questionnaire measure of trait levels of anxiety sensitivity), and highlights the predictive validity of expectancy bias. Finally, results suggested that priming a physical stressor did not independently or interactively affect expectancy bias. While this is contrary to the hypothesis that the prime would make physical concerns salient, and in turn augment the anxiety-linked expectancy bias, it is consistent with past null findings for the effect of anxiety-relevant primes on processing biases (e.g., Watts & Dalgeish, 1991). Future studies might consider using a stronger prime (that increases state anxiety more than the prime used in the current study) to evaluate if a stronger physical prime would have a significant impact on the anxiety-linked expectancy bias.

**General Discussion**

In this article, we report two studies that use the Expectancy Task, a recently developed paradigm that provides individuals with different forms of valenced information, and then evaluates their tendency to expect positive or negative events to occur in the future. The studies shared two goals: 1) to examine expectancy bias in anxious (HTA and HAS) samples, and 2) to determine the conditions that give rise to expectancy bias. Study 2 had the additional goal of exploring the effect of priming physical sensations on expectancy.

In both Studies 1 and 2, high anxious (both trait anxious and anxiety sensitive) groups showed a more negative/less positive expectancy bias relative to low anxious individuals. In this respect, the results confirm previous evidence of threat expectancy bias in trait anxious participants (e.g., MacLeod et al., 1997; Miranda & Mennin, 2007)
and extend this evidence to anxiety sensitive participants. Additionally, the results suggested a relationship between expectancy bias and various indicators of anxiety, such that a greater negative expectancy bias was associated with higher levels of subjective fear experienced during a stressor. This further supports an association between anxiety and expectancy bias.

An important feature of the Expectancy Task is that it is designed not only to determine if an expectancy bias exists, but also to illuminate possible cognitive underpinnings of this bias by evaluating the experimental conditions that give rise to the bias. In Study 1, for passages related to social concerns, the HTA group only displayed elevated expectancy for negative future events when initial scenarios included negative events, or a mix of negative and positive events. Although speculative, one reason that the negative expectancy bias may diminish in the context of positive social scenarios may be that even HTA individuals likely have more experience with social interactions going well, so this may seem more plausible than a potential physical concern turning out well. Along these lines, it will be interesting in future research to evaluate the expectancy bias in highly socially anxious individuals, given this group may more pervasively expect social interactions to go badly.

In Study 2, which employed only the scenarios related to physical concerns, HAS participants demonstrated heightened expectancy for less positive/more negative future events. This was unaffected by the valence of the information provided concerning the initial events that previously took place in each scenario, and is in line with the Pervasive-EBH. This replicates results from the physical scenarios from Study 1, and is in line with findings reported by Steinman et al. (2013) from an online version of the Expectancy Task given to an unselected sample varying in trait anxiety. Past research has suggested that anxious individuals tend to disqualify, or not learn from, past positive experiences (e.g., Beck, 1976; Heimberg & Becker, 2002), which may
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explain why the HAS group in Study 2 expected negative future events to occur, even following Positive Valence or Conflicting Valence scenarios. Future attempts to manipulate expectancy bias, as is done in cognitive bias modification research (e.g., Mathews & Mackintosh, 2000), can help determine if the bias is causally related to the onset or maintenance of anxiety problems.

It is intriguing that valence moderated the anxiety-linked expectancy bias when scenarios were related to social concerns (in Study 1), but not when events were related to physical concerns (in both Studies 1 and 2). It would be interesting to determine whether HAS individuals also show greater extrapolation from negative events when processing social scenarios. If they do, this would suggest that the tendency for anxious individuals to extrapolate more strongly from prior negative events is more readily observed when these negative events are of a social nature. In contrast, if HAS individuals do not display this pattern of results even when processing social scenarios, this would instead suggest that the mechanisms that underpin negative expectancy bias may differ across anxious samples.

While we have demonstrated that expectancy bias, observed for the physical and social scenarios, differs in groups of participants selected on the basis of their differing levels of anxiety, this does not permit the conclusion that anxiety alone is implicated in the observed effect. Anxiety is correlated with other dimensions of temperament, such as depression and neuroticism (Jylhä & Isometsä, 2006). Therefore it would be valuable to include measures of depression, and perhaps neuroticism, in addition to anxiety, in future studies of this nature, in order to potentially differentiate their respective contribution to observed patterns of expectancy bias. We speculate that the observed expectancy biases are not unique to anxiety alone, given the prominence of a negative future focus (e.g., hopelessness) in other disorders, like depression. However, the specific nature of expectancy biases may differ in anxiety and in depression. For
example, it may be that attenuation of positive expectancies may characterize depression, while amplification of negative expectancies may be more characteristic of anxiety. Delineating the patterns of expectancy associated with each dimension of emotion will be an important objective for future research.

It is important to consider the potential role of response bias in the observed effects. A response bias effect, reflecting an inflated tendency to endorse more extreme negative responses, regardless of actual expectancy, could mimic an expectancy bias in this kind of assessment task. The fact that we obtained different findings for the physical and social scenarios weighs against the plausibility of a response bias account. Moreover, the finding that anxiety-linked expectancy effects were moderated by the valence of previous events precludes a response bias explanation of the present group difference. Nevertheless, it would be prudent for future research to more directly assess for response bias effects. For instance, if negative and positive foil items (reflecting future events that do not plausibly follow from the previously presented scenarios) were included in the Expectancy Task, then negative response bias would be directly revealed by preferential endorsement of the negative foils. Further, to mitigate the impact of such response bias, future investigators may usefully seek to develop methods of assessing expectancy that bypass the need for self-report. For example, it may be possible to infer a higher level of expectancy for certain continuation events on the basis of speeded comprehension latencies to encode such events in a self-paced reading task. More implicit assessment of expectancy bias would also reduce the degree to which observed effects could plausibly be attributed to experimenter demand.

Of note, neither of the present studies found evidence to support the Emotional Weighting-EBH. In other words, in both studies, the anxiety-linked expectancy bias was not found to be the strongest in the Conflicting Valence condition. This finding suggests that anxious individuals’ heightened expectancy for future negative events (relative to
non-anxious individuals) cannot be solely attributed to the conflicting nature of previously presented information and the construed emotional valence of such information. Given the current finding, it seems unlikely that anxious individuals’ less positive expectations of the future would be remediated by only reducing their tendency to misconstrue emotionally contradictory information as predominantly negative in tone. Rather, it may be beneficial for clinicians to directly target anxious clients’ biased patterns of future expectations across both emotionally conflicting and non-conflicting situations, to encourage the development of an increased expectation for positive events and a reduced expectation for negative events.

In Study 1, when observing expectancies within each anxiety group, LTA participants were more positive in their expectancies following positive information alone, compared to negative information alone or information conflicting in emotional valence. However, they tended to have a positive absolute bias (e.g., above zero) in their expectancies across all of these differently valenced conditions, and this was true for both social and physical scenarios. In contrast, the expectancies of HTA participants were more consistent with the valence of previous information, with a positive absolute bias when previous information was positive, a negative bias when previous information was negative, and no expectancy bias (neither positive or negative) when preceding information was of a conflicting valence. In Study 2, both high and low anxiety sensitive participants tended to have a positive absolute expectancy bias across passage valence conditions, highlighting the importance of looking at both relative and absolute bias.

Finally, no effects of priming physical sensations on expectancy bias were found in Study 2. This is consistent with past null findings for effects of anxiety-relevant primes on processing biases (e.g., Watts & Dalgeish, 1991), but inconsistent with other findings suggesting that state anxiety can enhance (MacLeod & Mathews, 1988), or
attenuate (Mathews & Sebastian, 1993) cognitive biases, and contrary to our hypothesis that the prime would highlight physical concerns and magnify the anxiety-linked expectancy bias. Given that the prime findings were null, it is difficult to tease apart whether the lack of effects is meaningful, or due to a methodological issue. One possibility is that the effect of the prime may have simply dissipated quickly, obscuring the opportunity to see its’ effects. Another possibility is that the prime’s effect was not strong enough to affect expectancy bias. Given the mixed findings in the literature about the effects of state anxiety on cognitive biases more broadly, it is clear that more work is needed to determine the relationship between state anxiety and expectancy bias, and the moderators of this relationship.

The current research has some limitations. First, the samples comprised only young adult, college students, which are not representative of the general population. Second, analogue, rather than clinical, samples were used. However, the anxious participants had very high levels of anxiety symptoms, similar to those found in diagnosed samples. Third, as mentioned earlier, depressive symptoms were not assessed in these studies. More focused investigation of depressive symptoms would be helpful in evaluating the unique contribution of depression and anxiety to different forms of expectancy bias.

Fourth, our choice to use a relative strategy to calculate the bias index (i.e., subtracting average ratings of negative future events from average ratings of positive future events) has the advantage of simultaneously accounting for ratings of both positive and negative events, but has the disadvantage that we cannot determine to what extent the observed expectancy biases are driven by an evaluation that positive effects are especially unlikely or that negative effects are especially likely; an interesting question for future research. Similarly, interpretation of within-groups effects (e.g., evaluating whether bias is positive, negative, or does not exist) are somewhat clouded
by our use of a relative strategy to calculate bias, given that we do not have an objective measure of whether the positive and negative events occur equally often (i.e., whether they have, or are perceived to have, comparable base rates). However, several measures were taken to validate the Scenario Event Sets (e.g., ensuring that positive and negative events had equivalent valence intensity; see Cabeleira, 2010), which allows for more confidence in interpreting the results.

Fifth, while it seems unlikely that presenting scenarios in blocks of 4 (before requiring ratings to be made) would place significant demands on memory for younger adults, there was no explicit measure of the role of memory in this task. This leaves open the possibility that memory may influence the results found when using this task. Future research could explore this possibility by varying the number of scenarios presented before the Rating Component of the task. Lastly, it is possible that participants’ perceptions of the frequency with which the candidate future events tend to occur in general (i.e., perceived base rates) might have influenced their responses, separately from their perceptions concerning the likelihood that the candidate events would occur for themselves in particular. It could be interesting, in future research, to ask participants to provide two expectancy ratings: how likely each event is to occur to others, and how likely each event is to occur to oneself.

Despite these limitations, these studies provide valuable new information about anxiety-linked expectancy bias, revealed through the recently developed Expectancy Task. The results confirm that anxious individuals do display a less positive/more negative expectancy bias. Furthermore, they demonstrate that the conditions that give rise to this bias may differ depending upon the type of information being processed, with the inflated expectation of future negative social events reflecting a heightened tendency to extrapolate from present negative social events, while the inflated expectation of future negative physical events occurred regardless of the valence of
prior information. A better understanding of the cognitive conditions that give rise to
the negative expectancy bias shown by anxious individuals may not only shed light on
why they ‘expect the worst,’ but could also identify the processes that can be targeted
therapeutically to attenuate such expectations.
Acknowledgments

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Table 1

Study 1: Descriptive statistics for low and high trait anxious groups.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Low Trait Anxious (LTA)</th>
<th>High Trait Anxious (HTA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>M±SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>17.75±1.39</td>
<td>17.38±0.89</td>
</tr>
<tr>
<td>STAI-T</td>
<td>25.88±2.63</td>
<td>54.81±3.23</td>
</tr>
<tr>
<td>STAI-S</td>
<td>27.19±5.86</td>
<td>40.06±8.08</td>
</tr>
</tbody>
</table>

Note. STAI-T = State-Trait Anxiety Inventory – Trait Score
       STAI-S = State-Trait Anxiety Inventory – State Score
Table 2

Study 1: Summary of mean probability ratings for negative and positive future event statements, with mean ratings organized by Passage valence condition (Negative Valence, Positive Valence, Conflicting Valence), Scenario domain (Physical, Social) and Anxiety group (LTA, HTA).

<table>
<thead>
<tr>
<th>Passage Valence</th>
<th>Future Valence</th>
<th>Low Trait Anxious (LTA) n =16</th>
<th>High Trait Anxious (HTA) n =16</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Social scenarios M±SD</td>
<td>Physical scenarios M±SD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Social scenarios M±SD</td>
<td>Physical scenarios M±SD</td>
</tr>
<tr>
<td>Negative</td>
<td>Negative</td>
<td>2.1±0.6</td>
<td>2.2±0.8</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>2.9±0.5</td>
<td>2.9±0.5</td>
</tr>
<tr>
<td>Positive</td>
<td>Negative</td>
<td>1.8±0.5</td>
<td>1.9±0.5</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>3.1±0.4</td>
<td>3.2±0.5</td>
</tr>
<tr>
<td>Conflicting</td>
<td>Negative</td>
<td>2.0±0.5</td>
<td>2.1±0.4</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>3.0±0.4</td>
<td>2.9±0.4</td>
</tr>
</tbody>
</table>
### Table 3

**Study 2: Descriptive statistics for No prime and Prime conditions in low and high anxiety sensitive groups.**

<table>
<thead>
<tr>
<th>Measures</th>
<th>Low Anxiety Sensitive (LAS)</th>
<th>High Anxiety Sensitive (HAS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 68</td>
<td>n = 70</td>
</tr>
<tr>
<td>No Prime Condition</td>
<td>Prime Condition</td>
<td>No Prime Condition</td>
</tr>
<tr>
<td>n = 33</td>
<td>n = 35</td>
<td>n = 35</td>
</tr>
<tr>
<td>M±SD</td>
<td>M±SD</td>
<td>M±SD</td>
</tr>
<tr>
<td>Age</td>
<td>18.82±0.98</td>
<td>18.57±0.78</td>
</tr>
<tr>
<td>ASI</td>
<td>7.44±3.64</td>
<td>7.71±3.32</td>
</tr>
<tr>
<td>PANAS-FS</td>
<td>6.24±.66</td>
<td>6.97±1.82</td>
</tr>
</tbody>
</table>

Note. ASI = Anxiety Sensitivity Index  
PANAS-FS = Positive and Negative Affect Schedule – Fear Subscale (Baseline)
Table 4

Study 2: Summary of mean probability ratings for negative and positive future event statements, with mean ratings organized by Passage valence condition (Negative Valence, Positive Valence, Conflicting Valence), Anxiety group (LAS, HAS), and Prime condition (No Prime, Prime).

<table>
<thead>
<tr>
<th>Passage Valence</th>
<th>Future Valence</th>
<th>Low Anxiety Sensitive (LAS)</th>
<th>High Anxiety Sensitive (HAS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No Prime M±SD n = 33</td>
<td>No Prime M±SD n = 35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prime M±SD n = 35</td>
<td>Prime M±SD n = 35</td>
</tr>
<tr>
<td>Negative Valence</td>
<td>Negative</td>
<td>2.3±0.6</td>
<td>2.4±0.5</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>2.6±0.5</td>
<td>2.5±0.5</td>
</tr>
<tr>
<td>Positive Valence</td>
<td>Negative</td>
<td>1.8±0.4</td>
<td>1.9±0.5</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>3.1±0.5</td>
<td>3.0±0.4</td>
</tr>
<tr>
<td>Conflicting Valence</td>
<td>Negative</td>
<td>2.1±0.5</td>
<td>2.3±0.4</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>2.9±0.3</td>
<td>2.8±0.4</td>
</tr>
</tbody>
</table>
You find out you need a biopsy done.
Figure 1. A graphical depiction of the Scenario Presentation Component of the Expectancy Task which provides an illustrative example using a scenario relating to physical concerns delivered in the Conflicting Valence condition. (Minor visual modifications were made in Study 2.)
Figure 2. A graphical depiction of the Expectancy Rating Component of the Expectancy Task which provides an illustrative example using a scenario relating to physical concerns delivered in the Conflicting Valence condition. (Note that the word “RATING” moves to subsequent statements once a rating has been entered. Minor visual modifications were made in Study 2.)
Figure 3. Study 1: Expectancy bias by scenario type, valence condition, and level of trait anxiety.

Note. Expectancy bias was scored by subtracting average ratings of negative future events from average ratings of positive future events, so higher scores indicate a more positive bias.
Figure 4. Study 2: Expectancy bias by valence condition and level of anxiety sensitivity. Note. Expectancy bias was scored by subtracting average ratings of negative future events from average ratings of positive future events, so higher scores indicate a more positive bias.
Appendix

Example of a Scenario Event Set:

**Title:** Going to the Doctor

**Orienting Sentence:** You go to the doctor’s rooms

**Negative:** You find out you need a biopsy done

**Negative:** The doctor prescribes you medication that can have bad side effects

**Negative:** The doctor warns you all your family is at risk of diabetes

**Positive:** The doctor says your heart sounds very healthy

**Positive:** The doctor informs you that you are at a healthy weight

**Positive:** The doctor says she is happy with your exercise regime

**Neutral:** A bird flies past the window

**Neutral:** The telephone rings

**Neutral:** You notice a car drive by outside

Sample scenarios of different valence types based on above Scenario Event Set:

1. Positive Valence

**Title:** Going to the Doctor

**Orienting Sentence:** You go to the doctor’s rooms

**Positive:** The doctor informs you that you are at a healthy weight

**Positive:** The doctor says she is happy with your exercise regime

**Neutral:** A bird flies past the window

**Neutral:** You notice a car drive by outside
2. Negative Valence

**Title:** Going to the Doctor

**Orienting Sentence:** You go to the doctor’s rooms

**Negative:** You find out you need a biopsy done

**Negative:** The doctor prescribes you medication that can have bad side effects

**Neutral:** A bird flies past the window

**Neutral:** You notice a car drive by outside

3. Conflicting Valence

**Title:** Going to the Doctor

**Orienting Sentence:** You go to the doctor’s rooms

**Negative:** You find out you need a biopsy done

**Negative:** The doctor prescribes you medication that can have bad side effects

**Positive:** The doctor informs you that you are at a healthy weight

**Positive:** The doctor says she is happy with your exercise regime

Example of an Expectancy Rating Trial:

**Title:** Going to the Doctor

**Orienting Sentence:** You go to the doctor’s rooms

How likely is it that…

**Negative:** The doctor warns you all your family is at risk of diabetes

**Positive:** The doctor says your heart sounds very healthy

**Neutral:** The telephone rings
Appendix 2

“This task will be done on the computer and is made up of two parts. For the first part you will be asked to read a passage about a hypothetical scenario or situation. Try to imagine yourself in that scenario. After reading the scenario you will go on to rate the likelihood that 3 given statements would occur in the scenario you read”.

“Don’t worry if this seems complicated, it is actually quite straightforward and you will get the chance to do a practice session shortly”. If the person is worried about using the computer, say: “Don’t worry, it is a fairly simple task, and you don’t need to know anything about computers to do it well”.

“Throughout the task press the spacebar (show them the spacebar) once you have finished reading a sentence and would like the next sentence to appear. Whenever the next sentence appears, the sentence that you have just read will become a line of crosses. Any questions so far? Then we are going to do the practice”.

Explain the first trial: “Press spacebar to get the title. This is the title. Press spacebar to get the sentence describing the scenario. Then press spacebar for the next sentence. There are five sentences in each scenario; each sentence describes the next event that occurs in the scenario. Try to imagine yourself in this scenario, experiencing the sequence of events described. Keep reading the sentences, pressing the spacebar to bring up the sentence describing the next event. Keep going…”

Explain the rating: “Now the title of the scenario you have read appears at the top of the screen along with the sentence describing that scenario. The lines with crosses represent the occurrences in that scenario that you read about. Below this, in the middle of the screen, there will be three new sentences describing an event that might happen next. Although we know that you can’t be sure what would happen next, and that there are no right and wrong answers, we would like you to judge the likelihood of each of
the events occurring next, given that all this (point to crosses) has already happened in the scenario that was described earlier”.

“You’ll see at the bottom of the screen that a score of 1 indicates this statement is very unlikely to happen next, 2 indicates it is somewhat unlikely to happen next, 3 indicates it is somewhat likely to happen next and 4 indicates it is very likely to happen next. The statement that you are rating is highlighted in yellow. Once you have given this statement a score, by pressing either 1, 2, 3, or 4 (point to number keys on keyboard), then the next statement will be highlighted in yellow. Please rate each of the sentences. Keep going until the practice trial is over”.

Make sure the person is answering with the appropriate keys for each part of the task. After the practice: “Great! Any final questions before you begin the real task? You will see that it is exactly like the practice task. It goes on for quite a while, since you have to read a set of statements for a scenario after which you will be required to judge the likelihood of some statements occurring in that scenario you read. This pattern will be repeated at quite a few times. Thank you very much”.
Appendix 3

Expectancy Index Analyses

Negative Expectancy Index, Emotional Extrapolation Index and Negative Extrapolation Index scores were each subjected to a mixed design, 2 x 2 x 2 ANOVA. The between-groups factors were Trait Anxiety Group (Low trait anxious, High trait anxious), and Age Group (Younger, Older). The within-group factor was Scenario Domain (Social, Physical).

Negative expectancy index analysis.

The Negative Expectancy Index scores presented in the column third from the right in Table 8 were analysed. This analysis revealed a significant main effect of Scenario Domain, $F(1, 53) = 12.43, p = .001$, $\eta^2_{\text{partial}} = .19$, such that individuals generally showed significantly greater Negative Expectancy Index scores in physical than social scenarios (Physical M = -0.67, SD = .51; Social M = -0.84, SD = .53). Therefore, participants generally showed inflated expectancy for negative relative positive future events to a greater degree in physical than social scenarios.

There was also a significant main effect of Trait Anxiety Group, $F(1, 53) = 8.99, p = .004$, $\eta^2_{\text{partial}} = .15$, such that the high trait anxious showed significantly greater Negative Expectancy Index scores than the low trait anxious (High trait anxious M = -0.57, SD = .50; Low trait anxious M = -0.94, SD = .39). Thus there was evidence of an anxiety-linked bias in negative expectancy on this Index, with the high trait anxious showing greater expectancy for negative than positive future events compared to the low trait anxious.

While there was no significant main effect of Age Group ($p = .160$), the significant main effect of Scenario Domain differed by Age Group in a 2-way interaction of Scenario Domain and Age Group, $F(1, 53) = 3.98, p = .051$, $\eta^2_{\text{partial}} = .07$, which although failed to reach statistical significance, remained a strong trend. On
follow up analyses for this 2-way interaction, there was a significant Age Group difference in Negative Expectancy Index scores for social scenarios $F(1, 56) = 4.47, p = .039, \eta^2_{\text{partial}} = .07$, with younger adults showing significantly greater Negative Expectancy Index scores than older adults (Younger M = -0.71, SD = .60; Older M = -1.00, SD = .36). No significant Age Group difference in Negative Expectancy Index scores for physical scenarios was observed ($p = .520$). Thus there was evidence of an age-linked bias in negative expectancy characterised by age independently ameliorating negative expectancy, which was observed in social and not physical scenarios.

There was no significant 2-way interaction of Trait Anxiety Group and Age Group ($p = .669$), indicating that there was no age-linked bias in negative expectancy characterised by age attenuating an anxiety-linked bias in negative expectancy. No other significant effects resulted from this analysis.

**Emotional extrapolation index analysis.**

No significant effects emerged from the analysis of the Emotional Extrapolation Index scores presented in the column second from the right in Table 9. There was no significant main effect of Trait Anxiety Group ($p = .180$), providing no evidence of an anxiety-linked bias in negative expectancy on this Index. There was no significant main effect of Age Group ($p = .269$), thus revealing no age-linked bias in negative expectancy characterised by age independently ameliorating negative expectancy. Moreover, there was no significant 2-way interaction of Trait Anxiety Group and Age Group ($p = .386$) to provide evidence of an age-linked bias in negative expectancy characterised by age attenuating an anxiety-linked bias in negative expectancy.

**Negative extrapolation index analysis.**

The analysis of the Negative Extrapolation Index scores presented in the right-most column of Table 8 revealed a strong trend towards a main effect of Scenario Domain, $F(1, 53) = 3.08, p = .085, \eta^2_{\text{partial}} = .06$, such that individuals generally
showed greater Negative Extrapolation Index scores in physical than social scenarios (Physical $M = 0.25$, $SD = .87$; Social $M = -0.09$, $SD = .96$). Therefore, participants generally showed inflated negative relative to positive extrapolation to a greater extent in physical than social scenarios.

There was no significant main effect of Trait Anxiety Group ($p = .981$), indicating that there was no anxiety-linked bias in negative expectancy on this Index.

There was a strong trend towards a main effect of Age Group, $F(1, 53) = 3.02$, $p = .088$, $\eta^{2}_{\text{partial}} = .05$, such that younger adults showed greater Negative Extrapolation Index scores than older adults (Younger $M = 0.21$, $SD = .61$; Older $M = -0.08$, $SD = .60$). Thus, there was some evidence of an age-linked bias in negative expectancy characterised by age independently ameliorating negative expectancy, such that younger adults showed greater negative than positive extrapolation compared to older adults.

There was no significant 2-way interaction of Trait Anxiety Group and Age Group ($p = .167$) to provide evidence of an age-linked bias in negative expectancy characterised by age attenuating an anxiety-linked bias in negative expectancy on this Index.